



Strange Relations

A design inquiry into
infrastructure as topological place.

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ABSTRACT

Infrastructures multiply our connections, mediate our lives, and amplify the range of our effects. To the extent that these bi-directional effects are remote or asynchronous, experienced partially, indirectly, or not at all, I term them *strange relations*. Infrastructure can be interpreted as both corrosive to public space and constitutive of it. We are involved in broad and changing senses of the public. What is a designer to make of this context? Strange relations are a crucial indicator of tensions between the discontinuous, distributed, and networked locales of infrastructure, and design strategies that reflect a Cartesian-Newtonian model of space and isolate form and perceptual effects. *How can the strange relations mediated by infrastructure be drawn into projections of public place?*

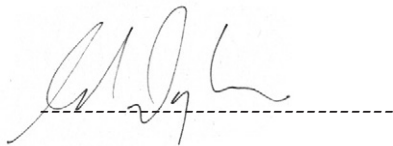
In this practice-led inquiry, I frame infrastructure using topological theories of place, and demonstrate strategies for projecting infrastructural place. My aim is to provide concepts, strategies, and exemplars as a foundation for new hypotheses, to further a line of experimental practice. The research is structured around three *project cycles*, each culminating in a design proposal for Tāmaki Makaurau / Auckland's Māngere Inlet, an arm of the Manukau harbour ringed, reshaped, and adversely affected by infrastructures. These proposals, to be exhibited in February, 2018, exemplify a set of relational strategies intended to extend designers' repertoires by re-situating experience, meaning and aesthetic value in a broader field.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgments), nor material which to a substantial extent has been submitted for the award of any other degree of diploma of a university or other institution of higher learning.

A handwritten signature in black ink, appearing to read 'C. Douglas', is written over a horizontal dashed line.

Carl Douglas

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Ko te wehi ki te Atua

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Soana, ko koe pe hoku ofa'anga. Ofa lahi iate koe.

For Hana, Josiah, and Amos .

1 Introduction Drawing in

1. RESEARCH CONTEXT

The city is inescapable. It has no outside. Where it once made sense to see cities as islands of inhabitation in a sparsely populated wilderness, the distinction between city and wilderness, or urban and rural worlds no longer holds. Urban processes enmesh the entire planet and extend above and below its surface. This does not mean, however, that a single, global space has prevailed. On the contrary, processes of globalisation multiply, partition and layer, and they generate both continuities and discontinuities. Many of these processes are organised *infrastructurally*.

In its first meaning, in French, ‘infrastructure’ designated the supporting works beneath a railway line: the base material, cuttings, bridges, retaining walls, and props that provided a stable substrate for tracks to be laid onto. The term found an increasing range of uses, and has become a general-purpose logic for any organised systems supporting an open-ended range of uses. In the present, we encounter not only transport, energy, and information infrastructures, but also economic, social, and environmental infrastructures. To inhabit the inescapable city is to interact with and be supported by infrastructures on a daily basis: knowingly and unknowingly, directly and indirectly, beneficially and detrimentally, by choice and mandatorily.

Infrastructures multiply our connections and amplify the range of our effects. By means of shipping channels, ports, freight handling facilities and couriers, I am connected to people working in distant factories, whom I will never meet. In buying a new phone, I become implicated in international banking, undersea cables, destructive mining practices, carbon emissions and exploitative labour practices. I will never know about many of the effects I produce, or I will only experience them indirectly through chains of repercussions. These remote or asynchronous effects, experienced partially, indirectly, or not at all, I term *strange relations*. While all human activities could be said to include such relations, they become more and more salient as infrastructures increasingly mediate our lives.

The idea of public places, even the very nature and constitution of publics, is at stake in this infrastructured world. Infrastructure can be interpreted as both corrosive to public space and constitutive of it. In both cases, the discovery of planetary-scale effects like climate change involve me in extraordinarily broad senses of the public. But even in the context of a single urban area, like Tāmaki Makaurau / Auckland, the setting for this thesis, infrastructural logic permeates public space.

2. RESEARCH QUESTION AND CONTRIBUTION

What is a designer to make of this infrastructural context? What kind of spatiality or situatedness pertains to it? How could a designer work with it, and through what conceptual and technical apparatus? In this designed inquiry, I take the presence of strange relations as a crucial indicator of tensions between the discontinuous, distributed, and networked locales of infrastructure and design strategies that reflect a Cartesian-Newtonian model of space and isolate form and perceptual effects. The latter are stretched by the complex range of activities and relations instigated by infrastructure. My central research question is: *how can the strange relations mediated by infrastructure be drawn into projections of public place?* That is, how can such relations be mobilised as factors in a design process that anticipates new or reconfigured places?

The contribution this thesis makes to existing knowledge is to investigate infrastructures using the idea of *place*, and demonstrate design strategies for

projecting place in light of strange relations. This entails reconfiguring the idea of the local and *drawing in* new (human and non-human) participants. To be in place in infrastructural contexts is to be situated not only in relation to things directly seen, heard, or touched, but also in relation to distant, dislocated, miniscule, enormous, future, past invisible and intuited things.

Discourses of place have sometimes been conservative and suspicious of technology. Nevertheless, these discourses can also contain resources for new thoughts and practices regarding the complications of infrastructural situations. In this thesis, I focus on topological theories of place as particularly useful for understanding infrastructured contexts. Specifically, I propose that Bruno Latour's actor-network theory is a hitherto under-exploited source for ideas about place.

The intended audience for this research are designers concerned with the projection of place. This includes those working within disciplinary frameworks traditionally concerned with the design of urban environments: for example, practicing architects, landscape architects, or urban designers. It also includes, however, those who design things that interact with processes of urbanisation: designers of products, objects, interfaces, spaces, images, texts, or processes. Further, although the model of design employed in this inquiry is potentially at odds with engineering's emphasis on weighted-factor analysis and optimisation, I invite engineers to be part of this audience, too. My inquiry is also relevant for entrepreneurial, activist, and speculative designers or artists who may work outside or between disciplines. Ultimately, the research is relevant to anyone concerned for the deliberate and thoughtful provision of public space, that is, for local and global publics, themselves.

3. POSITION OF PRACTICE WORK IN RESEARCH

This inquiry is *practice-led*: it is about the design of situations, intended for use by designers, and speculative design is its mode of field-work. For all its speculation, it is also essentially pragmatic: concerned with what works rather than disclosing essential truths. The research outcomes are not prescriptive systems or normative theories. In framing the idea of infrastructure as place and demonstrating strategies for projecting

infrastructural place, my aim is to provide concepts, strategies, and exemplars as a foundation for new hypotheses, to further a line of experimental practice.

The knowledge generated through this research is distributed across four locations. First, it is in the *concepts and theoretical considerations* worked out in this exegesis through the dialogue between practice reflections and my critical context. Second, it is embedded in the *techniques and processes* described. Third, it is present through the *design artefacts* themselves: the drawings, maps, objects, and writing to be exhibited. Fourth, it is embodied in myself in tacit forms. I have endeavoured to give a sense of this tacit knowledge by describing several personal *dispositions* that surfaced through my inquiry. The order of this list does not reflect priority: these forms of knowledge are interlinked and overlapping.

I have organised my inquiry as a series of three *project cycles*. Each project cycle culminates in a design proposal for Auckland's Māngere Inlet, an arm of the Manukau Harbour ringed, reshaped, and adversely affected by infrastructures including landfills, railyards, motorways, distribution hubs, sewerage treatment, and high-voltage transmission corridors. This locale serves as a case study or model for urbanised sites more generally: many of its difficulties are widely shared with other locations around the world.

None of the project cycles is a direct response to an external brief. While each makes a design proposal, they are all, first and foremost, pretexts for experiments with design *process*. The practice work does not merely respond to problems framed in advance – to the contrary, problem-generating is as important to the research as problem-solving. The emphasis is on the techniques, strategies, dispositions, and concepts that arise, rather than on the resolution or practical viability of any particular outcome.

Design involves decision making, even when these decisions must be based on partial understanding, incomplete information, or provisional judgement. “There is no escaping the making of decisions in designing”, writes Downton (2013: sec. 3.2.4): decision making requires judgements that crystallise values and understandings. A crucial aspect of generating design knowledge is therefore the return to already-made decisions, picking at them after the fact, looking for moments when the process could have taken an alternative path.

In designing, I draw widely on knowledge from other areas: philosophy, anthropology, sociology and geography, as well as the work of other designers and theorists. I have been opportunistic in the way I have made use of this material. While I have striven to be accurate and consistent in my use of others' ideas, and to avoid misrepresenting them, I cannot claim to offer a comprehensive interpretation. Where there are errors or misreadings, I hope they are "poetic misprision" (Bloom, 1973: 7). My contextual review aims to "establish a base camp of knowledge from which to venture into unknown territories" (Downton, 2013: sec. 1.2), even if this base camp was frequently reassembled, rearranged and relocated.

4. KEY TERMS

Three of my key terms are unpacked at length in separate chapters: *infrastructure* (Chapter 3), *place* (Chapter 5), and *public* (Chapter 8). These are described as "keywords": terms whose meanings are "inextricably bound up with the problems [they are] being used to discuss" (Williams, 1976: 13). Keywords are clusters of meanings and uses that cannot be simply defined or etymologised, since their meanings can change drastically over time and in different contexts.

As an initial orientation, however, I use *infrastructure* to mean a particular technological system that provides background support for a range of human activities (for example, a railway or telecommunication network) or, more generally, a systemic logic of submergence and support.

Place refers to location or situation, but not merely in terms of measured position in space. It comprises ideas of relative position and orientation, including cultural and subjective dimensions. Place is non-reductive, relational, temporal, and performative. Place and space are not binary opposites; space relates to place in complex ways.

Public refers to situations respecting other people, particularly strangers. It is a shared, open, or accessible context that accommodates difference, and even conflict. The configuration of public spaces encodes norms, roles, and power relations; it is thus highly political.

I describe place as having a *topological* structure. Topology, as a marriage of *topos* and *logos*, is literally a speaking of place. It also has a more specific mathematical sense, however, as the study of “abstract spaces that are invariant under homœomorphic transformations” (‘topology’, 1989). Topology describes such spaces in terms of relationships rather than dimension or position. I use ‘topology’ particularly with the figure of the network in mind. Place is topological if it is understood fundamentally as a network of relationships, rather than a spatial location.

By referring to *projecting place* rather than ‘designing space’, I aim to deprioritise disciplinary frameworks and preserve the holistic nature of place. ‘Project’ connotes forward movement (and thus the future-orientation of design) while maintaining a sense of provisionality. It also hints at the importance of projective drawing practices.

Likewise, *drawing in* has a double sense. I use it to mean explicit inclusion in a situation, but also literal inclusion in a drawing. It also suggests getting closer to something. This ambiguity flags drawing’s active mediating and mobilising role in design. By drawing in new participants, designers could facilitate a richer, more inclusive sense of place.

Throughout, I refer to design as a *practice*: a flexible, contingent, and improvisational collection of activities, “an open catalog of procedures” (Allen, 2008: xiv). I do not oppose practice to theory. Theories and concepts are inextricable from practice, and generating them is part of creative practice. I use the term “strategy” to suggest an approach that entails a mix of ideas and techniques. Strategies are not necessarily systematic, but they can be applied and adapted for multiple situations.

Finally, wherever I use ‘we’ or ‘us’ in this text, (for example, in reference to “we designers”, or “we inhabitants of metropolitan Auckland”) I have tried to be as inclusive as possible, but do not presume to speak for anyone other than myself. Questions of inclusion and exclusion are significant in this inquiry, and I have tried to hold my identity reflexively.

5. OUTLINE OF THIS EXEGESIS

This exegesis consists of one chapter on methodology, followed by four chapters on critical context (reviewing selected literature and practice) and four with accounts of practice work. The context and practice chapters are interleaved to reflect the way designing and reading, reflecting and projecting informed each other. Practice turned up ideas that needed to be contextualised and explored in writing; and contextual study generated, clarified or disrupted ideas and processes, opening up new directions for practice.

In Chapter 2, I discuss my methodology in detail, positioning my work in terms of design research generally, describing my approach to generating knowledge through design, and explaining the particular significance of cyclical structure.

In Chapter 3, I review understandings of infrastructure, drawing on perspectives from geography, technology studies, and particularly actor-network theory. Networks, argued Manuel Castells, are the spatial form of late capitalism, integrating the globe, but also producing spatial *unevenness*. I consider this unevenness in light of anecdotes from Martin Heidegger and Bruno Latour about technologies that fail. I then reflect on three design approaches to infrastructure. I draw out two key characteristics of infrastructure: strange relations and environmentality.

Chapter 4 is the first chapter directly to address my practice work. It gives a narrative account of five lines, routes travelled across the region of the Māngere Inlet. In place of systematically unpicking the region into discrete conceptual layers, these lines act to cut across and disclose the region as a complex place. They familiarise the reader with the area, introducing some of the locations, artefacts, systems, qualities and meanings that are taken up in the project cycles. A failed attempt at a transect drawing exemplified a need for different ways of drawing.

In Chapter 5, I describe infrastructures as topological places. Theories of place have often been suspicious of technology, and infrastructures are often presented as alienating and placeless. Marc Augé's idea of non-place exemplifies this perspective. I then discuss three models of topological place:

Jeff Malpas's topography, Bruno Latour's actor-network theory, and Timothy Ingold's life-lines. I assemble concepts from these three sources to open a more optimistic outlook for projecting infrastructural places.

In Chapter 6, I endeavour to mobilise these new understandings by seeking new or adapted modes of drawing, capable of modelling uneven and relational spaces. Notably, the close relationship between descriptive geometry and Cartesian-Newtonian ideas of space prioritises form and disconnects subjects from objects. As alternatives, practices of cartography and sketching use drawing as a means to negotiate inclusion and mobilise participation at a more fundamental level than descriptive geometry permits.

Chapter 7 describes my first project cycle, *Circuit*, a proposal for a path around the Māngere Inlet. Experimenting with cartographic projections, made using custom-built software, I explored how a path might reorient a terrain. Warped cartographic grids were used to establish a series of public surfaces: pavements, lawns, and platforms. The focus on orientation is highlighted as a key insight; but the cycle also underscored a weakness in my understanding of publicness.

This problem is addressed in Chapter 8. Beginning with Hannah Arendt's idea of a public "space of appearance" (1998: 198) that supervenes on a material world, and noting Jacques Rancière's critique through his concept of the "distribution of the sensible" (2004: 12), I consider publics as contextually dependent. I then turn to Latour's idea that publics form around "matters of concern", and to Nortje Marres's notion of "material participation". Using waste matter as an example, I describe publics as forming through participation in complex situations, not by mere co-presence.

My second project cycle, *Deposit*, is discussed in Chapter 9. It culminated in a proposal for a participatory public place: a waste collection and breakdown facility accompanied by public workshops. A densely-packed plenum replaced the empty surfaces of *Circuit*. In the design, I used shifts in orientation to reveal the participation of remote or asynchronous things. In particular, the line of the reclaimed shore was reinterpreted as a transformative border zone, at which things accumulated and eroded at various speeds.

In Chapter 10, I give an account of my final project cycle: *Exchange*, in which I projected a long-term future for the Māngere Inlet through a logistical choreography. Centring on three primary sites, materials, people, organisms and other things move, are recycled, reassembled and stockpiled for future use. As they move, they catalyse various public activities. *Exchange* culminated in a ten-metre long meshwork drawing, and in this chapter, I discuss the format of the drawing and deliberate over the significance of picturing a place as made up of linked objects.

Finally, in Chapter 11, I conclude by drawing out the relational design strategies I developed through this inquiry. In response to my research question, these strategies are ways to draw strange agencies into the projection of public place.

6. RESEARCH MOTIVATIONS

This research derives from a messy tangle of intentions, hopes, interests, and investments. I do not claim to be a disengaged, impartial analyst; on the contrary, design research offers the opportunity for me to be more fully engaged.

These motivations include my conviction that a robust and authentic public realm must be actively maintained and reinvented. They also include my fascination and sense of commitment and *tiakitanga* (care and protection), for the Māngere Inlet, around which I have lived my entire life. My inquiry was thus motivated by a concern to know my own place, to become *practiced* in it rather than simply to know of it.

It has been a central tenet of this research that the complexity of the world must be recognised, and that reductive simplifications of complex situations must be avoided. I hope through this inquiry to promote speculative reinventions of our strange and familiar shared world.

2

METHODOLOGY

Differential questions and project cycles.

1. PREPOSITIONS

While there is substantial agreement that design “is a way of inquiring, a way of producing knowing and knowledge” (Downton, 2013: sec. 1.1), and that there are “designerly ways of knowing” (Cross, 2006: vi), there is far less unanimity about the aims, methods, norms, and knowledge proper to design research.¹ It is far from clear that such a definitive consensus can be arrived at, given the very wide range of activities involved in design and its porous borders with art, humanities, and sciences. Generalising theories may be coloured strongly by particular disciplinary concerns. As Peter Downton puts it: “Many writers define design. Most of the definitions have some value for some purpose. Most will be inadequate from some point of view” (2013, sec. 1.3). In this chapter, I make no attempt to define design, nor to constrain how others might undertake design research. Instead, I describe what kind

1. Victor Margolin, for example, laments that “design research continues to grow without a sound foundation or consensus of what it is or what it is for” (Margolin, 2016: 5). He proposes to draw a line between, on the one hand, studying to become an expert designer and, on the other, studying “reflective issues” of history and theory (9). This may reflect a jealousy of the prestige and authority accorded to scientific research governed by a strict methodology.

of knowledge my thesis produces, how the practice work was structured to generate it, and the interplay between practice, theories and concepts.

Christopher Frayling made a “now seemingly consecrated – but still controverted” tripartite division of design research into research *into* art and design, *for* art and design, and *through* art and design (Findeli, 1999: 2; Frayling, 1993: 5). His third division takes seriously the proposition that the very activities and productions of design might constitute a methodology for design. This design inquiry is carried out *through* design, but because it is focused on design strategies, it is also intended to provide insights *for* designers. The central role of design practice does not mean, however, that theoretical and conceptual reflections are secondary, or even separate. On the contrary, they are deeply implicated.

2. LOCATING DESIGN KNOWLEDGE

Research is a creative labour intended to produce or advance knowledge “through the discovery and codification of new information or the development of further understanding about existing information” (Universities New Zealand, 2015: 24). What counts as knowledge, however, is sometimes unclear in design disciplines, particularly where design works themselves are intended to be taken as part of the research output.

One approach has been to argue that, since a designed output represents a novel production, it can simply be counted as research in and of itself: “a design can be seen as a repository of knowledge and interrogated to reveal the knowledge its designers have both intentionally and unintentionally embodied there” (Downton, 2013: sec. 6.5). This approach recognises that knowledge crystallised in design work may not be convertible into textual propositions.² Designed things are independent entities, no mere transports for textual knowledge. The relationship between text and project is a dialogue rather than a mirroring.

If the production of designed artefacts is understood to be research *per se*, it becomes difficult, however, to distinguish it from advanced practice. Jeremy Till, writing particularly of architectural research, refers to the myth “that

2. “Words have an important role to play in conveying design knowledge, but the central carrier of the knowledge is a designed work” (Downton, 2013: sec. 7.1.1).

designing a building is a form of research in its own right” (Till, 2008: 2). The logic of the myth is that, since architectural knowledge “ultimately resides in the built object”, and since each building is an original production, designing a building is inherently “the production of original knowledge” (2). But, he argues, since architecture

exceeds the building as object [...] research must therefore address this expanded field [...] Designing a building is thus *not necessarily* research. The building as building reduces architecture to mute objects. These in themselves are not sufficient as the stuff of research inquiry. In order to move things on, to add to the store of knowledge, we need to understand the processes that led to the object and to interrogate the life of the object after its completion (Till, 2008: 2).

Till, like Frayling, scopes architectural research using three areas of inquiry: architectural *processes*, *products*, and *performance* (4). Performance concerns the effects and behaviours of buildings once complete. Products concern buildings “as projected or completed objects and systems and might include for example issues of aesthetics, materials, constructional techniques and so on” (4). Process, concerns “for example, issues of representation, theories of design, modelling of the environment, and so on” (4). This model, continues Till, “avoids the science/art and qualitative/quantitative splits, and allows interdisciplinary research into any of the three stages. The model thus breaks the hold of research *method* and allows instead thematic approaches to emerge” (4). Till also suggests that the most productive use of this tripartite division is in feeding one of its terms into another, cyclically, so that research into products might offer insights into new processes or performances; research into new processes might illuminate or suggest new performances or products; and research into performance might provoke new products or processes.

Likewise, I see the knowledge produced in design research as distributed across four overlapping locations, rather than centred in designed artefacts. In this thesis, knowledge is embodied, first, in the designed artefacts themselves, from where it can be (partially) accessed through their interrogation. Second, it can be read in the written discussion in this exegesis. Third, it is embedded in the processes and techniques of my practice, which can be shared and set to work in new situations. Fourth, it has taken up residence in my own body as tacit knowledge. I have

endeavoured to make this tacit knowledge explicit where possible, but there remains a residue of dispositions I am unable to articulate: a “knowing” that is not yet quite knowledge (Downton, sec. 6.1.2).

3. KNOWLEDGE EMBEDDED IN PRACTICE

Throughout this work, I have been unconcerned with asserting any kind of disciplinary identity.³ Instead of *discipline*, I have thought and operated in terms of *practice*: a flexible, opportunistic and improvisational collection of activities. In professional practice, design processes often take highly structured forms. Architectural ‘plans of work’, for example, break down the process into tightly defined sections, with clear deliverables, and quite different work practices at each stage. These are highly artificial and question-begging descriptions of design, however: In the RIBA plan of work, for example, one of the phases is “conceptual design” and another “developed design” (Sinclair, 2013). This distinction, however, says little about how creative production actually occurs in these phases: “[b]reaking the process into steps does little to alleviate the mystery because it tells us nothing about how to have ideas or conduct syntheses” (Downton, 2013: sec. 3.2.4).

Ethnographic descriptions of what actually takes place in these design phases show that they are fine-grained and messy. Albena Yaneva, for example, gives an account of scaling practices through her observations in the architectural office OMA, and Inger Mewburn explores the hand-gestures performed by designers in studio (Yaneva, 2005; Mewburn, 2009).⁴ Studies like these expose the “messy and inconsistent” negotiation with “a reality that is itself messy and inconsistent” (Allen, 2009: xi). My understanding of practice is informed by Michel de Certeau, who points to the tactical, opportunistic, and improvised “ways of operating” that make up daily life (de Certeau, 1984: xiv). Practice takes on fluid forms resulting from circumstantial contingencies: “The practitioner looks for performative

3. I do not claim to be outside any disciplinary frame, however. I learned to design in a school of architecture, and my modes of thinking, tools and techniques, are steeped in architecture’s disciplinary history. This is an aspect of my own situatedness; but one that comes into question in this inquiry.

4. See also the dialogues recorded by Cross (2006), and the actor-network inspired studies listed by Fariás and Bender (2010: 4).

multiplicities in the interplay between an open catalog of procedures and a stubbornly indifferent reality” (Allen, 2009: xiv). To consider a practice requires attending to implicit particularities, not only stated ideals: “Approaching a practice then means approaching it as it diverges, that is, feeling its borders, experimenting with the questions which practitioners may accept as relevant, even if they are not their own questions” (Stengers, 2011: 186).

As tactical ways and means, design practices are entangled with tools and techniques. Drawing, modelling, photography, site documentation and other activities characteristic of design most often make use of techniques that have been successfully used in the past. Formalised bodies of technique, like orthographic drawing, can also become reified in tools like CAD software. Since techniques and tools encode existing biases, conventions, and assumptions, devising new techniques, working principles, rules of thumb, or writing new code, constructing new implements and viewing sites in new ways, are valuable for two reasons. First, they help to critically disclose the assumptions and tendencies of existing techniques and, second, they provide alternative modes of practice. To the extent that these tools and techniques can be described in ways that others can access, they become repositories of design knowledge.

Much of such a “catalog of procedures” however, is held in the form of “tacit knowing” (Polanyi, 1966: 9). Tacit knowing is not simply hidden information but a different structure of knowing incorporating both “proximal” and “distal” terms: “[i]n an act of tacit knowing we *attend from* something for attending *to* something else” (Polanyi, 1966: 10). Tacit knowing can manifest in intuitive leaps and creativity. However, it can also serve as a repository for assumptions, discriminations, values, institutionalisation; and for this reason, tacit knowledge needs to be critically interrogated.

Unpacking the tacit and intuitive knowledge embodied in the designer, and in the technologies of his or her practice, may need to include “an *archaeology* of the processes” at work (Till, 2008: 3), or perhaps an “autoethnography” (Adams, Jones and Ellis, 2015: 1). This does not mean, however, that tacit knowing can simply be brought from the shadows to the light. It is intensely context-dependent, and even on careful reflection, a designer may be unable to account for its workings. There will always be a remainder that has not yet

been understood, or that cannot take communicable form. This remainder, embodied in the designer, will ramify in future practice. Further, knowledge is encoded not only in the designer's mind, but also in tools, institutions, habits, conventions. A significant part of the evaluative movements of my design cycles consists therefore in exploring and excavating hitherto tacit dimensions.

4. DIFFERENTIAL QUESTIONS

Design practices and techniques are not independent of a design process but draw their meaning from its orientation toward the forward: "material practices analyze the present in order to project transformations in the future" (Allen, 2009: xiii). This forward trajectory is sometimes oriented by a brief, but is here set by a *research question* (Ch.1, sec.2). A design research question, however, is not simply a problem in search of a solution:

[C]an a work of art and design ever simply answer a question? [...] In research, processes need to be argued to formulate the project, develop the question to be posed, and wrest the answer from it — by words, diagrams or drawings — none of these in a necessarily linear path. Some parts of the research may be hypothesis-led, some discovery-led [...] the question does not always arrive at the start as a pre-given. It may come late, justifying the project retroactively after long and fruitful negotiations between perplexity and the very intuitions that led the research. (Jenner, 2014: 89)

The question does not entirely precede the project; the project is as much a way of questioning as a way of answering a question. Design doesn't simply respond to problems formed elsewhere, but incorporates the discovery, disclosure, and invention of problems.

Typically, the practitioner finds that [a] problem cannot be solved as it has initially been set, so the framing of the problem must be surfaced and criticised, and the problem reframed [...] The process spirals through stages of appreciation, action, and reappreciation, whereby the unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it. (Scrivener, 2002: 28)

The question and the project unfold dialectically. The question may expose unsatisfactory aspects of the design; the design may expose a poorly formulated question, or disclose that the question is the wrong one to ask, or suggest how the question may be linked to others.⁵ The design research proceeds with a forward movement that requires it to pull away from the question; and the differential between question and production requires the reformulation and harmonisation of both; or perhaps the force of one or the other takes charge. For this reason, the question can be thought of as motivating an oscillation. These spirals and oscillations can give the project an obsessive character:

when design is pursued as research it often emerges from the preoccupations of an individual: that is, it springs from a point of departure that receives limited or even no social recognition and that appears to be inordinately and incomprehensibly fixed upon something it shouldn't be... the obsessive is transported, compelled by his/her object, and is less authoring of it than authored by it... Rather than the object of the obsession playing a due part in the overall field of architecture, architecture becomes—to the contrary—diverted and forced to flow through the object. Thus the obsessive constantly poses the question to architecture, *What if...?* (Dorrian & Hawker, 2003: 188)

The question disturbs the object of the inquiry, and necessitates repeated returns; the forward movement of the project is driven by a cyclical engine.

5. CYCLES

In order to exploit the dialectical relationship between design production and my understanding of the design situation, I planned my inquiry as a series of *project cycles*. Cycles allow for design to be understood as a dialogue between designer and situation:

In answer to the situation's back-talk, the designer reflects-in-action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his [*sic*] moves. (Schön, 1983: 79)

5. This is particularly true in the case of “ill-defined, ill-structured, or ‘wicked’” problems (Cross, 2006: 7). Terming a problem *wicked* frames the designer's activity inappropriately as a battle of good against evil. I prefer not to see complexity as a troublesome condition to overcome.

In the context of my research, cycles allow for the reforming of research questions, improvement through iteration, and the ability to explore alternatives. Just as it is necessary to iterate through versions of a design, I iterated through versions of a design process.

Lawson describes the design process as cyclical, moving periodically between modes of analysis, synthesis, and evaluation (Lawson, 2005: 39-40). It is commonplace to describe design as involving these three modes or movements, and there are various descriptions of their interrelationships.⁶ This variety likely reflects variances between individual designers and design situations, rather than fundamentally different types of design.

Rather than seeing the modes or movements as separate phases, I consider them as co-existing and overlapping, separated only through a conscious change of focus. How to direct this focus is a substantial element of learning to design: When would it help to focus on understanding an existing condition or situation better? When do I need to make some kind of inventive leap, step, estimate, hypothesis or guess based on what I have already got to hand? And when do I need to stop and reflect on what I have just done and where I am up to? There is rarely a clear answer to these questions. Rather, they remain available as three stances or possibilities to be selected from. Thus, momentary cycles nest inside larger ones, which are in turn framed by the project's formal project cycles. Differential relations *between* the projects cycles echo the differential structure of the project-question problematic.

I planned to allow for a period of preparatory explorations (selectively recounted in Chapter 4), followed by three project cycles, to which I assigned preliminary themes: *Circuit* (Chapter 7) would address restless flow and the continually moving nature of the infrastructural world. *Deposit* (Chapter 9) would counter this by inquiring into settledness, slowness and piling up. *Exchange* (Chapter 10) would concern the movement between these two states of transit and residue. Thus, each cycle provided the opportunity to build on and critique the previous one. Finally, there would be an opportunity to revisit and reflect on all three project cycles in preparation for exhibiting the design work. I did not predetermine what, specifically, would be designed in each cycle.

6. See, for example, the compendium of design models compiled by Dubberley (2005).

When there is no external agency (like a client) calling for deliverables, or where deliverables are very loosely defined, the nature of *completion* is ambivalent. This was particularly pertinent when deciding to conclude a project cycle. My pragmatic solution was to identify intuitively the point when I transitioned from designing to presenting. In each cycle, when new insights began to occur less frequently, and decisions began to seem less and less consequential, I stopped, leaving the project ‘hanging open’. As the inquiry on the whole drew to a close, I revisited the projects, taking up the loose threads. This allowed later work to feed back into the earlier work, giving the entire inquiry a cyclical form.

The project cycles shared a single site – the Māngere Inlet – which served as a *case study*. Far from being merely anecdotal, case studies support “the development of a nuanced view of reality” and ameliorate the shortcomings of “context-independent theory” (Flyvbjerg, 2006: 223). Since nuance and context-dependency are crucial themes in this research, the notion of case studies is useful. Through “the study of the particularity and complexity of a single case, [we come] to understand its activity within important circumstances” (Stake, 1995: xi). A case study is thus a way of unpacking something in its messy contextual entanglements, prioritising its particularity.

While the three cycles could be understood on the model of a Hegelian thesis, antithesis, and synthesis, this was not intended. The Hegelian model places undue emphasis on the third movement, as encapsulating and summarising the previous two. In this thesis, though, the final proposal is no more complete or authoritative than the other two. Each project cycle is both an *extension of* and a *revision of* the previous one; that is, the three projects can be understood both as successive versions, and as simultaneous possibilities. Design cycles harness both the forward impetus implicit in the idea of a *project*, and the way design *returns* on itself.

The forward movement of the project, the sense in which it is *projected*, “thrown forward” (Jenner, 2014: 89) is ensured by the necessity of producing concrete externalised outputs. Design involves a dialogue with these concrete productions, “an iterative conversation with the (partial) propositions already put” (Downton, 2013: sec. 6.3.4). It follows that design cannot move forward without putting propositions, even if they must

necessarily be provisional. These *motivated productions* are discrete, shareable artefacts that are available to others and capable of acting back into the project. There is no guarantee that these productions will lead the project in the right direction, but by moving the project, they increase the chance of new insights.

Jacques Rancière described the teacher's primary role as demanding speech of the student and verifying that work is done attentively since the two primary conditions for learning are "the manifestation of an intelligence" and the presence of attention (Rancière, 1991: 29). The designer's motivated productions are like this: they direct manifestations and externalisations of thought and require attentive action, thus advancing the intelligence of both the work and the designer. Much anxiety in design derives from a concern that the current production may not move the project in a useful direction; but a designer's nerve has to hold against this anxiety. The benefits that can be accrued from reflecting on motivated productions, and the chance of serendipitous discoveries, offsets the very real possibility of failure.

6. VOICES

Designing is conversational, as it were, involving more than one voice, even when there is only a single designer involved. The conversation occurs as drawings, models, and other productions "back-talk" (Schön, 1983: 79), and as the designer switches between perspectives. In my research, a conversation also occurred in the movement between writing and designing. The difference between writing and designing should not be conflated with that between theory and practice: in this thesis, writing was part of the designing. There are, nonetheless, two discernible voices in this exegesis. The first, more impersonal and expository, is the voice of the contextual and critical chapters (Chapters 3, 5, and 8). The second, more narrative and testimonial, is the voice of the practice-focused chapters (4, 7, 9, 10).⁷ But, as with interlocutors who have lived together for a long time, the voices begin to take on inflections from one another, and in Chapters 1, 6, and 11, they blend.

Giving an account of a design process runs two risks: either the account is so historically faithful that it drowns in detail and fails to surface anything

7. For the distinction between expository and testimonial voices, see Hamilton (2011).

of significance; or, it offers “a rather image-conscious and suspiciously hygienic story for public consumption” (Downton, 2013: sec. 6.3.3). I have tried to strike a balance, evoking the texture of my design practice: the weave of its contingent happenings, techniques, intentions, materials, and evaluations, combined with my opportunistic use of texts, references, and images. Rather than producing a detailed journal, I have limited myself to drawing out crucial themes and artefacts from each cycle to characterise the conversation’s main movements. This editing has itself been part of the revision of the creative practice.

Conversely, in the contextual chapters, concepts take on a firmer shape than they necessarily did during the everyday design conversation. Ideas nascent in the practice work are unpacked so that potential I had not fully noticed at the time could unfold more fully. Sometimes, a problem was only understood as related to a broader framework or problematic in retrospect. In retrospect, some things that seemed momentous dwindled in significance, while underlying or fleeting things that had been overlooked surfaced. The cyclical movement of the practice allows these latter to be rediscovered, reconsidered, and reactivated. Drafting chapters for the exegesis, which partly took place in parallel and partly in advance of my final revisions of the project cycles, played a role in reforming the project cycles. Thus, the exegesis is neither purely descriptive nor summative but, rather, generative and open-ended.

7. BEING INTERESTING

To summarise: this research is instigated by a question that triggers and interchange between ideas and practices through a series of project cycles: How can the strange relations mediated by infrastructure be drawn into projections of public place? The inquiry generates a series of project outcomes, but also include the strategies and techniques devised to arrive these outcomes, as well as the reflections, understandings, and concepts related to them, and new tacit dispositions.

The project cycles are not envisaged as ideal solutions. Their value lies in the techniques and strategies they surface, and in the concepts and theoretical orientations that have formed in dialogue with them. They are *fieldwork*, in the sense that they involve travelling in a field, encountering its animation,

complexity, and otherness, and returning to offer an account of my travel, along with maps for others who wish to make similar journeys. The thesis does not claim to be optimal, ideal, or complete – but it aspires to be *interesting*:

used well, ‘interesting’ registers a genuine sense of surprise together with the intimation that there is something of importance at stake here, something that can make a difference that counts — and this in turn opens onto a vivifying and mutual endeavour of thinking and articulation that takes place around a shared matter of concern. (Dorrian, 2016: 182)

Table 1. The start of a list of things described as infrastructures.

Waste management	Reno, 2015
The Internet	Frischmann, 2012
Farming practices	Jensen and Morita, 2015
Undersea communication cables	Stephenson, 1996
ISO standards	Easterling, 2014
Surveillance systems	Schouten, 2014
Shipping logistics	Waldheim and Berger, 2008
“Smart cities”	Greenfield, 2013
Military bases	Carse, 2016
Asphalt	Bélangier, 2006
Databases	Star and Ruhleder, 1996
Global Positioning Systems	Edwards, 2003
Street lighting	McLuhan, 1987
Algorithms	O’Neil, 2016
Schools and universities	Frischmann, 2012
Dikes	Pleister and van der Veecken, 2014
Management protocols	Easterling, 2014
Rice paddies	Jensen and Morita, 2015
Prop-houses	Sumrell, 2009
Railways	Osterhammel, 2014
Motorways	Banham, 1971
Cadastral surveys	Scott, 1998
Banking and financial systems	Edwards, 2003
Airports	Ballard, 1997
Economic zones	Easterling, 2014
File folders	Star and Ruhleder, 1996
Emergency services	Edward, 2003

3

INFRASTRUCTURE

Strange relations

1. UNDERPINNINGS: INFRASTRUCTURE AS A KEYWORD.

Attempts to define infrastructure tend to spawn lists: “cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers” (Edwards, 2003: 185); “highways, airports, power plants and landfills” (Bélanger, 2010: 332); “wires, ducts, tunnels, conduits, streets, highways and technical networks” (Graham, 2000: 114); “pipes, cables, relay stations, logistical apparatuses” (Swyngedouw, 2006: 105). In Table 3.1 I provide a list of my own. In no way comprehensive, this list simply indicates that infrastructure is an open set without immediately obvious defining features. Such lists gesture towards the essential heterogeneity of infrastructure and the difficulty of providing a simple definition.

Infrastructure has variously been described as “a form of calculative reason” (Carse, 2016: sec. 1, para. 4), “a shared resource” (Frischmann, 2012: 32), a “large technological system” (Hughes, 1987: 51), “the architecture for circulation” (Larkin, 2013: 328), “objects that create the grounds on which other objects operate” (Larkin, 2013: 329), and a “second nature” (Bowker, 1995: 50). Given this scope, is the term useful for anything? Ashley Carse argues that it is “promiscuous” and “plastic... stripped of its former specialized meaning”. However, she suggests that this nature “is not a weakness, but central to its utility in a wide variety of projects” (Carse, 2016: sec 1, para. 3). The term, she proposes is better managed in the style



Fig. 1. Railway lines to Metroport.
From pedestrian bridge at Southdown.
March, 2016.

of a “keyword”: a polysemous member of a cluster of terms rather than straightforwardly denotative (Williams, 1976).

The word “infrastructure” poses basic questions. Structuring is involved; these structures are ‘infra-’, “below, underneath, beneath”, or in medieval Latin, “within” or “subordinate to” (“infra-”, 1989). Many of our infrastructures, though, are not literally below or underneath the surface: sewer pipes typically are, but railways, cell-phone towers, and motorway flyovers are not. ‘Infra-’ thus suggests not only literal undergrounding, but some *underpinning* role. Edwards notes that technology is significant for *not* being salient for much of the time – it is relied on but not necessarily attended to (2003: 185). As we consider ways to define infrastructure we need to recognise it not only as a particular *class* of structure or system, but also as a *logic* of submergence and support.

Initially a French term for the construction work underlying railway tracks, and extended to analogous engineering situations (Carse, 2016: sec. 3, para. 1), it was adopted after the Second World War by NATO as a military term for all the fixed installations modern armed forces require (sec. 4, para. 2). “Organized around relationships of depth or levels of organization, this usage extended the concept’s history as a heuristic for coordinating projects to new areas” (sec. 4, para. 5). Non-military development organisations such as the World Bank took on the term. At the same time, the term also found (allied but distinct) use in Marxist theory and Saussurian structuralism (sec. 6, para. 2). The term expanded from describing largely technical engineered service networks to describing a whole range of systemic structures serving collective or public goals. This expansion marks the ingestion of many fields of public activity by an infrastructural logic.

This chapter is in three parts. In the first, I draw on sociological and ethnographic accounts of infrastructure. Networks proliferate under capitalism, and urban processes have become global. I place infrastructure in this context, noting particularly that it generates *uneven* spaces. In the second part, I draw on two anecdotes from philosophers of technology: Martin Heidegger’s broken hammer and Bruno Latour’s broken car. Thirdly, I discuss work by several designers, attending to the way infrastructure’s relational networks provide the context for their practice. Ultimately, remote and indirect connections, termed here *strange relations*, are argued to be

characteristic of infrastructural space, and offered as a prompt for new forms of spatial designing.

2. LOCALES IN THE INESCAPABLE CITY.

2.1. Expansions and refigurations of the local.

Infrastructures place us in a very broad system of relations, connecting things widely displaced in space and time, varying in scope of operation or scale:

When our analytical focus centres on how the wires, ducts, tunnels, conduits, streets, highways and technical networks that interlace and infuse cities are constructed and used, modern urbanism emerges as an extraordinarily complex and dynamic sociotechnical *process*. Modern urban life is revealed as a ceaseless and mobile articulation. Cities and urban regions become, in a sense, staging posts in the perpetual flux of infrastructurally mediated flow, movement and exchange. They emerge as processes in the distant sourcing, movement and disposal of water reserves and the remote dumping of sewerage and waste. They are the hotbeds of demand and exchange within international flows of power and energy resources. They are the dominant sites of global circulation and production within a burgeoning universe of electronic signals and digital signs. They remain the primary centres of transnational exchange and distribution of products and commodities. And they are overwhelmingly important in articulating movements of workers, migrants and tourists via complex and multiple systems of physical transportation (Graham, 2000: 114).

The *local* is made problematic by infrastructures. Through them we are connected to remote sites, including ones we may be unaware of. We are synchronised to rhythms we may not recognise and which originate in places and ways we may not understand. The effects of our activities are amplified and projected into unexpected registers: banal choices made in a supermarket are a referendum on the future of fragile landscapes or the labour conditions of workers foreign to us. In return, the activities of others affect us. Various kinds of accelerated transport are available, but not everywhere. Some places are brought close while others remain

inaccessible. The local vicinity is expanded and continually reconfigured by infrastructures. Star and Ruhleder write:

An infrastructure occurs when the tension between local and global is resolved. That is, an infrastructure occurs when local practices are afforded by a larger-scale technology, which can then be used in a natural, ready-to-hand fashion [...] This is not a physical location, nor a permanent one, but a working relation (1996: 114).

Locality is not a bounded area, as they describe it, but a “working relation”, one that results from ongoing negotiations and is defined in relation to activities or practices. Through infrastructures we enter into *strange relations*: relations with things we are estranged from, things we are unfamiliar with, things we may not ever be aware of.

2.2. The urbanisation of the world.

The whole world is implicated in the infrastructural processes of urbanisation. Henri Lefebvre hypothesised in 1970 that global urbanisation was already virtually complete:

Society has been completely urbanized. This hypothesis implies a definition: An urban society is a society that results from a process of complete urbanization. This urbanization is virtual today, but will become real in the future (Lefebvre, 2003: 1).

The city has become inescapable. There is no outside, argues Neil Brenner (building on Lefebvre’s hypothesis), because ex-urban territories, wilderness landscapes, and rural populations are already being operationalised by infrastructural processes. These processes move over the entire surface of the planet. Even the most remote places – equatorial rainforests, arctic wastes – are intricately tied into supply chains and population movements: they are used as carbon sinks, recreational areas, biodiversity preserves, waste disposal sites, or resource production regions. City is coextant with world (Brenner, 2014: 16). Because of this, Brenner (writing with Christian Schmid) insists on the “polymorphic, variable and dynamic” nature of urbanisation, in which “new differentiations” are continually being produced (Brenner and Schmid, 2013: 20). Urbanisation works through extension as well as concentration (as Lefebvre put it, “implosion-explosion”; 2003: 14). Although

the city extends over the whole planet, the local becomes discontinuous and variable, taking on the structure of a network rather than a delimited area.

2.3. Networks as the spatial form of capitalism.

In his influential *The Rise of the Network Society* (1996), Manuel Castells argued that these networks reflect the processes of late capitalism:

Networks constitute the new social morphology of our societies, and the diffusion of networking logic substantially modifies the operation and outcomes in processes of production, experience, power, and culture [...] the power of flows takes precedence over the flows of power (Castells, 1996: 469).¹

Infrastructures enable this networked space, supporting capitalism's socio-economic structure. Keller Easterling writes "infrastructure is now the overt point of contact and access between us all — the rules governing the space of everyday life" (2014: 11). Infrastructure, she argues, includes the standards and protocols that allow various systems to interconnect. She points to the International Standards Organization (ISO), which specifies, for example, the required thickness of credit cards, but also certifies management practices and "quality standards". ISO standards are "a perfect conduit of undeclared activities and intentions" (19). Infrastructure "orchestrates activities that can remain unstated but are nevertheless consequential" (11).

Where, in the past, individuals formed their identity with reference to locales, Castells argued that ours is formed by networks. Our experiences of work, for example, are transformed:

the work process is increasingly individualized, labor is disaggregated in its performance, and reintegrated in its outcome through a multiplicity of interconnected tasks in different sites (Castells, 1996: 471).

Workplaces have become supra-local. Formerly localised productive activities are morcellated and scattered; they are reassembled and become cohesive only via networks. Networking is the formal logic of contemporary

1. Fredric Jameson diagnosed three stages of capitalism, each associated with its own spatial form (Jameson, 1988). Castells elaborates on the third, late stage.

societies, and infrastructures are the literal workings of that logic, manifest in lived experience.

That infrastructure is a crucial factor in capitalism was understood by Karl Marx. In *Capital*, technology was one of the factors that leveraged the extraction of capital from labour; and this extended to infrastructural technologies.² In addition to tools and machines found in workplaces, technology presented a background, almost a kind of territory or commons. “Instruments of this kind, which have already been mediated through past labour, include workshops, canals, roads, etc.” (Marx, 1976: 287). Such instruments did not produce value in and of themselves, but embodied the sunken labour of previous workers. From the “original larder” and “original toolhouse” of nature, we have moved into a “second nature” (285). Infrastructure is *instrumental* but also a *precondition*; both a means to extract profit and the ground of profitability. It is a hybrid of technology and territory.

Kazys Varnelis calls this second nature “a wild and untamable terrain that undoes our attempts to control it or even understand it fully” (2009: 15). While powerful agencies shape this terrain, there are also minor, distributed, and opportunistic participants at work.

In terms of our analysis, these infrastructures form the basis of the contemporary city, but they are vastly different from the infrastructures of old. Rather than being executed in conformance with the outline of a plan, they are networked, hypercomplex systems produced by technology, laws, political pressures, disciplinary desires, environmental constraints and a myriad of other pressures, tied together with feedback mechanisms (15).

Large-scale projects administered by central governments or very large private corporations continue to exist as traditional networks, but infrastructure can also take less centralised forms. Sumrell gives the examples of “prop-houses”, huge privately-run warehouses of objects and costumes that support the region’s film industry (2009: 220). They are not

2. Marx was far from a technological determinist, however. Harvey maps out six factors that Marx saw in continual interplay: our relation to nature, technology, modes of production, social relations, the reproduction of daily life, and mental conceptions of the world (D. Harvey, 2010: 195). In this interplay, we have a precursor to the idea of the “sociotechnical” (Graham and Marvin, 2001: 8).

singly owned or cohesively administered, but they are not entirely separate either: they define niches and refer customers to one another. Collectively they form an emergent infrastructure. In the twenty years since Castells wrote *The Rise of the Network Society* it has become clear that networks are becoming ever more intricate structures of interdependence, niches, and feedback loops. For this reason, Varnelis suggests that the word “network” may be inadequate, proposing instead “*networked ecologies*” (Varnelis, 2009: 15).³

With infrastructures permeating daily life and binding far-flung activities, it does not seem possible to ever *leave* them. Thomas Hughes pointed to the difficulty, even the inappropriateness, of distinguishing simply between such a system and its environment:

“the convention of designating social factors as the environment, or context, of a technological system should be avoided [...] Over time, technological systems manage increasingly to incorporate environment into the system, thereby eliminating sources of uncertainty” (52-3).

Just as locality is made problematic by pervasive infrastructure, so is *environment*. Networked ecologies are enmeshed with atmospheric, geological, hydrological, and biological processes.

2.4. Inherent unevenness.

While infrastructures might be imagined to be unified like a human body’s integrated circulatory system or a machine’s conduits and circuitry, they can also be observed to generate inequalities, discriminations, and inconsistencies. Infrastructures systematise and bind into cohesive networks; but they also separate, segregate, and splinter. Stephen Graham and Simon Marvin, in *Splintering Urbanism* (2001) seminally described “the fragmentation of the social and material fabric of cities” (Graham & Marvin,

3. Varnelis derives the concept from Reyner Banham, who in *The Architecture of Four Ecologies* proposed that conventional planning mechanisms failed when it came to the Californian metropolis. “It feels more natural (I put it no stronger than that) to leave the effective planning of the area to the mechanisms that have already given the city its present character” (1971: 121). This faith in ad-hoc emergent processes to generate the city has proved persistent, particularly in America, perhaps because it links an apparently democratic ideal of freedom to build where and how one wants, to processes of neoliberal capitalism.

2001: 33). Capitalism's infrastructures might superficially appear to be homogenising, but according to Graham and Marvin, these

homogenising networks [...] become punctured and ruptured [...] unbundled and splintered, ushering in new geopolitical and geoeconomic logics based on the highly uneven warping of time and space in highly localised and valued places (200).

In other words, “[r]ather than unmitigated *public* goods, different infrastructures turn out only to be good for some people, some of the time” (Harvey, Jensen, and Morita, 2016: ch.1, sec. 4, para. 8).

Robert Moses's mid-twentieth century highways through New York exemplify this: buses and trucks were discouraged from accessing certain areas because motorway underpasses were too low. Because those reliant on bus transport were often poor and black, the motorways reinforced racial and economic disparities (Winner, 1986: 22-3; Harvey, 2008: 33-4). In the same way, contemporary software algorithms, masquerading as impartial, frequently encode prejudices and assumptions (O'Neil, 2016). Areas of deprivation and disorder are produced as the “externalities” of capitalist infrastructure (Graham and Marvin, 2001: 147). Castells predicted that networks,

will penetrate all countries, all territories, all cultures, all communication flows, and all financial networks, relentlessly scanning the planet for new opportunities of profit-making. But it will do so selectively, linking valuable segments and discarding used up, or irrelevant, locales and people. The territorial unevenness of production will result in an extraordinary geography of differential value making (Castells, 1997: 21).

The networked structures of globalised capitalism produce inequalities and territorial unevenness, and the disjunctive forms of locale and environment in which we live out our lives. But such unevenness is not only produced by technologies insofar as they are taken up in globalised capitalism, and does not reflect purely the kind of “imperial [...] network power” described by

Negri and Hardt (2005: 9). In the next section, I will explore another, more fundamental source of unevenness: discontinuities inherent in technology.

3. BROKEN TOOLS: TECHNOLOGY'S INHERENT DISCONTINUITIES.

3.1. Failures and controversies.

Technology involves inherent discontinuities, disclosed particularly when it *fails*, but present even when it works smoothly. Writers on infrastructure commonly observe that it becomes most visible when it fails: “The normally invisible quality of working infrastructure becomes visible when it breaks; the server is down, the bridge washes out, there is a power blackout” (Star and Ruhleder: 1996: 113). Edwards emphasised the exceptional character of failing infrastructures: we “fundamentally depend on them, yet we notice them mainly when they fail, which they rarely do” (2003: 185); while Harvey, Jensen and Morita see “seamless flow” as a “fragile achievement”, suggesting that the real question is what makes infrastructures “function *against the odds*” (Harvey, Jensen and Morita, 2016, ch.1, sec. 4, para. 18).⁴ Paul Virilio memorably proposes that every system latently carries an “integral accident”, a particular mode of catastrophe that can be said to have been *invented* along with it (Virilio, 2002: 129).⁵ “When systems fail we become temporarily conscious of the extraordinary power of design, and the effects that it generates”, writes Bruce Mau (2004: 5). Failure involves an “infrastructural inversion” in which a formerly backgrounded infrastructure unexpectedly obtrudes into the foreground (Harvey, Jensen and Morita, 2016, ch.1, sec. 2, para. 12).⁶

4. “From this starting point, we would no longer need to be surprised by the apparently unending series of mishaps, dysfunctions, and inefficiencies of complicated large-scale infrastructures [...] It follows that the conceptual and empirical task of picking apart infrastructures, must be complemented with analysis, images, and visions that help us understand what makes (some) infrastructures function *against the odds*” (Harvey, Jensen and Morita, 2016, ch.1, sec. 4, para. 18).

5. “Daily life is becoming a kaleidoscope of incidents and accidents, catastrophes and cataclysms, in which we are endlessly running up against the unexpected (Virilio, 2002: 15).

6. Infrastructures are not exclusively invisible, however, Larkin notes that infrastructures also perform socially in a range of highly visible roles, and therefore that “many studies that begin by stating how infrastructures are invisible until they break down are fundamentally inaccurate” (2013: 336). He proposes recognising a continuum of visibility.

In J.G. Ballard's novella, *Concrete Island*, architect Robert Maitland crashes his Jaguar over a motorway embankment onto a traffic island, a thin triangle of waste ground two hundred metres long. Here, in a parody of Robinson Crusoe, he finds himself marooned:

His jacket and trousers were stained with sweat, mud and engine grease – few drivers, even if they did notice him, would be eager to give him a lift. Besides, it would be almost impossible to slow down here and stop. The pressure of the following traffic, free at last from the long tail-backs that always blocked the Westway interchange during the rush hour, forced them on relentlessly (Ballard, 2009: 17).

The fast-flowing arms of the motorway continue to operate perfectly, ensuring the rapid movement of bodies and objects; but their operation is inaccessible to Maitland. Maitland has dropped off the grid, immobilised by the infrastructure of mobility.⁷ He has not simply fallen *out* of urban life, he has slipped “off the grid” while remaining firmly within its network of effects (Douglas, 2011: 45). This is failure by *misalignment*: the infrastructure has not experienced a general breakdown, but it has ceased to work for Maitland.

Failure reveals not only the workings of particular infrastructures, but patterns of interdependence:

The effects of such failures can be magnified by interdependencies among infrastructures. For example, natural cataclysms can cripple one infrastructure, such as the emergency services system, by taking out others, such as the telephone system and the roadway network. Indeed, we depend so heavily on these infrastructures that the category of “natural disaster” really refers primarily to this relationship between natural events and infrastructures (Edwards, 2003: 193-4).

7. As the narrative unfolds it becomes evident that Maitland's alienation is not strictly an imprisonment, but a disconnection. There is a phone, but he cannot get to it. It emerges that Maitland is, at least on some level, psychologically complicit with his disconnection: early in the story cars *do* in fact stop for him, but he waves them on; and he treats with hostility and dismissiveness two other characters who seem to enter and leave the island with no difficulty. His situation is poorly-grasped if it is considered only from the point of view of the embankments and fences that enclose him. It is not so much that he is securely incarcerated, as that he has become unable to make connections. See Douglas (2011).

Where Maitland's experience of failure is personalised, natural disasters reconfigure a broad relational field, instigating chains of knock-on effects that involve many people, places, objects, systems, and processes. What is disclosed particularly is *reliance*, especially dependencies that have gone unnoticed. Rather than being a single misalignment, failure reveals an infrastructural context as a network of precise alignments that only remain calibrated under particular conditions.

Bruno Latour refers to failures as moments of *controversy* in which the formerly unobtrusive and unremarkable suddenly becomes a matter of dispute, disagreement, and uncertainty.

It is with *controversies* that the heterogeneity of technological systems appears most clearly. An accident, a breakdown, and incident of pollution, and suddenly the 'system' by dint of polemics, trials, media campaigns, becomes as unsystematic as possible, multiplying the unforeseen branchings that delight sociologists of technology (Latour, 2013: 213).

Rather than mere difficulties to overcome, controversies present uncertainties, revealing contradictory and complex workings. Norms and assumptions are embedded in smoothly operating systems, and what once appeared controversial can become unremarkable. Failures, accidents and disruptions, however, return these settled matters to controversy, causing their hidden workings to spill out.

3.2. The hammer: modes of disclosure.

These accounts of failure recall (and in some cases directly refer) to Martin Heidegger's famous analysis in *Being and Time* (1962 [1927]) of a broken hammer. Heidegger imagines a hammer in use that disappears from the user's awareness as the user attends to some task. The hammer does not occupy his or her awareness; it is absorbed in the task of nailing wood together. Heidegger says the hammer is "ready-to-hand" (1962: 99). When the hammer unexpectedly breaks, and is practically useless, it is disclosed as "present-at-hand" (100), an object brought to the foreground of awareness. Readiness-to-hand and presence-at-hand are not different kinds of thing, but different "modes of disclosure... in constant interplay"; they "are always

underlain by a more basic gatheredness of being-there and world” (Malpas, 2006: 141).⁸

Paradoxically, we encounter equipment more “unveiledly” (Heidegger, 1962: 98) when it recedes into the background: “The peculiarity of what it proximally ready-to-hand is that, in its readiness-to-hand, it must, as it were, withdraw [...] in order to be ready-to-hand quite authentically” (99). The background into which the hammer withdraws is a “referential totality” or “totality of assignments” (99), a densely-woven place oriented by activity. For Heidegger:

Tools are turned towards or ‘involved’ with other tools independently of any given tool user. They go their own way and Dasein [i.e. a situated human being – CD] can let them do so. It need not focus on each one and piece them together like a jigsaw puzzle (Inwood, 1999: 130).

For Heidegger, technology is:

the human *disclosure* of things by bringing them into... their pre-theoretical intelligible availability [i.e. their readiness-to-hand – CD], not by thinking or speaking about them but by working on them, shaping and transforming them into something that they were not before (Sheehan, 2015: 277).

This disclosure is peculiar because it does not involve bringing something to light, but making it ready-to-hand. Technology is not *visible* but *available*, part of an ambient backdrop of possibilities. A technological failure foregrounds something that was previously in the background.

3.3. The car: black boxes and technical folds.

Bruno Latour, in a passage paralleling Heidegger’s, describes technology’s “sumptuous opacity” as the result of a “dazzling zigzag” (Latour, 2013: 217).

8. Harman makes an idiosyncratic reading of Heidegger’s analysis. He argues that readiness-to-hand is not only characteristic of how humans relate to things, but is also characterises relationships between things. This opens up into a strange form of phenomenology (Harman, 2006).

Let's try to follow this zigzag. Nothing more common, more ordinary: you were heading for your office, getting into your car, and suddenly, without quite grasping what's going on, you find yourself in a garage, trying to somehow understand what a mechanic in work clothes is muttering as he crouches under the chassis [...] A cascade of indubitable detours. There, you have felt the breath of technology pass over you, but — here is the whole difficulty — *only for a brief moment*. As soon as you have paid the bill and left the garage, the purring under the hood will make you *forget everything* right away (217)

Where Heidegger chooses a simple hammer, Latour takes a car as his exemplary equipment. Like Heidegger, he describes the car's sudden eruption out of the background to become an object of attention. Where Heidegger stops his analysis at the moment when the hammer breaks, Latour describes the complications and "detours" involved in trying to get it working again. The car, on failing, doesn't simply throw us out of our state of absorption, it throws us into a new field of relations: with mechanics, tow-trucks, spare-parts supply chains, an insurance company, buses or taxis, rescheduled appointments. It is not only our relation to the car that is reconfigured, but the referential totality it implicates us in.

Technology, writes Latour is the construction of a fold within which a complicated network of relations is concealed.⁹ The car is able to be ready-to-hand, to disappear as a mere means to an end, because this network of relations is temporarily simplified or short-circuited. Technologies become more naturalised, appear more stable and robust, the more this simplification can be maintained:

When we talk about a 'technological infrastructure,' we are always designating a more or less patched-together mix of arrangements from more or less everywhere that others seek to render *irreversible* by protecting it from analysis, making it a carefully sealed and concealed *black box*" (213).

9. The image seems to be that of the Al Jaffee's *Mad Magazine* 'fold-ins', in which a picture is transformed by a double fold; so, for example an image of a car is folded open to reveal itself as a monstrous oil-guzzling creature. For examples, see Genzlinger, Jackson, and Rupani-Smith (2010).

“Black box” was a term Latour favoured in his earlier work. It describes any entity to the extent that we remain agnostic concerning its composition, genealogy, or workings, attending only to its input and output:

The word *black box* is used by cyberneticians whenever a piece of machinery or a set of commands is too complex. In its place they draw a little box about which they need to know nothing but its input and output [...] that is, no matter how controversial their history, how complex their inner workings, how large the commercial or academic networks that hold them in place, only their input and output count (1987: 3).

The black box is a performative element, a mechanism that produces some kind of difference, or a *mediator*. Amongst actor-network inflected accounts of infrastructure, “black-boxing” has come to describe the submergence of technical means as they become “settled items whose user and colleagues (human and non-human) act in ways which are unchallenging to the technology” (Hinchcliffe, 1996: 665). Black boxes can be taken to signify acceptance, lack of attention, backgrounding, or becoming “naturalized” (Edwards, 2003: 185) – “[a] technological assembly including infrastructure networks whose inner workings are so completely unknown or hidden to its users that its successful functioning is totally taken for granted” (Graham & Marvin, 2001: 422).

Latour’s black boxes, however, are only ever *provisionally* sealed. It is always possible for a settled fact, unchallenging technology, or naturalised system to be revealed as a complicated relational network that in turn takes other things for granted as black boxes. Black boxes are relational assemblies that are stabilised to the point that their workings can be overlooked; but they are also contextual in that they “can be viewed either as a black box or as a multitudinous network, depending on the situation” (Harman, 2009: 34). They oscillate between background and foreground. Withdrawing into a “referential totality” like Heidegger’s hammer (Heidegger, 1962: 99), they support new activities and can themselves enter into new relations.

Obtruding from that background, however, they cease to be taken for granted and are disclosed as complex assemblies.

3.4. Breaks in continuity.

Capitalism generates uneven spaces. But unevenness and discontinuity is essential to technology; and this is not just because technologies are prone to failure. Rather, as Heidegger points out, it is because technology configures the dual modes of disclosure (ready-to-hand and present-at-hand). Latour elaborates on this by describing the ready-to-hand as “*technical folding*” (2013: 227). By collapsing and concealing a relational network a short-cut is formed. Means and ends only come into view as the end-points of such a short-cut:

Nothing is less proper to technologies than the relation between the end and the means, since ends and means are invented simultaneously [...] Despite what is often said of cold, smooth technology, in it there is never anything but *breaks in continuity*; things never quite connect (Latour, 2013: 220, 222).

The sociological and ethnographic descriptions of this world in Sections 1 and 2, above, locate discontinuities arising from the applications of technology (particularly in the ways capitalism applies it). Heidegger and Latour, in their different but resonant ways, articulate such discontinuities as innate to technology itself.

4. FORMATTING FIELDS: DESIGN APPROACHES TO INFRASTRUCTURE.

Infrastructure, as I have described it, is a networked phenomenon that eludes simple definition. Different accounts emphasise various aspects. The ones I have chosen to emphasise are the *contextuality* of infrastructure, which I have described as an intricate enmeshing; secondly its backgrounding, the way it involves a play of folding and readiness-to-hand. In this section I will briefly consider approaches by several designers to this context.¹⁰ Given the ubiquity and scope of infrastructure, the role it plays in urbanisation and

10. A thorough historical review of infrastructural architecture is outside the scope of this research. I will not, for example, discuss the importance of infrastructures to Modernist architects like Le Corbusier, for whom bridges, cars, grain elevators, and airplanes were as significant as architecture’s patrimony. Nor will I discuss the industrial architectural systems which followed these early Modernist enthusiasms.

capitalism generally, it could be argued that *all* design is now infrastructural. Therefore, my aim is not to summarise design approaches, nor to advocate that any single approach is universally applicable. Rather, the selected examples demonstrate some ways designers have exploited infrastructure's discontinuous locales and strange relations. They each take up the opportunity described by Keller Easterling:

To truly exploit some of the intelligence related to network thinking, an alternative position might operate from the premise that the real power of many urban organizations lies within the relationships among multiple distributed sites that are both collectively and individually adjustable (Easterling, 1999: 2).

Each of the projects briefly discussed here conceives of the city as a densely-woven relational network. They also reconsider the role of designers in relation to the many agencies involved.

4.1 Forays into the supra-local: The Unknown Fields Division.

How might these shifting networked contexts be made visible in the first place? Kate Davies and Liam Young take up the project of describing them by means of travel narratives. Their practice, which they call the Unknown Fields Division, is

a nomadic research and teaching studio that [...] ventures out on expeditions to the ends of the earth to bear witness to alternative worlds, alien landscapes, industrial ecologies, and precarious wilderness [...] It engages an active dialogue between 'here' and 'there', where the local is conditioned by a wide array of global supply chains, a network of vast but elusive tendrils that twist threadlike over everything around us, crisscrossing the planet, connecting the mundane to the extraordinary" (Davies, 2016: 205).

They reject the idea of site "as a bounded piece of ground for the architectural object" (206), engaging in fieldwork to disclose complicated contextual entanglements. In their maps, drawings, videos, interactive installations, scans, and animations, they claim to be producing "an elaborate portrait of a city" (207). Davies writes:

**Fig. 2. Rare Earthenware. The
Unknown Fields Division, 2015.**

Ceramic vessels made from
contaminated mine tailings. (Victoria
and Albert Museum, 2017)

[→ view online](#)

We view infrastructure as a series of interwoven narratives, a network of hidden stories that connect us to each other, and to remote locations, becoming *force fields* and thus broader stages for narrative and tactical intervention. We follow supply chains, drawing on the fieldwork practices of other disciplines to construct ‘*thick descriptions*’ (207).

In their 2015 expedition to the mining landscape of Inner Mongolia, they traced the supply chains of consumer electronic good back to their sources. The Bayan Obo mine is responsible for 45% of the world’s rare earth elements, including those essential for manufacturing batteries, magnets, and lenses (Victoria and Albert Museum, 2017). One of the results of this trip was a set of ceramic vessels titled *Rare Earthenware* (Fig. 2). The amount of clay in each vessel corresponds to the amount of toxic waste produced as a by-product of making a laptop. The mud, drawn from mine tailings, contains acids, carcinogens, and radioactive material. The objects manifest strange relations, giving tangible presence to remote landscapes and industrial processes.

A project by Aram Mooradian for the Unknown Fields Division, entitled *A Comprehensive Atlas of Gold Fictions* (2010), uses Aboriginal song lines to generate a new collection of gold artefacts (Mooradian, 2011; Fig. 3). Each is inscribed: a pendant carries a voice impression from a lover, an eyebrow implant bears a DNA sequence, and landscape story is recorded onto a headphone jack. A mechanism is devised to replay the stories borne by the objects. Mooradian traces recondite uses of gold, noting how it is melted down and reused, passing from one story to another.

These fictions and design speculations are a means to examine the workings of the real, which is itself made to appear strange and unlikely. Objects like the *Rare Earthenware* vases and Mooradian’s artefacts, through their strangeness, point to the network of relations through which they are constituted and in which they take on meaning: “things and objects are static phantoms like photographs; slices of time drawn delicately from a continuum” (Davies, 2016: 207-8). There is a temporal structure to narratives and expeditions: beginning, middle, and end; or the “three-act structure, of origin, destination and return” (208). These lines through time are like “a cross-sectional slice through something to reveal lateral connections” (208).

Fig. 3. Gold object player. Aram Mooradian 2011. Machine for playing sounds inscribed as grooves on ceramic objects.

[→ view online](#)

**Fig. 4. Network of gold stories
encoded into everyday objects.** Aram
Mooradian, 2011. Visualisation of
globally distributed objects.

[→ view online](#)

This resonates with Casper Bruun Jensen’s idea of the “activity trail” (Jensen, 2017: 629). An activity trail is a pattern or form, a line laid down in a series of links to produce a kind of worn-in path, or a line of least resistance. While such trails can reflect the decisions and conscious movements of a subject, they also channel or direct, and can result from connections made independent of any particular subject. Such lines can intersect, converge, and veer off; and they structure various possibilities for subjects and objects along the way.¹¹ Infrastructure, insofar as it is topologically structured, offers possibilities for movement; more commensurate with the travel narrative than the comprehensive map.¹²

Davies and Young voyage through infrastructural networks, articulating their strangeness. Their approach blends ethnography, architecture, and fiction. They see themselves as “bearing witness” to “emergent infrastructural landscapes” (Young and Davies, 2013: 38): “By understanding the mythology and stories of these distant landscapes and disrupting or intervening in them as a “second site”, we can bridge a gap between the here and there.” (40).

4.2 Infrastructural fields: Stan Allen.

In terms similar to those used by Davies and Young, Stan Allen sees the city as an “artificial ecology”, “a complex choreography of agents, objects, and processes” (Allen, 2009: 175). “Agents and context are not separated out as figure and ground, but rather reconceived as interacting relations within a field condition” (179). A field condition “could be any formal or spatial matrix capable of unifying diverse elements while respecting the identity of each. Field configurations are loosely bound aggregates characterized by porosity and local interconnectivity” (218). Fields hybridise networks and

11. Timothy Morton argues that tracing and tracking is the fundamental characteristic of ecology, which he describes as a *practice* rather than a field of study. That is, rather than thinking *about* ecology, we think ecologically (Morton, 2010). Ecological thought is a practice of tracing connections, following trails that lead outward, and on which we find ourselves. Morton argues that rather than discovering and disclosing boundaries and essential conditions, we need to become expert at tracing the threads through which we are suspended in place.

12. Neal Stephenson’s “hacker tourist” narrative of undersea communication cables exemplifies this kind of narrative (Stephenson, 1996: para. 1). The recent proliferation of ‘field guides’ to infrastructures and technological systems caters to a new form of infrastructural tourism: see Shannon Mattern’s critique of this phenomenon (Mattern, 2016).

territories. They are two-dimensional and continuous like territories, but weave or bind things in discontinuous ways.

In an early competition project, *The Reconstruction of the Souks of Beirut* (1994), Allen proposed a set of layered and interacting systems.¹³ He illustrated these layers with line drawings – schematic plans and axonometric diagrams that recall the affectless graphic language of construction drawings (Fig.5). In the first layer he identified existing structures, articulating them as isolated blocks floating in which space. He proposed, in his second layer, new generic surfaces that bind these monuments together. Onto these surfaces, Allen located new buildings as blocks. He floated a roof overhead. Mapping out two levels of programme, Allen identified key public spaces, and some of the interstices produced. Each layer has a certain amount of freedom with respect to the others: new buildings could be added or subtracted or the modular roof system could be modified, without the design needing to be completely revised.

The design is a framework that “anticipates the future incorporation of various styles and various functions within an overall framework. It allows phasing, incremental realization, and broad participation in the reconstruction process (Allen, 1999: 59). The layers describe flexible systems or logics rather than overall form, so the design does not lose its integrity when it adapts in response to contingencies: “Field conditions’ here implies the acceptance of the real in all its messiness and unpredictability” (Allen, 2009: 217). The *souks* were infrastructures that were oriented to the future, modulating a relation between the fixed and unfixed:

By specifying what must be fixed and what is subject to change, they can be precise and indeterminate at the same time [...] They do not progress towards a predetermined state (as with master planning strategies), but are always evolving within a loose envelope of constraints (1999: 55).

The designer’s role is not only to specify, constrain, and fix; but also, to accommodate and leave open. For Allen, horizontal surfaces are particularly

13. Contemporary uses of this layering strategy have been influenced by Bernard Tschumi’s and Rem Koolhaas’s proposals for the 1983 Parc de la Villette competition. James Corner wrote: “When these separate layers are overlaid together, a stratified amalgam of relationships amongst parts appears. The resulting structure is a complex fabric, without centre, hierarchy or single organizing principle” (1999: 235).

Fig. 5. Reconstruction of the Souks of Beirut. Stan Allen, 1994. Diagrams showing conceptual layering of plan (Allen, 1994, p.64-5).

Fig. 6. Reconstruction of the Souks of Beirut. Stan Allen, 1994. Drawing of roof canopy component (Allen, 1994, p.66).

capable of this kind of accommodation and openness. They imply freedom of movement, and de-emphasise hierarchies. These surfaces are differentiated rather than segregated; the project defines a terrain rather than volumes.

Allen's *Reconstruction of the Souks of Beirut* exemplified the possibility for an architecture based on "relationships among multiple distributed sites that are both collectively and individually adjustable" (Easterling, 1999: 2). The project was less interested in built form, and more concerned with the "protocols for formatting space" (2). The Unknown Fields Division see design as a way to narratively apprehend the complex networks of relations produced by infrastructures. Allen, by contrast, sees infrastructure as a potential design paradigm, a way to construct new fields that have its flexibility and future-orientation.

4.3 River as infrastructure: Mathur and da Cunha.

In their speculative project, *SOAK: Mumbai in an Estuary* (2009), Anuradha Mathur and Dilip da Cunha responded to 2005 flooding in Mumbai resulting from a metre of rainfall in a single day. The floods overwhelmed the city's stormwater and flood control infrastructure. Mathur and da Cunha argue that new strategies are needed:

An estuary demands gradients not walls, fluid occupations not defined by land use, negotiated moments not hard edges. In short it demands the accommodation of the sea not the war against it [...] *Soak* is an appreciation of an aqueous terrain. It encourages designs that hold monsoon waters rather than channel them out to sea; that work with the gradient of an estuary; that accommodate uncertainty through resilience, not overcome it with prediction. (Mathur and da Cunha, 2009: 4, 9)

Infrastructure and environment are inseparable in their proposal; rivers, mangroves, markets, trenches, *maidan*, boats, historic forts, and sediment form an infrastructural ecology (Fig. 7). The fluid terrain of the estuary is set to work as system, but not a centralised system of concrete channels and reservoirs. In analysing the estuary, Mathur and da Cunha employ photographic sequences (Fig 8.) to represent relations as continually in flux.

Fig. 7. SOAK: Mumbai in an estuary.
Anuradha Mathur and Dilip da Cunha,
2009. System diagram of reconfigured
Mumbai estuary (Mathur and da
Cunha, 2009).

[→ view online](#)

Fig. 8. SOAK: Mumbai in an estuary.
Anuradha Mathur and Dilip da Cunha,
2009. Photographic composite showing
sectional conditions of landscape
(Mathur and da Cunha, 2009).

Mathur and da Cunha describe the flood control infrastructure of the Mumbai estuary as a relational field. Distinctions between the natural and the technical are muddled. The webs of relation involved defy reduction to a simple diagram. Allen's infrastructural fields tend to be crisply demarcated, whatever uncertainty or variation they may include; his spare line-drawings confirm this. Mathur and da Cunha situate their design interventions in fluid contexts which they redirect and adapt to. The demarcation between a project and its environment is indistinct, recalling the way infrastructures tend to merge with their surroundings (see 2.3, above).

There are, perhaps, three dispositions towards infrastructure and three ideas of design agency represented by the designers in this section. The Unknown Fields Division see design as a means to disclose the strange relations of global infrastructure. Allen sees design as a means to construct new spatial settings that learn from infrastructure how to incorporate flexibility. Mathur and da Cunha see design as a means to insightfully adjust the flows of a hybrid environment through strategic interventions. At stake for all three is a relationship to the *background*.

5. CONCLUSION: ENVIRONMENTALITY AND STRANGE RELATIONS.

Paul Edwards observes that:

The most salient characteristic of technology in the modern (industrial and postindustrial) world is the degree to which most technology is *not* salient for most people, most of the time [...] mature technological systems — cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers in the majority of their uses — reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt (2003: 185).

Things pass into this background until they cease to even count as technologies any more — Edwards gives the example of “ceramics, screws, basketry, and paper” — until they become “the invisible background, the substrate or support, the technocultural / natural environment, of

modernity” (185).¹⁴ As they slip below the horizon of attention, they produce a feeling of environmental stability, a “feeling that things work and will go on working” (185). Infrastructures progress *towards* the background, and emerge out of it. Their readiness-to-hand, their availability, depends on activity. Because activities are always changing, infrastructure involves a play of world-disclosure, an “environmentality” (Heidegger, 1962: 95; Malpas, 2006: 79). Things appear and disappear, become available and withdraw.

For Latour infrastructures disclose *technically-folded contexts*. To become directly available, a host of indirect relations must be concealed. Amongst these indirect relations are other spaces and times:

The hammer that I find on my workbench is not contemporary to my action today: it keeps folded heterogeneous temporalities, one of which has the antiquity of the planet, because of the mineral from which it has been moulded, while another has that of the oak which provided the handle, while still another has the age of the 10 years since it came out of the German factory which produced it for the market. When I grab the handle, I insert my gesture in a ‘garland of time’ as Michel Serres has put it, which allows me to insert myself in a variety of temporalities or time differentials, which account for (or rather imply) the relative solidity which is often associated with technical action. What is true of time holds for space as well, for this humble hammer holds in place the quite heterogeneous spaces that nothing, before the technical action, could gather together: the forests of the Ardennes, the mines of the Ruhr, the German factory, the tool van which offers discounts every Wednesday on Bourbonnais streets, and finally the workshop of a particularly clumsy Sunday bricoleur [...] There is nothing less local, less contemporary, less brutal than a hammer, as soon as one begins to unfold what it sets in motion; there is nothing more local, more brutal and more durable than this same hammer as soon as one folds everything implicated in it” (249).

Latour describes what I have designated *strange relations*. I am surrounded by hints of connections to somewhere and somewhen else. The infrastructural tourism of the Unknown Fields Division aims to disclose some of these

14. He also warns that this backgrounding is uneven: “This notion of infrastructure as an invisible, smooth-functioning background ‘works’ only in the developed world. In the global South (for lack of a better term), norms for infrastructure can be considerably different” (Edwards, 2003: 188).

things, places, people, and processes I am connected to without being conscious of. These indirect relations may return to me as unexpected effects. Capitalist networks multiply and intensify these connections, but are not their sole explanation.

These strange relations require us to reconsider ideas and experiences of locality. I will unpack and explore this in Chapter 5, by considering infrastructure in terms of theories of *place*. Before this, however, I will turn from the general to the particular. In Chapter 4 I describe my own journeys through an infrastructured field, the Māngere Inlet.

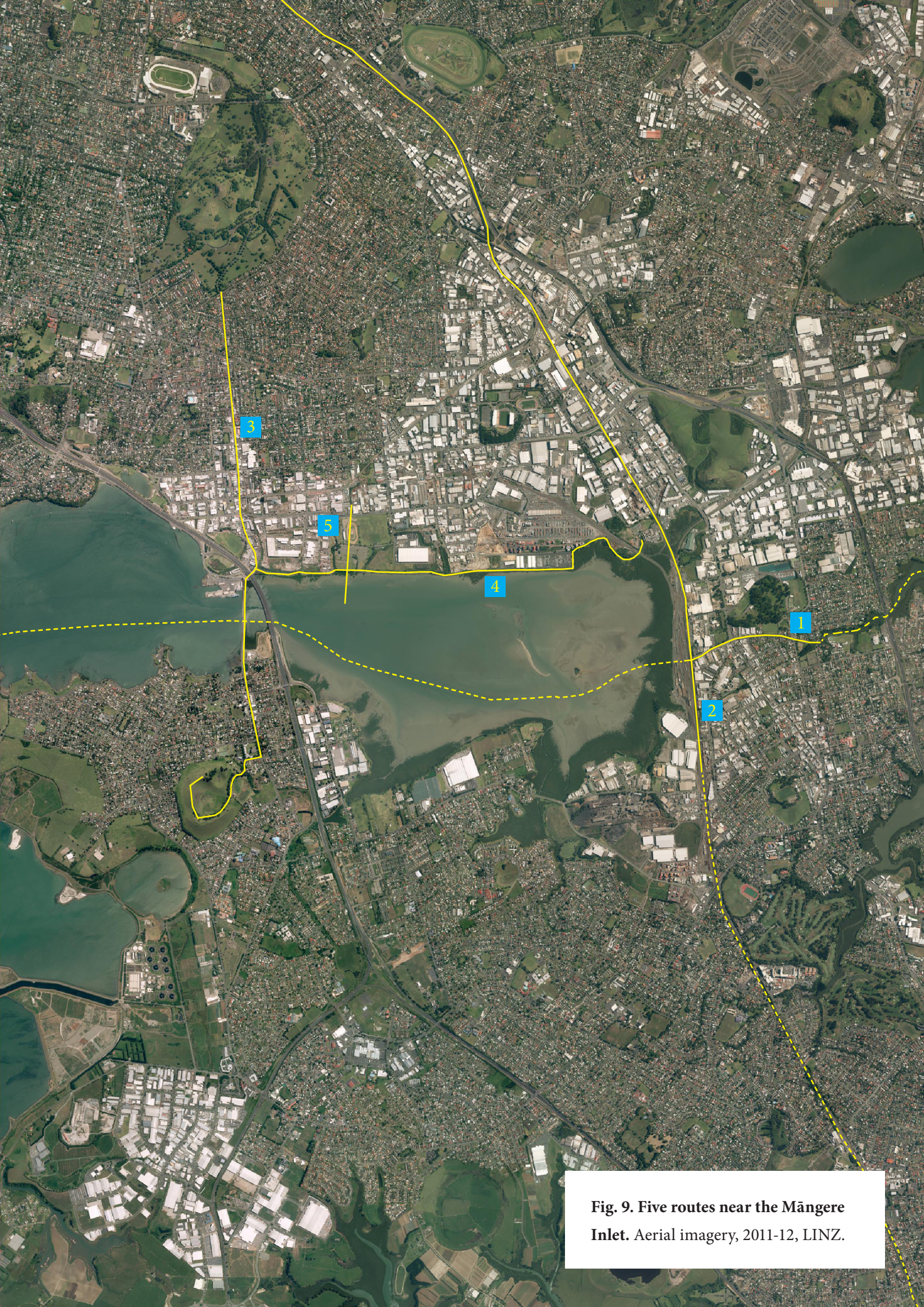


Fig. 9. Five routes near the Māngere Inlet. Aerial imagery, 2011-12, LINZ.

4

TRACING THE MĀNGERE INLET

A site description in five lines.

1. (RE)ORIENTATION

In this chapter, I introduce the context for the three project cycles: Auckland's Māngere Inlet. In the preceding chapter, I have already presented infrastructure as producing heterogeneous and entangled sociotechnical contexts, which cannot be simply unpicked into discrete layered systems (geological, biological, transport, services, etc.) without obscuring the complex interplay between them. Accordingly, rather than seeking a systemic overview, I trace five lines, influenced by Timothy Ingold's discussion of lines as "wayfaring" (Ingold, 2007: 81).

This chapter offers travel narratives describing five discrete routes (Fig. 9). These are actually composites of a number of journeys, as well as memories from previous experiences, and information gathered from other sources. As a long-time resident of the area, these travels were a way to reorient myself: both familiarising myself with the region and estranging myself from it.¹ The

1. There is an evident relationship to the Situationist *dérive* (Debord, 2014 [1958]), but also the common habit of wandering the streets and exploring (Sinclair, 2003). The extensive literature on walking in cities is outside the scope of this thesis.

five lines disclose a play of visibility and invisibility resulting from the site's infrastructural entanglements.

2. FIVE LINES

The first line was a walk retracing a historically significant route: the portage Te Tō Waka, the path of the *Tainui* canoe passing through the inlet some time during the 13th or 14th centuries (Anderson, Binney, & Harris, 2015: 56). The second line is a regularly-made journey on the commuter rail line running south from the central city to Papakura. The third line is a route from Maungakiekie to the summit of Te Pane o Mataoho / Māngere Mountain. It is a composite of a number of walks I took during my work on this thesis. The fourth line is a walk along the controversially proposed (and lately quashed) route of the East West Link highway, along the Inlet's northern foreshore. The fifth line was randomly-positioned on a map. I walked it in order to produce a one-kilometre long transect drawing, my first attempt to graphically register the Māngere Inlet's relational web. This drawing *failed* in a certain sense, a failure which I unpack as a preliminary to Chapter 5, concerned with relational strategies for drawing.

2.1. Hawaiki — Kawhia

Portage Road in Ōtahuhu crosses the narrowest part of the North Island. It begins at a muddy tidal arm of the Tāmaki River, intersects the old military Great South Road, passes a few houses, some light industry, and a rugby club overlooked by the volcanic hill Ōtahuhu (Fig. 10), towards the shallows of the Māngere Inlet. This 1.2 km long route (walked and driven repeatedly between 2012 and 2017), retraces Te Tō Waka, one of two major waka (canoe) portages and a crucial link in the network of Māori regional routes: Tamaki-makaurau / Auckland's earliest infrastructures.² The hill, Ōtahuhu, strategically controlled the busy passage. When Ngāti Whātua, originally from Kaipara, became the primary occupants of the isthmus, displacing the Te Waiohua iwi (tribe), they migrated seasonally between the fertile shark-fishing of the Manukau harbour, residing at Onehunga and Māngere, and

2. "In what was essentially a canoe age, this portage must be regarded as one of the major features of the Aotearoa coastline" (Stone, 2001: 2)



Fig. 10. View from Ōtāhuhu. Looking west by northwest towards Māngere Inlet, over Great South Road. July, 2012.



Fig. 11. Photograph of stones marking bow and stern of Tainui (canoe), Kawhia. c.1900s. Creator unknown. Ref: PAColl-8245. Alexander Turnbull Library, Wellington, New Zealand. / records/23158718.

their plantations and fisheries at Orākei.³ These routine migrations went overland and via the portage.

Portage Road retraces these movements, the first of which was the *Tainui* waka's migration from Hawaiki.⁴ Making landfall at East Cape, the migrants made their way west, then across Te Tō Waka into the Manukau Harbour. As the ocean-going waka was dragged over this portage, the scouts heard the chatter of voices; but when they looked down onto the Inlet, they exclaimed "he manu kau noa iho" / "it is only birds" (Kelly, 2002: 57).⁵ Not risking the passage through the turbulent heads, they made their way to the southern reaches of the Harbour at Waiuku, where another portage gives access to the Waikato River. From the river's mouth, they continued south, ultimately coming to rest at Kawhia Harbour. There, the waka was brought up onto the hillside and buried. Stones mark its head and foot (Fig. 11), and the anchor stone is at Maniaroa marae at Awakino. *Tainui's* passing is memorialised by the small island in the centre of the inlet, Ngarango Otainui, 'the rollers of *Tainui*'.

The route is now blocked; there is no public access to the sea. Instead of arriving at the water, you arrive at the shore of a rail-yard: line after line of tracks and freight cars (Fig. 12). A narrow footbridge provides access to the retired Westfield station platform, and Kiwirail's workshops. Portage Road is a ghost or a shadow of former uses, and a formal memory in asphalt of the *Tainui* migration. Routine and repetition inscribe paths in ways that make

3. This summary does not do justice to the complex tribal history of Tamaki Makaurau / Auckland. There are at least seven iwi (tribes) that include parts of the area within their rohe (territory of concern). Stone (a Pākehā historian) gives an outsider's summary (2001: 28-55). The main marae of the area are: Pūkaki at Māngere and Makaurau at Ihumatao (both of the iwi Te Ākitai Waiohua), Te Puea at Māngere Bridge (Waikato iwi), and Ōrakei (Ngāti Whātua o Ōrakei).

4. For current understandings of the 'great fleet' theory and the location of Hawaiki, see (Anderson, Binney, & Harris, 2014: 43-47). *Tainui* is believed to have set out from the Cook Islands. For a tribal history, including a discussion of these origins, see Kelly (2002).

5. Other etymologies for the name refer to uncertainties and anxieties, perhaps in relation to the dangerous harbour entrance (Simmons, 1987: 71). Large numbers of shore birds still take up residence in the area, including kūaka (bar-tailed godwits). Occasionally an appreciable fraction of the world's population of wrybills can be seen on the huge roofs of the area's distribution warehouses (Lovegrove, 2008).



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Fig. 12. Westfield rail yards. Looking west towards Māngere Inlet, from pedestrian overbridge. October, 2012.

them re-enactments of previous activities, establishing invisible resonances with places and people distant in time and space.

2.2. Ōtahuhu Train Station — Britomart Transport Centre

My second line is the route of a commuter rail trip, highlighting temporal patterns of routine, synchronisation and development. The Southern Line, one of Auckland's most heavily used transport corridors, crosses and blocks the portage route. While the rail line, too, has historical resonances (Ōtahuhu Station was first opened in 1875), I have treated it here as a line in a repetitive and continual present. This is the way I have encountered it, as the route by which I have travelled to and from the central city, five days a week, since 2015.

Looking south from the narrow footbridge over the Kiwirail yards, Ōtahuhu station is visible, hanging above the tracks, new, glossy, and angular (Fig. 13). Auckland's commuter rail network is flourishing, and Ōtahuhu station is a major transfer point between South and Central Auckland, at the border of two public transport zones. Commuter and freight services share two lines of tracks: goods from the Port of Tauranga, steel from Glenbrook Steel Mill, freight from further down country. A third main rail line is imminent, a fourth possible.⁶

It is a busy station: At seven thirty, when I catch my train to the city, clumps of high-schoolers are playing fragments of songs loudly from Bluetooth speakers, the odd fare dodger is trying to talk their way past the guard, and a steady flow of people are swiping their cards through the gates. A video cycles through a rendered animation of the building, pointing out its symbolic references to the nearby portage (Auckland Transport, 2017). One Saturday morning I watched a boy with a collection of stereo components in a box sort a prodigious pile of coins on the seat in front of him; he asked me to call his phone, because he had left it in a taxi. I recognise the regulars and know where they alight. They are variously equipped with laptop bags, hi-viz vests, cakes for a shared morning tea, polar fleece vests, high heels, headphones.

6. The National government in 2017 tried to conceal the business case for the Third Main, apparently because it made the business case for their favoured East West Link (see 2.4 below) look poor (Ross, 2017).

Fig. 13. Ōtāhuhu Station. Photograph:
Auckland Council.

[→ view online](#)



Fig. 14. Mutukaroa hill and Ann's Creek wetland, Southdown. Looking northeast from a train travelling on the Southern Line. August, 2015.





Fig. 15. Electricity substation, Southdown. Taken from a train travelling on the Southern Line. August, 2015.





Fig. 16. Light industry with Maungakiekie in the distance, Penrose. Taken from a train travelling on the Southern Line. July, 2015.

I have started to organise my life around train and bus destinations and try to avoid going to places not served. I have learned the timings for certain transfers, how long to hold my payment card against the reader, and how long the train's doors take to open. Like the other people on the Southern Line, I have become synchronised to infrastructural rhythms. These daily and hourly repetitions and schedules link to slower temporal patterns of growth, development and optimisation. As a habitual route, it is deeply familiar to me; but as narrowly canalised movement, my experience of the path is flattened into a smooth visual continuum punctuated unevenly by stations, points where I can choose to redirect my activity or change speed.

2.3. Maungakiekie — Te Pane o Mataoho

Travelling along Portage Road and the Southern Line means travelling *along* a line. The third line is a *transverse* line, a route intersecting infrastructural connections. The things one *comes across* along the way here are points of contact with other narratives; what Ingold calls “knots” in a “meshwork” (Ingold, 2007: 100; see Ch.5, sec. 5 below). The task of untangling all the threads, at even a single point, is perhaps impossible. Walking is like tracing a finger over a meshwork, feeling the weave, attending to some of its more prominent knots. I have been walking parts of this route for over thirty years, but the following narrative is composed from a series of walks taken between 2013 and 2017. They were sometimes made in the company of others, including groups of students, and sometimes alone.

This line connects two prominent volcanic cones that overlook the Māngere Inlet, encountering particularly the interplay of geology and ground with infrastructural trails. At the top of Onehunga Mall Road, formerly Queen Street, is the entrance to Cornwall Park, the clipped and groomed domain surrounding the volcanic cone of Maungakiekie (Fig. 17).⁷ The second largest volcano on Auckland after Rangitoto and second tallest after Maungawhau / Mt Eden, Maungakiekie erupted a little more than 50 000 years ago through the uplands of the isthmus, spreading a broad apron of lava over twenty

7. Maungakiekie was known briefly as Mount Prospect, and One Tree Hill, after a totara (Te Totara-i-ahua), then a distinctive Monterey Pine that stood on its summit (Forbes, 2015). The latter was injured by Mike Smith, a Māori activist protesting the then-government's Treaty of Waitangi negotiation policy, and ultimately removed. A cluster of native trees is now being grown at the site.



Fig. 17. Maungakiekie seen across the Māngere Inlet. Suburbs of Onehunga, Te Papapa, One Tree Hill are visible. March, 2016.

square kilometres (Fig. 18) (Hayward, Murdoch, and Maitland, 2011: 136-40; Leonard et al., 2017: 6). Most of Onehunga, Royal Oak, Penrose, Greenlane, and Epsom is built over this lava field. Looking from the southern side of the inlet, the land rises to the point of the cone, conveying a sense of its bulk. Much of it was acquired by colonial entrepreneur and philanthropist John Logan Campbell during a flurry of purchases authorised after the initial grant of land by Ngāti Whātua to the British Crown for the establishment of colonial Auckland (Stone, 2001: 260-1; McLauchlan, 2008: 59-68).⁸ Maungakiekie's cone is inscribed with terraces, clearly visible in the low light of morning or evening. They are the sculpted remains of the massive Te Waiohūa pā.⁹ Amanda Yates has called Maungakiekie “urban architecture [...] a generative landscape [...] carved whenua” and noted how this topography was used to generate food and energy, and manage waste (Yates, 2010: 32-3).

Rain falling on these slopes soaks through scoria and cracked basalt until it reaches the smooth firm Waitematā sediment,¹⁰ from where runs down and pools as an aquifer near the harbour, welling up at Captain Springs. There's a pump station: a generic looking concrete building with pipes coming out that still feeds into the Auckland water supply (Hayward, Murdoch, and Maitland, 2011: 137-8). Onehunga residents will sometimes point out that their water tastes better than the rest of Auckland's. However, what they do not often mention (and may be unaware of) is that, south and east of Captain Springs, the aquifer is one of New Zealand's most contaminated sites: phosphate and heavy metals leach from a former fertiliser factory and trickle into the Māngere Inlet at Miami Creek (Ministry for the Environment, 2017: no.4).

8. The summit bears an obelisk installed by Campbell. The park was his gift to the city, and the obelisk is inscribed as a memorial to Māori. The monument's inscription is admiring of Māori but elegiac, reflecting a view of Māori as an historic presence.

9. “There are times of day, as the sunlight falls low and harsh, when the history of New Zealand is revealed in shadows on the land” (Ell, 1985: 9) finally abandoned in the seventeenth century. 5-7000 inhabitants (Yates, 2010: 31, Bulmer, 1994: 27).

10. Lava tunnels riddle Maungakiekie's suburban slopes, accessed from back yards and via unremarkable manhole covers (Hayward, Murdoch, and Maitland, 2011: 14-8) Grotto Street is named for a large one, and beside it there is a swampy pond formed when another collapsed. Behind the Onehunga Workingmen's club on the Mall there is another.

Fig. 18. Lava flows from Maungakiekie. Crosses mark visible outcrops and caves. (Hayward, Murdoch, and Maitland, 2011, p.136).

Down the hill, past brick sausage flats and timber cottages, a brash outlet mall, and shops for second-hand goods, army surplus, vegetables, dumplings, and books, is St Paul's Anglican Church. Its graveyard contains the dead from the *HMS Orpheus*, which sank on the bar at the entrance to the Manukau harbour in 1863, carrying supplies for the colonial armies in the invasion of the Waikato.

At the bottom of the mall, there is a less visible volcano: Te Hopua a Rangi, once a circular tidal basin full of boats (Fig. 20), but now reclaimed and bisected by State Highway 20 as it approaches the bridge over the harbour. There are, in fact, two bridges. In the sweeping shadow of the new bridge, the old, slated for demolition, is still used for walking, cycling, and fishing. It looks onto the port which, due to the difficult entrance to the harbour, has remained small. Cement used to be shipped from Westport in the South Island on the *MV Milburn Carrier* (two tall Holcim silos tower over the port), and coal barges fed the power station at Southdown until it was mothballed. Now there are only fishing boats. Reaching the south end of the bridge, the Māngere side, there are the shops of Coronation Road (another reference to the Queen). St James's Church, on the rising ground to the west, was built by members of Ngāti Mahuta as part of a Māori Militia settlement, established by Governor Grey in 1849 to provide a buffer against hostile incursions from the south. The church is made of black basalt from Māngere mountain, held together with lime mortar made by burning shells collected from the harbour (Hayward, Murdoch, and Maitland, 2011: 79; Timespanner, 2011; La Roche, 2000). When Ngāti Mahuta locals refused to swear an oath of allegiance to the Crown in 1863, the settlement was evicted and their land confiscated (Ringer, 2010) in 1863.¹¹

The mountain rises behind the church. From here, the route I have been tracing curls around the huge crater of Te Pane o Mataoho / Māngere mountain, with its bulbous lava plug swelling in the middle. Te Waiohua had another major pā atop the hill. When invaders took it they laid dog-skin cloaks on the shell path to muffle their movements (Stone, 2001: 43). From the top, one can look down onto the fringe of lava that spilled out from the

11. Waikato chief Te Wherowhero wasn't a signatory to the Treaty of Waitangi. The request for a pledge of allegiance was deliberately provocative at a time when the belligerent Colonial government looked for pretexts to push Māori away from Auckland (La Roche, 2000; Ringer, 2010).





Fig. 19. View from Te Pane a Mataoho / Māngere Mountain, looking back towards Maungakiekie. Rangitoto visible in the distance. View overlooks Port of Onehunga and Māngere bridges. July, 2016.



Fig. 20. Gloucester Park, Onehunga, Auckland. 1948, Whites Aviation.
Ref: WA-13238-G. Alexander Turnbull Library, Wellington New Zealand. / records/23134829. The circular basin of Te Hopua has been filled in.

mountain when it erupted (around 70 000 years ago; Leonard, et al. 2017: 6), and back across to Maungakiekie (Fig. 19). Shifting sands, tide-borne sediment, volcanic basalt and scoria cones interact in complex ways with colonial and pre-colonial military logistics, water supplies, agriculture, horticulture, transport, and the production of construction materials.

Through a walk like this, one can describe infrastructures in two directions: longitudinally and transversally. Longitudinal lines follow the connections of an infrastructural topology, moving *within* the weave, highlighting its temporality and potentials. Transverse lines intersect those lines, cutting through the weave, moving “*off the grid*” (Douglas, 2011: 45; Ch. 3, sec. 3.1) disclosing externalities, residues, and unintended effects through side-tracks and digressions.

2.4. State Highway 1 — State Highway 20

Another route, walked in July 2016, followed the northern foreshore of the Māngere Inlet, also the path of an erstwhile projected highway. Although the path follows a projected infrastructural line, I consider my walk a transverse line: rather than moving within the network I moved alongside it, noticing how the infrastructure itself cut across a weave:

Drawn cross-country, [such lines] are inclined to ride roughshod over the lines of habitation that are woven into it, cutting them as, for example, a trunk road, railway or pipeline cuts the byways frequented by humans and animals in the vicinity through which it passes (Ingold, 2007: 81).

The East West Link was proposed in the second tranche of the National government’s “roads of national significance” (RoNS) project, instigated originally in response to the 2008 global financial crisis (Robertson, 2011). Portions of seven state highways were selected for significant capital investment, administered by the New Zealand Transport Authority (NZTA). Intended both to stimulate the economy and to support long-term economic

Fig. 21. Waikaraka Park Cemetery.

June 2014.



growth, the RoNS exemplify the political and economic entanglement of infrastructures and their links to narratives of development.¹²

The new East West Link was to connect State Highway 20 at Onehunga to State Highway 1 at Sylvia Park, running along the foreshore, and elevated over the wetlands of Ann's Creek (New Zealand Transport Agency, 2017). Congestion chronically hampers freight movement in the area and the main impetus for the new road project was to facilitate such movement. While the NZTA claimed environmental and social benefits to the project, the plausibility of these claims was severely criticised (Wilson, 2017). At the time of my walk, and for most of the period of this research, the East West Link seemed inevitable. After the 2017 election, however, the Labour–New Zealand First coalition government announced it would be halted in favour of greater investment in public transport (Jacobson, 2017).

The northern foreshore of the inlet is largely reclaimed land. Two former bays were used as landfill sites, and toxic leachate from a former fertiliser factory gets into the harbour along this edge (Figs. 54, 55). Walking from Onehunga along an existing path, I crossed this constructed ground looking for traces of other temporal lines, beginning at Waikaraka Cemetery, established in 1890 to serve the growing colonial community (Mogford, 1977: 28) (Fig. 21). The cemetery, like the railway, synchronises many human stories by placing lives in parallel. The cemetery's ground, too, was reclaimed from the harbour: once a promontory surrounded by the sea, today only the south-facing sea wall remains.

Industrial buildings are gradually covering the landfilled area inland, but many weed-filled lots remain. The path crosses the filled-in former bays and then runs through a damp, regularly mown grass sward. Dense foliage separates this narrow lawn from the sheds and weeds, but there are regular traces left by people or animals pushing through on informal and improvised routes. On the seaward side, a rubble bank resists erosion (Fig. 24).

12. In 2017, campaigning for re-election to a fourth term, the National government proposed a second tranche of ten projects (New Zealand National Party, 2017; New Zealand Transport Agency, 2017). Critics argue that they ignore opportunities to move more freight by rail, and siphon money away from other worthy projects, particularly public transport and active mode projects (Wilson, 2017).

Fig. 22. Metroport inland container terminal. Looking west from Onehunga-Southdown walkway, with low basalt stone walls of unknown date. June 2016.







Fig. 23. Railway line into Metroport inland container terminal. Viewed from a train travelling on the Southern Line. The pedestrian bridge at the end of the Onehunga-Southdown walkway is visible. August, 2015.



Further along, heavy metal clangs and thuds emanate from stacks of steel containers emblazoned with the logos of international shipping companies: Maersk, Hamburg-Süd, China Shipping, Safmarine (Fig. 22). This is the back of Metroport, an inland container terminal fed by rail, mainly from the Port of Tauranga, in competition with Ports of Auckland. The generic boxes that are moved around here connect to supply chains for car tyres, baby strollers, sacks of rice, Samsung TVs, iPhones, fast fashion, towels, machines. On a map, the rail line from the south sprays out into sidings, as if it were a firehose flooding the city with goods.

On the path behind Metroport are the remains of scoria-built walls and steps leading to the water whose provenance or intent I have been unable to trace (Fig. 61). At the end of the path, beside the now retired Southdown Power Station, a footbridge over the tracks connects to Hugo Johnston Drive (Fig. 23). Deviating from the path, however, I pick my way over Maungakiekie's uncovered toes. Sounds of traffic and industry blend into distant white noise. Amongst rocks, mangrove pneumatophores, samphire, and oysters, and watched by a broken-footed seagull, I find shattered plastic debris pausing from its tidal migrations.

Ingold compares “the path of the wayfarer” that “wends hither and thither” with the transported traveller “who departs from one location and arrives at another” with “nowhere at all” in between (Ingold, 2007: 84). Wayfaring along the proposed highway route, I experienced it as oscillating between nowhere and somewhere. Whereas the East West Link was predicated on an ideal of optimised transport, more complex patterns of departures, arrivals, accumulation, and exchange are indicated by the circulating plastic debris, consumer goods, leachate, scavengers, and gravestones that crossed my path.

2.5. (174.7972, -36.9256) — (174.7957, -36.9345) ¹³

This fifth line was my first attempt to document the knotted meshwork of the Māngere Inlet. I interpreted my transverse lines (lines 3 and 4) as *section lines*, reasoning that they *cut through* the urban fabric. On that basis, I set out to sample the site more rigorously with ten one-kilometre-long transect

13. Unless otherwise specified, all geographic coordinates are according to the New Zealand Transverse Mercator 2000 projection (Land Information New Zealand, 2017).

Fig. 24. Onehunga-Southdown walkway, near Waikaraka Park.
Looking west towards Māngere Bridge and Port of Onehunga. The walkway crosses landfill reclamation. July, 2016.



drawings at a scale of 1:1000. After drawing the first transect in July 2014, I reconsidered this intention for reasons I will discuss below.

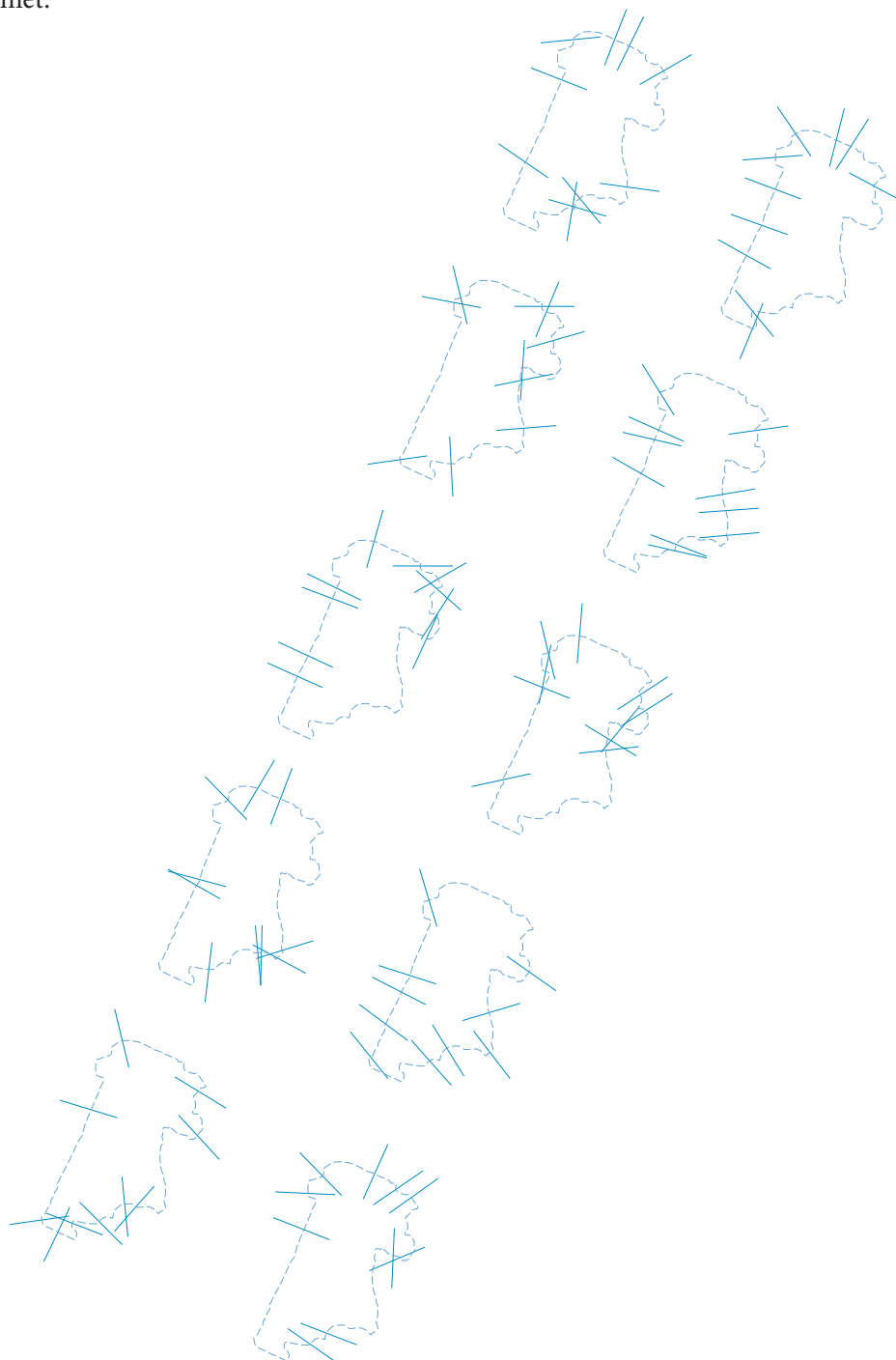
The line was randomly placed onto a map using GIS software (Fig. 25).¹⁴ I then visited the site and took notes with a camera, notebook and tape measure. In the subsequent, intricate CAD section drawing (Figs. 26, 27), I endeavoured to capture contingent and fleeting details, as well as comparatively fixed ones. Where information was missing or unavailable, I made educated guesses. So, for example, the sub-ground structures were estimated based on geological reconstructions of the region's history (Eobrooke, 2001; Hayward, Murdoch, and Maitland, 2011; Searle, 1981).

The line begins in a yard beside a factory producing kitchen and bathroom fittings. I cannot not gain access, but I can see through the chicken-wire fence. Pallets and plastic wrapping lie around, and large pipes are stacked next door. The line then takes me across Neilson Street. Over the road, a high scoria wall separates the street from Waikaraka Park (one of Auckland's earliest recreational facilities; Mogford, 1977: 43) and the Waikaraka Park Speedway (a dirt oval for stock-car racing and demolition derbies). Grazing the speedway oval, the line extends into Waikaraka Cemetery, past the sober columns, angels, and inscriptions of the nineteenth-century graves, and the lavish floral arrangements of Pacific Islanders' graves. At the edge of the cemetery, pōhutukawa trees overhang the 1935 stone seawall. After a few metres of mangrove is mud and water.

I hoped through this drawing to apprehend infrastructural relations, but I came to see it as a failure in this regard. Because the drawing only captured a single instant (even though it took several hours to walk and survey), dynamic relations and movement congealed into a simulated moment. Because it was a kilometre long but only a few metres tall and deep, everything was compacted into a thin layer. And because it cut *through* things, infrastructural links were severed. The network of storm-water drains manifested only as little circles where pipes are cut; the road did not lead anywhere. I encountered difficulty with my transect drawing because I

14. I tested several techniques for this, including a program written in the Processing scripting language (v. 3.3.6; Processing Foundation, 2017), settling on an algorithm made using the Grasshopper node-based modelling plugin (v.0.9.0076; Rutten, 2017) for Rhinoceros 3D (v. 5 SR13; McNeel Software, 2017). My algorithm located random points on the foreshore around the inlet, and drew a 1km line crossing the shoreline at a perpendicular angle.

Fig. 25. Randomly generated transect locations. Produced using Grasshopper plugin for Rhinoceros 3D. Each iteration of the algorithm randomly generates ten perpendicular lines across a curve representing a path circumnavigating the Māngere Inlet.



had mistakenly conflated the transverse and the sectional. Section drawing is a well-established conventional technique for describing bounded places as patterns of solid and void. The notionally impartial stare of orthographic drawing emphasised physical dimensions, but these do not correspond to significance. The drawing provided some sense of spatial volume and mass, but told me little about the relational networks in play.

3. RETURNS: ALONG AND ACROSS LINES

Wayfinding via these routes, the Māngere Inlet returned to me as a densely-woven meshwork of temporal lines. The lines I walked disclosed or intimated some of the many other lines forming this entangled place. Ingold writes:

the environment does not consist of the surroundings of a bounded place but of a zone in which their several pathways are thoroughly entangled. In this zone of entanglement – this meshwork of interwoven lines – there are no inside or outside, only openings and ways through (Ingold, 2007: 103).

Such relational networks do not have simple interiors and exteriors; but they do configure spaces of visibility and invisibility, of connection and remoteness. When I moved longitudinally, I experienced synchronising and accelerating effects of infrastructure; when I moved transversally I observed a more finely woven mesh of relations. I was particularly struck by circulation (repetitions, habituations, re-enactments, recycling), accumulation (deposits, slowings, residues, stockpiles), and exchange (intersections, knots, transitions) as recurring phenomena.

The following two chapters pick up on some of the threads that came loose in these explorations. In the next chapter, Chapter 5, I will review a selection of theories of *place* that resonate with the experiences I have just described. After this, in Chapter 5, I will explore *drawing* conventionalised disciplinary method, and seek out some alternative relational strategies more suitable for describing these infrastructural entanglements.

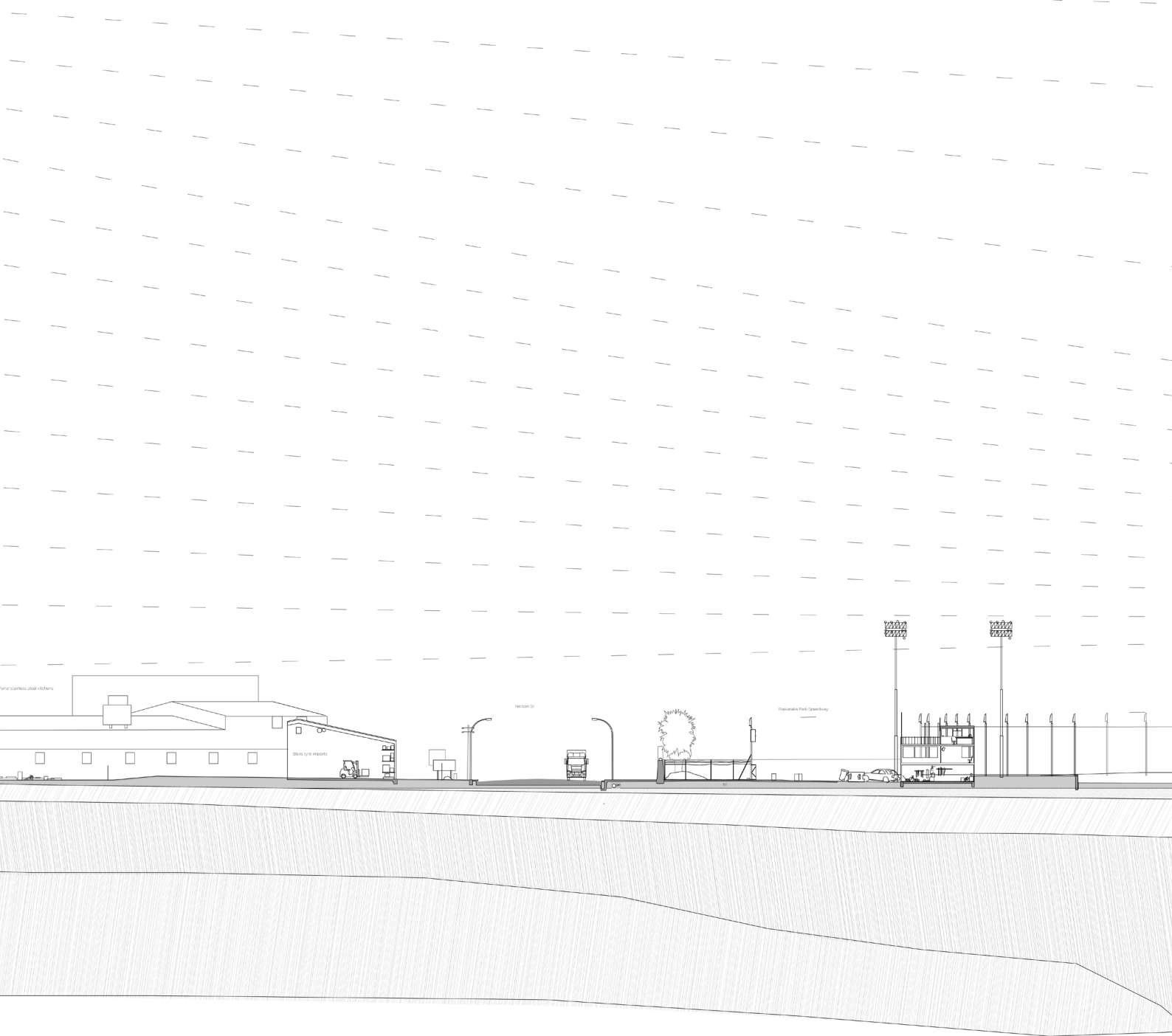


Fig. 26. 1km transect drawing.
 From vicinity of Neilson Street to the
 Māngere Inlet, via Waikaraka Park
 Cemetery. Detail showing Neilson
 Street.

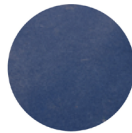
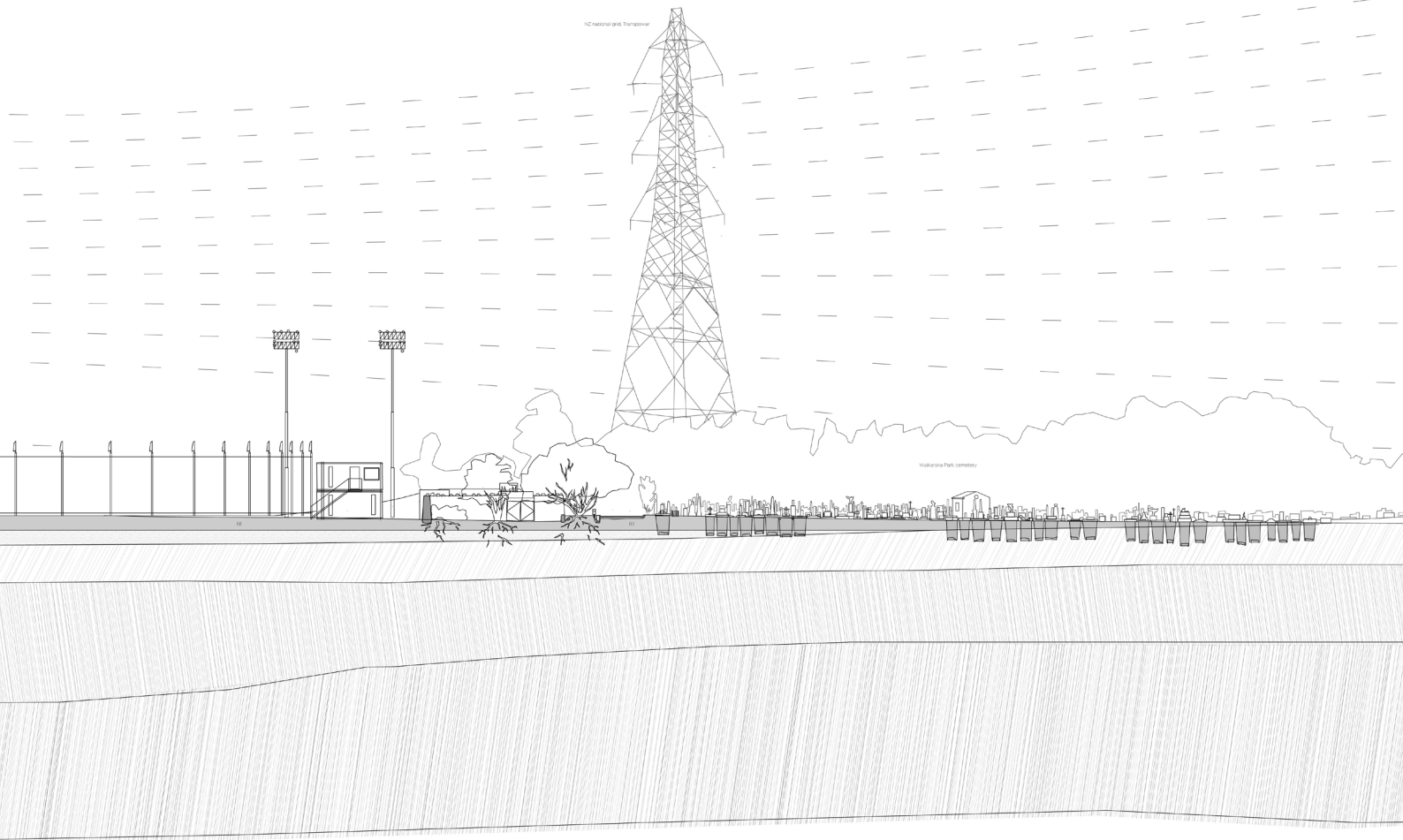




Fig. 27. 1km transect drawing.
From vicinity of Neilson Street to the
Māngere Inlet, via Waikaraka Park
Cemetery. Detail showing Waikaraka
Park Cemetery.

5

TOPOLOGIES:

Infrastructure as place.

1. PLACE AS A KEYWORD: INITIAL DEFINITIONS

In my discussion on infrastructure generally (Chapter 3), and as I traced lines across the Māngere Inlet (Chapter 4), I encountered relational fields, “loosely bounded aggregates characterized by porosity and local interconnectivity” (Allen, 2009: 218). These fields compress, dilate, and introduce discontinuities in space; and include remote and asynchronous elements. In this chapter, I seek conceptual resources for understanding these fields in theories of *place*. Specifically, I refer to models of place as *topological*: assembled from a network of connections.

The term *place*, like *infrastructure* (Ch.3, sec. 1) can be thought of as a “keyword”: a polysemic clustering of concepts and related language that do not settle into any single definition (Williams, 1976: 13). Place concerns location or situation, but is not merely a measured position in some domain. It includes ideas of context, setting, landscape, and environment; orientation, facing and immersion; grounding and backgrounding; and making room (Malpas, 1999: 21-2). Theories of place may implicate the nature of world, universe, cosmos, or creation (Casey, 1997: 19-24). They may address particular sites, local regions, individual spaces, conditions of interiority.

They may concern the ways entities define, take up, mark, or open spaces. And they may concern humans as both bodies in space, but also somehow cosmic: simultaneously figures against a ground and the grounding condition of all figures (Casey, 1997: 375-6). Concepts of place are cultural: in Aotearoa / New Zealand's colonial context, "the indigenous world view, the land and the people, have been radically transformed in the spatial image of the West" (Smith, 2012: 53).¹ Place is also commonplace, associated with "the practice of everyday life" (de Certeau, 1984), and an aspect of our "lifeworld" (Husserl, 1970: 254):

Place is latitudinal and longitudinal within the maps of a person's life. It is temporal and spatial, personal and political. A layered location replete with human histories and memories, place has width as well as depth. It is about connections, what surrounds it, what formed it, what happened there, what will happen there. (Lippard, 1997: 7)

As replete, relational, performative and inextricably complex, place rather than space is my focus in this inquiry.²

I begin this chapter by considering place and its other: placelessness. Anxieties about placelessness are often attended with a suspicion of technology, and infrastructures sometimes feature ominously in these accounts as corrosive of place. I then turn to three models of place that are potentially more amenable to infrastructure: Jeff Malpas's topography, Bruno Latour's actor-network theory, and Timothy Ingold's life-lines. Resonances exist between these three models, although they cannot be simply conflated or harmonised. While each incorporates significant critiques of technology,

1. "[A]lternative, long-held, comprehensive and theoretically sophisticated understandings of place exist outside, alongside, against, and within the domain of the Western philosophical tradition. These understandings of place, often framed in terms of *land*, derive from entirely different epistemological and cosmological foundations and, thus, cannot be easily combined or absorbed into Western argumentations. They come from, and go to, a different place" (Tuck & McKenzie, 2015: 11). For example, see Albert Refiti's detailed exegesis of Samoan concepts of space (Refiti, 2017). Keri-Anne Wikitera provides an example of the crossings and conflicts of Western and Māori understandings of space in her discussion of Hinemihi o Te Ao Tawhito, a whare tūpuna (ancestral house) taken to England (Wikitera, 2015).

2. I use 'space' mainly in a Cartesian-Newtonian sense, and thus in tension with the fuller concept of place; but the two are not in simple opposition. Lefebvre, with the idea of "social space" (1991:1), closed the gap between the two (as does Massey; 2005). Both Casey (1997) and Malpas (1999) provided nuanced accounts of the interplay between the two.

they also allow for nuanced positions on it – opening the door for creative and constructive exploitation of infrastructure.

2. ANXIETIES OF PLACELESSNESS

At least since Heidegger's description of technological "enframing" (1977: 19)³, place has commonly been used to evoke resistance to the globalising and homogenising forces of technological modernity and capitalism epitomised by networks. It is described as something that has been lost or suppressed by technological modernity and is in need of rediscovery.⁴

In the context of a world which is, indeed, increasingly interconnected the notion of place (usually evoked as 'local place') has come to have totemic resonance. For some it is the sphere of the everyday, of real and valued practices, the geographical source of meaning, vital to hold on to as 'the global' spins its ever more powerful and alienating webs. For others, a 'retreat to place' represents a protective pulling-up of drawbridges and a building of walls against new invasions. Place, on this reading, is the locus of denial, of attempted withdrawal from invasion / difference (Massey, 2005: 5-6).

Edward Relph, who associated place with security and identity, diagnosed a contemporary condition of rootlessness, writing that "'placelessness' – the weakening of distinct and diverse experiences and identities of places – is now a dominant force" (Relph, 1976: 6). Without meaningful places, we are cast adrift in abstract and homogeneous space, "made and processed like sliced bread" (Relph, 1993: 26).

Infrastructures, being symptomatic of technological modernity, often feature as examples of lost or failed place. Marc Augé described the condition of "supermodernity" as characteristically producing "non-places" (1995), "places divested of meaning, homogeneous, and largely interchangeable" (Trigg, 2017: 127). Non-places include supermarkets and airports, as well as:

3. "Enframing means that way of revealing which holds sway in the essence of modern technology and which is itself nothing technological [... It] demands that nature be orderable as standing-reserve" (Heidegger 1977: 20-3). Heidegger initially developed the concept in a lecture in 1949.

4. For example, Casey asks "The question is, can we bring place out of hiding and expose it to renewed scrutiny?" (1997: 16).

hotel chains, leisure parks, large retail outlets, and finally the complex skein of cable and wireless networks that mobilize extraterrestrial space for the purpose of a communication so peculiar that it often puts the individual in contact only with another image of himself (Augé, 1995: 64).

Non-places are “closed universes where everything is a sign” (33) and there is “no organic society” (112), only “contractual relations” (101). History is reduced to spectacle and image by “the urgency of the present moment” (104). In Augé’s account, infrastructure appears problematic.⁵

When place is opposed to non-place (or place to placelessness), place is given a fixed set of qualities lacking in infrastructural locales. Trigg, however, calls this move of Augé’s “misguided”, because it makes place a particular category of locale, rather than the general condition of situatedness. (2017: 139). A café table in an historic precinct and an airport queue are very different places, but places nonetheless. The distinction between place and non-place marshals the “totemic resonance” of the former against the technologized contexts of modernity (Massey, 2005: 5).

While Augé’s critique is important, its casting of infrastructure as hostile and corrosive to place, as the spreading grey of an alienating technological context, underestimates the practiced ways in which we make ourselves at home in infrastructured contexts.⁶ It also makes it difficult to “exploit,” “reclaim,” recuperate or learn anything of value from them (Easterling, 1999: 2; Allen, 1999: 52).

In the next sections, I discuss three alternative approaches to place. They are not premised on distinguishing between place and non-place, because they each regard placedness as inescapable. For this reason, they have provided

5. Augé’s account is not as binary as it might seem. Place and non-place are in a dialectic relation: “the first is never completely erased, the second never totally completed; they are like palimpsests on which the scrambled game of identity and relations is ceaselessly rewritten” (Augé, 1995: 78-9). Augé’s terminology obscures this under an apparent binary.

6. Trigg refers to Ballard’s experience of airports. Ballard wrote: “I have learned to like the intricate network of car rental offices, air freight depots, and travel clinics, the light industrial and motel architecture that unvaryingly surrounds every major airport in the world. Together they constitute the reality of our lives, rather than a mythical domain of village greens, cathedrals, and manorial vistas.” (1997: 26)

productive insights for my own analyses and projections of place in the Māngere Inlet.

3. TOPOGRAPHY

The first alternative model I will consider is that of Malpas, who proposes a “topography”, a tracing-out of place akin to the work of a surveyor:

The topographer who is concerned to map out a particular region and who has nothing to go on but the basic technology of theodolite and chain – along with a good eye, a steady hand, and strong legs – has the task of mapping out that region while located within it. Such a task can only be accomplished by looking to the interconnections among the features of that region and through a process of repeated triangulation and traverse (Malpas, 2006: 34).

The topographer is already situated, and thus can only proceed through a series of relative determinations that are made through movement.

Malpas draws on Heidegger’s account of human situatedness, in particular the notion of human being as “*Dasein*”, “being-there” (Malpas, 2006: 47).⁷ Human beings are, before anything else, situated. This situatedness is not, however, a comfortable grounding for identity, but fundamentally uncertain. Rather than referring to a particular way of being, *Dasein* refers to something essentially unknown. It is not “a turning back into the familiar and the secure” but,

the opening up of a genuine questioning and listening [...] a turning back that involves a proper attentiveness and responsiveness to the place in which we always already are [...] In belonging to place we are drawn into the questionability of place, the questionability of dwelling, the questionability of our own identity, rather than into some secure and comfortable residence in which questioning has somehow been brought to an end (Malpas, 2013: 27-28).

For Heidegger, to be situated, to be in place, is to be thrown open – not merely *pulled* open from a previously secure and closed condition, but to

7. The nuances of Heidegger’s language lead to lengthy discussion of how and when to translate his terms. For discussions of *Dasein* that bring out its relation to concepts of place, see Sheehan (2015: xvi) and Malpas (2006: 47-51).

find oneself already open from the outset.⁸ Significantly, *Dasein's* world is not one of raw perceptual data that is then interpreted, but a world laden with meaning (or at least potential meaning):

the place in which we first find ourselves... is not an abstract world of ideas, not a world of sense-data or “impressions,” not a world of theoretical “objects” nor of mere causal relata. In finding ourselves “in” the world, we find ourselves already “in” a place, already given over to and involved with things, with persons, with our lives.”
(Malpas, 2006: 39)

Accordingly, Malpas's topography does not pre-empt things, people, and activities by reducing them to configurations or effects of an underlying reality.⁹ Nor does it predetermine which will be significant for a place. Rather, it insists on a kind of superficiality. Because “[t]he lie of the land is given – almost literally – *on* its surface rather than being hidden *beneath* it” (1999: 40), the elements of place are understood “not in terms of an underlying structure to which they can be reduced, but rather in terms of their own interrelation” (40). Topography emergent structures implicate spaces, but space is not understood to be a universal structuring matrix.

There is no reduction of the landscape down to some underlying foundation from which the features of the landscape could be derived or in which they are founded. For the topographer, there is only the surface of the land itself — the topography that is written into that surface and accessible from it, rather than lying beneath or being visible from some point far above (Malpas, 2006: 34-5).

Surveyors use triangulation to locate points in the landscape. By sighting locations from multiple positions, even if no absolute position is available, a map of relative positions can be determined. Although it is not absolute, such a map is nonetheless *objective*: “[T]he determination of location in

8. Thus, situatedness is not a marginal concern for Heidegger, but fundamental to his philosophy. We cannot think of ourselves, or think at all, independent of our “*thrownness*” (1962: 174).

9. Heidegger himself referred once to a “topology” that would map out the “location of being” (Heidegger, 2003: 47; Malpas, 2006, p. 33). Malpas titles his 2006 book *Heidegger's Topology*, but refers to his own thinking of place as “topography” (2). He explains that ‘topology’ has mathematical overtones, referring to the study of surface geometries; while ‘topography’ (with its reference to *grapheme*), connotes drawn or written lines. In this exegesis, topography refers either to describing the shape of a terrain, or specifically to Malpas's model of place. For my use of topology, see (Ch.1, sec.4).

triangulation is thus essentially *relational*, and this is a feature of such locations and not only of our knowledge of them” (2017: sec. 2)¹⁰ By prioritising movement and activity, the topographical model is potentially well-attuned to describing infrastructured places. Topography provides a methodology for studying place based on the principle that structure emerges by tracing out relations. It does not aspire to discover an ultimate or fundamental sense for place. Place’s questionability cannot be foreclosed. Through triangulation from multiple angles, place can be differently *articulated* by its joints.

While it may support critiques of technology or modernity, the topographical model of place does not pre-emptively embed them. An airport lounge or a motorway on-ramp could be subject to a topography as much as an historic townscape. The crucial factors of Malpas’s analysis are, first, that we are always already in place, not merely located in space. Our situatedness derives from our investment and orientation in the things we find ourselves surrounded by. Second, place is fundamentally a question, not an identity. No ultimate determination of place is possible, only an open-ended interrogation. Thirdly, this interrogation proceeds like a triangulated survey, making objective but relative determinations through traverse and cross-reference.

4. ACTOR-NETWORK THEORY AS TOPOLOGICAL THEORY OF PLACE

The second alternative model of place is Latour’s actor-network theory. ANT is not typically understood as a theory of place; Latour is not cited in any of the texts I have referred to in this chapter thus far. I suggest this is an oversight.

In spite of its name, ANT is less a theory than a sociological methodology (Latour, 2005: 17).¹¹ ANT rejects the idea of a “science of the social” on the grounds that it presumes exactly what it purports to demonstrate: the

10. Malpas notes that it might seem problematic that “each element within the topographical structure... supposedly finds its unity in relation to other elements”, but says it is “not obvious why we should take such apparent ‘circularity’ to be problematic” (2006: 195) unless we are employing an inappropriate concept of causality.

11. Latour has variously lamented and upheld the name ANT (2005: 9). Actant-rhizome ontology has been proposed as an alternative (Jensen, 2017b).

existence of social relations. Instead, Latour insists, sociologists need to resume a more basic task: “the *tracing of associations*” (5). This “cartography” or “ecology” (171) makes the social appear as particular *situations* in the form of a relational network. Elements in the network are all deemed active (whether human or nonhuman) and designated *actors*. Actor-networks are situations understood as heterogeneous congregations, messy hybrid situations. Reading a newspaper article on the hole in the ozone layer, Latour wrote:

A single thread links the most esoteric sciences and the most sordid politics, the most distant sky and some factory in the Lyon suburbs [...] The horizons, the stakes, the time frames, the actors – none of these is commensurable, yet here they are, caught up in the same story. (1993: 1)

Such situations cannot be well understood if they are partitioned into different registers (the political, the scientific, the corporate, the environmental). The constituents and organisation of a situation must be discovered, never assumed. This requires a deliberate “uncertainty” (22).

[N]o science of the social can even begin if the question of who and what participates in the action is not first of all thoroughly explored, even though it might mean letting elements in which, for lack of a better term, we would call *non-humans* (2005: 72).¹²

To the extent that something acts, it is said to have “agency”, and something “that makes no difference, produces no transformation, leaves no trace, and enters no account is *not* an agency” (53). Latour explicitly disconnects this idea of agency from consciousness, will, or intention, and thus extends agency to non-humans.

After all, there is hardly any doubt that kettles ‘boil’ water, knives ‘cut’ eat, baskets ‘hold’ provisions, hammers ‘hit’ nails on the head, rails ‘keep’ kids from falling, locks ‘close’ rooms against uninvited visitors, soap ‘takes’ the dirt away, schedules ‘list’ class sessions, prize [sic] tags ‘help’ people calculating, and so on. Are those verbs not designating

12. ANT aims for a “common conceptual repertoire to describe and analyse the relations between humans and non-humans” (Fariás and Bender, 2010: 3).”This, however, does not mean that we are “projecting” anthropomorphic features on what should remain an object: it simply means that the shape, that is, the *morphism* of the human character is just as open to inquiry, to shape-changing, as that of a non-human” (Latour, 2014: 22).

actions? [...] If we stick to our decision to start from the controversies about actors and agencies, then *any thing* that does modify a state of affairs by making a difference is an actor – or, if it has not figuration yet, an actant. (Latour, 2005: 71)

This is not to devalue the specific modes of human agency, but to enable more intricate accounts of how actors, including humans, interrelate in networks. Agency, in Latour's sense, could be understood as synonymous with performance. Thus, by taking note of how something is being affected in a situation, the ANT cartographer can trace what else might be acting there, and in turn discover actors behind it. There is no end to this process, no ultimate structure underlying it.

This emphasis on performance also modifies the concept of *scale*. Scale is sometimes imagined as series of nested spatial frames to which things or effects can be assigned. This predetermines the structure of place, and obscures effects that are transmitted between the large and small. Things might outperform for their size, or be huge but ineffectual. Scale is an effect of how something performs in a network, rather than either an underlying hierarchy or a purely analytical convenience. According to Latour, places do not nest within one another, "like some Russian Matryoshka doll" (2005: 176). A large space, even a global or cosmic one, is *added* to a network as "another equally local, equally micro place, which is connected to many others through some medium transporting specific types of traces." (176).¹³ Accordingly, places do not have *size*, "but some can be said to benefit from far safer connections with many more places than others" (2005: 176). On this reading, infrastructures loom large in urbanised contexts not so much because they have huge dimensions, but because they amplify and transmit effects widely.

The crucial factors of Latour's account are, first, that all situations are hybrid assemblies that cannot be reduced to effects of comparatively simple underlying structures or hierarchies. Second, the participants or constituents of a situation are not known in advance; they can only be known through

13. "I hope it's clear that this flattening does not mean that the world of the actors themselves has been flattened out. Quite the contrary, they have been given enough space to deploy their own contradictory gerunds: scaling, zooming, embedding, 'panoraming', individualizing, and so on. The metaphor of a flatland was simply a way for the ANT observers to clearly distinguish their job from the labor of those they follow around" (Latour, 2005: 220).

the tracing of associations, and this task is necessarily open-ended. Third, no constituent of a situation is entirely inactive. To the extent that they produce effects, they are actors. Situated according to Latour is participation in a hybrid, interscalar, relational network of human and nonhuman actors.

5. ENTANGLED LIFELINES

A third alternative model of place is Timothy Ingold's.¹⁴ Ingold distinguishes networks from meshworks. Networks have the structure of a "hub-and-spokes" (Ingold, 2007: 98). Place, understood as "a nexus in which all life, growth and activity are *contained*" is a node connected by lines of transport, "static point-to-point connectors" (98). Railway networks are exemplary: stations are like islands of space connected by transport corridors in which it is rare to stop. Meshworks, though, have *knots* rather than *nodes*. A knot "does not contain life but is rather formed of the very lines along which life is lived" (100). The lines that entangle to form the knot are life-lines, the trajectories of "wayfarers" (100).

For inhabitants [...] the environment does not consist of the surroundings of a bounded place but of a zone in which their several pathways are thoroughly entangled. In this zone of entanglement – this meshwork of lines – there are no insides of outsides, only openings and ways through. An ecology of lines, in short, must be one of threads and traces, not of nodes and connectors. (101)

In his criticisms of networks, Ingold explicitly refers to infrastructures of transport. Modern rapid transit systems compete with time and reduce wayfarers to travellers. Ingold prioritises time, contending that "lives are led not inside places but through, around, to and from them, from and to places elsewhere" (2009: 33). His lines are not *relations* or *connections*, but temporal *paths*. Because of this difference, it seems Ingold and Latour talk past one

14. Latour cites Ingold's *Lines* (2007) favorably (Latour, 2014: 11). Ingold criticises Malpas for holding an excessively spatial view of place (Ingold, 2009: 30), and steadfastly opposes Latour's conception of networks (2008).

another.¹⁵ The two accounts are not necessarily in opposition; but Ingold's wayfarer aligns more closely with Malpas's surveyor in the importance accorded to time. Although Ingold's wayfarers are explicitly human, it is possible to imagine (as I have in Chapter 4) that nonhuman things, too, have careers as they move through the world in time.

With his opposition between meshwork and network, Ingold provides a strongly temporal account of place. He begins to return, however, to the opposition between place and placelessness. Accordingly, he looks askance at the a-temporal transports of infrastructure, and makes wayfaring a more authentic relation to place and time.

6. INFRASTRUCTURE AS TOPOLOGICAL PLACE

Place is not merely a concept for critiquing modernity, but accounts that rely on a binary opposition between place and non-place struggle to move beyond this. By contrast, my interest is in using topological models of place, understood as an intricate relational field, to reach for a better understanding of infrastructured locales like the Māngere Inlet.

In Chapter 3 I described infrastructure as *contextual* or *environmental* – not simply a tool to be used, but a context for action, a platform, operating system, or terrain that supports, hosts, or facilitates a range of possible activities. As a “naturalized background”, “upon which something else ‘runs’ or ‘operates’” (Edwards, 2003, 185; Star and Ruhleder: 112), infrastructure is not only a location in which things are positioned, but an active *placing*. At an airport, for example, I am situated in terms of possible journeys and security controls, not only by my latitude and longitude. Infrastructures reconfigure space “as an arrangement of priorities” (1995: 89) rather than a Cartesian-Newtonian matrix. The various electric outlets that connect from the walls of my house to the electric grid are not neutral potentials, but are correlated with my actions, desires, expectations. They are the possibility

15. Ingold criticises ANT because it reduces relations to links between objects rather than granting them a material reality of their own (2008: 210-1). However, it would appear pointless to speak of either a relation without terms or a term without relations, and mediation is a crucial feature of ANT. He also criticises Latour's concept of agency for making things conform to an ideal of human intelligence (213-4), although this does not seem an accurate reflection of Latour's concept. However, Ingold's insistence on the importance of time and material change is useful: these may be aspects underplayed by ANT.

of light after the sun has set, of hot food and hot water at any time. The repertoire of actions, connections, practices available to me configure my present being, my being-there. I find myself in a world of meaningful things, and possibilities for action.

As discussed earlier in this chapter, several different kinds of topological structure can be distinguished. First, there are the technological networks allied to capitalist modernity: railways, cellular phone networks, financial data systems. These are the networks that Ingold criticises as mere transports. Second, there is the network of triangulated points constructed by Malpas's surveyor. This network emerges through movement and repeated sightings. It is not the territory itself, but reflects its relative structure. Third, there are Latour's actor-networks. These are relational structures comprising active entities and their effects on one another. While Latour insists ANT is not merely a way of describing situations that already have the form of networks (2005: 131), he also describes situations themselves as having

a fibrous, thread-like, wiry, stringy, ropy, capillary character that is never captured by the notions of levels, layers, territories, spheres, categories, structure, systems." (Latour, 1996: 370)

Finally, there are Ingold's meshworks, living trajectories knotted together to form places. Without conflating these accounts, I suggest there is room for a productive dialogue between them.

All three accounts shift us from ideas of spatial containment to those of connection and relation, and are thus *topological*. They necessitate re-evaluation of the extensive space of Cartesian-Newtonian space with its emphasis on form. This emphasis on relation and de-emphasis on metric distance allows for the presence of strange (indirect or remote) relations in addition to explicitly apprehended ones. They prompt reconsiderations of ideas of scale and the nature of agency that suggest new models for design practice. Projecting place (that is, anticipating and mobilising future situations) might consist of traversing, triangulating, enrolling agents, assembling networks and entangling trajectories.

In the next chapter I will explore possibilities for activating this topological sense of place through design drawing.

6

Drawing Revisions

Relational strategies.

1. INTRODUCTION

Infrastructures, as I have described them in Chapters 3 and 5, are topological not only because they involve technical systems organised as networks, but because they implicate a web of relations. This web is far-reaching and complicates ideas of the local by entangling us with places, times, people, things, and happenings that may be remote, asynchronous or invisible. If, as Boyer suggests, this space of links, connections, exchanges, and thresholds threatens the “privileged status of Cartesian geometry” (2000: 75), then this has implications for design drawing practices that uphold this privilege.

Descriptive geometry is predicated on a Cartesian-Newtonian model of space, in which objects are stripped of their qualities, and location, dimension, and shape are prioritised. It is a systematic technique well-suited for describing volumes, shapes, and the relations between them, but not for the complex “positionality” of topological space (Sheppard, 2002: 318).

In Chapter 4, I indicated the density of this relational weave, using a series of narrative lines and noting particularly how a conventional section drawing in the beginning phases of the research tended to sever rather than disclose infrastructural connections. The failure con-

firmed that I needed to devise better relational strategies for drawing, ways to trace out and assemble a more diverse collection of relations than those which registered on my transect drawing. In particular, such strategies needed to be able to handle relations in *time*, relations over large *distances*, and relations that turn on the *performances* of things. How could such possibly fragile, obscure, invisible, or *strange* relations be assembled in a drawing?

In this chapter, I first briefly consider the spatiality implicit in descriptive geometry and the model of design practice allied to it. Against this, I propose to treat drawing as a process negotiating inclusion and mobilising participation. To de-privilege the Cartesian-Newtonian model of space, I identify two relational strategies taken up significantly in my practice cycles: cartography and sketching.

2. DESCRIPTIVE GEOMETRY AND CARTESIAN-NEWTONIAN RELATIONS

2.1 Architecture as a practice of descriptive geometry.

Descriptive geometry was codified by Gaspard Monge (1798), who brought together two lineages of drawing practice emerging from the Renaissance (linear perspective and stereotomic drawing) in “a three-dimensional matrix, extended indefinitely in space, in which any object could be situated and described” (Pérez-Gómez & Pelletier, 1997: 137). The logical consistency of this space was supplied by mathematics.¹ By the late 19th century, drawings of construction details, interior and exterior perspectives, plans, sections, axonometrics, and site plans were all taken to be various forms of *projection* of a virtual artefact. Descriptive geometry could describe any object, so long as it was three-dimen-

1. It is difficult to conceive of architecture as a discipline independent of its graphic procedures. The distinction between the architect as *designer* and medieval master mason – that is, the separation of the designing and building as professional roles, with the former taking on artistic and rational aspects and the latter becoming a matter of following instructions accurately – only emerges along with the regularisation of graphic techniques acting as a mediator. From the fifteenth century, architectural ideas were conceived increasingly as geometric *lineamenti*, as ubiquitous two-dimensional, orthogonal drawings. This transformation marks the beginning of a practice that contemporary architects take for granted (Pérez-Gómez & Pelletier, 1997: 9).

sional.²

René Descartes insisted that measurable spatial extension was ontologically primary: all other properties could be stripped away from any body until only an extended three-dimensional form remained.³ He envisaged a mélange of extended bodies jostling against one another with no space between, “like a bucket full of water and lumps of ice of different sizes” (Huggett & Hofer, 2017, sec. 3). For Descartes, there was no universal space; it remained relative to particular bodies. Stereotomic techniques current at the time of Descartes, which focused on the need to carve volumes accurately,⁴ tended to be tied to relative ideas of space. Coordinates in this context were not absolute, but relative to the particular stone being cut, and geometry defined how a particular object was measured and cut, not a universal abstract domain.⁵

While various precursors exist, perspective technique first came into focus with Filippo Brunelleschi and Leon Battista Alberti (Pérez-Gómez & Pelletier, 1997 24-6; Vesely, 2004 144-9; Alberti, 1988). Perspective, according to Erwin Panofsky’s seminal analysis, was a “symbolic form” (Panofsky, 1991), rather than mere technique. Its absolute division between viewing subjects and depicted objects closely reflected Descartes’s absolute division between *res extensa* and *res cogitans*. Panof-

2. Geometric techniques provided “a place for abstract thought about architecture, governed by the codes and conventions of discourse... delineated apart from the building site” (Allen, 2000: xiv). The assumptions and tendencies implicit in these techniques still resonate in contemporary practice. As software design tools have come to the fore, descriptive geometry continues to be central, making up the core algorithms of drawing and modelling programs.

3. “[T]here exists something extended in length, breadth and depth and possessing all the properties which we clearly perceive to belong to an extended thing. And it is this extended thing that we call ‘body’ or ‘matter’” (Descartes, 1985: 223).

4. Philibert De L’Orme’s *Premier Tome de l’Architecture* (1567) was substantially devoted to the use of geometry for the purposes of stone-cutting. In one of De l’Orme’s drawings, an oblique view of a classical entablature, two cuts appear. In the background, the cut is a pictorial break, as if the stone had been fractured and broken off. In the foreground, however, the cut is an abstract slice. Rather than the immaterial lines of perspective, commonly understood as rays of light, the lines of stereotomy are material edges, tracings, and cutting planes.

5. In this, it was allied to axonometric and isometric projections, which had found military applications because the regularity of their measurements suited them for instrumental use in calculating trajectories, ranges, quantities of material, and other logistical matters (Pérez-Gómez and Pelletier, 1997: 266-79; 307-16).

sky argued that modern subjectivity relies on perspective technique. In contrast to stereotomy's external view, perspective described surfaces as they presented themselves by surrounding an observer.

What Descartes began culminated in Isaac Newton's contention that a universal, absolute space exists, within which extended things are located and move.⁶ Space was "absolute and infinite, homogenous and unitary, regular and striated, isotropic and isometric" (Casey, 1997: 334)⁷ The progressive mathematisation of space and the development of a generalised system of descriptive geometry proceeded together.⁸ The ontological primacy of form, understood as mathematically-describable three-dimensional shape, is hard-coded into the techniques of descriptive geometry, from where it continues to exert influence on architecture. The Cartesian-Newtonian world-view, which Vesely calls "divided representation" (2004: 177), has a "tendency to strip the world of things of their qualities, which are then transferred to human consciousness" (179). What remains is purely formal and geometric.⁹ Objects are emptied out, and subjects are simultaneously universalised and disconnected.

2.2 Drawing relations

Such stark distinctions between subjects and objects are not borne out in the way designers draw in practice. Latour and Albená Yaneva write:

"a building is not a static object but a moving *project*... [a] modulator regulating different intensities of engagement, redirecting users' attention, mixing and putting people together, *concentrating* flows of actors and *distributing* them so as to *compose* a productive

6. A.N. Whitehead criticised this as the idea of "simple location" (1948: 50). Casey develops this critique (1997: 138-9).

7. Casey continues: "Such space is not only all-embracing but also all-consuming, remaining unappeased in its insatiable appetite for ingesting places" (1997: 334).

8. Vesely asserts that "it is not difficult to see that Cartesian reasoning originated in the development of perspective" (2004: 190).

9. Dichotomies between subject and object "tend to obscure the more fundamental, historically constituted tension between the symbolic-communicative and the instrumental-noncommunicative representations of reality" (Vesely, 2004: 178) so that "symbolic and instrumental representation are inevitably opposed" (241)

force in time-space.” (Latour & Yaneva, 2008: 80)

Drawings are not only passive ways to visualise formal and spatial arrangements. The various drawing sets, diagrams, schedules, requests for information, email conversations, on-site scrawls, text messages, and digital models are all means to *move things along*, ways to produce and regulate activity. Architectural drawings do not “re-produce architecture. They *produce* it in the first place” (Benjamin, 1988: 89; Vidler, 2000: 7).

There is an inherent forwardness in the idea of a project, which, “as its etymology implies, is something thrown forward, representation awaiting existence” (Jenner, 2014: 88-89). Design drawings *mobilise* things, setting them in motion; in their forward orientation, they project as well as gather. Theirs is not a smooth trajectory, however, but a negotiation that is constantly adjusted and manoeuvred, sped up and slowed down.

The idea of drawing as a neutral bearer of ideal content, “a uniform space through which meaning may glide without modulation” may be delusional, but it is also an “enabling fiction” (Evans, 1997: 154). Simultaneously upholding and disbelieving in drawings as transparent mediators motivates architectural practice, enabling representation to be generative, not merely communicative. Through transmission, translation, and transferral, architecture takes on a “projective cast” (Evans, 1995: 366).¹⁰

Design drawings are complex performative documents incorporating notation, calculation, rehearsal, and expression.¹¹ Marco Frascari referred to drawing as a genetic process:

10. Allen writes that for Evans, “[p]rojection is not a thing in itself, but a relationship between things. As such its internal relations are not fixed, and can always be reconfigured” (Allen, 2009: 12).

11. New technologies and modes of practice, while offering new complications and opportunities, have not lessened the significance of this generative mediation. Allen writes: “the computer simultaneously collapses and increases the distance between the architect’s two-dimensional representations and the building’s three-dimensional reality” (2000: 151). It is important not to underestimate the conceptual shift represented by Building Information Modelling approaches, however. They represent a shift from representation to simulation (Scheer, 2014). Full consideration of this shift is outside the scope of this research.

[T]he ontogenesis of architectural lines assimilate within itself the primary processes of designation that take place on construction sites. Lines weave enigmas that are slowly translated on paper and their solution determines architects' ability to consider and savor the facture of the building. (Frasconi, 2011: 69)

Drawing is thus *drawing in*. To design a space, building, scene, landscape is to muster, enrol, sort, filter, link, coordinate, compose, shape, and organise disparate entities. To be *drawn in* has the literal sense of becoming part of a project's forward movement.¹²

Cartesian-Newtonian space includes anything that has (or can be given) three-dimensional form. The tenets of descriptive geometry format a space in which only two and three-dimensional objects are included. Even when supplemented or hybridised, this assumption is embedded in descriptive geometry, which therefore lends itself to formalism. But to design situations, to *project place*, requires a more inclusive mode. This need does not imply a lack of interest in measurement of form. Metric and formal Cartesian-Newtonian space remains pertinent, but it is taken up in a larger relational field. How might drawings negotiate a more inclusive relational strategy?

3. CARTOGRAPHIC ALTERNATIVES

3.1 Tracing locales

My first relational strategy is drawn from cartography. Cartography supplies an alternative set of practices, procedures, and priorities to descriptive geometry. Although modern cartography emerged alongside and interacted with descriptive geometry, it is nonetheless distinct. Descriptive geometry reduces three-dimensional objects to two dimensions by projecting them onto a plane, but cartography faces a different problem: how to unfold the surface of a sphere.

As well as measuring out the surface of the globe, maps also allow for

12. Drawing provides an "optical consistency" that enables diverse things to come together (Ivins, 1938: 9; Latour, 1981: 7).

pictorial and symbolic elements. Even strictly purposeful maps employ a library of patterns, colours, and markers to discriminate features of a territory. Maps both trace territories, and describe them. Thus, they are “dashboards of a calculation interface that allows one to pinpoint successive signposts while moving through the world” (Latour, November, and Camacho-Hübner, 2010: 581); and “de-cribe – literally, ‘draw a line around’ – the local features that make a place that particular place and no other” (Casey, 2002: 156).

I first consider two technical difficulties of mapping: surveying and cartographic projection. I then consider the cultural role of maps in actively constructing worlds, not just representing them, and point to some speculative mapping instruments.

3.2 From point-based surveys to triangulation

At around the same time that perspective was transforming visual representation, new types of cartography were also coming into use. There was “an explosion in the production of images of cities”, characterised by a new precision and regularity in surveying (Ballon & Friedman, 2007: 680).¹³ One of the early techniques enabling this production has a clear relationship to perspective. Alberti surveyed Rome in the mid-fifteenth century, using a simple instrument similar to a theodolite, consisting of a “*horizonte*”, a graduated disk, and a “*radius*”, a bar pivoting about the centre. Centrally positioned on an elevated vantage, he located the city walls using angles radiating from this point and, in doing so, “defined the principles of triangulation that allowed the map-maker to fix the position of monuments without direct measurement” (Ballon & Friedman, 2007: 682). Triangulation and indirect measurement allowed the wide spaces of the city to be measured, providing a “spatial matrix” from which smaller measurements could be made and

13. Ballon and Friedman count about 30 “city views with a geographically identified subject” prior to 1490, but consider the number made during the next century uncountable. “[A] visual record of measured space was possible only in the Renaissance” because of the invention of linear perspective, which demonstrated the geometrisation of space (Ballon & Friedman, 2007: 680).

Fig. 28. Plan of Rome. Reconstructed
by Mark Lien, 2012, from data
tabulated by Leon Battista Alberti,
c.1450 (Alberti, 2005).

[→ view online](#)

Fig. 29. Perspective plan of the White House, Omarska Camp, Bosnia. Scan Lab Projects, 2014.

[→ view online](#)

details drawn.¹⁴

Alberti's drawing is not extant, but he devised a numeric code and recorded the measurements in his *Descriptio urbis Romae* (2005 [c.1450]), from where it can be reconstructed (Fig. 28). The measurements trace the outline of the city wall and locate key monuments using polar coordinates. Points indicate corners, and curved sections of the wall are tabulated as a series of points. The drawing is noteworthy for being stored in code (Mario Carpo calls Alberti's method digital; Alberti, 2005: 16). Each line is stored as a table of measurements; each point is marked as either a sharp "corner" or an "apex", a point on a curved section. Present-day point-cloud survey systems use lasers and stereometric cameras to locate millions of points relative to a station point. These points can be cross-referenced with those from other station points to assemble composite digital models (Fig. 29). The pivoting eyes of the laser-scanner echo Alberti's viewing of Rome. Automated, they bring a consequent increase in metric precision and number of readings, but remain essentially Albertian.

Alberti's earliest use of this technique is centralised, like his perspective technique. This centre, however, devolved into the node of a network. By moving from one elevated point to the next, and sighting back to previous points, measurements could be confirmed and made more accurate. Raphael demonstrated a technique for measuring irregular streets using a device similar to Alberti's, reconstructing their curve from a sequence of readings taken at intervals along the street.¹⁵ The station point was no longer fixed, but a temporary position from which a network of relative measurements could be taken. Raphael's im-

14. In Da Vinci's map of Imola (1502), a circle is visible, divided into eight sectors. This implies the use of a technique similar to Alberti's, based on a survey from a single point, using radial lines. Notes on the drawing indicate lines of sight to nearby towns. From here, Leonardo seems to have worked from measurements of individual blocks; and the ultimate plan included free-hand elements "determined imaginatively... giving the plan a greater organic coherence" (Ballon & Friedman, 2007: 683).

15. The Roman *groma*, an instrument used for orienting the *cardo* and *decumanus* of a new military camp or settlement, is a significant precursor, but included no means for measurement, although trigonometric principles of Euclidean mathematics were known to them (Rykwert, 1988: 50). Ballon and Friedman note that Albertian survey techniques were quickly taken up by the military (2007: 687).

proved survey instrument was augmented with a compass. The accuracy of readings could be checked by performing a circuit that returned to an earlier station point. Decentralised, surveying became peripatetic.

By walking and constructing a network of relative measurements, an entire city could be brought to appear as a single knowable artefact. Imaging the city as distinctive and knowable, it became “a text for its rulers, its citizens and its visitors” (Cosgrove, 2004: 52). Designers working in the city could “know limits that could not be seen”, and these could become generative factors in designing (Ballon & Friedman, 2007: 704).

3.3 Flattening the globe

These metric techniques encountered new difficulties when extended from city to globe. Travel and trade, from the Renaissance on, resulted in proliferating representations of the globe. They figured significantly in the development of ideas of the global, projects of globalisation, and the rise of environmentalism:

Alongside the representation of the sphere begins the production of the sphere; on the strength of this development begins the graphic and technical play, with the totality and its picture pursued by geometrically enlightened Europeans from the high classical period onwards. (Sloterdijk, 2009: 29)

This vast cultural and metaphysical project, however, required resolving a prosaic technical difficulty: how can the surface of a sphere be represented on a flat page? Three basic strategies emerged: a binocular depiction of two hemispheres, stretching the surface into an ellipse, rectangle, or some other form, and cutting the surface up into more easily-flattened sections (Snyder, 2007: 366).

A curious projection by John Blagrave from 1596 (Fig. 30) is azimuthal, centred on the north pole. The circular view of the northern hemisphere is extended to fill a square by deforming the lines of latitude and longitude. Like Alberti’s surveying instrument, Blagrave’s map had a circular scale and included a rotating arm drawn in the margin, that

**Fig. 30. Polar stereographic projection
with extensions to a square.** John
Blagrove, 1596. (Snyder, 2007, p.370).

[→ view online](#)

Fig. 31. Gnomonic projection. Franz Ritter, 1610. The geometry of a sundial is used to produce a projected map of the world (see Snyder, 2007).

[→ view online](#)

could be cut out and attached at the centre. The northern hemisphere is recognisable and familiar, but the southern hemisphere is stretched and crammed into the corners, graphically demonstrating the trade-offs and biases involved in map projection.

Projection methods proliferated with the development of algebraic mathematics (Snyder, 2007: 381). Snyder has compiled an album of around 80 discrete projections, any of which can be adjusted in a number of ways (Snyder, 1989). The globe is partitioned, folded, stretched; projected onto spheres, planes, cones, cylinders; oriented in various directions. There is no way of performing these translations without some form of deformation.¹⁶

Descriptive geometry relied on a direct metric correlation between the picture plane and a sheet of paper (or another substrate).¹⁷ This direct correlation could not be assumed in global cartography. To bring the other side of the world into the same space as the familiar hemisphere, the picture plane itself had to become more complex. Cartographic projection is thus a case study in the inclusion of remote sites into an integrated conceptual space. Infrastructures produce new globalised and uneven spaces. Mapping them may require new projective deformations.

3.4 The agency of mapping

Gissen recognises a “geographic” and “performative turn” in 21st century architecture, visible in the proliferation of maps and geographic datascapes and in new “transdisciplinary alignments” (Gissen, 2008: 59). Maps produce “a type of site charted by a particular data-driven

16. Equidistant projects, for example, prioritise the preservation of consistent lines of distance, at the cost of changing the shape of regions; while equal area projections preserve the relative areas of regions, with lines of distance unscaled. See Snyder (1989).

17. The question of deformation did, however arise. Pérez-Gómez and Pelletier compare Caramuel de Lobkowitz’s use of projection with Desargues’s, seeing in the latter a totalising system, and in the former “a ‘strange’ symbolic order” (Lobkowitz, 1678; Pérez-Gómez & Pelletier, 1997: 125-138). Rather than providing a unifying space, Caramuel’s projections are a means to distort and deform. Notably, Caramuel was criticised by Guarini (Pérez-Gómez & Pelletier, 1997: 161-176). Although Guarini also saw projective geometry as opening a symbolic order, he couldn’t accept distortion and subjectivity. For Caramuel, however, distortion provided a means to introduce anamorphic points, to weight the material world according to perspectival transformations.

architectural project”. He refers to James Corner, who describes maps as:

revisions of conventional analytical and quantitative maps and charts that both reveal and construct the shape-forms of forces and processes operating across a given site... Where they differ from the quantitative maps of conventional planning is in their imaging of data in knowingly rhetorical and generatively instrumental ways... The artistry lies in the *use* of the technique, how things are framed and set up. There is no assumption of truth or positivist methodology. (quoted in Gissen, 2008: 63).

The rise of mapping thus points to an appreciation of site as a condition produced out of a larger field of relations and processes. The latter “reveal, construct and project the *epistémé* against which the project builds itself” (Bordeleau & Bresler, 2010: 45).

Mark Dorrian discerns a more specifically “cartographic turn... an increasing use of mapping as a generative – that is as a formal, formative, and not simply analytical – process within architectural projects” (Dorrian, 2005: 1).¹⁸ He also writes that maps operate rhetorically; they

have been used to orientate the architectural project in contrasting ways: as supplying procedures supporting avowedly ‘post-humanist’, ‘weak’, or ‘abject’ architectures [... they] are also deeply implicated in the closest thing we have to a contemporary ‘visionary’ architecture, one whose discourse is saturated with references to spirit, faith and hope. Both call upon the resources of the map in the context of a rhetoric of ends: of man, humanism, architecture and its possibilities. (1)

He situates this turn with reference to “a new ‘productivist’ ethos” that he traces to Deleuze and Guattari’s discussion of maps and diagrams. Deleuze and Guattari use maps and diagrams as revisions to the concept of representation (and to “revamp hylemorphic theory”; Zdebik,

18. Gissen does not refer to Dorrian’s earlier discussion. There is a difference between the two: Gissen remarks on the ingression of geographical concepts into architecture, while Dorrian remarks on strategies of mapping.

2001: 1; Ch.1, note 1). Maps and diagrams are oriented towards the future: potential journeys, possible actualisations.

What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real... The map is open and connectable in all its dimensions [...] The map has to do with performance, whereas the tracing always involves an alleged 'competence.' (Deleuze and Guattari, 1987: 13)

James Corner's essay 'The Agency of Mapping' (1999) also drew on Deleuze and Guattari's performative understanding, and consolidated many of the themes of the contemporary turn towards maps¹⁹. In particular, Corner emphasised that maps have *agency*, that is, they are active and performative, not passive or neutral spatial representations:

Mapping is a fantastic cultural project, creating and building the world as much as measuring and describing it [...] The function of mapping is less to mirror reality than to engender the re-shaping of the worlds in which people live [...] Hence in describing the 'agency' of mapping, I do not mean to involve agendas of imperialist technocracy and control but rather to suggest ways in which mapping acts may emancipate potentials, enrich experiences and diversity worlds [...] As both analogue and abstraction, then, the surface of the map functions like an operating table, a staging ground or a theatre of operations upon which the mapper collects, combines, connects, marks, masks, relates and generally explores. These surfaces are massive collection, sorting and transfer sites, great fields upon which real material conditions are isolated, indexed and placed within an assortment of relational structures. (Corner, 1999: 213-5)

Corner's reading of maps resonates with the Latourian conception of agency (as performance rather than wilful activity). Thus, maps are drawings that actively mobilise a range of materials, conditions, and relations. Mapping is allied to the *strategic* and *operational* rather than the formal and compositional. Cartographic space differs from the space

19. Corner's essay has been influential. It is cited by Gissen (2008: 59), Dorrian (2005: 61), Bordeleau and Bressler (2010: 48), and Allen (2009: 212).

of descriptive geometry. Where the latter strips back relations to pure extension and position, the former, because it has had to accommodate deformation, sees extension and position as relative aspects of a broader relational field, disclosed as the map is put to work.

3.5 Live maps

Rather than pertaining mainly to the preliminary phase of a design, then, mapping might *enact* design. Instead of merely measuring and documenting a place prior to a design intervention, the design itself might take place through mapping, *be* a map, or be a means of mapping.

Laura Allen and Mark Smout, in *Inhabiting the Horizon* (2007) propose a series of alternative surveying instruments. Where Alberti used his instruments to project a geometric net over a territory, Smout Allen devise “ballistic instruments” that “momentarily occupy the space between the sky and the ground” at dusk, registering the effect of local conditions by means of wavering lines. One instrument hurtles into the sky and bursts into a spangled net that becomes entangled in large trees. The flat shadow of the tree is illuminated by this glimmering line, which “infiltrates the depth of the blurred or fractured horizon to reveal silhouettes as deep three-dimensional objects” (2007: 47). Another projects into the sky and unfurls reflective wings to catch the sun and flash brightly, “momentarily foreshortening the three-dimensional space between foreground and background” (49). A third spins, unravelling a dynamic line across the “irregular and interrupted horizon” of an urban environment (51). Aarati Kanekar writes that this project (along with several others by Smout Allen) creates “a live performative map of the environmental conditions that would otherwise have been invisible to the naked eye” (2015: 122).

The idea of a live mapping recurs in Smout Allen’s *Retreating Village* (2007). Here, however, the movement is much slower. A village in Norfolk is slowly falling into the sea as nearby cliffs erode. Smout Allen propose an elaborate configuration of ground beams, pulleys, skids, weights, and winches to slowly pull the village back from the advancing cliff-edge (Fig. 32). The proposal “adopts an architectural language of impermanence, of permeable screens, loose-fit structures, and cheap

Fig. 32. Retreating village, Happisburgh. Folded section drawing showing the village's movement over time, and sketches of moving components. Smout Allen, 2007.

[→ view online](#)

materials that complement and contribute to the nature of the restless landscape” (Allen and Smout, 2007: 55). Collapsing houses are reconstituted as “hulks” which, as they retreat, drag huge woven sacks full of earth with them as mobile gardens (72). The entire village becomes a slow-moving survey instrument drawing lines across the ground and registering the changing landscape. Kanekar writes that the project “brings into focus architecture as an instrument of mapping that is both denotative of the existing but also connotative of the projected new” (2015: 129). More than merely *connoting* the new, however, the project-as-map actively *mobilises* the new.

3.6 Cartographic openings

Cartography is an active and constructive process. While its descriptive role remains vital, cartography can be set to work in other ways. As Casey indicates, maps survey and mathematise, but also interrogate and constitute regions as *places* (2002). This involves an ongoing, reflective openness. What makes it onto the map? What other aspects of a region might be mappable? What reductions and notations will be applied to render visible the coherence of a place? What participates in a place?

Alberti’s centralised survey discloses Rome as geometry around a point. The drift away from this polar method to methods of traverse and triangulation allows cartography to describe a *field* of relations which cannot be fully grasped from any one point. Making the city visible as if it were an artefact also induces *strangeness* in the map. The need to flatten out the globe in order to map emergent global spaces generated a spatial plasticity outside the bounds of descriptive geometry.²⁰ The globe became a single space by means of stretching, folding, and splitting operations. The agency Corner attributes to mapping depends on how a place is assembled. The design of the underlying surface is not prior to this assembling, but part of it. Cartography opens to an ongoing dialogue with place, in which its relational field is at once discovered and invented. Projecting place, imagining and mobilising future configurations of place, could be understood as a *live, ongoing cartography*.

20. Cartographic deformations foreshadow later non-Euclidean geometries like those of Riemann and Klein. Torretti gives a good summary of these new spaces (2016).

4. SKETCHES

I turn now to a second relational strategy: sketching. Although I place sketches in counterpoint to systematic descriptive geometry, it is important to note that these various drawing techniques are neither completely discrete nor consistent. Descriptive geometry, cartography, and sketching (along with diagrams, timelines, collages, and other related practices) overlap and cross-pollinate. The particular characteristics of sketching that I draw attention to here are its enfolding of precision and imprecision, its circuitous, conversational nature, and its tendency to accumulate into archives.

4.1 Drawing circuits

Sketching is circuitous. Downton describes drawing as “an iterative conversation with the (partial) propositions already put”, in which “marks are the context for new marks” (Downton, 2013, sec. 6.3.4). In this conversation, an intention is marked, perhaps with a pencil on paper. As soon as the mark is there it becomes contextual, inviting or resisting further marks which incorporate adjustments of the intention. Cognitive science suggests this circuit introduces a gap between act and awareness: “The awareness of our graphic act, then, implies a very brief discrepancy – 350 milliseconds – between what we see and what we know we have seen” (Belardi, 2014: 23). Precisely because there is a discrepancy between the intention and the mark, both must be re-evaluated. Sketching is thus a temporal practice.

A series of sketches by Álvaro Siza demonstrate this circuitousness. The drawings (c.1999) explore a new interior setting for Michelangelo’s *Rondanini Pietà* (Fig. 33). Walls, floors and archways are delineated economically with a few pen strokes. The sculpture itself is more intricately drawn so it appears as a dense twist of lines, and other human bodies are pictured standing nearby. Each perspectival sketch looks from a new direction, as if Siza is circling the statue, testing how its curves and tensions work against an architectural frame. Frequently the viewing bodies are accompanied by sweeping lines or arrows that indicate their movement. This twisting and turning dialogues with a simple spatial move: placing the statue off-centre in the room, on a square rotated with respect to the walls.

**Fig. 33. Sketches of a new setting for
Michelangelo's Pietà, by Alvaro Siza.**
(Repishti, 2013, p.47-9).

Drawing closer, the posture of the statue is placed in relation to the posture of a viewer. The statue's unfinished stone surface is exposed, including the parts where the figures have not been completely released from the original block. And then, moving away, a series of drawings contextualise the statue by considering the path a viewer will take when approaching and leaving, and the vaults, patios, and stones seen on the way.

There is a restlessness to Siza's drawings, a desire to move in response to the statue, to set it in motion on the page and project this animation as a design intention. Hélène Cixous wrote of the restlessness of sketching as a struggle:

This is what we draw, tripping, because, instead of throbbing, we trace. We want to throw ourselves ahead and we go backwards. Do you see these footprints? We are advancing backwards. (Cixous, 1993: 101)

Struggle suggests contention, but there can also be something patient, even mesmerising about the unfolding of sketches. Sketching involves "absorption" (Clarke, 2014: 51): Siza is folded into his sketch as he circles. As a dialogue, sketching is procedural, evolutionary, reliant on what has already taken place.

4.2 Sedimentary deposits

Each sketch can stand alone as a figure but is also, as we have seen, part of a negotiation pursued iteratively and interactively over time. Sketches thus form archives, rich with "a tangle of meanings" (Belardi, 2014: 34) and laden with potentials.

[Sketches] are 'dense schemes' as Nelson Goodman has defined these. Such sketches reveal with their 'thickness' the tortuous process of design, revealing references and images that were not strictly part of the project: ideas abandoned and then retrieved, along with uncertainties, disappointments, and enthusiasm. (Belardi, 2014: 30)

The density and thickness of this archive, and the extent to which it

consists of things abandoned, stored, or discredited, is obscured when a single sketch is isolated, but it can be revealed by flicking through entire sketchbooks, piles or boxes full of drawings.

In my own sketchbooks, there are patterns that only surface over the course of weeks or years. Habitual forms, and recurrent themes sit alongside the contingent and momentary. A number of metaphors can be used to describe how these sketchbooks work. They are sedimentary, comprising layers of solidified material that can be mined. They are like the humus of the forest floor, where things are decomposing and fertilising new growth. They are like a ransacked library of disorganised material leading to surreal or portentous juxtapositions. Palimpsests have also been used to imagine drawing: “through palimpsest”, writes Hendrix, “the sketch can emulate the human mind... The displacement, condensation, fragmentation, and substitution found in dream images are found in the palimpsest of the sketch” (Hendrix, 2014: 39). The sketchbook becomes a material subconscious.

4.3 Setting the table

Siza’s sketches have a fairly direct pictorial relation to a design intention: his perspective views correspond with anticipated views of the interior setting. But sketches are not simply representational. Andrew Benjamin argues that representation is an inappropriate framework to apply, suggesting instead that the “force of drawing” is the “potentiality” by which a drawing “always has an indeterminate relationship to actualisation” (Benjamin, 2014: 471-2). This indeterminacy is particularly apt for sketches, which are sometimes pictorial, but may often become diagrammatic or notational.

Junya Ishigami’s sketches, for example, are often like planning diagrams or graphs (Fig. 35). He envisages an architecture that incorporate scales far outside those normally involved in building:

To toss things of all kinds into a world of interacting and fluctuating relationships, so that all slowly expand, as if from quantum fluctuation. Vague concepts, vague functions, vague roles, vague territories, vague aggregations, vague directions. (Ishigami, 2010: 5)

Fig 34. Erased drawing. Pencil on permatrace, erased.



Fig. 35. Table. Junya Ishigami,
2006. Layout sketch of the table, and
photograph of table as built.

[→ view online](#)

This interest in looseness and vagueness leads him to collect diagrams of natural processes, populations, and effects: figures of how trees are distributed in forests, how atmospheric layers distort the circle of the setting sun, how various forms of snow crystal form. Complex and intricate phenomena are figured in anodyne diagrams. These diagrams give or disclose relational structures through which complexity and intricacy arise.²¹

His own sketches are similarly schematic, typically filled with icons and emblems. A sketch for his *Table* (2006) shows a broad rectangle filled with bubbles of various sizes, linked with arrows. In the bubbles are lists of items to sit on the table, and around the outside of the table are lists of numbers summing the weights of the collected items. The resulting table was made from a single sheet of coiled steel; only once carefully loaded up according to Ishigami's calculations would it sit completely flat over its 9.5 metre span. In his sketch, there is no visual indication of material, but the performance of materials is the central concern. Ishigami's drawing exemplifies the relational quality of sketching; its potential to actualise rather than fix.

For Benjamin, drawing has two axes, each describing a kind of distance. First, there is "the negative and positive determinations of mimesis and representation", i.e. the axis along which determinations of accuracy or degree of correspondence are made. This axis is crossed by a second, which describes "a relationship between an inside and an outside" (2014: 475). The drawing does not simply refer to some out-

21. 'Diagram' was a significant, although ambiguous, term for Deleuze. Generally, it describes an abstract function that links different systems together. Seemingly incongruous systems can be revealed to operate according to the same diagram: "It is an abstract machine. It is defined by its informal functions and matter and in terms of form makes no distinction between content and expression, a discursive formation and a non-discursive formation" (1986: 34). De Landa explains Deleuze's diagram as "a set of universal singularities [...] that would structure the space of possibilities of an assemblage" (2006: 30). In this sense, a diagram would articulate a mix of flexibility and singularity: "The diagram is not precise, or representational, but charts the relation of forces that can be utilized or made manifest in various situations (Zdebik, 2001: 7). This parallels my understanding of sketching. A Deleuzian conception of the diagram did not significantly inform my approach, however.

side world, but creates the distinction between insides and outsides.²² This “twofold distancing” opens the space within which drawing operates: “drawing enables architecture to stage a relation to an outside” (470). Rather than representational, sketches gain their “force” from their flexible articulation of relations (470)²³.

Paolo Belardi described sketching as “*a quick, readily available, dense, self-generative, and above all, extraordinarily communicative notational system*” (2014: 32), one that is “somehow ahead of the future” (26). As quick, sketches are also often “fleeting” because they are folded into or overwritten by subsequent marks or made obsolete by new drawings. Belardi allied density to “conciseness” (28), the quality of compactness or efficiency, a way of discovering or consolidating something crucial. At the same time, sketches have the looseness of notation. It always remains undecided exactly how seriously to take any given mark in a sketch, because notations “have little to do with traces, imprints or indexes [, being] highly specific and somewhat arbitrary” (Allen, 2009: 42-3). A sketch designates a range of future possibilities through the interplay between condensation and looseness.

4.4 Sketch openings

Sketches are a-systematic. They make opportunistic use of conventions and codes, exploiting them, but also bending them and disregarding them when it seems productive. In my own drawing, sketches often evoke orthographic projections, sections, perspectives, or axonometrics; but they freely slide out of these modes. Words and numbers stray over the surface. Sketches that started out as discrete drawings conjugate with their neighbours. Ideas circulate from page to page and accumulate. If associated with the early part of a design process, sketches might be understood as superseded by increasingly detailed, denotative, and conventional drawings. But a design process might not necessarily require ever-increasing degrees of fixity.

22. “In other words, it is only the assumption of a relation to a posited outside that has the effect of creating a positioning that then becomes the place of the drawing” (Benjamin, 2014: 477-8).

23. Force expresses drawing as a struggle or conflict. Nancy provides an alternative framing: “pleasure”: “Not the pleasure of completion but the pleasure of tension” (Nancy, 2013: 26).

Sketches are circuitous, iterative and conversational. They are not simply representative, not simply anticipatory, but are the fault along which a before and after become separated, “not as preliminary to that which occurred after but as a pure limen” (2014: 478). They open and mobilise relations rather than simply picturing them.

5. RELATIONAL STRATEGIES

Infrastructure challenges descriptive geometry. Infrastructures are large and diffuse, comprising material and immaterial elements. They are not simply *larger* than buildings but present another spatial condition to be negotiated.²⁴ Because descriptive geometry is a means to describe form and volume in Cartesian-Newtonian space, the remote, moving, asynchronous, or formless aspects of infrastructure remain invisible here.²⁵ To design for spatial conditions that descriptive geometry cannot capture, I have sought to displace the latter from the centre of my design techniques. This is not in order to supersede descriptive geometry, but to foreground relational strategies better tuned to topological place.

Cartography and sketches, as I have understood them here, are useful because they do not prematurely determine what kind of relations can appear in the drawing. Both are (also) concerned with the outside. In the map, the existence of the other side of the world necessitates workarounds and geometric innovations so that the globe can come to appearance as a unified surface (and so that Antipodeans and Europeans are seen to inhabit a single space). When sketches unfold in series, new concerns and possibilities are entered onto the page, and others move out of view in the interests of conciseness.

24. If infrastructures can't easily be rendered as objects, we might consider them “hyperobjects” in Timothy Morton's terminology: objects so far extended in space and time as to resist all attempts to grasp or summarise them (Morton, 2013).

25. It could be argued that the formal is, in fact, the proper domain of the design disciplines, the very meaning of *designing*. But the Albertian idea of *disegno* as a formal outline (even if one subtly submerged in the work) contrasts with the Vasarian idea of *disegno* as an explicatory arrangement, a more relational concept (Dodds, 2016: 24).

Decentralising descriptive geometry expands the kinds of relation that can be mobilised in projecting future places. Changing modes of drawing also entails changes to ontological assumptions, modes of practice, and ideas of design agency. I pursue these relational strategies and their implications through my practice cycles.

7

CIRCUIT: PROJECT CYCLE 1

A path around the Māngere Inlet.

1. REORIENTATION

This chapter recounts and reflects on my first project cycle (May 2015 – March 2016), which was planned as the longest project cycle to allow room for discovery and learning new techniques (as detailed in Chapter 2). I began by responding to the perceived tension I encountered between infrastructural space and my existing repertoire of representational techniques. The failure of my transect drawing (Ch.4, sec. 2.5) to gain purchase on infrastructural space triggered this response.

In what follows, I will first outline how I reoriented my inquiry thematically (around the idea of *circuits*) and technically (by looking for new representational strategies). I will briefly describe the project outcome in its anticipated final state (at the time of writing the final draft of this exegesis, the form in which the work will be exhibited is not fully settled). I will then discuss key aspects of the design process, beginning with the construction of an unorthodox relativistic cartographic projection, then moving on to discuss my use of this projection to design and furnish an infrastructural surface. Along the way, I will reflect on the concepts and techniques that emerged. Finally, I will remark on some of the key *returns* from this project

cycle: noting how it reflects back on my research questions, and opens towards subsequent cycles.

1.1. Thematic reorientation

How can the interconnected, uneven and territory-spanning nature of infrastructural space be represented? My initial attempt had not been convincing. Through my journeys (which were ongoing during this period and are summarised in Chapter 4), the Māngere Inlet was coming to appear as an increasingly complex relational field.

In planning my research, I specified three conceptual foci: *circuits*, *deposits*, and *exchange*. These, as was explained in Chapter 2, were chosen to direct attention to both fixity and change. As I took up the idea of *circuits*, I had in mind the global circulations of Manuel Castells's "space of flows" (Castells, 1996 407), but also the quotidian cycles and patterns of daily living described by de Certeau (1984) and Ingold's "routine or habitual bodily techniques" (Ingold 2007: 127), natural cycles and rhythms. This allowed me to place infrastructures in the context of broader patterns of circuitous movement.

Having spent time studying the Māngere Inlet, I needed to move from analysing and describing the site into a *projective* mode. In professional design contexts, this is often instigated by an externally defined brief, which describes a problem in search of a solution. Instead of such an external imperative, I posed for myself the task of designing a footpath around the inlet. This initial proposition acted as a reference point: an anchor or pivot around which the project could drift. Through this anchor's movements, the pull and push of the conceptual field could be discerned.

1.2. Outline of project and key strategies

At present, there is a walkway across the northern edge of the inlet, and a bridge across its mouth to the west. The water has little public presence in the south and east, however, because these parts of the inlet are cut off by the railyards and commercial uses. Cycle 1 culminated in a design for this path, as a continuous concrete and stone loop with steel structures, connecting wetlands, rail lines and mangrove swamps. It opens out into public stone *pavements* at key access points, which are accompanied by circular *lawns*

and scoria *platforms*. On some of the platforms are *sheds*, which open the possibility of various kinds of community activity on the water's edge.

There were two main movements shaping the design process. First, I formatted the space by devising a cartographic system that prioritised the circulating pedestrian. Secondly, with reference to Stan Allen's "field conditions" (2009: 217), I designed the path as a surface and considered how it could be furnished.

2. FORMATTING THE SPACE

2.1. The aerial view

Given that I was designing over such a large area, my opening move was to print out and trace over aerial photographs. Indeed, already my preliminary journeying (described in Chapter 4) was imagined as the drawing of lines on a map. Tracing over aerial photographs (by contrast to maps) supplies a sense for the life of a place, even if the photographs are out-of-date. Marks on the ground, the presence of vehicles and people, the colour and texture of vegetation, remind me of a complexity often lost in more schematic drawings. On reflection, though, this reliance on aerial photography embedded an inappropriate idea of space and locale in my design process, as had my initial reliance on sectional drawing.

The aerial view became instrumental in twentieth-century discourses of place. As Dorrian puts it, "the aerial [...] is central to the modern imagination and, indeed, might even be claimed to be its emblematic visual form" (Dorrian & Pousin, 2013, p. 1). In the twenty-first century, the advent of publicly available geospatial information systems, most notably Google Maps (from 2004), made access to aerial overviews ubiquitous. We now start many of our activities with an aerial view; for architects and other spatial designers, viewing aerial photography is an indispensable and early part of site analysis.

The aerial views stored in GIS databases are not single framed images; they are imagined as fragments of a continuous visual field, georeferenced

into a seamless space¹. Such a view is strictly impossible; there is nowhere from which such a topologically continuous view could be had. If we zoom out into space, our view eventually becomes delimited by the curve of the earth. Far enough out, we see something like the famous “Blue Marble” photograph taken by Apollo astronauts – an image Google Earth “reperforms” (Dorrian and Pousin, 2013: 298).² GIS aerial photography sets are notionally continuous; GIS viewing software wraps the view seamlessly (depending on which specific map projection is employed). Such datasets are hybrids of maps and photographs. At present, they are static snapshots of the planet’s surface, although it seems plausible that at some point in the future they might be comprised of live satellite streams, democratising the view of military drone-cam surveillance in the same manner Google Earth democratised the view of military satellite photography (Google’s initial purchase of satellite imagery was from a company with CIA investment). Aerial datasets are thus synthetic visual surfaces that abstract the viewer in a similar way to the picture plane in descriptive geometry.

Aerial datasets perform a sleight-of-hand, smoothly blending an (almost) possible view and an entirely fabricated one. Coming in to land at the Auckland International Airport, planes often bank, and it is possible to look straight down on small sections of the terrain. The extension of this view over the whole planet, as if in a single day lit moment, however, is a fiction enabled by a “*technical folding*” (Latour, 2013: 227). The massive labour of collecting, sorting, adjusting, aligning, and stitching together aerial photography is hidden by the apparent smoothness of zooming in and out.

Even if I walk along, device in hand, with this view on screen (perhaps with a blue dot marking my position as I walk), I am not experiencing the space of the aerial photograph. But nor am I experiencing something purely perspectival. J.J. Gibson, in his analysis of mobile perception writes that “[t]he world is *not* viewed in perspective’, nor is it “an infinite set of successive instants” as a film might show it (Gibson, 2015: 188): “The perceiving of the

1. Georeferencing is the process by which images are positioned, oriented, and scaled within a cartographic projection, so that they match with other geospatial data.

2. These images were critical “to the totalizing socio-environmental discourses of *One-world* and *Whole-earth*” (Cosgrove, 1994: 271). Part of this significance derived from “their liberation of the globe from all cultural signifiers – borderlines, grids, and cartographic codes” (Dorrian and Pousin, 2013: 297-8).

world entails the coperceiving of where one is in the world and of being in the world at that place. This is a neglected fact that is neither subjective nor objective” (190).

How, then, could I envision the relative space of a path? It occurred to me that *unrolling* the path as a straight line might turn it into a simple trajectory and position its surroundings relative to this line of movement. Such a map would thus be oriented around the body of the moving pedestrian and describe a “ready-to-hand” world oriented by the activity of walking (Heidegger, 1962: 99).

2.2. Unrolling

To make this map, I wrote a piece of software,³ first prototyping an algorithm using Grasshopper (Rutten, 2017), a plug-in for the digital modelling program Rhinoceros 3D (McNeel Software, 2017). Finding the results unsatisfactory, I tried a second method, using the Python programming language⁴ to interface between Rhinoceros 3D and my chosen GIS software, QGIS.⁵ I worked with the aerial photography dataset maintained by the Auckland Council and held in the Land Information New Zealand database.⁶ The code I used to generate the exhibited map is contained in Technical Appendix 1.

Using Grasshopper’s node-based interface,⁷ I divided a line representing the path into segments. At each division point, I drew a line normal to

3. The work was carried out in two phases. Initially it took several months in 2015/16; and I revisited, rewrote, and refined my approach in 2017.

4. Python (Python Software Foundation, 2017) is an open-source scripting language. It can run as a standalone program, but is also built into other programs to provide a scriptable interface (a console) to their functions. Although I had not used Python before, I selected it because it is built into both QGIS and Rhino.

5. QGIS (QGIS Project, 2017) is open-source geospatial information software (GIS). It allows geospatial data (like aerial photographs or map lines) to be accessed, viewed and manipulated.

6. In particular, I used the Auckland 0.125m Urban Aerial Photos (2010-2011), and Auckland 0.075m Urban Aerial Photos (2015-16) datasets held by Land Information New Zealand (LINZ): <https://data.linz.govt.nz>

7. Node-based describes a kind of software interface based on defining a process through a flow-chart. Parameters in the flow chart can be adjusted and will update the resulting model

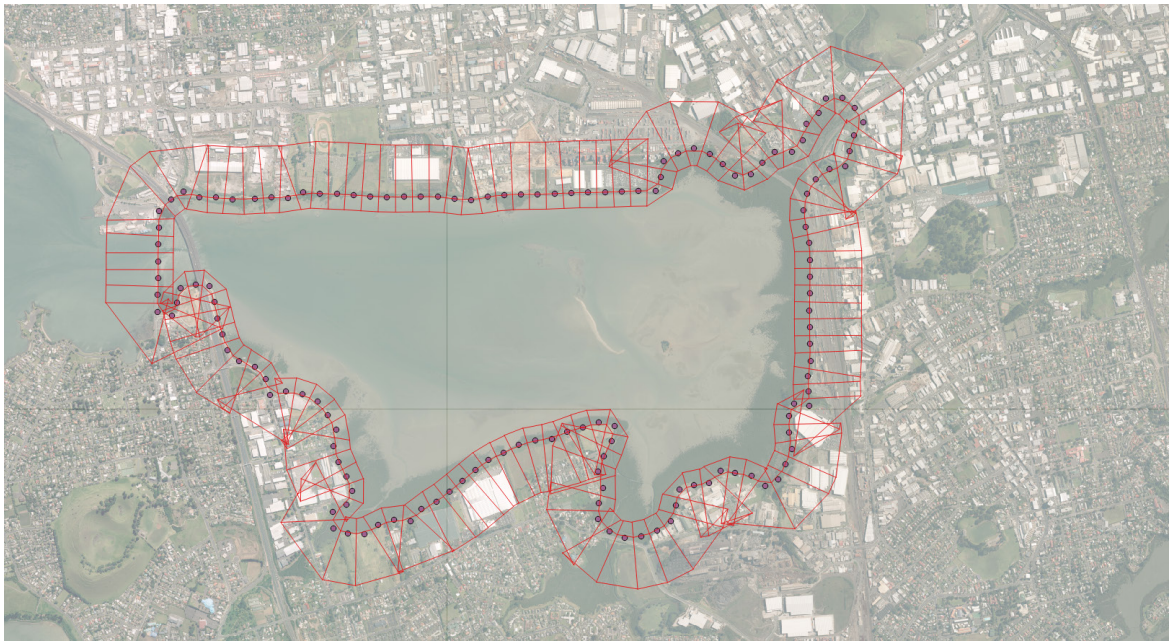


Fig. 36. Construction process for an unrolled map of a path around the Māngere Inlet. The path is divided into quadrilateral sections using the Grasshopper plugin for Rhinoceros 3D. The resulting lines are imported into QGIS and used to cut out sections of the map that are then mathematically transformed into regular rectangles. Aerial photographs, 2011-12, LINZ.

Fig. 37. Unrolled map of Māngere Inlet (detail of Westfield area).

Discontinuities occur at between rectified sections; and errors are visible.



the path; that is, a line perpendicular to the curvature tangent of the path at that point. Measuring a set distance along this line on either side of the path produced a series of quadrilaterals (Fig. 36). I overlaid these quadrilaterals onto the aerial photographs using QGIS and used them to cut out the corresponding sections of the imagery. Then I wrote a small Python program to straighten the irregular quads into regular rectangles. Finally, I pieced these rectangles together in Adobe Photoshop by hand to produce a single strip (Fig. 37).

While this method produced the anticipated results, it was slow and labour-intensive; and the image it produced was discontinuous, with visible seams where the segments joined. These discontinuities could be reduced by dividing the path into smaller segments at the outset, but at the cost of even slower production. The revised method started by specifying the scale and desired pixel resolution of the final output. This determined how finely I needed to divide the path, and how many points would be needed to build the image smoothly. Rather than handling the image in quadrilateral chunks, this approach treated each pixel of the image separately.

Consequently, I wrote a Python program that analysed a line representing the path in Rhinoceros 3D and output a data file containing geospatial coordinates for each pixel of the desired image. A second Python program read the coordinates from this file, one at a time, using them to sample one pixel from the aerial photography dataset and inserting it into the appropriate location in the final image. This method produced seamless images much more quickly, but required extensive computing power. The exhibition image, for example, contains 227,644,000 pixels. The data file containing the coordinates was around 90GB large and took approx. six hours to process.⁸ The code itself (see Technical Appendices 2 and 3) thus involved a circuit, looping iteratively to build up the image.

I chose to call these linearising method *curve-offset projection*, since the horizontal axis is determined by distance along the curve, and the vertical

8. The first part of the programme is constrained by available disk space (the last file generated was around 90GB) and acceptable processing time (noting that if the program is interrupted by a crash or remotely-triggered reset it must start again from the beginning). The second part of the programme is constrained by the size of the aerial dataset (which needs to be a single image file at present), and RAM available (the program needs to hold the entire aerial photograph and the new image in memory at the same time).

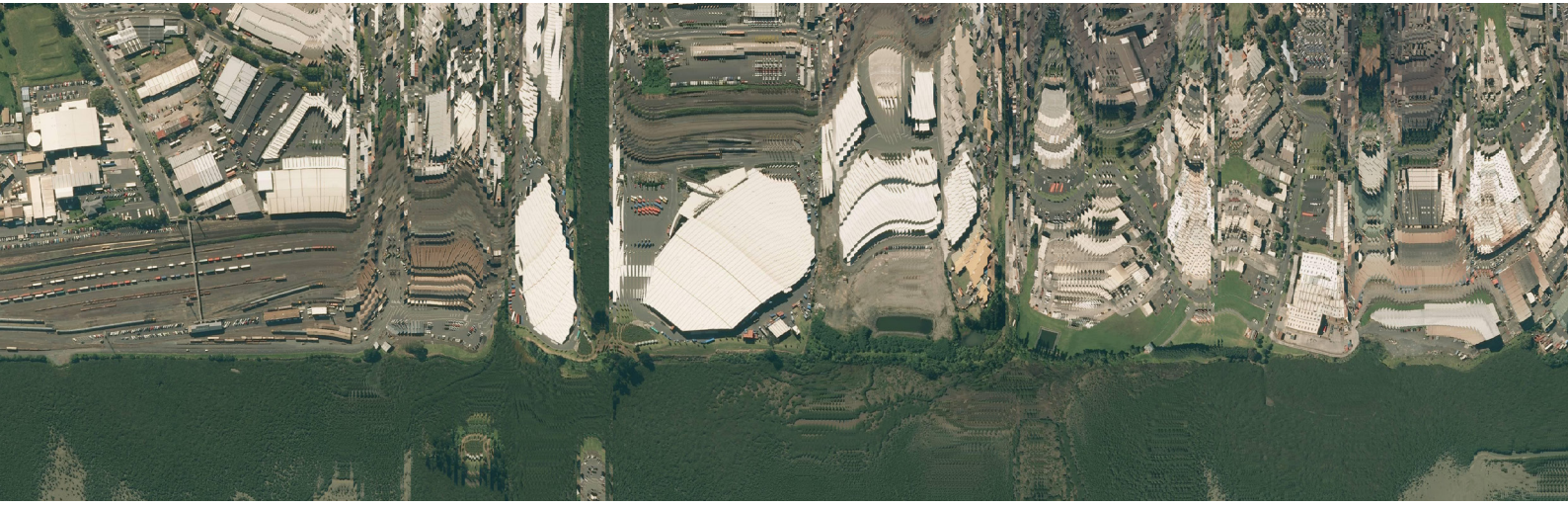




Fig. 38. Curve-offset map of Māngere Inlet. Constructed using my second method (described in sec. 2.2), resulting in a smoother deformation. The path appears as a straight line, and vertical lines in the map correspond to lines drawn at 90° to the path. Curves in the path result in distortions in the map.

axis is determined by the perpendicular offset from the curve (Fig. 38). The resulting projection has a consistent scale along the vertical axis. The scale is also consistent along the path itself. Angled lines, or horizontal lines that are not on the path, are not to scale.⁹

The image is effectively equivalent to those produced by slit-scanning photography, most commonly seen in finish-line photographs from athletic events. Slit-scan images are assembled from photographs taken multiple times per second from a fixed camera position. A visual mapping of the moving object as it crosses the line can then be pieced together. My curve-offset projection captures slices *along* the path. While they therefore correlate with movement, the speed of that movement does not affect the view. The horizontal axis of the slit-scan view is time, where in the curve-offset view it is distance along the path.

2.3. Cognitive maps and affordances

Curve-offset projection is relativistic. Territory is mapped relative to the line, instead of the line being mapped across the territory. This approach has something in common with the 1849 Petition of the Ojibwe Chiefs (Fig. 39), a map in which the coast of Lake Superior is figured as a line, with features and marked against its edge. The map was made for a delegation of Chippewa who travelled to Washington to petition the United States Congress to guarantee their ongoing inhabitation of their lands (Great Lakes Indian Fish & Wildlife Commission, 2005: 1). The family groups of the tribes are symbolised as a parade of totem creatures. Rather than a people scattered over a terrain, the map figures them as a purposeful collective, moving together.

My technique also recalls John Ogilby's road atlas *Britannia* (1675; Fig. 40) Ogilby drew one hundred plates showing land routes throughout Britain. Each plate shows the route as a continuous straightened line, with towns and natural features appearing along the way. Compass roses mark the changing orientation of the route. He used a consistent scale of an inch to a mile, and provided detailed written instructions to accompany each map. Ogilby's

9. Daniel Huffman (2015) has used a method similar to my initial quad-based one to produce unrolled maps of Lakes Michigan and Superior.

Fig. 39. Symbolic petition of the Ojibwa Chippewa chiefs. Lake Superior is drawn as a line, with the tribes on the shores represented by their totems, moving together to express unison. (Great Lakes Indian Fish and Wildlife Commission, 2005, p.1)

[→ view online](#)



Fig. 40. The road from London to Dover. John Ogilby, 1675. The route is presented in linear sections with landmarks and towns marked on the way. (Ogilby, 1675). Public Domain.

maps show an itinerary rather than a territory. They are organised by time and progress rather than location in a two-dimensional field.

Using two-dimensional Cartesian coordinates, a curve can be defined as the trajectory of a point through absolute metric space according to a function. Orientation in Cartesian-Newtonian space (Ch.6, sec. 2.1) is relative to an origin point. Alternatively, a curve is a function that links any point to the previous one. In this way, the curve can be described independently of any external system of coordinates. A curve in Cartesian-Newtonian space is *absolute*, but defined functionally is *relative*.

Straightening a path in this way takes into account that the primary experience of walking a route is *linear*. In following a path, we are oriented *forward and back, left and right*. This relative orientation does not correspond merely to the orientation of a body standing on the path. I can turn myself to face in any direction, wherever I am on the path. This is not a purely mental orientation, in the sense of a “cognitive map” or a “city image” (Gibson, 2015: 188; Lynch, 1960: 46). Rather, paths organise subjectivity: “These structures order and reorder space in ways that establish and constrain the actions and lives of the individuals who inhabit that space [... and] the possible forms of subjectivity in that space” (Malpas, 1999: 186). While the space of the path is not purely subjective, it has implications for subjective experiences. As we trace a finger along the curve-offset map, we discover a pattern of adjacencies. From any point along the path, we can see what we would encounter if we were to turn off the path. The map shows the affordances of the local region – what I have access to, what nearby opportunities present themselves.¹⁰

The map emphasises the smoothness of moving along a path. Because the path does not involve sudden changes in direction, but tends to turn the body gently, it is experienced primarily as facilitating *forward* movement. Alternatively, it offers the possibility of an about-face and *return*. Anything other than these two movements is, first and foremost, a move *off* the path, off the line of reduced friction, off the route of linked points into the ‘open’ of the terrain. As we walk a path, we settle into a groove.

10. There is some relationship to the drawing of *isochrones*. (Street, 2006).

One of the notable effects of the curve-offset map is that the water stays on one side and the land on the other. This situation changes only where the path crosses a stream or inlet, where the path does not track along a peninsula or protrusion, and where the path crosses the Māngere Bridge. By moving with the water to left or right, the water becomes a constant geographical reference. Moving clockwise, the sea will always be to the left. The mountains around the inlet are often visible, but these will change their position as the path turns; the water remains a relatively fixed referent. The circuit also circumnavigates, encircles, orbits. It objectifies the inlet to the extent that it portrays it in the round and provides us with the opportunity to integrate many views. The inlet attains an ambulatory unity.

The visual effect of warping and bending is generated by the curvature of the path. When the path curves, the world on the outside of the curve passes more quickly than the world on the inside of the curve. When the path is straightened out, the broader area on the outside of the curve becomes compressed and it registers more briefly. Conversely, the narrower space on the inside of the curve is expanded by the straightening process. Where the path curves around something, it remains close by for longer, hence registering larger in the image.¹¹

A related effect is the mirroring or echoing of parts of the hinterland. As the path turns, regions of the hinterland come into range, then move out of range, and then come into range again from a different angle. Something in range on one side of the path subsequently comes into range on the other side of the path. This appears as mirroring: parts of the territory appear more than once.

Stretching and mirroring result because the space is oriented around the activity of *moving along*. The path produces a space of activity: an intentional space (in phenomenological terms; Dreyfus and Wrathall, 2005: 54); a space of affordance (in ecological terms; Gibson, 2015: 119); or a space of mental integration (in cognitive terms; Lynch, 1960: 9).

11. Where the curve is tight enough that the centre of curvature is in range, that centre becomes stretched out as a horizontal line parallel to the path (such artefacts are visible all along the image).

The terrain disclosed by curve-offset projection is not a ubiquitous flat 'site', but an intensely polarised relational field. It is not defined by extension in x, y, and z directions, but by relative position, by forward-back (not the forward back of an individual body, but the bi-directionality of a line), left-right, and seaward-landward. Curve-offset projection yields a cartographic grid for a polarised field rather than the even space of a global coordinate system. For a person standing on the path, the space of the curve-offset map is arguably more real than the space of latitudes, longitudes and grid references. The path is a space of ambulatory possibility and an orientation system.

2.4. Michael Webb: Sin Centre and Temple Island

Michael Webb, in his *Sin Centre* project (1962) explored the kinetic and spatial implications of driving. In several meticulously hand-constructed drawings (Fig. 41) he explored the complex geometry of a circular car ramp. Cambered, tapered, and helical, the ramps formed a circuit experienced almost exclusively from the driver's seat. Although he never made it, he envisaged an unrolled section, similar to my curve-offset projection:

Webb imagined, he wrote, encountering the architecture at speed, 'the sense of having the building spin around you as you negotiated corners; of entering it; of being absorbed by it', and in a recent interview commented on his regret not to have drawn a section projected from the centre line of the ramp. To do this would be, in effect, to turn the car into a kind of drawing device, to translate the experiences of driving and drawing onto one another – for not only would space at the zones of the opened coils become compressed and intensified, as it is for the driver when the vehicle spins around, but the unfolding of the ramps would produce a redistribution of the parts of the building, causing them to appear multiple times within the drawing. (Dorrian, 2017: 2)

The warping of space by movement also manifested in *Temple Island* (1987) where he imagined "a building existing in the form intended only as a result of speeding towards it, or into it, or past it" (Webb, 1987: 1). In an extremity of anamorphic projection, the titular temple becomes a smear across an elliptical picture plane subtended from the eye of the "tripper", contained in a high-speed submersible (26). In one plate (Fig. 42), two views are juxtaposed in a single circular frame. To the left, a bucolic watercolour scene,

Fig. 41. Sin Centre, Leicester Square, London. Michael Webb, 1962. Axonometric of the cambered, spiralling, parking ramps (Webb, 2015).

[→ view online](#)

tinted as if viewed in a Claude glass, with trees and the gradient of the sky reflected in the glassy surface of the water. To the right, a graph showing the exponentially increasing mass of the submersible as it accelerates towards the temple. Lists of numbers and calculations are scattered over the concentric rings of a polar reference grid. Scenography and calculated motion sit together. The design is contingent on plotting a trajectory: “If the design for a new temple has emerged, it is the result of the journey towards it... For the new temple to thingify it must be seen only from T1, T2, T3 and T4, and in sequence” (52). Objects are “precipitated” onto the picture plane, “in the meteorological sense of the word as in moisture condensing in the form of rain” (18).

Webb’s speculative space is calculated as much as designed. *Temple Island* is a novel minimalism, one that does not require new construction, but builds with what is already present by defining a line of motion towards, around, and through it. Similarly, the first construction of my Project Cycle 1 was a single line that modelled a new space out of what already exists. As a minimal infrastructure, this line orients a new space. My next concern was what this line would precipitate.

3. NOT ENOUGH AND BARELY ENOUGH

By this point in the process, an aesthetic disposition was beginning to take shape: a kind of sub-minimalism. The minimal could be understood as being *just enough*. I became curious about the potential of the *just insufficient*. In *Temple Island*, Webb described a new design coming about simply through describing a new trajectory. Similarly, the line of my path formatted space, even though its material presence was still indeterminate. Sub-minimalism might orient, polarise, or condition a space without necessarily defining, producing, or framing it.

This is not to revert to the ideal of the neutral, ubiquitous spaces admired by Modernists like Mies van der Rohe, who seems to have seen his gridded spaces as spiritual in their access to the mathematical purity of universal space (Frampton, 1992: 232-3). This poetry has dwindled: today such ubiquity often serves primarily the need for economic construction and maximum flexibility of rentable floor plates. The *just insufficient* might have a closer analogue in Alejandro Aravena’s concept of “incremental housing”

Fig. 42. Temple Island, Michael Webb, 1987. Perspective along the route of the submersible 'tripper', showing how the view will shift as it approaches the speed of light (Webb, 1987).

(Elemental, 2016): Aravena designed houses that were incomplete – or rather that remained *open* in a different way from the abstract openness of Mies’s Crown Hall (1956). The structural and serviced parts of the house were built, but room was left so that the inhabitants could extend and rework it. The house as initially built is a platform for future activity.

The idea of the *just insufficient*, as it began to emerge in Project Cycle 1, countered the idea of *Gesamtkunstwerk* that Adolf Loos mocked in his acid tale, “The Poor Little Rich Man”. Loos ridiculed the idea of designing total environments as hubristic. His pompous architect exclaims, “How dare you presume to receive presents? Didn’t I draw everything up for you? Haven’t I taken care of everything? You need nothing more. You are complete!” (Loos, reprinted in Sarnitz, 2003: 20).

Where the sufficient achieves, defines, frames, the insufficient provokes, prompts, permits, orients, invites. Infrastructures are not merely efficient, but crucially insufficient, leaving ends open and unresolved. This does not mean the insufficient is entirely ineffective, however. As Latour points out:

there might exist many metaphysical shades between full causality and sheer inexistence. In addition to ‘determining’ and serving as a ‘backdrop for human action’, things might authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on. (Latour, 2005: 82)

My path is an insufficient but orienting thing. David Leatherbarrow wrote of a need to account more fully for “the ways that better buildings have been oriented or inclined beyond themselves – which is to say *otherwise*” (Leatherbarrow, 2009: 9). He gives the example of O’Donnell Tuomey’s Lewis Glucksman Gallery in Cork (2005), which is internally oriented to point away from itself through its openings and postures, towards the landscape. Internal circulation is organised around *landings*. These expand beyond what is strictly necessary for circulating, but do not quite become independent floors. As wasted or unresolved space, they do not gather attention as architectural figures or statements, suggests Leatherbarrow, but effectively turn the building outwards.

He finds a similar deference in the performative nature of furniture. A table, for instance, might be “as immediate as the palm of your hand, as expedient

as a molded plastic tray, or as refined as bone china on black lacquer” (124). Tables are generic surfaces, but also if they are “[p]resaturated” (122) once they are set: “Elements in service forego conspicuousness once they commit themselves to sustaining events” (123).¹²

Above, I called my interest in the insufficient a disposition. At this point, the just insufficient was not a resolved concept, nor the result of analysis. Rather, at this point in my inquiry, it expressed itself as a preference or a curiosity; I will track its evolution through subsequent project cycles in Chapters 9 and 10. Conditioned by these thoughts, however, I embarked on *furnishing* the path I had marked out.

4. SURFACING

4.1. Points of inflection as scale transitions

Around the inlet, there are relatively few existing points of access to the water’s edge. Studying my mappings, I identified opportunities to make connections from the foreshore to areas of significant activity (parks, main roads, local town centres, and landscape features, for example). These connecting routes came down to the water’s edge, where they met the path. I thought of these as *waypoints*, as moments of *reorientation*, or *crossings*. The crossings connected the circuit path to existing networks of routes and sites around the Māngere Inlet. At these waypoints, the path would broaden into a pavement wider than necessary for walking or cycling. The broader pavement would channel movement less urgently, and invite cross movements and pausing.

Addressing the detailed design of these pavements involved a shift in scale. Rather than working on maps between 1:1,000 and 1:10,000, in which a human body is a point or a few pixels, I now had to think and draw at smaller scales. At 1:100, bodies can take up a range of positions, posture

12. Tables withdraw into the ready-to-hand: “The enjoyment of a meal hardly requires steady attention to the chairs, glasses, and napkins that allow it to take place. The ‘service’ they perform involves not only subjection and anticipation but a particular kind of recession, a retreat or withdrawal from perceptual prominence. That they allow themselves to be overlooked during the mean is not a fault of their ‘form’; actually it is the reverse, its relative perfection” (Leatherbarrow, 2009: 122-3).

begins to matter, and the body becomes one object among others. At 1:10, bodies might be considered in part – perhaps just as a hand or foot – and tectonic details become visible. This shift, conventional in architecture and well ingrained in my habitual design practices, made me uncomfortable because it seemed to imply that the large and the small were separate worlds with different concerns.

In geography, scale has become a questionable concept. In an interview, Nigel Thrift admitted:

I never really understood scale and I still don't. One of the problems you do get into if you decide there are scales is that you start allocating things to one scale of another, to one territory or another. Once you start doing that you almost predetermine the conclusions in ways which are really quite problematic... For me it is a term we can do without. (Farías & Bender, 2010: 116-7).¹³

I have discussed in Chapter 5 an alternative way to see scale, as something generated by things as an effect of their performative relations (sec. 4). How was I to manage the need to address things of different sizes without placing them in a hierarchical system of scales?

In my earlier Grasshopper experiments with the geometry of the path curve, I had generated a number of curvature analyses (Fig. 43). At any given point along a curve, the curvature can be compared to that of an osculating circle: a tight curve corresponds to a small circle centred close to the curve, and a gentle curve corresponds to a large circle centred further away. At points of inflection, the curvature changes from positive to negative, and the centre of curvature crosses over the line. Points of inflection and centres of curvature do not depend on scale. Bernard Cache wrote of the potential for them to link the large and the small: “Geography is not the field next door, nor even the neighbouring district, but a line that passes through our objects, from the city to the teaspoon, along which there exists an absolute outside.” (Cache, 1995: 70)

13. Similar critiques are reviewed by Jones (2015). For Latour's understanding of scale, see (Ch.5, sec. 4).

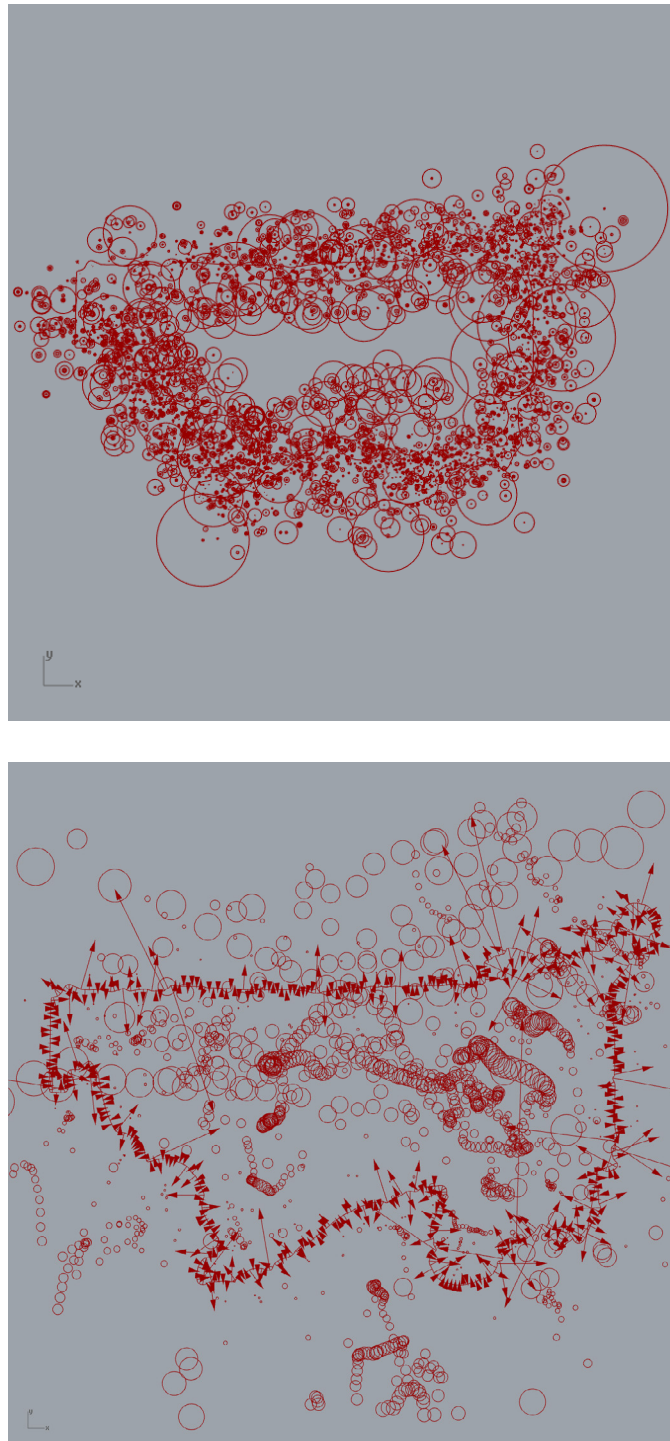


Fig. 43. Curvature analyses of the path around the Māngere Inlet. Circles identify centres of curvature at increments around the path, and are proportional to the radius of curvature at those points.

By adjusting my path curve to produce patterns of inflection points at each of my waypoints,¹⁴ I gained a means to conceptually link detail to geography. I concentrated detail around these points and articulated the grid-lines generated by my curve-offset map to visually indicate the spatial expansions and compressions radiating out from them.

4.2. Stones

In considering material and construction of these pavements, I recalled (Fig. 44) Caruso St John's Stortorget Square (2003), the floor of Lewerentz's Klippan Chapel (1966), and a detail in the floor of Asplund's Woodland Crematorium (1940). In each case, space was created not through envelopment or immersion, but by the articulation of a stone or brick surface.

In *The Writing of Stones* (1985), Roger Caillois expresses the strangeness of stone, its evocation of nonhuman agency: "For a stone represents an obvious achievement, yet one arrived at without invention, skill, industry, or anything else that would make it a work in a human sense of the word, much less a work of art." (1985: 2) As aesthetic marvels that do not result from human activity, Caillois believed stones make our assumptions about art and agency problematic. In her foreword, Margaret Yourcenar says,

Stones, like us, stand at the intersection of countless lines crossing one another and receding to infinity, at the center of a field of forces too unpredictable to be measured; and we awkwardly call the result chance, hazard, or fate (in Caillois, 1985 xix)

For Caillois, stone is not generic material, but specific matter, notable for its particularity not its general properties. His account of stone contrasts with that of Gottfried Semper, who describes it from the perspective of stereotomy as "those raw materials that strongly resist crushing and cracking because of their hard, thick, and homogeneous aggregate composition, and thus have significant compressive strength" (Semper, 2004: 725). To apply a

14. In doing so, I had to regenerate my curve-offset map since the pattern of deformations had changed.

Fig. 44. Plan of Stortorget Square (detail), Kalmar,
Sweden, Caruso St John (2003)

[→ view online](#)

Floor detail of St. Mark's Chapel, Klippan, Sweden,
Sigurd Lewerentz (1966). Photo: Seier+Seier.

[→ view online](#)

distinction made by Ingold, Semper is concerned with materiality whereas Caillois is fascinated with materials (Ingold, 2007b: 3).¹⁵

Auckland has a well-established tradition of building in stone, specifically the scoria and vesicular basalt deriving from the Auckland Volcanic Field. These constructions are typically rough in finish. Scoria cracks and crumbles easily, depending on its porosity. Various degrees of finish and methods of assembly are visible nearby the Māngere Inlet. At Ōtuataua, to the south, Māori were using stone landscape constructions for horticulture as early as the fourteenth century (McLean, 2013; Fig. 45). These were later disassembled and reconstituted as dry stone walls by colonial farmers. The Jellicoe Park War Memorial arch (1929) is made of red scoria, rusticated but tightly fitted. Stone walls surrounding Waikaraka park were made from lava stone excavated during reclamations; and the groundskeeper's cottage there is made of neatly cut and mortared blocks (Fig. 46). On the other side of the Inlet, St James's Church is made of stone from Māngere Mountain (see Ch.4, sec. 2.3). In addition, there are many minor constructions: fences, retaining walls and steps.¹⁶

With this tradition in mind, I decided to articulate the pavement with basalt blocks (Fig. 47). Where the blocks become largest, because furthest from the centre of curvature, they are finished more roughly. Closer in, they are flamed and, in the tightest parts of the curve, they are polished. The friction of movement is articulated in the literal friction coefficient of the surface. All this is subtle, and may well pass unnoticed. As muddy coastal land subsides and people walk and ride over the pavement, the blocks will sink and move slightly. Marking time, the precise lines of the grid will begin to decay.

There are also stone platforms, located randomly near the pavements. Some sit out in the water, accessible across the mud at low tide but islands at high tide. Others stick out from shore like piers, and still others are on land. They are made from scoria using a range of techniques borrowed from the examples found in the area. The specific techniques chosen, the location of

15. "What academic perversion leads us to speak not of *materials and their properties* but of the *materiality of objects*?" (Ingold, 2007b: 3).

16. A substantial history or catalogue of this architectural tradition does not exist. A small collection of the more notable buildings is found in Hayward, Maitland, and Murdoch (2011: 75-9). The observations in this paragraph are my own.



Fig. 45. Collapsed stone walls, Ōtuataua. Māori horticulturists built stone walls around hollows in the ground to create a micro-climate suitable for kumara. These later walls were built by Pākehā farmers. Ōtuataua volcanic cone visible to the top right. Feb, 2012.





**Fig. 46. Waikaraka Park
groundskeeper's cottage.** Unknown
designer, 1942. Basalt stone and
concrete construction. Nov, 2012.

the platforms, and how heavily they are used, will affect their rate of decay and modes of failure. I imagine some platforms slumping into the sea over the course of twenty years, or becoming lost in overgrowth.

Stone would evidence both human and nonhuman agencies, and weave together human and geological timelines. As they diverge from (but retain traces of) their initial alignments, they “stand at the intersection of countless lines crossing one another” (Caillois, 1985, xix). By making some of these lines almost visible, the stone pavements disclose place as a “knot” in a “meshwork” (Ingold, 2007: 100).

4.3. Furnishing the pavement

In furnishing these pavements, I was guided by Allen’s observations regarding variable components. While infrastructures employ “typical elements or repetitive structures” (Allen, 1999: 57) they also make use of “an extensive catalog of strategies [that] exist to accommodate irregularities” (57). They often use mass-produced components, but these have a looseness or flexibility of fit that allows them to accommodate variable conditions. Accordingly, I proposed three sets of components: *sheds*, *lawns*, and *lighting masts* (Fig. 48).

On some of the scoria platforms, sheds are built (Fig. 50) from a kit of parts comprising steel frames and metal panels of various types (perforated steel, expanded mesh, corrugated and trough-section). These could be event spaces, leased out, used as temporary shelter from the weather, or be disassembled and taken away if unwanted. They are invitations for improvisational use rather than programmed spaces.

At the inflection points themselves, there are a series of circular lawns (Fig. 51). Each is framed by curved steel edging; some are kerb-height, others are elevated to a height comfortable for sitting, others are higher but able to be clambered onto, others still are isolated by their height. The grass species and length vary: some are shaggy and tussocky, some like clipped English lawns, some of sandy pingao, others a scraggly mix of wildflowers and weeds. Each of these types implicates a rhythm of maintenance; over time, they could be replanted and the mix varied. While some lawns clearly invite sitting or



Fig. 47. Pavement study. Pencil on permatrace, selectively articulating printed grid underneath.

gathering, or could be used as a stage, others send mixed messages about what activity is anticipated.

Lines of lighting masts describe curved trajectories across the path. These do not follow the line of the path directly, but follow a derivative curve (the evolute). This curve tracks the centre of curvature as it crosses over the path and foreshore. Lighting masts cluster around points of inflection. Sometimes they stand in the middle of a lawn, or protrude from sockets in the stone pavement, and sometimes they jut out of the mud or shallow tidal waters.

5. GRAPHEMATIC DRAWING

As I worked, I moved back and forth between digital drawing, using AutoCAD¹⁷ and Grasshopper; and drawing by hand, using either graphite on permatrace, or graphite and ink in a sketchbook. Much has been written about the impact of digital drawing on design processes.¹⁸ Frascari, wary of digital drawing, writes: “A *graphema*, an emotional piece of drawing, should not become a *mathema*, an indifferent digital drawing and an after-the-fact analysis of algorithmically produced representations.” (Frascari, 2009: 202) This distinction, however, cannot be conflated with the distinction between drawing in pencil and drawing with software. A pencil drawing can be *mathema* and a CAD drawing potentially a *graphema*. Frascari is distinguishing between drawings that involve an imaginative circuit between the drawer and the drawing; and those which merely calculate and involve no such imaginative investment.

There is no reason, however, to exclude calculation from the imaginative circuits of drawing. The path generated the points of inflection and evolute curves with which I laid out my design. They were literally calculated by software algorithms (both those built into Rhinoceros 3D / Grasshopper and those I devised myself), but these algorithms were continually revised and adjusted, producing oddities and unintentional effects (Fig. 52). The

17. AutoCAD (Autodesk, 2014). I was interested in this as an historic tool; digital drawing in this manner is becoming rarer.

18. For example, Frascari, who claim digitally produced drawings are “pseudo-efficient and often unnecessarily precise” (in Frascari, Hale and Starkey, 2007: 2); and Scheer, who writes of the shift from drawing to simulation. “These technologies are not ‘another pencil;’ they are both evidence and agents of fundamental changes in the nature of architecture” (2014: 2).

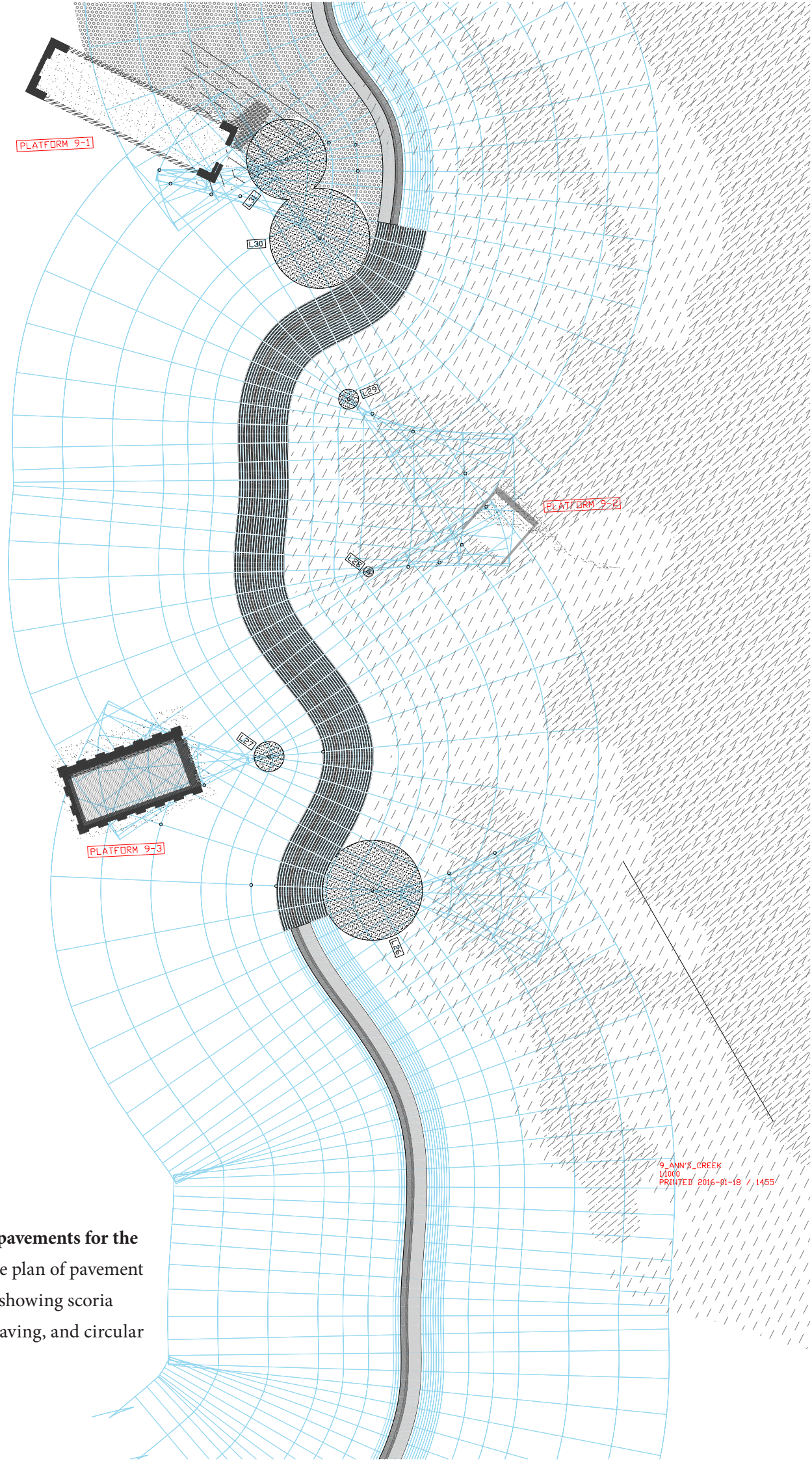


Fig. 48. Path and pavements for the Māngere Inlet. Site plan of pavement near Ann's Creek, showing scoria platforms, basalt paving, and circular lawns.

code itself, and the curve-offset projection it produced was *graphematic*, “a generative graphic process understood in its slow making [ruled by] a fruitful vagueness” (202).

This relation between calculation and vagueness was also evident in my pencil drawings. Even if the irregularities and tolerances of the drawing are not the same as the tolerances of fabrication and construction, they are similar enough to allow the drawing partly to rehearse the condition of being in an irregular world. In particular, the slowness of the hand-drawings was valuable because it allowed me to filter out unnecessary detail, and pressured me to define very clearly the distribution of fixed and unfixed aspects of the design. In both hand-drawing and digital drawing, there was a blending of the contingent and the determined; and an opportunity for unintentional discoveries to suggest the presence of other agencies.

I decided to exploit the anodyne qualities of CAD schematics – the bland but intricate drawings of infrastructural engineers – as I developed the proposal in detail. I made site plans of each pavement, and a set of typical details describing the construction systems and components. This worked well for survey lines and industrially mass-produced components (for example steel panels, I-beams, or CNC machined basalt blocks).

The scoria platforms, however, with their approximations and variability, called for a different technique. I used AutoCAD’s hatching tools in unorthodox ways to draw these (Fig. 49). By layering and manipulating hatch patterns and deleting perimeter lines, I found I could produce an effect similar to the lines of copper point engravings. Accumulations of sharp fine line could describe softer and vaguer material conditions.

During the later revision of the body of work carried out in Project Cycle 1, I integrated these CAD drawings with the curve-offset map. This required writing new code to perform curve-offset distortions on vector data (the previous code only worked with pixel-based raster data). I patched together a new Python script (Technical Appendix 4) that re-projected my site plans into curve-offset format.

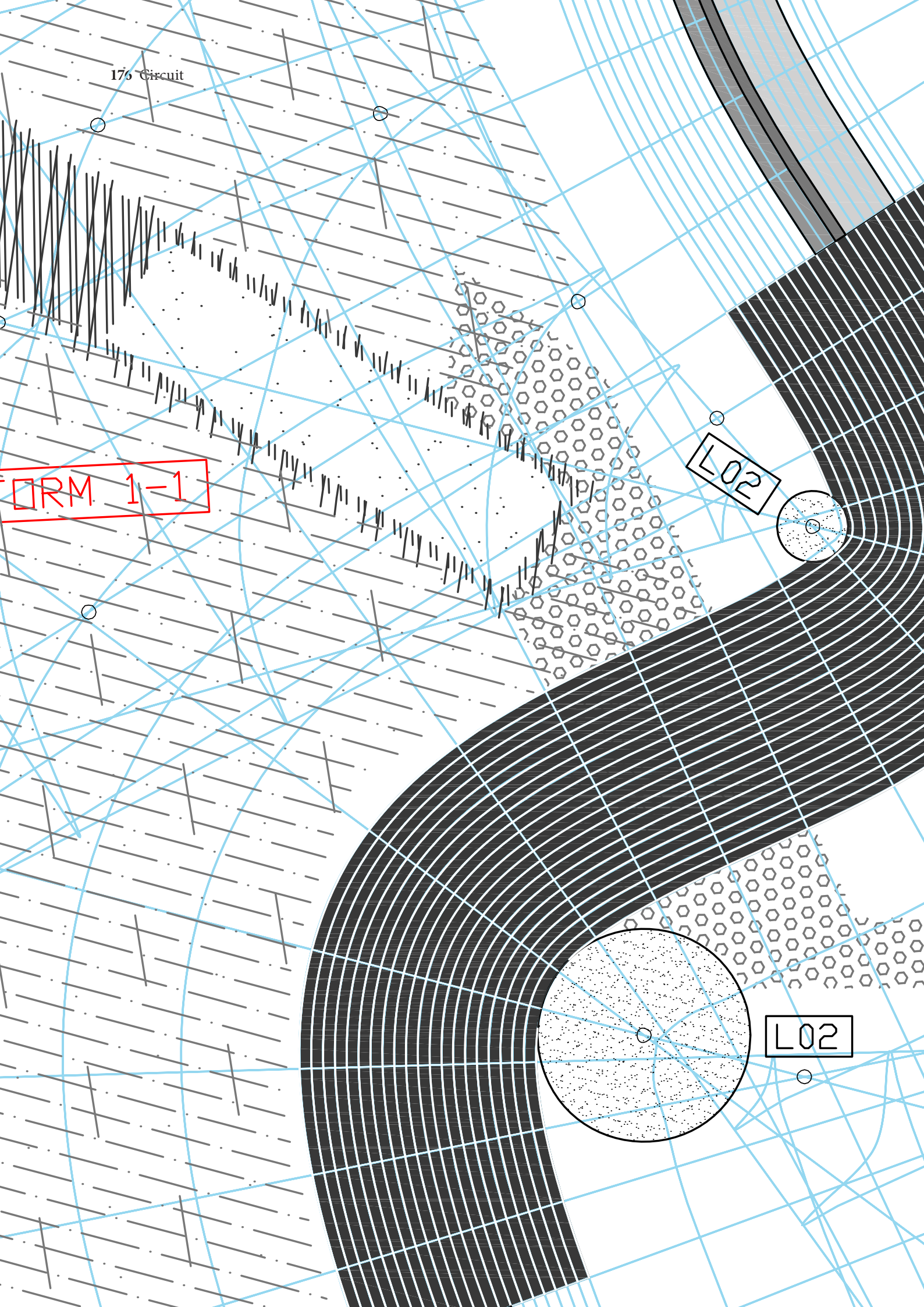
Frasconi refers to the “facture” of architectural drawing; its reflexive quality of being “a record of its own having been made” (2009: 203). The marks of an architectural drawing “derive their meanings from actually embodying in

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FORM 1-1

L02

L02



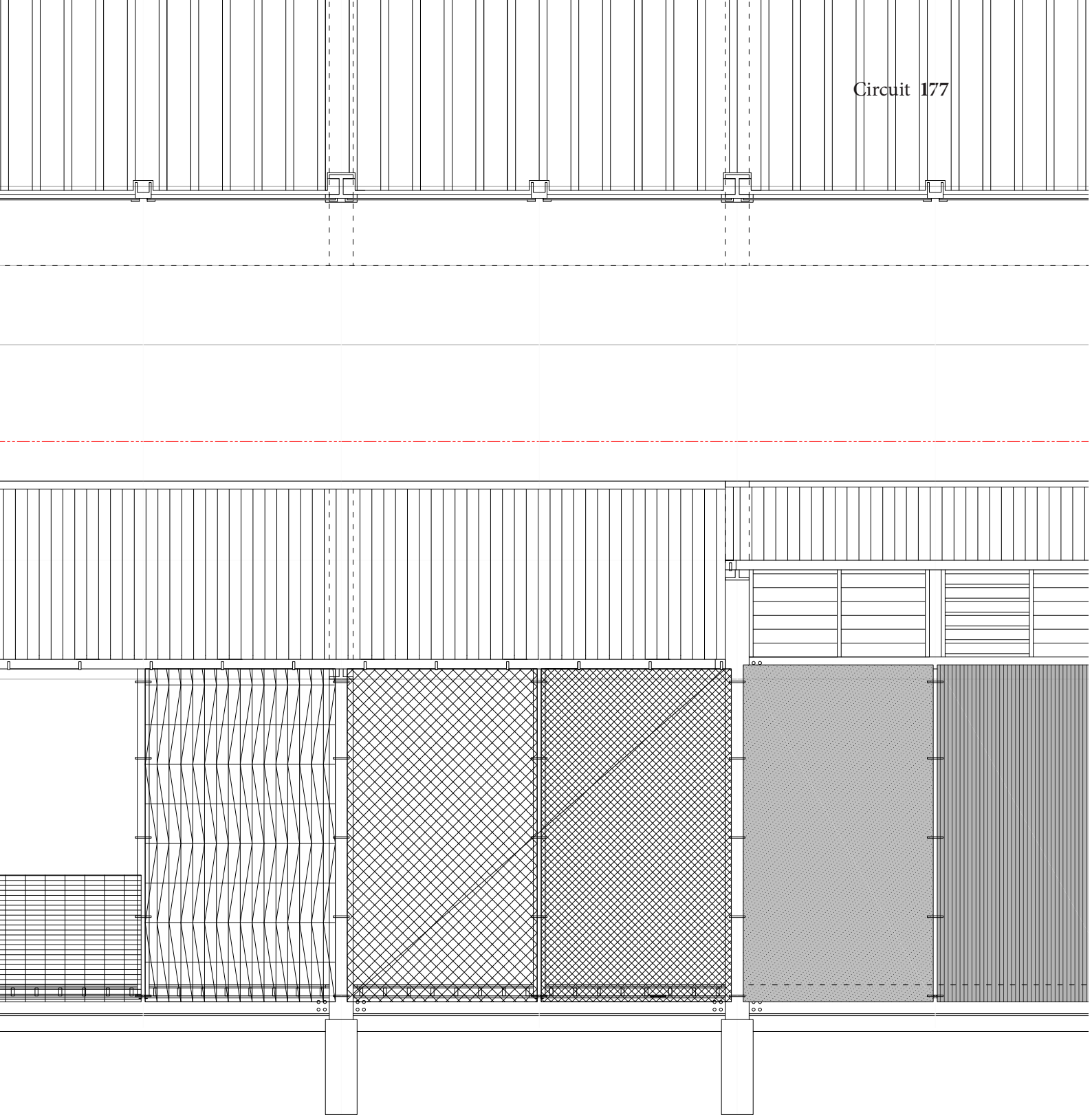


Fig. 49. Hatching detail from site plan of pavement near Te Tō Waka / Portage Road.

Fig. 50. Partial plan and elevation of typical shed. Steel meshes, perforated sheets, and corrugated panels are used to vary visual density.



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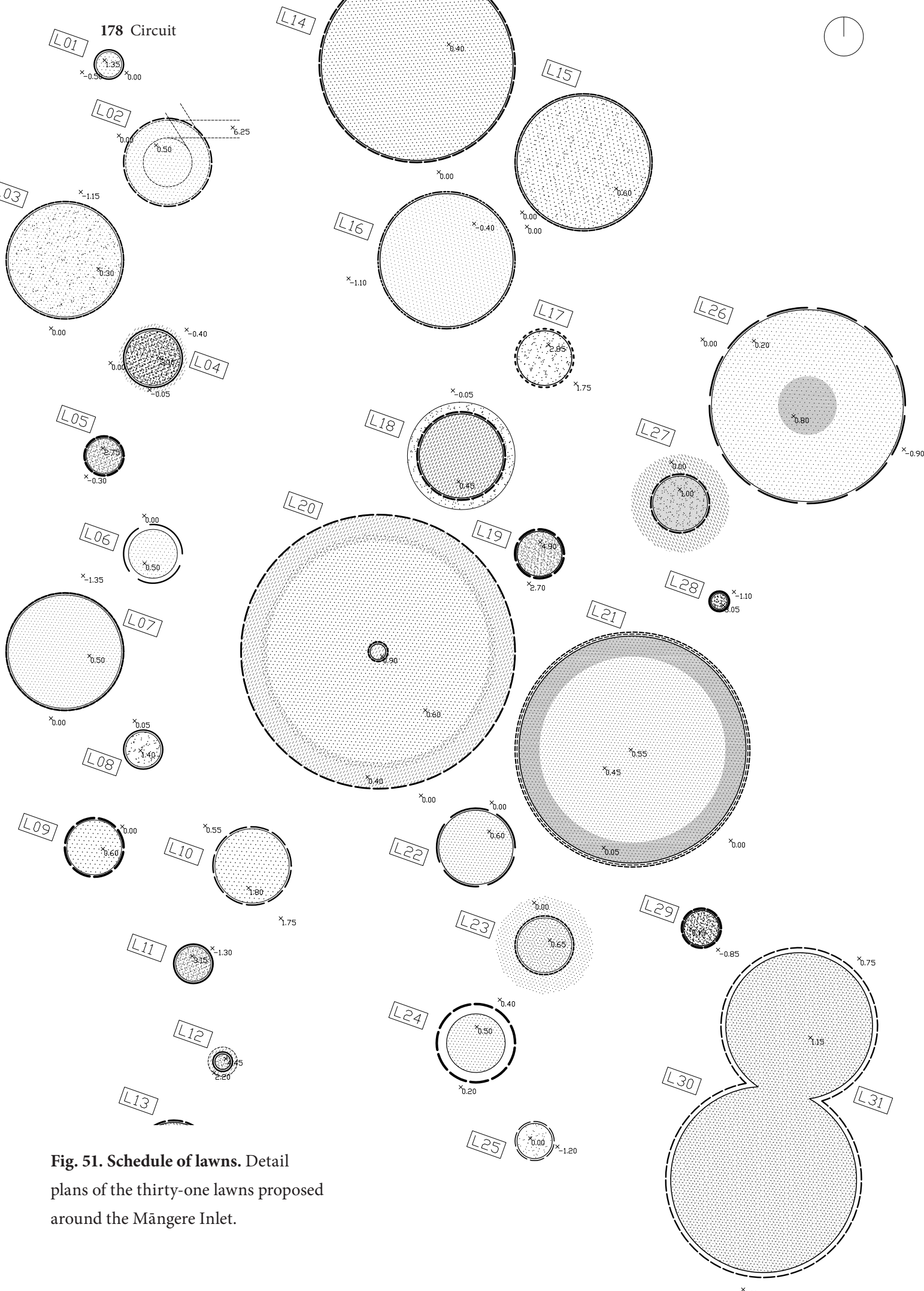


Fig. 51. Schedule of lawns. Detail plans of the thirty-one lawns proposed around the Māngere Inlet.

their tracing the events that they represent” (203). He uses this idea to give importance to physical mark-marking. So, for instance, the slow scratching and polishing movements involved rendering stone blocks pre-enact the finishing of the stone itself. But the clumsiness and indirectness of layering hatch patterns in AutoCAD might also anticipate the awkwardness of stacking scoria; and debugging loops of code might prefigure the repetitions and adjustments of deploying construction systems into irregular and shifting contexts. Emmons, following Frascari, distinguishes lines that are traced across a page from lines that are “rubber-banded” on screen by selecting two points (2014: 554). Ingold makes a similar distinction between “*wayfaring*” lines and lines of “*transport*” (2007: 75). Yet both might be necessary to grasp the spatialities involved in infrastructure.

6. RETURNS

In my Project Cycles, I aim to demonstrate strategies for projecting place in light of the topological spatiality of infrastructure. In this first cycle, the conceptual figure of the *circuit* prompted a design inquiry into the relationship between *movement* and infrastructure’s topological space. *Circuit* responded directly to questions arising from my failed transect drawing. Through the curve-offset analysis, I felt I had grasped infrastructural space more convincingly. I analysed and manipulated the geometry of the path in terms of the *orientation* it provided. The territory surrounding the path was reconfigured through the construction of a curve-offset projection. The curves of the path generated a layout for pavements at significant points along it. I surfaced and furnished these pavements, thinking of this as preconditioning a space for future activities. Deliberating on this work, three key openings appeared.

First, ideas of looseness, the just-insufficient, and the vague had begun to seem important, but were themselves vaguely defined. These resonated with my reading of infrastructure (in Chapters 3 and 6) and with aspects of my drawing and coding. I resolved to sharpen and experiment with these ideas in Project Cycle 2.

Second, I had focused tightly on a single activity: moving along a path. Other possibilities, and the multifarious activities already underway around the Māngere Inlet, were barely sketched. The region’s meshwork was far denser

than I had allowed. The spaces I had designed remained conspicuously empty and unpractised. What were the possibilities for diverse things moving at different speeds to encounter one another? How might orientation work in more complex settings?

Third, I wondered what happened to the experience of *immersion*. I had deliberately constrained myself to work mostly on the formatted surface underfoot. Was there a place for people to be surrounded, enclosed, or immersed, as well as in the open? *Circuit* had emphasised *moving on*, but what about pausing, or settling in to a place?

Linked to the realisation of these openings, I became aware that my understanding of how a space is *public* was still inadequate. In the next chapter, I frame notions of the public in reference to the topological places induced by infrastructure. I then return to accounts of Project Cycle 2: Deposit (in Chapter 9) and Project Cycle 3: Exchange (in Chapter 10).

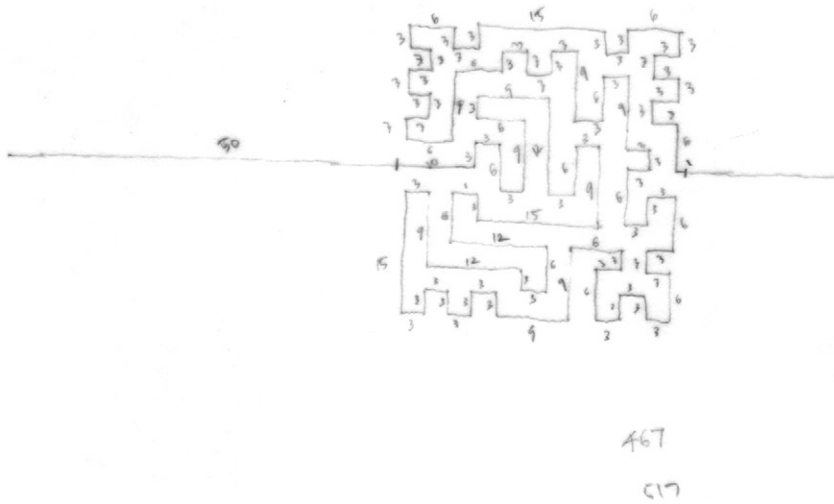
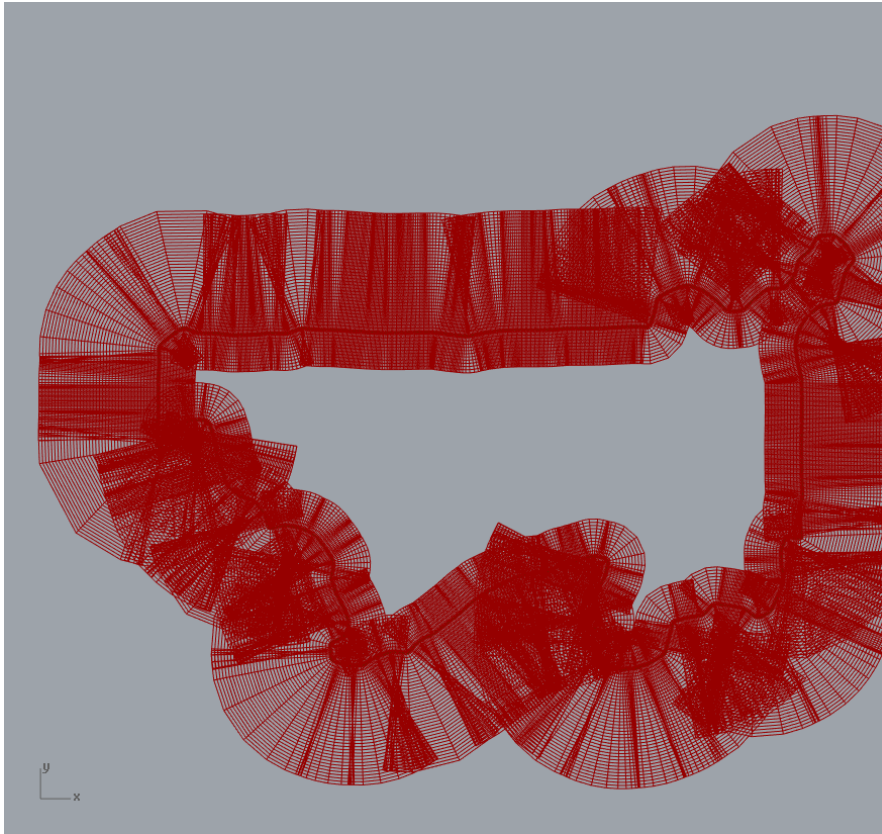


Fig. 52. Graphematic digital drawings, and mathematic hand drawings.

8

PUBLICS

Material participation and waste regimes

1. PUBLIC AS A KEYWORD: INITIAL DEFINITIONS

In my first project cycle, *Circuit*, my treatment of the idea of a *public* was still relatively naïve: public space appeared as surfaces (pavements, lawns, platforms) left open for use by the public in a general sense. On reflection, I became concerned that this practice underestimated the ways in which publics and public activities are inter-dependent with places and spaces and sought a more dynamic understanding of publicness and public place.

Public, like *infrastructure* and *place*, is a term that resists clean definition. Like those terms, too, it can be considered a keyword, a clustering of meanings and uses. It can denote, for example:

(a) the people, interests, or activities which are structured by or pertain to a state; (b) anything which is open or accessible; (c) that which is shared, especially that which must be shared; (d) all that is outside the household; and (e) knowledge or opinion that is formed or circulated in communicative exchange (Bennett, Grossberg, and Morris, 2005: 389).

Publicness involves openness and accessibility, and hence potentially exposure. For this reason, *strangers* are often significant in ideas of the public. Michael Warner posits that “an environment of strangerhood is the necessary premise of some of our most prized ways of being” (Warner, 2002: 74-5). Julia Kristeva asks, “shall we be, intimately and subjectively, able to live with the others, to live as others, without ostracism but also without levelling?” (Kristeva, 1991: 1-2). To be in public involves the company of strangers, but also being strangers to ourselves. Who or what are the public? Is there *a* public, or are there *many* publics? How does a public form? These general questions interlock with questions of situation: we are situated not merely in space (Ch.5, sec. 1) but also with reference to other people.

Infrastructures, as platforms and environments for human activity, accommodate difference, even conflict. These conflicts can be hardwired into institutions, technologies, spatial configurations, governance, and conventions of infrastructures. “Power”, writes Michel Foucault, “has its principle not so much in a person as in a certain concerted distribution of bodies, surfaces, lights, gazes” (1979: 202). To the extent that infrastructures make such distributions permanent, they also enact power relations. According to Madeleine Akrich, “technical objects not only define actors and the relationships between them, but to continue functioning must stabilize and channel these” (1992: 222). Infrastructures align people and create opportunities for them to meet as strangers, but can also assign them limited roles. An occupant of Augé’s non-place “retrieves his [*sic*] identity only at Customs, at the tollbooth, at the check-out counter” (1995: 103). In such contexts, it seems naïve to assume that publics simply occupy neutral infrastructural spaces. Rather than pessimistically concluding that infrastructures can only produce impoverished and impaired public places, however, I seek ways to reinvigorate public space in the presence of infrastructure.

In Chapter 3, I described infrastructure as an intentional context characterised by backgrounding, and noted its production of uneven spaces and strange relations. In Chapter 5, I explored the application of theories of place to infrastructure. I begin this chapter by discussing Hannah Arendt’s idea of public space as a “space of appearance” (1958: 198), and Jacques Rancière’s subsequent idea of the “distribution of the sensible” (2004: 12). I then compare these ideas with Bruno Latour’s idea of a politics of things, a

Dingpolitik formed around “matters of concern” (2005b: 14). In the last part of the chapter, I test these ideas with reference to the positioning of *waste* in relation to public space. My thoughts on waste feed directly into the practice work of Project Cycle 2, discussed in the following chapter.

2. DISTRIBUTIONS OF THE SENSIBLE

2.1. Spaces of appearance

In Hannah Arendt’s seminal book *The Human Condition*, public space, the space of the *polis*, is “the space of appearance” (1958: 198):

The *polis*, properly speaking, is not the city-state in its physical location; it is the organization of the people as it arises out of acting and speaking together, and its true space lies between people living together for this purpose, no matter where they happen to be. [...] action and speech create a space between the participants which can find its proper location almost any time and anywhere. It is the space of appearance in the widest sense of the word, namely, the space where I appear to others as others appear to me, where men [*sic*] exist not merely like other living or inanimate things but make their appearance explicitly. [...] To be deprived of it means to be deprived of reality, which, humanly and politically speaking, is the same as appearance. To men [*sic*] the reality of the world is guaranteed by the presence of others, by its appearing to all; [...] (198-9)

For Arendt, the public does not simply exist when people are together. It is an achievement, a particular construction that is laboured over. The *polis*, public space, is not the dimensionally extended space of the city, placed in a landscape. It is “the organization of the people as it arises out of acting and speaking together” (198). This organisation, a relational network of human agents, opens up a space: a stage on which and a backdrop against which people themselves can be seen.

Appearance is not merely the potential to be detected by human eyes, but the ability to be recognised and taken account of, to be credited with reality and able to have effects. In the same way, speech for Arendt is not only meaningful noises made by human mouths, but the ability to enter into meaningful exchange, contest, even conflict with others. Appearance comes

about when human activity moves beyond self-supporting labour and world-building work, and becomes *action*. Action is “the only activity that goes on directly between men [*sic*] without the intermediary of things or matter” (7) and is thus the pure expression of humanity. Arendt’s space of appearance is an exceptional space that relies on, but transcends the material conditions of a shared world.

2.2. Distributions of the sensible

Jacques Rancière revises Arendt’s position by focusing on the plight of those who do not become visible; who are *denied* visibility.¹ A space of appearance, according to Rancière is also a space of *non-appearance*.

He demarcates the difference between two social regimes: “the police” (Rancière, 1998: 28), in which everything is assigned its place as a part of a social whole, without remainder; and “politics” proper (29), in which there is always a remainder, poised to break? into appearance:

The police is thus first an order of bodies that defines the allocation of ways of doing, ways of being, and ways of saying, and sees those bodies are assigned by name to a particular place and task; it is an order of the visible and sayable that sees that a particular activity is visible and another is not, that this speech is understood as discourse and another as noise. [...] Policing is not so much the ‘disciplining’ of bodies as a rule governing their appearance, a configuration of *occupations* and the properties of the spaces where these occupations are distributed. (29)

Politics, by contrast, describes a social order in which the accounting is always incomplete. Under the regime of politics, there is never a complete list of participants or a full accounting of roles: “Political struggle is not a conflict between well defined interest groups; it is an opposition of logics that count the parties and parts of the community in different ways.” (Rancière, 2001, Sec. 6). The police can never be surprised by the emergence of new participants, since all the players have been enumerated and assigned their parts in advance. Politics, however, is constantly surprised as “the part of

1. According to Schaap, Rancière claims that “Arendt in fact adopts an ‘archi-political position,’ which represses politics by subordinating it to the logic of police [...] she characterizes the political sphere as a realm distinct from that of necessity.” (2012: 151).

those who have no part” (1998: 11) manifests itself by disputing the very conditions according to which the stage has been set.

Rancière’s term for this social order or setting is the “distribution of the sensible” (2004: 12). What is visible, sayable and doable in public space is naturalised, not natural. Through contextual relations, subjects are intricately sensitised and enabled to speak and act.

2.3. Keep moving: policing the street

Rancière gives the example of a street:

“Move along! There is nothing to see here!” The police says that there is nothing to see on a road, that there is nothing to do but move along. It asserts that the space of circulating is nothing other than the space of circulation. (Rancière, 2001, Sec. 8)

A police regime (here represented by a literal police officer), tries to convince people that the street is not a place for stopping, looking, or meeting, only for moving along. Rancière seems to be thinking particularly of attempts to deny public gatherings (of protest or resistance) the use of the street. When the street is naturalised as a space of circulation, it is not only a space in which circulation is *possible*, but a space *for* and *defined by* circulation.

Politics, in contrast, consists in transforming the space of ‘moving-along’ into a space for the appearance of a subject: i.e. the people, the workers, the citizens: it consists in refiguring the space, of what there is to do there, what is to be seen or named therein. (Sec. 8)

The police officer claims that the street is just for moving, there is nothing to be seen, and no reason to stop. Rejecting this claim and repurposing the street disrupts the current distribution of the sensible, bringing new possibilities for appearance.

This is exemplified by considering two duelling reconfigurations of the streets of Paris: Haussmann’s boulevards and the revolutionary barricades. Haussmann cut broad boulevards through the dense urban fabric of streets and alleys.

Paved with new macadam, lit with the latest design of gas light, carefully planned to separate pedestrian, stroller, loiterer, ambling service vehicle, and rushing carriage, planted with rows of trees to ensure shade in summer, provided with underground piping for rain water, sewerage, and gas, cleaned with the aid of scientifically designed gutters, faced by the uniform height of the residences and stores of the *nouveau bourgeoisie*, and carefully sited to point toward a monument or vista as the object of civic pride or aesthetic pleasure, the boulevard of Haussmann was in effect the epitome and the condenser of Second Empire daily life: the modern artifact par excellence. (Vidler, 1978: 94-5)

Walter Benjamin was only partly joking when he wrote: “The widening of the streets, it was said, was necessitated by the crinoline” (Benjamin 1999: 133). The boulevards were places to act, to see and be seen in particular ways. Other activities were moved on or suppressed: the wide streets were intended to be difficult to barricade in the event of an insurrection, and instead facilitated military operations. In resistance to this, “the activity of demonstrators and those manning the barricades [...] literally turned urban communications paths into ‘public space’” (Rancière, 1998: 30). Barricades and boulevards represent warring distributions of the sensible.²

In Arendt, action transcends the material world, causing human figures to appear against it as a backdrop. Rancière points out that what can appear depends on how that material world is configured, and that any configuration necessarily *excludes* as well as *includes*. “If for Arendt politics is participation in public life, Rancière sets this idea in motion: politics is *the struggle to participate* in public life” (Ingram, 2006: 239).³ The possibilities for action, speech, and visibility depend on how the stage is set. A public

2. The discussion in this paragraph is expanded in “Barricades and Boulevards: Material Transformations of Paris 1795-1871” (Douglas, 2007) and revisited in “Inorganic Collections: Atmospheric distributions of the sensible and regimes of public space” (Douglas, 2014).

3. Bonnie Honig claims that the importance of things to Arendt has been inadequately recognised, going so far as to call her “a kind of object-relations theorist” (2017: 34). In their permanence, Arendtian things “stabilize a world for human inhabitation” (34): “human existence is conditioned existence, it would be impossible without things, and things would be a heap of unrelated articles, a non-world, if they were not the conditioners of human existence” (Arendt, 1958: 9).

forms in active exchange with a place,⁴ it corresponds to a space of appearance. That space is not merely a room or town square in which people put themselves on show, however, but the *scope* for their manifestation as subjects.

The pavements, lawns, and platforms of *Circuit* were unsatisfying as public space because, although they left plenty of *room*, they offered little *scope*. They provided a space in which strangers could encounter one another, but gave little *opportunity* for those encounters. Once again, the distinction arose between space as an empty container and places of activity, participation, and investment.

3. MATERIAL PUBLICS AND MATTERS OF CONCERN

3.1. Object-oriented democracy

The role of material things in the production of public place is pursued in yet a different way by Bruno Latour. He points out that politics is entangled with objects.

Just go in your head over any set of contemporary issues: the entry of Turkey into the European Union, the Islamic veil in France, the spread of genetically modified organisms in Brazil, the pollution of the river near your home, the breaking down of Greenland's glaciers, the diminishing return of your pension fund, the closing of your daughter's factory, the repairs to be made in your apartment, the rise and fall of stock options, the latest beheading by fanatics in Falluja, the last American election. For every one of these objects, you see spewing out of them a different set of passions, indignations, opinions, as well as a different set of interested parties and different ways of carrying out their partial resolution (Latour, 2005b: 14-15).

As is evident in this passage, Latour uses 'object' in a very general sense, synonymous with his more famous terms 'actor' or 'actant'. An object is not an entity constituted in opposition to a subject, but anything that has effects,

4. Sloterdijk pursues this idea in his discussion of spheres: "Spheres are air conditioning systems in whose construction and calibration, for those living in real coexistence, it is out of the question not to participate" (Sloterdijk, 2011: 46).

producing some kind of difference. An object does not have to be the origin of action, so long as it mediates some effect.⁵

Objects catalyse dispute, consensus, and community. They “bind all of us in ways that map out a public space profoundly different from what is usually recognised under the label of ‘the political’ (15). Latour proposes a “*Dingpolitik* [...] an *object oriented* democracy” (14).⁶

What Latour means by *objects* is better indicated by his alternative term “matters of concern” (Latour, 2005b: 14): a matter of concern is something I care about or that pertains to me. Unlike a matter of brute fact, a matter of concern is fragile and open to question. It “agitates, it troubles, it complicates, it provokes speech, it may arouse a lively controversy” (Latour, 2004: 103). These questionable and contentious things do not provide a stable, well-formed space for pre-defined publics to meet. Rather they coalesce constantly-shifting “gatherings” of people and non-human things (Latour, 2005b: 114).⁷

3.2. Public problems

Latour derives the idea that publics form around issues that concern them from Walter Lippmann and John Dewey. For Lippmann, there is no fundamental mechanism or essential unity that holds a public together, except the pragmatic concern for problems as they arise: “a problem ceases to occupy attention not when justice, as we happen to define it, has been done but when a workable adjustment that overcomes the crisis has been made” (Lippmann, 1993 57). Where Arendt’s public space is constituted by

5. For a detailed discussion of objects in Latour’s thought, and his philosophical context, see Harman (2009: 99-116).

6. According to Honig, Latour may underestimate the role already accorded to objects in existing political theory: “*contra* Latour, it is actually possible to read most of the canon of political theory from a Latour-type *Dingpolitik* perspective” (Honig, 2017: 1). Latour is not widely recognized as a political thinker, and ANT has been criticized as insufficiently political. As Harman writes, however, it is possible to see ANT as nothing *but* a theory of power and politics, and Latour as concerned for “the fragile composition of a common space for all” (Harman, 2014: 58).

7. Latour links his use of the term ‘gathering’ specifically to Heidegger’s ‘The Question Concerning Technology’ (1977) and Harman’s re-reading of the idea in *Tool-Being* (2006).

pure, unconditioned action, Lippmann's arises through ongoing corrections and compromises.

Lippmann's public cannot fully grasp their situation.⁸ So long as a situation does not arise as a *problem* demanding a response, it does not mobilise a public:

When power, however absolute and unaccountable, reigns without provoking a crisis, public opinion does not challenge it. Somebody must challenge arbitrary power first. The public can only come to his [*sic*] assistance. (Lippmann, 1993: 60).

This evokes Rancière. Only when a distribution of the sensible is disrupted do other possible ways of being emerge. Adjustments, corrections, and compromises are necessitated by disruptions and problems.

Latour extends this thought in describing the way in which situations can become settled and naturalised: "the silent workings of the sewage systems in Paris has stopped being political, as have vaccinations against smallpox or tuberculosis. It is now in the hands of vast and silent bureaucracies that rarely make the headlines" (Latour, 2007: 79). Things that were once problematic have receded into the background. Situations that were once experienced as controversial, ill-defined, and fragile constructions have "become part of the daily routine of administration and management" (79). We could see infrastructure's withdrawal into the background in this light: as it retreats from awareness, it also may also cease to catalyse a public.

John Dewey built on Lippmann's view, emphasising the significant of *indirect effects* (which I term *strange relations*; Ch.1, sec. 1; Ch.3, sec. 5). Every activity involves both direct and indirect effects, and Dewey uses this observation to distinguish between public and private:

When the consequences of an action are confined, or are thought to be confined, mainly to the persons directly engaged in it, the transaction is a private one. [...] Those indirectly and seriously affected for good or

8. Callon argues that Lippmann makes our incapacity or lack of information into a robust public mechanism: "The idea is insightful that each of us is disabled and that the construction of collectives must take advantage of the existence of those disabilities. It applies not only to the public itself; the issue of disabilities also concerns the actual process of making things public, when matters of concern emerge and, with them, concerned groups" (Callon, 2005: 308).

for evil form a group distinctive enough to require recognition and a name. The name selected is The Public. (Dewey, 1946: 12-13; 35).

Indirect effects may not be clearly defined, but this does not prevent them from being problematic.⁹ For example, my choice to pave part of my property might seem to be a private matter; but it has implications for water running downhill into my neighbour's property, and impinges on the capacity of the drains in the street. For this reason, in Auckland, the percentage of impermeable ground covering is regulated by the city council. Similar problems of indirect effect are common in urban life. Problems arise *obliquely*, so publics might be catalysed by matters of concern that they are unable to identify. The very figuration of a matter of concern is contestable. Even withdrawn infrastructures can produce and transmit such oblique effects.

3.3. Participation in material publics

I am in public not only by speaking or acting in specifically public ways. Rather I am drawn into the orbit of matters of concern as they begin to appear as problematic; and since my actions have indirect effects I also generate matters of concern for others. As I observed above, the space of my public appearance is not merely room to be recognised, but scope for activity. Noortje Marres suggests that public activity can be usefully understood as “material participation” (Marres, 2012: 2).¹⁰ Material participation “deliberately deploys its surroundings, however widely these must be defined, and entails a particular division of roles among the entities involved: things, people, issues, settings, technologies, institutions and so on” (2). Distinctly echoing both Rancière's distributions of the sensible and Latour's *Dingpolitik*, material participation deploys and divides a web of contextual relations.

Designing a public place may amount to artfully arranging a space: a town square, streetscape, or marketplace. What this discussion suggests, however, is that there are other aspects of public places that attend to the dynamic interplay between context and public. A public place could explicitly put

9. “Vagueness is not eliminated from the idea of importance” (Dewey, 1946: 64).

10. There is a reciprocal influence between Latour and Marres; he credits her with bringing Lippmann and Dewey to his attention (2005b: 14).

people in contact with contestable matter. In the next section of this chapter, I consider *waste* from this perspective.

4. INORGANIC COLLECTIONS

4.1. Home and away

Waste is not “a fixed category of things; it is an effect of classification and relations” (Hawkins, 2006, Ch.1). In this section, I note how waste is disclosed in two different “waste regimes” (Gille, 2010: 1056), which are distributions of the sensible insofar as they allocate visibilities and possibilities for action. In the *circulatory regime*, waste is channelled into mostly invisible conduits and taken away. In the *public waste regime*, however, it becomes a matter of concern, catalysing public activity. Through this comparison, I hope to make explicit the dynamic interplay between infrastructured contexts and publics, foregrounding the importance of activity and participation.

The circulatory regime is represented by the system of sewerage pipes, rubbish collections, transfer stations, incinerators, recycling plants, and landfills. Under this regime, various conduits channel waste into “waste streams” (Gregson, Metcalfe and Crewe, 2010: 197). When converted into a waste stream, waste is understood to be an inarticulate, relatively homogenous substance to be managed, “translated into metrics – tonnes and targets” (Gregson & Crang 2010: 1026). Once an item passes the event-horizon of the bin, it ceases to be particular (the top of the celery, a dried paint roller or a nappy) and becomes a generic substance to be taken away by specialists.

‘Away’ is a short list of places: in Auckland, it consists of four active landfill sites (Auckland Council, 2013). It is constructed and maintained as a counter-space to the ‘here’ of the city. Timothy Morton writes that implicit in the concept of throwing things away is the concept of an infinite exteriority:

When we flush the toilet, we imagine that the U-bend takes the waste away into some ontologically alien realm. Ecology is now beginning to tell us of something very different: a flattened world without

ontological U-bends. A world in which there is no “away”. (Morton, 2012: 98)¹¹

The circulatory waste regime involves a partition between here and there, home and away. Haussmann built sewers as part of his boulevards, channeling waste out of the street and into a concealed system of containment and handling, separating public life from its abject aspects. Waste infrastructures demarcate a boundary through public space, partitioning it into visible and invisible parts.¹² ‘Away’ is a symbolic space that isolates the undesirable or redundant.¹³

4.2. Inorganic collections

An alternative waste regime is that of the *inorganic collection*. Until 2016, the Auckland Council provided annual or biannual kerbside collections for inorganic waste too large to dispose of in the usual manner. Each household was permitted to put “one small trailerload” of waste beside the kerb “keeping clear of footpaths, driveways, fire hydrants, trees, and power and telephone poles” (Auckland Council, 2014). Collection piles could not include anything that could reasonably be put in the weekly rubbish

11. Latour makes a similar point: “As is now well known, the notion of “environment” began to occupy public consciousness precisely when it was realized that no human action could count on an outside environment any more: There is no reserve outside which the unwanted consequences of our collective actions could be allowed to linger and disappear from view. Literally there is no outside, no *décharge* where we could discharge the refuse of our activity.” (Latour, 2009: 144). Morton further contends that the modern concept of nature itself is little more than the idea of an away formed as a necessary counterpoint to capitalist modes of production: “Nature was always ‘over yonder’, alien and alienated. Just like a reflection, we can never actually reach it and touch it and belong to it. Nature was an ideal image, a self-contained form suspended afar, shimmering and naked behind glass like an expensive painting. In the idea of pristine wilderness, we can make out the mirror image of private property: Keep off the Grass, Do Not Touch, Not for Sale. Nature was a special kind of private property, without an owner, exhibited in a specially constructed art gallery.” (Morton, 2010: 5-6)

12. “Pierre Patte (1723-1814) [...] is credited for having been the first to design a modern sewer system for Paris” (Pelletier, 2015: 96).

13. . “No outside is left. As usual Peter [Sloterdijk - CD] has a striking way to bring this up when he says that the earth is finally round: Of course we knew that before, and yet the earth’s rotundity was still theoretical, geographical, at best aesthetic. Today it takes a new meaning because the consequences of our actions travel around the blue planet and come back to haunt us: It is not only Magellan’s ship that is back but also our refuse, our toxic wastes and toxic loans, after several turns.” (Latour, 2009: 144)

Fig. 53. Inorganic collection pile,
Grotto Street, Onehunga. This pile
infringes on a number of the Council's
rules: it contains organic matter and
recyclables, and is considerably larger
than a small trailerload. June, 2013.





collection, any organic waste, recyclable material, or a list of proscribed items.¹⁴

During the period leading up to the date of the collection, huge piles of waste (frequently infringing on the Council's rules) would accumulate (Fig. 53). Scavenging was commonplace. People would go from pile to pile collecting recyclable scrap metals for sale, reclaim items of furniture in usable or repairable condition, improvise games, or release pent up frustrations by smashing things. During inorganic collections, waste became a condenser of public activity.

Whereas, under the circulatory waste regime, decisions about waste are unilateral (I decide privately that some item is of no further value and place it in the bin. Sealed inside an opaque receptacle, my evaluation is inscrutable. A rubbish-truck with a robotic arm takes my waste away. The council provide a standardised rubbish bin, which is my abstract private interface with a system of conduits that siphon waste away), when I put out waste for the inorganic collection, my evaluations are made in public, staged in sight of my neighbours and passers-by. 'Away' is temporarily close by. My judgements are open to question. What to me is a box of old magazines may be a trove of classic 1990s' *Vogues* to someone else; the furniture I deem irreparable may simply require someone with a little more motivation or practical skill to restore it; the defunct analog television has a few dollars' worth of copper windings inside; and while pole-tennis may have given way to another recreational pursuit for me, it may excite my neighbour's kids. What counts as waste is contestable.

The interfaces and conduits and handling sites of the waste management network interpose between people, eliding a potentially valuable dimension of public experience. Gregson, Metcalfe and Crewe argue for the importance of recognising "practices of divestment" (2007: 187) as constituent of our social identities. Handing down, donating to charity, re-selling online or at a garage sale, gifting, dumping, storing, lending, burning, recycling, and discarding "*not only work to move objects along, but work back, as practices, on their divestors [...]* to constitute narratives of us, of others and our relations

14. Building waste, tyres, car parts, plaster board, liquids, paint, containers for gas, oil, or petrol, solvents, car batteries, fire extinguishers, oil, and broken glass are specified (Auckland Council, 2014).

to them” (198).¹⁵ The circulatory waste regime is organized around the stark distinction between here and away, but this does not reflect the various sites and practices involved in moving things along.

The circulatory waste regime makes waste a mere flux of inchoate matter to be managed technically. In the public waste regime activated during inorganic collections, waste becomes a matter of concern. It temporarily presents waste as problematic, contestable, and value-laden. Inorganic collections enable participatory material practices, opening up a space of public activity.

Yet, because of the mess, the perceived safety risks, and the blocking of paths, gutters, and vehicle access, inorganic collections were stopped in Auckland in 2016.¹⁶ They have been replaced by yearly bookable collections of items, which cannot be left in the street. Illegal dumping continues, however, especially in parts of the city where it is expensive to get rid of large waste [FIG].

5. CONCLUSION

Inorganic collections are more than an historical curiosity of Auckland’s urban culture. Momentarily, when the inorganic collection took place, the smooth operation of the streets as a circulatory system was disrupted. Waste activated public activity (disputes, perhaps, but also potentially exchanges, discoveries of commonality or difference) as a matter of concern. Inorganic collections were made up of things that did not fit the regular conduits. They were *exceptional* matter that resisted assimilation into generic waste, “vivid entities not entirely reducible to the contexts in which (human) subjects set them” (Bennett 2010: 5) and helped us to “develop a more nuanced and

15. . Mary Douglas’ famous proposition that dirt “is the by-product of a systematic ordering and classification of matter” (2002: 44) is questioned by Gregson, Metcalfe and Crewe because she seems to indicate that social order is founded on the *exclusion* of unwanted matter itself rather than various *practices* in which exclusion occurs (2007: 189).

16. The *Auckland Waste Management and Minimisation Plan* (Auckland Council, 2013) lists numerous “negative impacts” of the current inorganic collection system: “health and safety issues for collectors and the public, mess, security issues, damage to reusable items through scavenging, illegal dumping and providing a disincentive to product stewardship” (49). It acknowledges that “they are popular with some parts of the community” (49) without any attempt to account for this popularity.

ambivalent appreciation of the role of things in the enactment of public participation” (Marres, 2012: 9).

In this chapter I have cross-pollinated several theories of the public that invoke an active role for things. For Arendt, the public realm is an achievement whereby individuals come to appearance by transcending the material realm they rely on. By contrast, Rancière insists that no pure transcendence is possible but that the prevailing distribution of the sensible defines what actions are recognised as such, and what positions are available for subjects to take up. A *room* for a public does not necessarily offer *scope* for that public to manifest. The former assumes that the public is independent of its context and can simply move whereas the latter recognises that publics form through activity and participation in a particular context.

For Latour, who draws on Dewey and Lippmann, publics form around common problems, which he terms matters of concern (quite different from Rancière, for whom political disruption is something significant that happens rarely). We are continually being challenged by new matters of concern, gathered together by problems that we address pragmatically through adjustments, corrections, and compromises.

While the importance of human bodies taking up space together and speaking should not be underestimated; this is not the defining characteristic of public space in general. Publics form through active material participation in complex situations, not merely by co-presence.

I now resume discussing my practice work. In the following chapter I give an account of my second project cycle, *Deposit*, in which I try to envisage such a participatory public place, with particular reference to waste matter.

9

DEPOSIT. PROJECT CYCLE 2

Waste recycling and public workshops on the foreshore.

1. REORIENTATION

My second project cycle, *Deposit* (April 2016 – September 2017), was deliberately framed in contrast to a number of characteristics of the first cycle. By consciously opposing certain aspects of the earlier work, the new practice drove critical reflection on the assumptions and forms of practice I had settled into. It also responded to new understandings of *public place* (developed in Chapter 8). In this chapter I narrate Project Cycle 2, and reflect on its continuities and discontinuities with the preceding work. As in my account of Project Cycle 1, *Circuit* (Chapter 7), I open with a discussion of how I reoriented myself at the outset, thematically (in terms of *deposits*) and in terms of design strategy and technique. Through key moments in the design process – analysing the shoreline, laying out a ground plan, and articulating a roof – I foreground ideas of looseness, orientation, and immersion. As previously, I conclude by reflecting on key *returns* as openings towards the third project cycle.

1.1. Thematic reorientation

Circuit had addressed orientation in a relatively stark manner, simply in terms of the directions of facing and movement of a mobile subject. The

human body was reduced to an oriented point. In *Deposit*, I wanted to work from a messier, fuller sense of what it might mean to be immersed in topological place at the Māngere Inlet.

The theme of deposition, of deposits, accumulation, remainders, stockpiles, and residues came initially as a counterpoint to the emphasis on flow, movement, circulation, and flux in *Circuit*. Infrastructures involve things set in motion, but also things piling up, gathering as masses. Deposits result from accumulation, repetition. They are not opposed to movement but dialectically related. Deposits build up incrementally as material is brought to a place; often deposits form when there is a differential between processes of accumulation and processes of dispersal or erosion. So, for example, in my thinking, the sediments accumulating in the harbour are a kind of deposit, but so are the traffic jams on Nielson Street, the growth of a tree, bodies added to Waikaraka Cemetery, and skills learned in a workshop.

In keeping with my analysis of infrastructures as processual (in Chapter 3), deposits are therefore *spatiotemporal*. Imagine deposits as objects modelled spatiotemporally, as things forming and dispersing. Deposits connect us to things happening at various timescales, including the very long ones: geological and anthropo-geological.

The materials that had accumulated in the site had focused my attention early on: the sediment of the inlet, the waste that accumulated in the landfills that reshaped the northern edge of the inlet, and the scoria stone deposited by the various volcanoes. Each of these three deposits results in a kind of ground material, earthy matter.

1.2. Reorientation of techniques

In Project Cycle 2, I also made deliberate changes to my design practices. In *Circuit*, I had used an algorithmic approach, working slowly to derive a proposal that unfolded rationally from its initial premises. This approach suited my concern with disclosing the ramifications of a single line.

The narrow focus, however, made the process slow to respond when unanticipated possibilities or conditions came into view. In response, I decided at the outset of *Deposit* to move more quickly, approximately, and

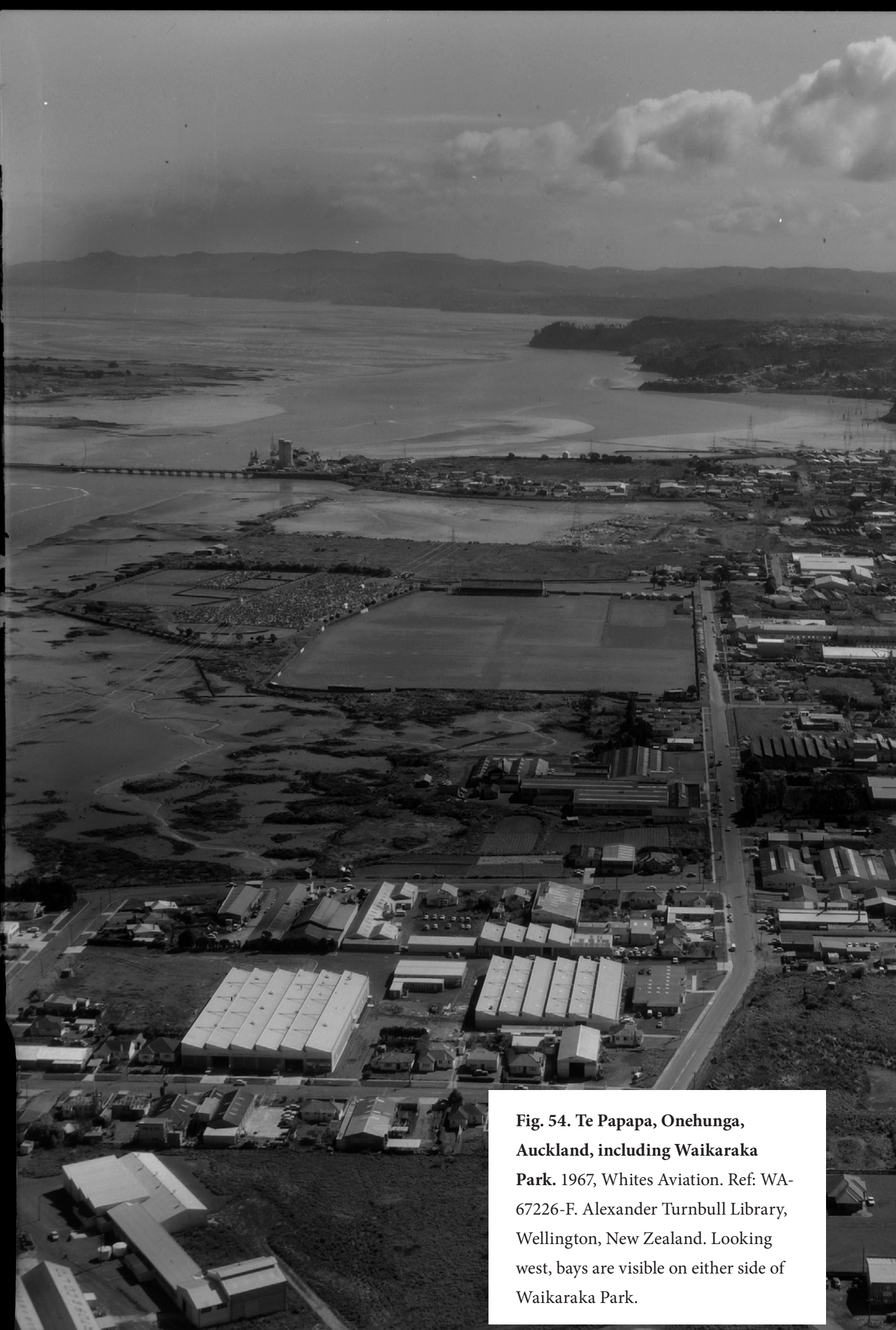


Fig. 54. Te Papapa, Onehunga, Auckland, including Waikaraka Park. 1967, Whites Aviation. Ref: WA-67226-F. Alexander Turnbull Library, Wellington, New Zealand. Looking west, bays are visible on either side of Waikaraka Park.

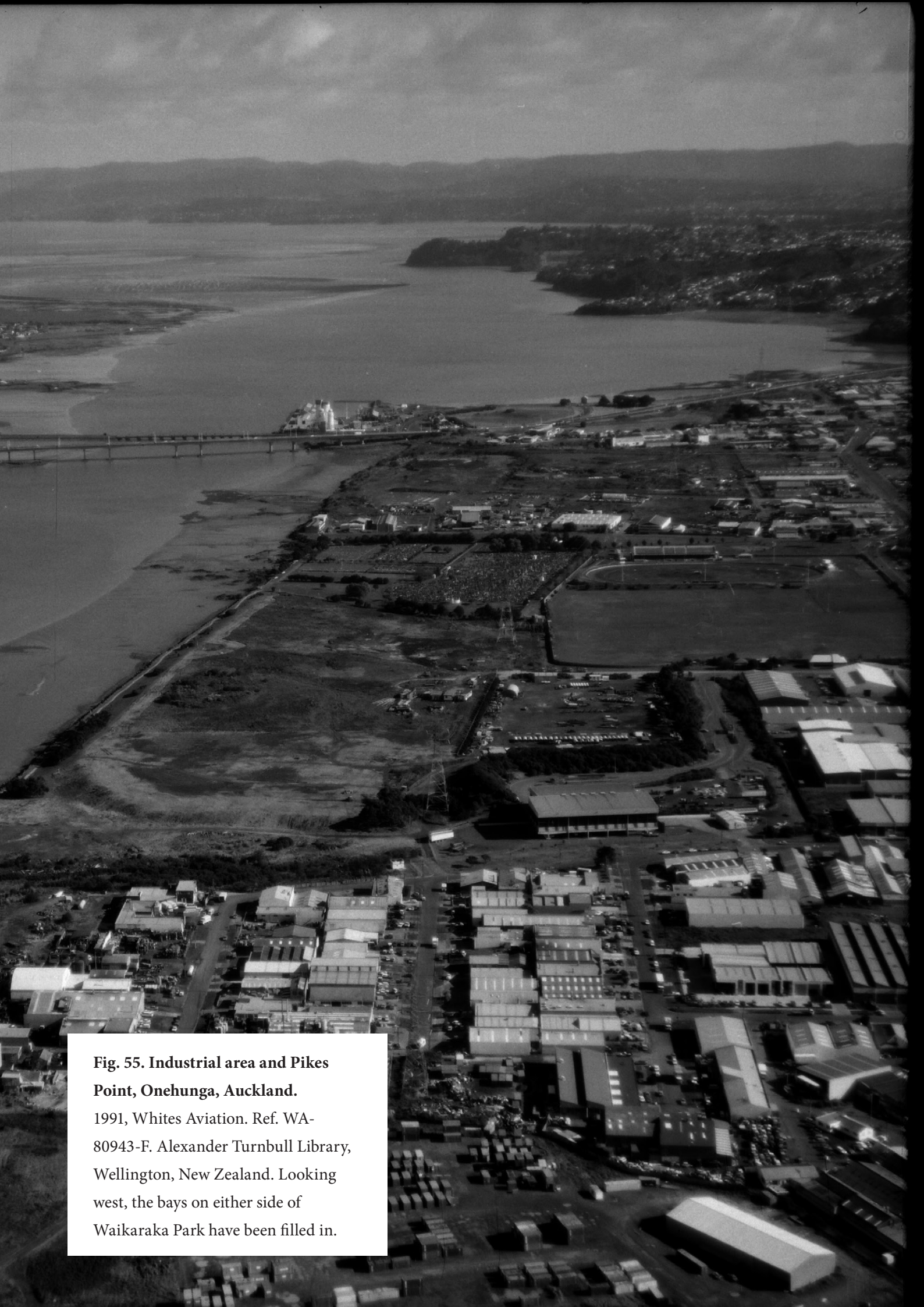


Fig. 55. Industrial area and Pikes Point, Onehunga, Auckland.

1991, Whites Aviation. Ref. WA-80943-F. Alexander Turnbull Library, Wellington, New Zealand. Looking west, the bays on either side of Waikaraka Park have been filled in.

intuitively, even when this resulted in arbitrary decisions, on the basis that these arbitrary decisions could be productively analysed in retrospect.

To support this intention, I decided to make greater use of hand-drawing, sketch models, and found objects. While I had found the CAD drawings from *Circuit* aesthetically interesting, informal conversations around the work suggested that others found them banal and lacking in affect. I am a prolific sketchbook user, but now that hand-drawing came to the fore in my research, I needed to re-evaluate this practice. Serendipitously, I noted that hand-drawing itself is a literal manifestation of deposits: graphite or ink is laid out across a surface, accumulating into a figure. Downton describes drawing as “an exchange between the person designing and the marks already made [...] an iterative conversation with the (partial) propositions already put” (2013: sec. 6.3.4). I organised Project Cycle 2 around this accumulative dialogue.

1.3. Outline of project and key strategies

This was the most conventionally architectural of the three cycles, culminating in a proposal for a building and associated landscape works. The aim, however, was not to simply produce a ‘complete’ building, but to gain a sense of how localised spatial conditions might interplay with other processes and objects, particularly remote and asynchronous ones.

Ultimately, I proposed a recycling centre with associated public workshops. A facility for dropping off, sorting, and breaking down waste would feed into an open-ended collection of public workshops. These workshops would provide employment, public access to tools and equipment, and support a culture of making-do, improvisation, customisation, entrepreneurship, and repair. The proposal envisages a future in which such facilities become a public infrastructure similar to libraries.¹ Whereas many public spaces in Auckland centre on recreation (parks and sports facilities, for example), these workshops centre on making and the sharing of know-how.

1. Blackhorse Workshop (<http://www.blackhorseworkshop.co.uk>) in London, instigated by architectural practice Assemble in 2014, models this kind of public space. Similar ‘maker spaces’ exist in New Zealand: MENZSHED (<http://www.menzshed.co.nz>) is specifically targeted at retired men; and Makers Org NZ (<http://makers.org.nz>) emphasises digital technologies.

Waste in the administratively rationalised city is, as I have pointed out in the previous chapter, treated as a homogenous “waste stream” (Gregson et al., 2007: 198), a flow of unclean, undesirable, and potentially contaminating matter. Instead, this proposition exploits waste as a matter of concern, capable of catalysing a public.

2. THE RETICULATED EDGE

The first key movement of this design cycle was interrogating the northern edge of the Māngere Inlet. Historic photographs of the inlet’s northern edge show a reticulated edge with two large bays, formed from the toes of basalt lava flows from Maungakiekie / One Tree Hill, Rarotonga / Mt Smart, and Maungarei / Mt Wellington.² This edge was a fluid tidal zone, in which sediments accumulated and shifted.

At present, however, the edge runs in a straight east-west line for nearly three kilometres (Figs. 54, 55). A rubble seawall draws a sharp distinction between land and sea. This sharp line resulted from successive reclamations, most notably landfills dating from the 1960s and 70s.

Located outside the confines of the Pākehā settlement at Onehunga, and understood as “wasteland” (Mogford, 1977: 23), the area was used industrially. By the 1960s, the area included a meat processing plant, a wool-scourer, timber-works, and a tannery (47-8). Historical images of waste deposits in this area are abundant: junkyards of cars, burning waste on the foreshore (Fig. 56). Waste accumulation accelerated further when a formal landfill was established in the early 1960s. In anaerobic environments like landfills, waste does not break down, which makes the landfill also potentially an archive or record of toxic and discarded materials. Although closed and sealed about 1990, the landfill continues to leak leachate. This is still less problematic, however, than the contamination of the Onehunga Aquifer, where superphosphate from the former New Zealand Farmers Fertiliser Factory accumulated. Heavy metals steadily trickle from the

2. The condition of this edge prior to reclamation is well represented by the current coastline of Ambury Farm, just to the southwest of the Māngere Inlet.



**Fig. 56. Onehunga rubbish dump
on Manukau Harbour with Mount
Smart stadium, centre left, Auckland.**

Ref: WA-66233-G. Alexander Turnbull
Library, Wellington, New Zealand. /
records/23206523



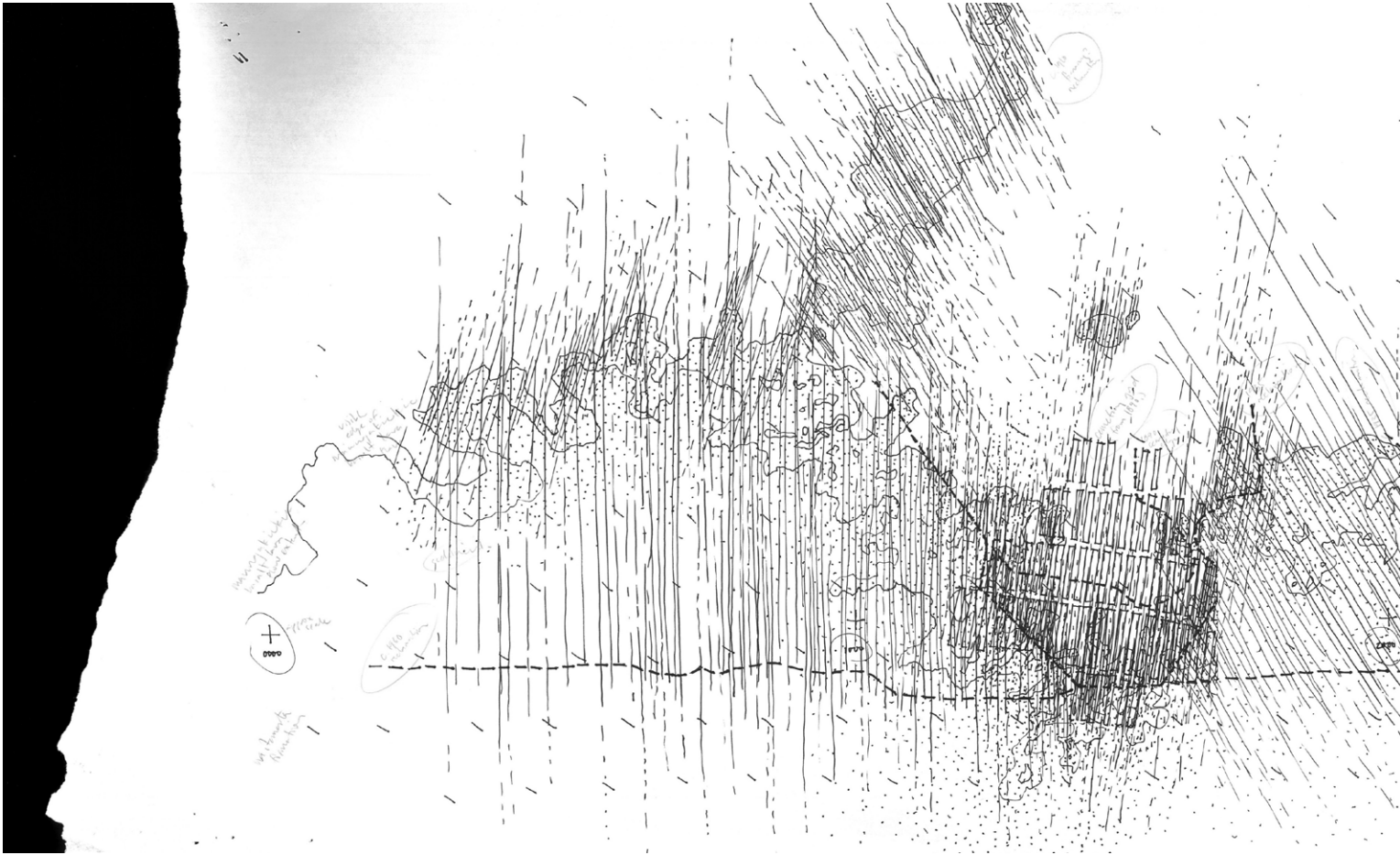
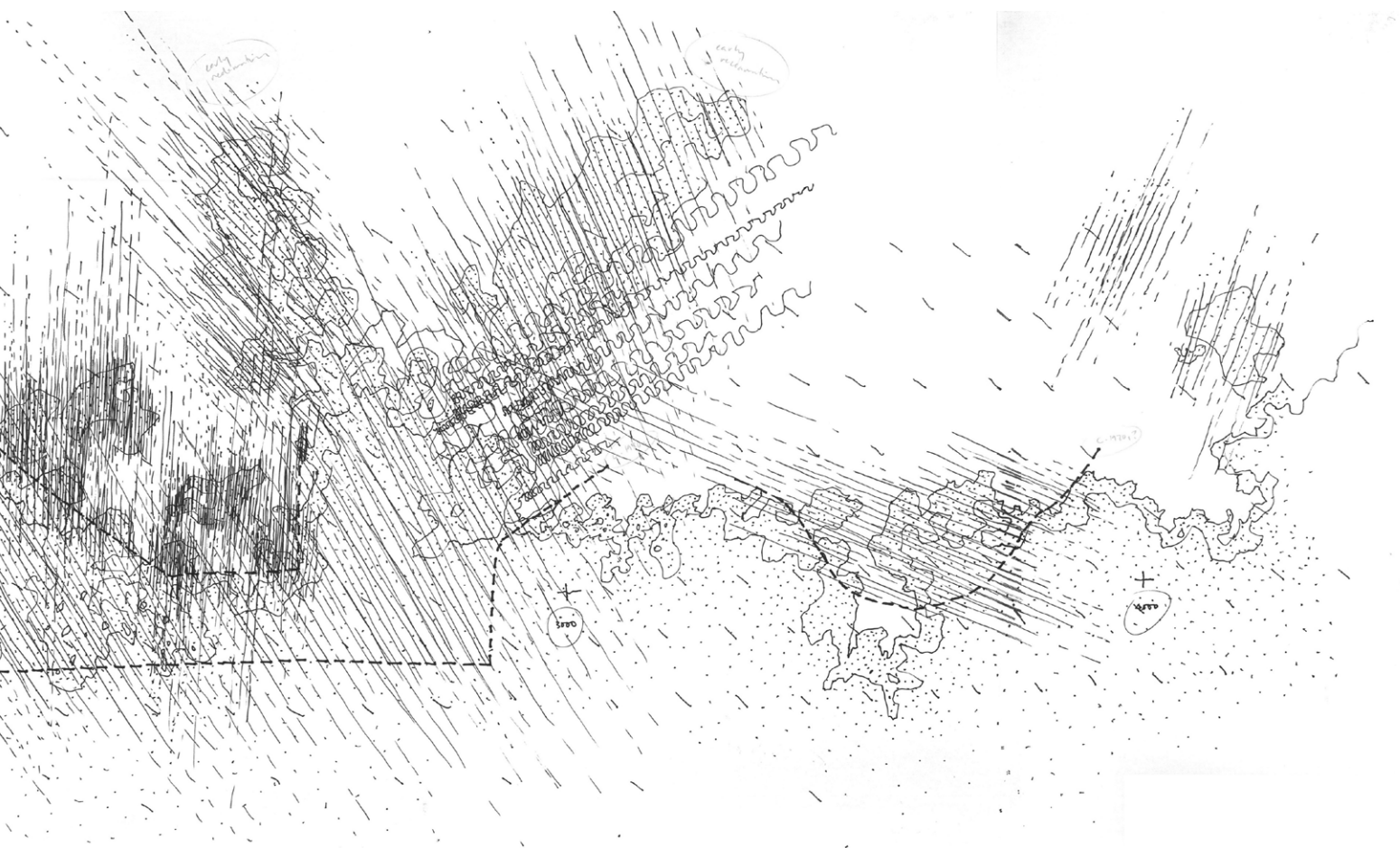


Fig. 57. Interpretative drawing of Onehunga foreshore. Ink on paper.



aquifer into the sea via Miami Creek, which is one of the most contaminated sites in the country.³

I made a series of freehand drawings, in which I responded intuitively to the formation of this edge. In one, the ground appears as various consistencies of hatching, like a wispy haze (Fig. 57). I produced it using sparse lines, so that it would require many layers of hatching to make some parts appear solid. By depriving the ground of weighty solidity, it became translucent, revealing past configurations. The drawing contrasted the dotted boundary of the seawall with a fuzzier, porous border-zone. According to Richard Sennett, “a borderland is full of time” whereas a boundary is “a static space in time, because there is less exchange” (Sennett, 2011: 326). This drawing tried to recapture the foreshore as a borderland: graves, mangroves, mud, smoke, rubbish, leachate, and lava accumulate and redefine the edge.

I also considered the effect of rising sea levels on the foreshore (Fig. 58). In a series of temporal studies carried out using GIS software, I charted current sea levels and potential tidal surges, and forecasted sea level rise.⁴ If the sea rises (as conservatively expected) by 1-2 metres by 2100, the low-lying parts of Onehunga will first become more prone to storm surges and king tides, and ultimately become tidal zones. Interestingly, I discovered from my analysis that the two raised landfill mounds would become coastal islands. The rippling, curling contour lines of the maps foreshadow this tidal future.

As I considered this locale, my sketchbook began to fill with pages of junk. The idea that the ground was not generic matter but a monumental agglomeration of *objects* was fascinating: pipes, furniture, wires, domestic appliances, pieces of timber, bathtubs, bicycles, fish-heads, plastic bags, and lightbulbs. Each represented a distinct trajectory through time: a product of different agencies, exerting different effects, a part of different life-worlds, and ultimately decaying in different ways. In one drawing, I represented this scenario as a series of overlapping linear patterns that, accumulating, produced a density gradient (Fig. 59).

3. The Onehunga Aquifer and Miami Creek are on the Ministry for the Environment’s list of the twenty most contaminated sites in the country (Ministry for the Environment, 2017). Oysters at the mouth of this stream are green inside from the concentration of copper.

4. This required reconciling various sea level datums with the standard measures for sea level rise. My calculations are roughly in accordance with technical studies on the expected effects of sea level rise on Auckland and government guidance (Bell et al., 2017).

Fig. 58. Effect of two metre sea-level rise on Onehunga foreshore. Contour data: Auckland Council.



Onehunga Foreshore
Tidal Inundation 2016 plus 2.0m
1:8000

- Dry
- - - Flood Risk (5.129)
- Tidal (HAT 4.339 — LAT -0.091)
- Wet

At the same time, I accumulated found objects and images. Some were from the site: stones, photogrammetric scans of stones, photographs of puddles and shadows (Fig. 60), audio recordings of heavy machinery, archival photographs, composite images of a scoria wall (Fig. 60). Some were symbolic of aspects of the site I wanted to remind myself of: a plastic shark I found on the floor of a room I teach in, a strip of electrical terminal blocks, photographs of mud near the port taken by a student. These hoarded objects helped me keep in view the motley and incommensurable actors potentially in play. They fed a denser view of the site, which produced a sense of the site as a plenum, too full to handle in strategic overview.

This led me to think that there was an opportunity to see the foreshore as a zone of flux once more, and to articulate this edge in the tension between demarcated boundary and porous border.

3. LAYOUTS AND SKETCHES

All this disparate early material I informally curated into table layouts (Fig. 62), which I used to begin tracing the region's contours through a collection of materials, gestures, processes that could characterise or resonate with it. Because these elements were only laid in place on the table (not fixed onto a plane in the manner of collages), they remained loose and temporary. In conversations (both formal supervision conversations and informal peer conversations), objects from the table could be taken up and reordered. On the flat, horizontal surface of the table, elements could remain unfixed (or very lightly fixed). Because the table was a limited area, I had to make decisions about what to include. Laying the table, each time, was like making a sketch or composing a still life. Through resonance or dissonance, each element not only contributed some discrete idea, but also adjusted how other elements might be understood.

The layouts had a similar quality to the pages of my sketchbook. Stockpiling partial thoughts, fragments, diagrams, visual notes, calculations, and automatic drawings, my sketchbook pages are also *compositions*. Synthetic aesthetic effects persist page by page, and book by book. The table layouts, too, were compositions. In the ongoing dialogue “with the (partial) propositions already put” (Downton, 2013: sec. 6.3.4), they were seeking some kind of overall effect or higher-level insight. I was in search of the

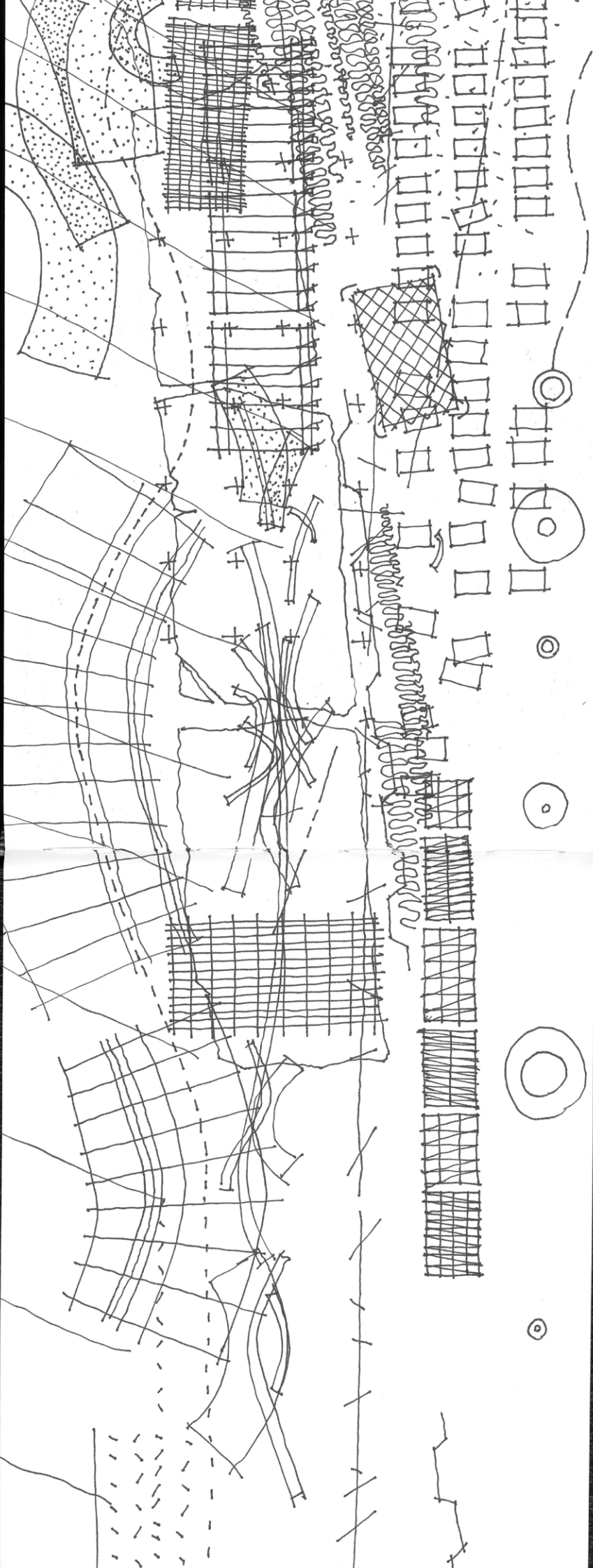


Fig. 59. Overlapping linear patterns. Ink sketchbook drawing.

Fig. 60. Shipping containers at Metroport inland container terminal.

Looking north from the Onehunga-Southdown pathway. March, 2016.



67.7 CU.M
2.390 CU.FT

CIMC

U4
G

493627 4
42G1

32.500 KGS
71.650 LBS
3.700 KGS
8.158 LBS
28.800 KGS
63.492 LBS
67.8 CU.M.
2.394 CU.FT.

ATTENTION

MAKING



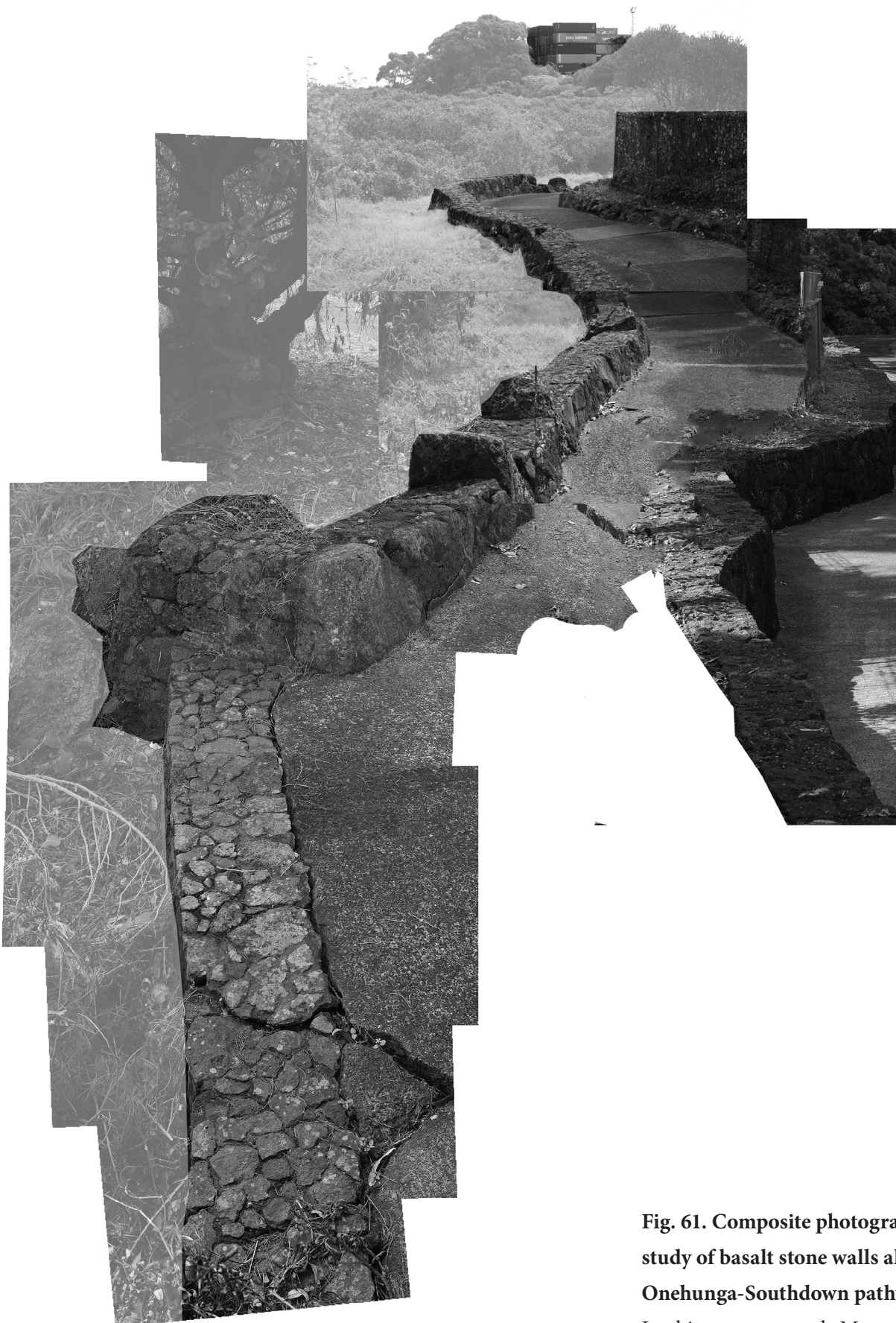


Fig. 61. Composite photographic study of basalt stone walls along the Onehunga-Southdown pathway. Looking west towards Metroport inland container terminal. The age of these walls is unknown.



Fig. 62. Table Layout. A selection of drawings, photographs, archival materials, models, stones, and reference images. 29 April, 2016.

moment when a mere accumulation becomes a confederation; when some unity begins to hold; the moment when, by adding, moving, and removing elements, the coherence of the confederation becomes clearer, until it attains a quality of conciseness.

The concision of a sketch or a table layout is not necessarily minimalist, but it articulates a kind of elegance or economy of performance. Paolo Belardi says, “sketching is a quick, readily available, dense, self-generative, and, above all, extraordinarily communicative notational system” (2014: 32). A sketch opens up a domain, a range of possibilities. It is variable and malleable, allowing for tolerances and approximations. While sketches may be notational, as Belardi says, they have a flexible relationship to codes and conventions. A sketch is *loose*. It may not have a single referent, but refers to a range of possibilities. Moving freely between representation, notation, and diagram, sketches produce “directed indeterminacy” (Allen, 2009: 64).

During this research phase, sketches and table layouts were a means to incorporate the looseness I had begun to prize in Cycle 1. They embedded tensions between fixed and unfixed, resolved and unresolved, committed and irresolute.

4. ALONG AND ACROSS. REPETITIONS AND DIFFERENTIALS.

As in *Circuit*, this cycle was oriented by an initial line. In this case, though, the line was understood as something more complex. Two axes emerged through iterated drawings: *along* the line of the foreshore, and *across* it. Along the straightened edge of the foreshore, the plan became a repeated linear pattern. The other axis, perpendicular to the foreshore, crossed various grounds: the mud and water of the Inlet, the seawall and rising ground behind, the levelled-out industrial building platforms formed over the landfills, and the vehicular space of the streets. These two directions provided an initial polarisation.

The programme lent itself to a horizontal approach. Waste drop-off and stockpiling require vehicle access, and machine tool workshops typically remain at a single level. I began by diagramming the flow of materials and relationships of activities across a plane. Working north-south across the

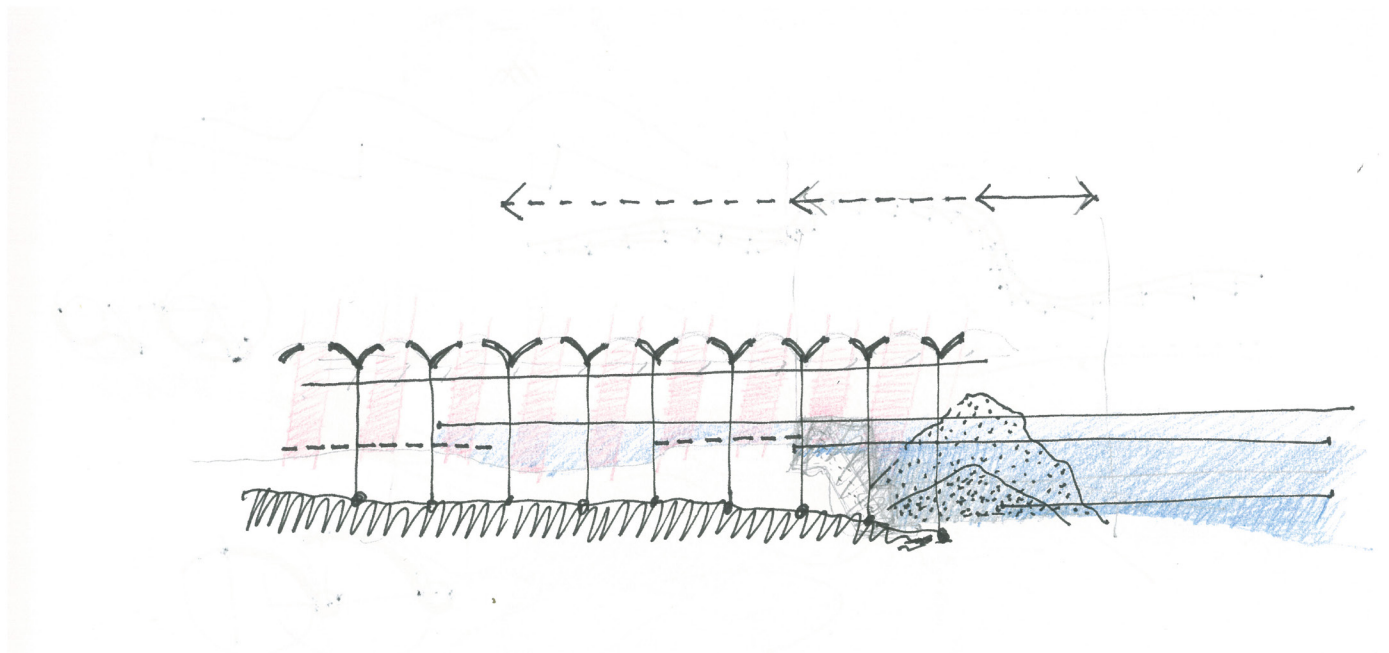
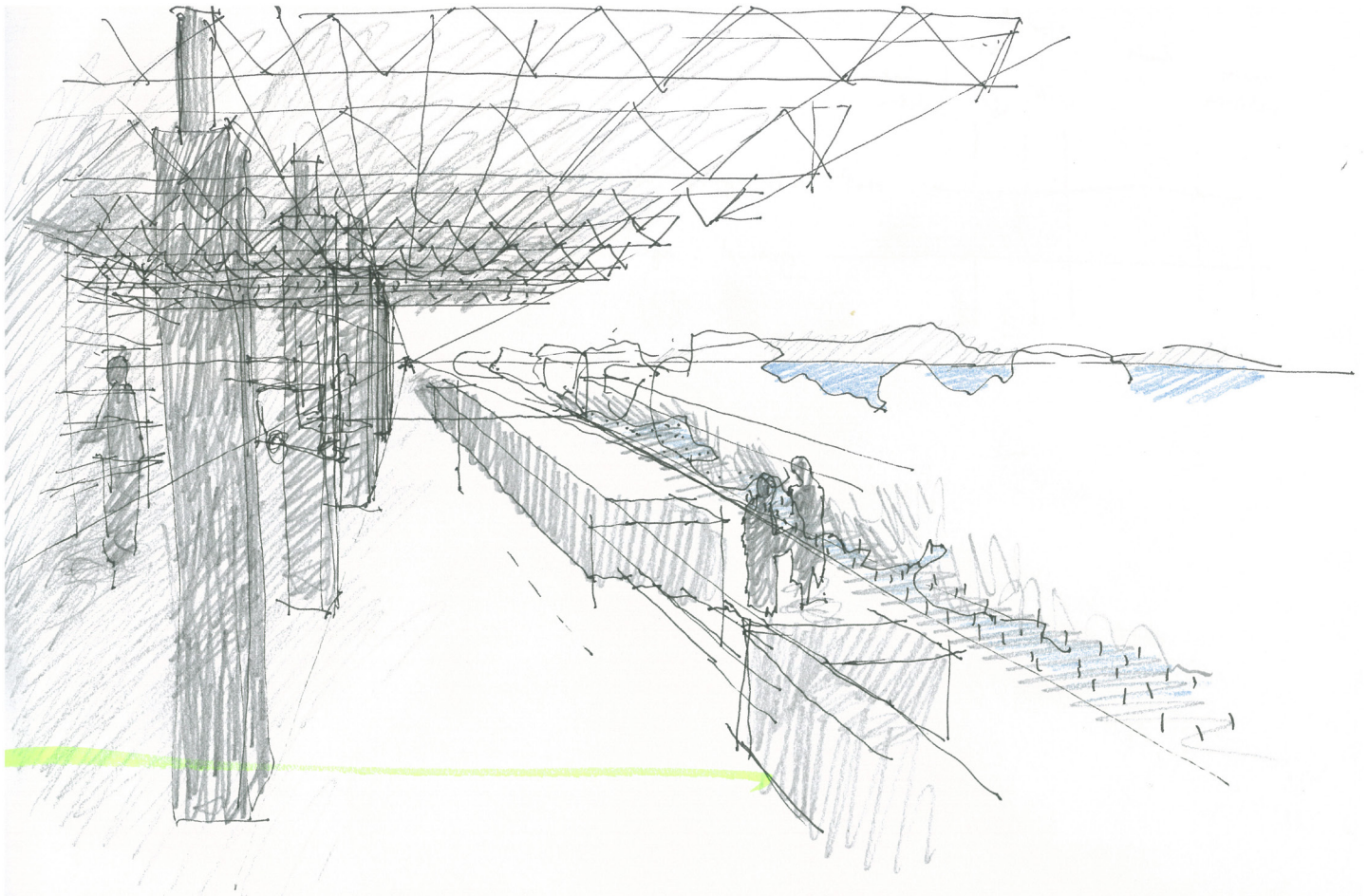


Fig. 63. Sketches exploring how the recycling centre and workshops could meet the foreshore. Perspective looking east along shoreline, with mangroves and truss roof visible; section showing vaulted roof alternative, and exploring effects of rising tides.

plane, differences in speed and grounding were articulated. Working east-west along the plane, a logic of extension and repetition dominated.

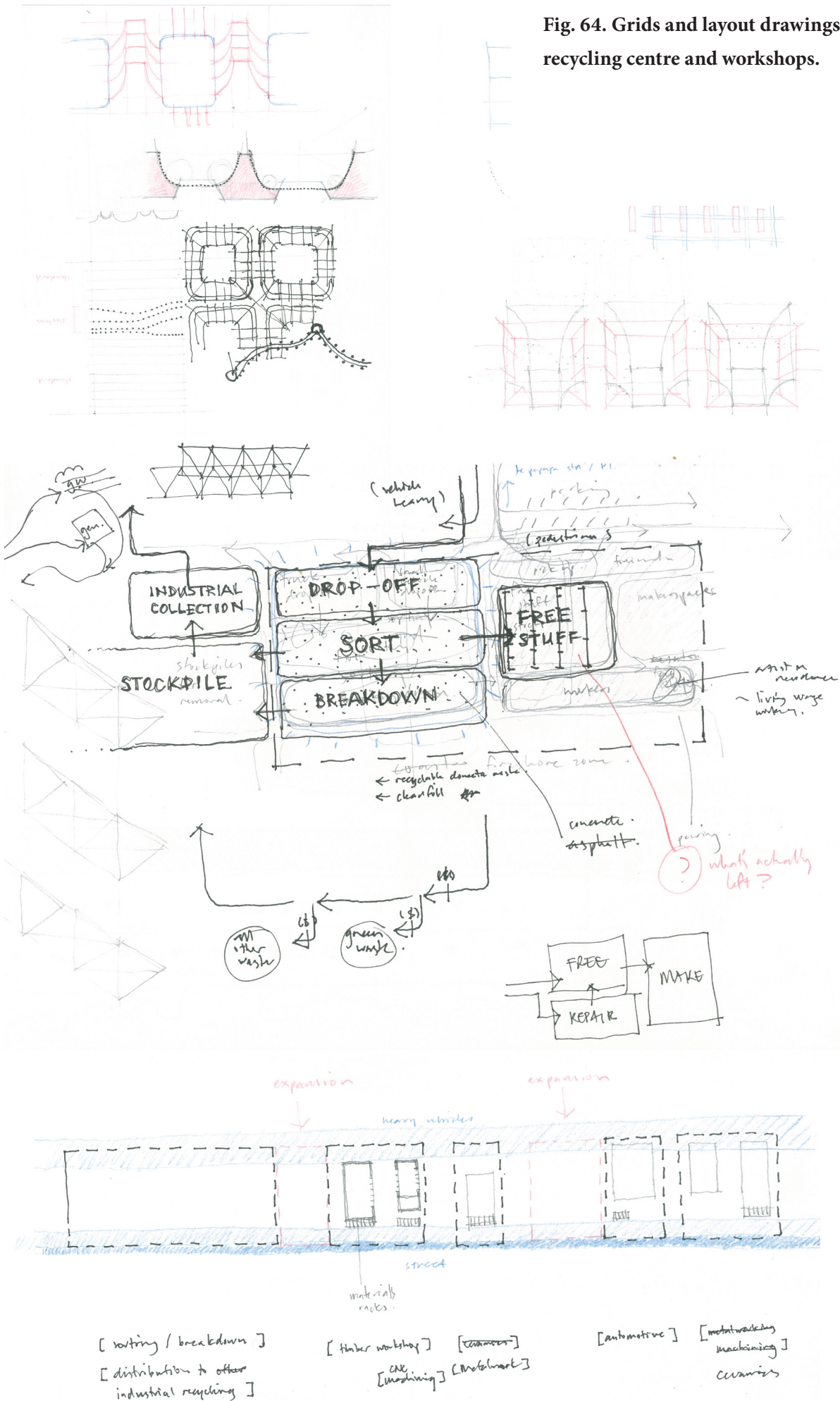
At the northern edge, the programme was industrial. Heavy vehicles and cars would need to approach from the north, and the spaces required would be large and simple. To the south, where the ground slopes down to the water, there was an opportunity to scale spaces to the human body rather than vehicles; there are views to the water and the potential to connect to the pedestrian route along the shore. Workshops would mediate these conditions.

In perspective and sectional sketches (Fig. 63), I explored terracing the water's edge to lead people down to the mangroves and close to the tides, and to shelter them from the noise of trucks and tools. Whatever I built along this edge would be slowly reclaimed by the sea. I played with different options for facilitating the accumulation of sediment along this edge, so that estuarine wetlands might form. Their accumulation would result from the temporal rhythms of the tide, as well as the slow progression of climate change.

Along the site, I mapped out a grid (Fig. 64) which defined a pattern of sheds and yards. This building grid was extensible to allow for future developments. I imagined a modular bolt-together building system based on existing industrial systems. New workshops could be assembled or altered as necessary, and ultimately removed or transferred elsewhere. Mixed waste would arrive from the west, be sorted, and moved along the building to the workshops. There, it would enter into new processes and be restructured before leaving the site.

In the longitudinal direction, the grid was mechanical and regular, while differentials of time worked laterally. The two systems work across one another to form a polarised grid. These two polarisations conditioned the field of the plan and implicated different kinds of time. There was a danger that the idea of a pair of systems intersecting could turn into a simple opposition between the technical and the natural. In some drawings, this became explicit: the natural mangrove-fringed edge of the harbour contrast the machines and steel structures under the workshop roofs (Fig. 65). To overcome this, I aimed to weave these conditions together more undecidably. The interplay between the two systems creates a differential. I imagined this

Fig. 64. Grids and layout drawings for recycling centre and workshops.



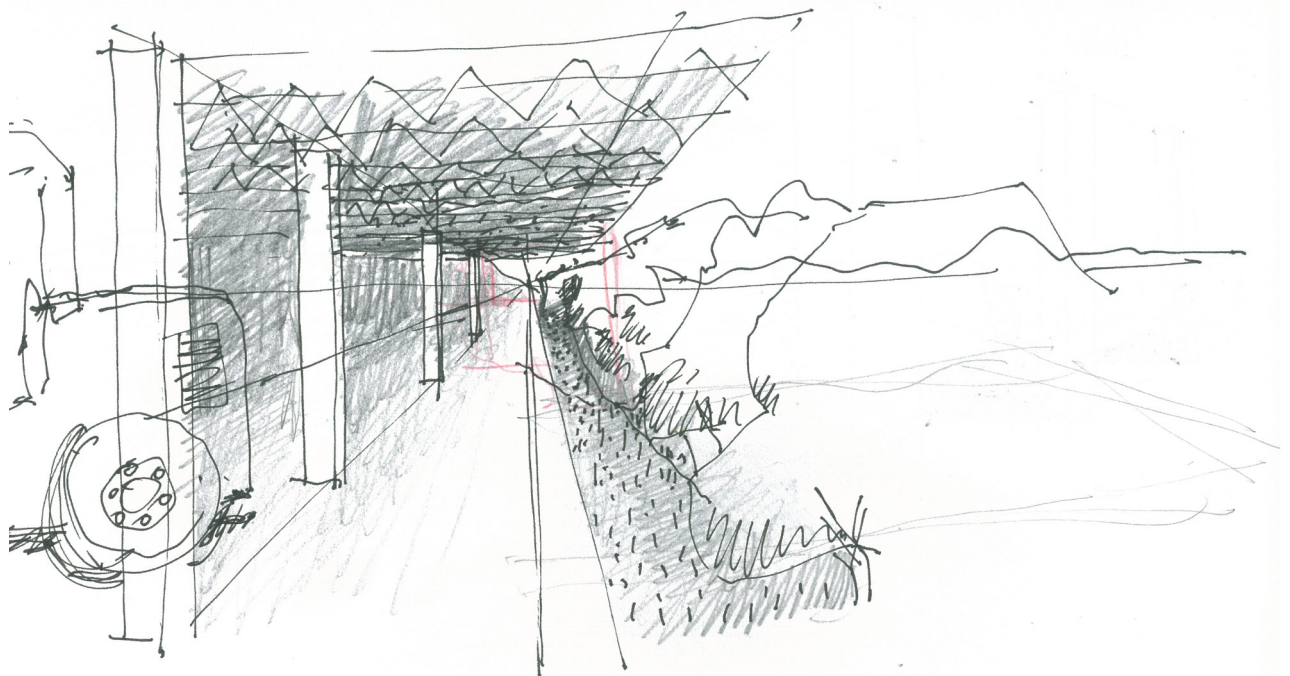
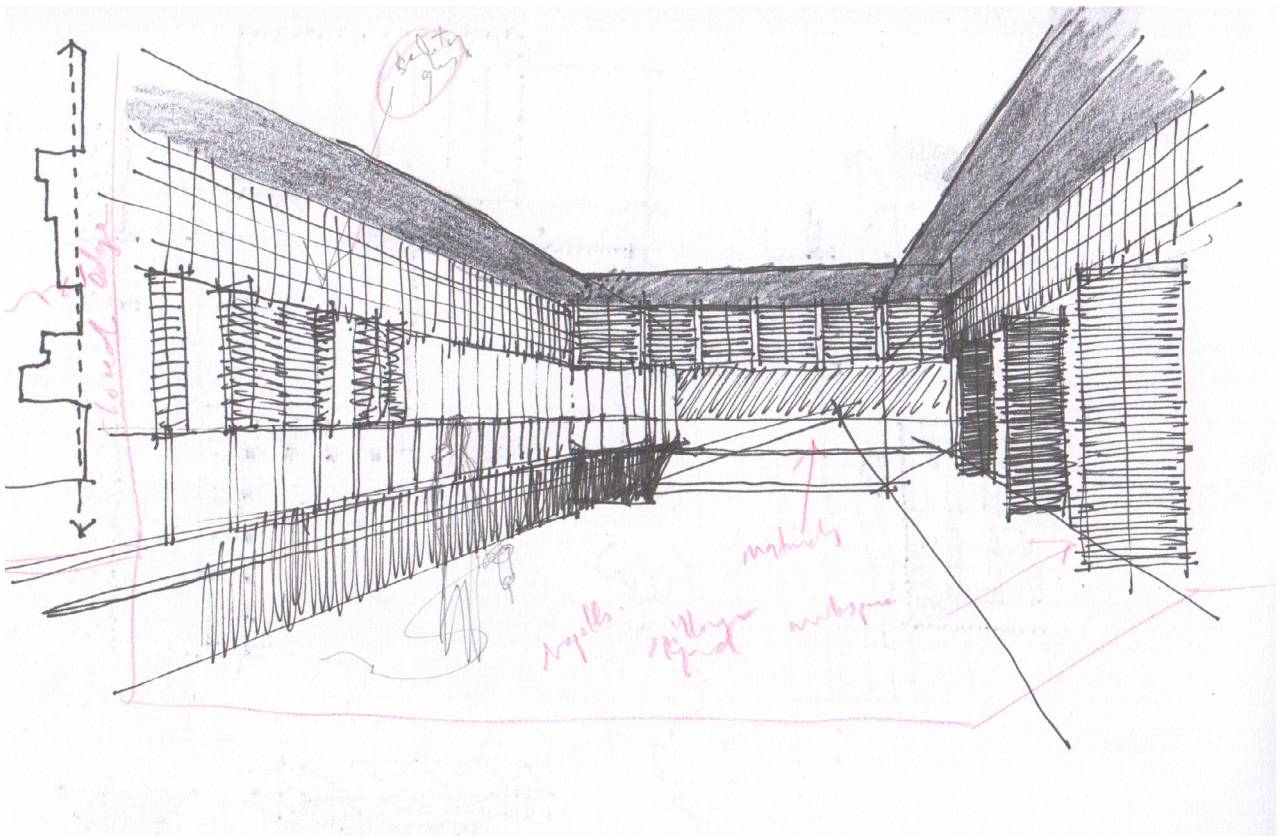


Fig. 65. Perspective drawings of yard and foreshore. The yards open towards the vehicles and materials of the industrial area; the south-facing parts of the building open to the mangroves and horizon.

like a tidal zone: a place where things can accumulate, wash up, pause, or drift away.

5. ABOVE AND BELOW.

Many of my drawings during this phase were efforts to reconcile gridded or patterned systems with the reticulated and messy line of the harbour – in plan and in one-point perspective drawings looking along the foreshore, approximately from positions on the current path. They also manifested as pages of drawn grids and in algorithmic experiments with grids (Fig. 66), and – while they found their first application in the ground plane – grids soon after began to float overhead, floating above the ground, touching it lightly on slender supporting columns.

Because the waste-sorting spaces and the workshops would be cluttered at ground level, the primary visual impression of the building would be the ceiling. Piles of sorted timber, racks of pipes, bins of offcuts, tools, people, forklifts, shelves, and workbenches would fill the visual field. Practical necessity would keep the ground plane simple. The gridded roof structure, however, would hang over these, imposing regularity from above and gathering things beneath it.

Thus, whereas the grid was drawn underfoot in *Circuit*, it was overhead in *Deposit*. A roof plane collects things in a different way to a ground plane. Things rest on the ground, they are stacked there and moved across it. Particularly if separated from the weather-line of enclosure, the roof can be a loose grouping, a kind of net cast over things, rather than a ground plane on which things rest (Fig. 67). The roof plane shadows or shelters, but does not support (in the literal sense).

Konrad Wachsmann envisaged gigantic space frame constructions as aircraft hangars (Fig. 68). They linked the ideal of an infinitely-extensible generic spatial system to the design of a single tectonic connection. Wachsmann did not propose to partition or organise this space at all: he designed a constructed sky under which people could walk and bombers shelter. An expression of the logistical space of military infrastructure, this roof plane was also cosmic, a “universal surface” predicated on an “*atomic theory*” (Alonso, 2006: 160, 162). This universal surface, divorced from the



Fig. 66. Grid study for roof planes.

Modelled in Rhinoceros 3D. I explored the relationship between viewing angle and permeability.



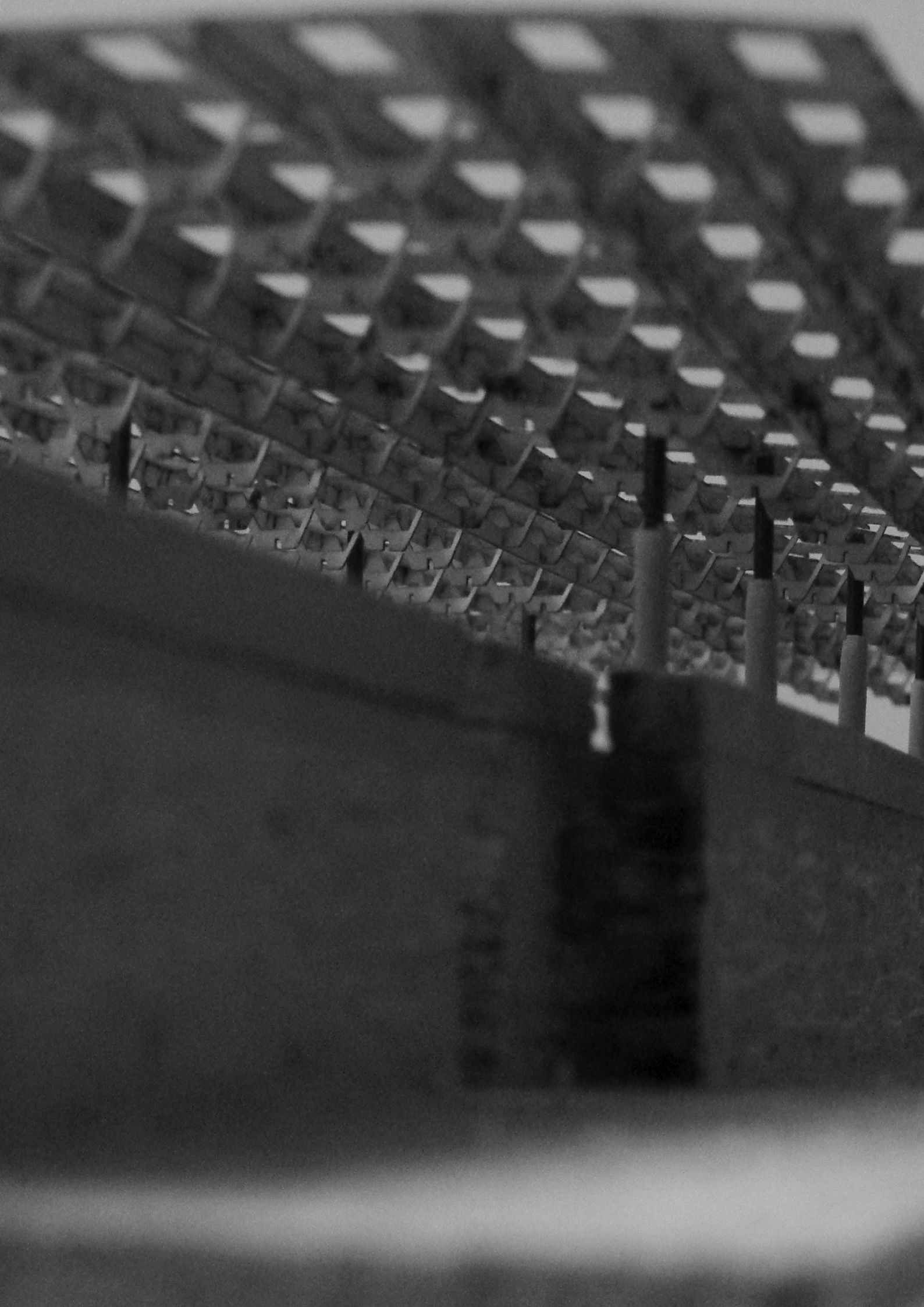


Fig. 67. Concept model of roof plane floating over basalt retaining walls.

The groundworks are carved solid mass, like ramparts. The lightweight, componentised roof is like a mesh or textile floating above.



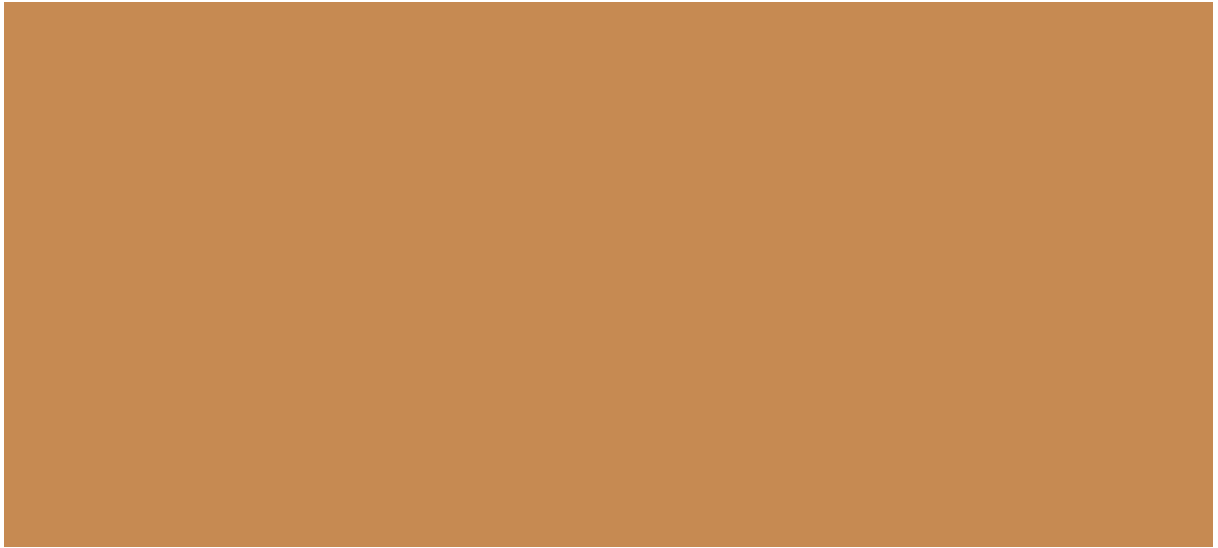


Fig. 68. Design for US Air Force hangar. Konrad Wachsmann, 1951.

[→ view online](#)

Fig. 69. Sawtooth roof of O+I glass factory, Penrose. The vertical face of the sawtooth faces southwest. Taken from a train travelling on the Southern Line. August, 2015.

ground, projected the grid in the air, where it could be imagined to continue in all directions. Unlike Wachsmann, I was unconcerned with asserting any universality. On the contrary, the roof would act like a cartographic grid: an arbitrary overlay that acts to register the particularities and variations of the territory.

At the coastal edge, the grid would be suspended over stone groundworks. Drawing on my interest in scoria constructions in Project Cycle 1, I sketched out a cambered and buttressed scoria and basalt retaining wall and pavement to handle the downwards slope towards the water. These walls would be weighty, textural and weathered. Lichen, moss, and small plants would accumulate in the crevices; stones would shift and ultimately give way to the pressures of flora, fauna, geology and tide. While these conditions prevailed at ground level, the floating steel grid would reach out overhead. The path, the mangroves, and the mud would be partly sheltered under its eaves, gathered under its net.

The roof, however, evolved away from being a single plane. At first, this occurred in order to accommodate variations in interior ceiling height. The waste drop-off space, modelled on the volume of the existing Pikes Point Waste Transfer Station would need to have high clearance to allow for large vehicles; but the workshops, scaled for people at workbenches, called for lower ceilings. The move away from a single roof plane at a fixed height opened new opportunities to give the roof more a more actively orienting role. It also complicated an over-simple binary I had, despite my reticence, settled into: irregular, complex nature versus abstract, simple technology.

I made the roof more actively orienting by using a saw-tooth pattern. In the southern hemisphere, industrial saw-tooth roofs are typically oriented to the south to collect even daylight and exclude direct sunlight. Examples of this are already present nearby (Fig. 69). As I explored this roof typology, I realised I could use this polarising effect as a way to create two distinct interior conditions under the one roof. In the sketches in which this idea first appeared, I flipped the direction of the saw-tooth pattern over the linking spaces between workshops (Fig. 70). Sunlight would cut directly into these spaces, creating stark patterns of shadow and light. It also gave rise to an interesting internal situation: looking in one direction, the roof appears

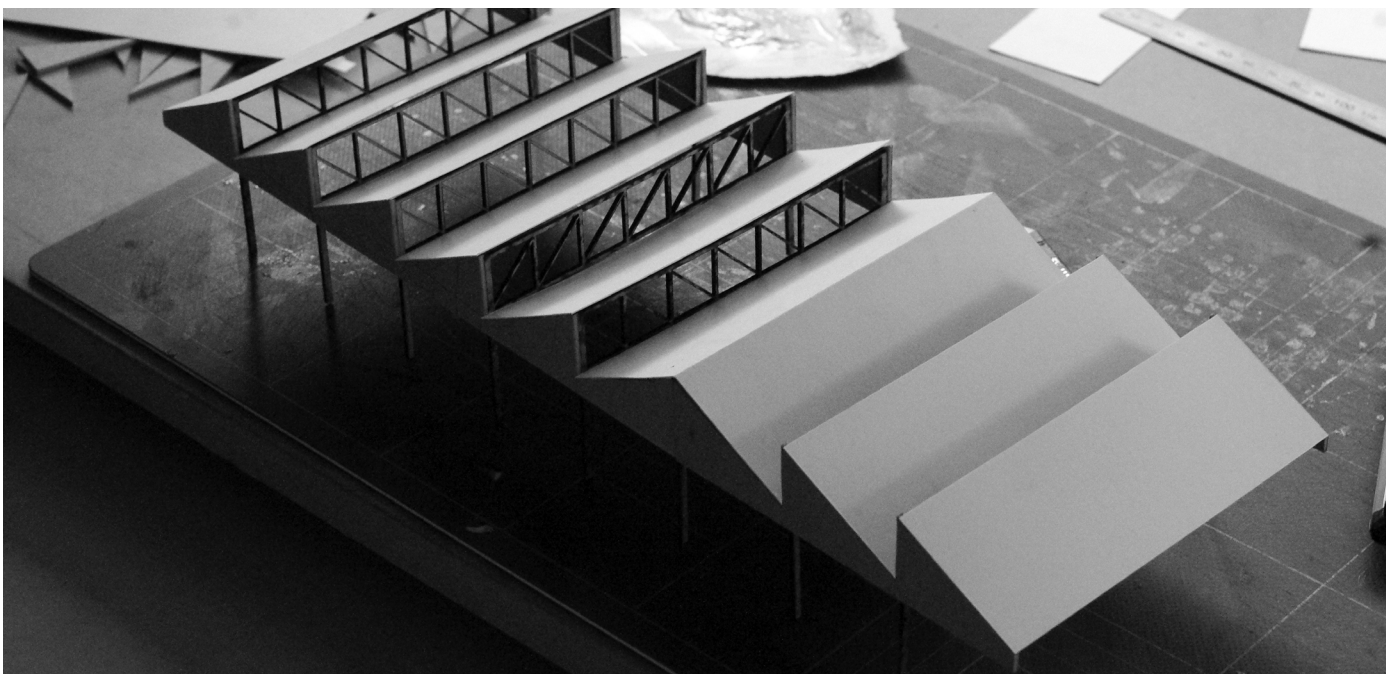
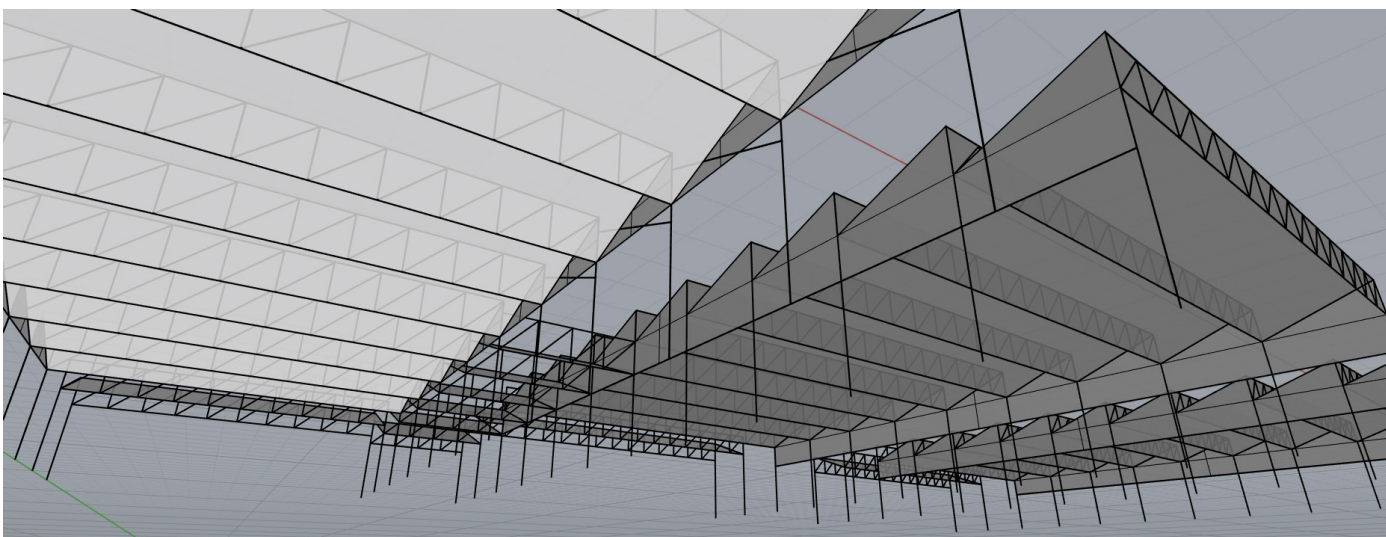
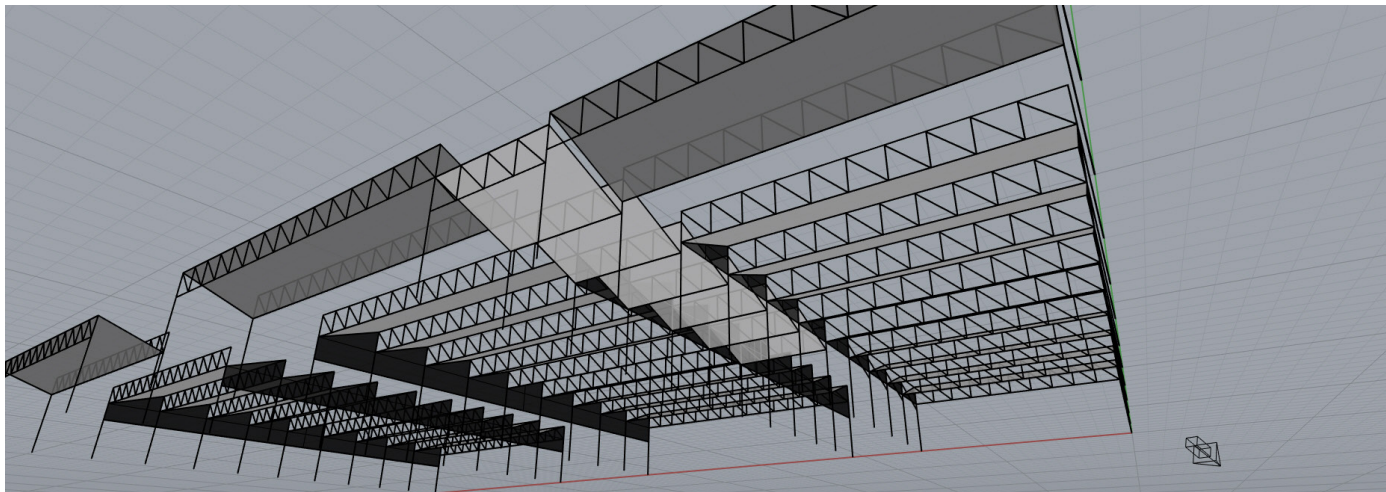


Fig. 70. Sawtooth roof studies. Modelled in Rhinoceros 3D, and in cardboard. By using sawtooth roofs facing in two directions, distinct interior lighting conditions can be produced.

as a solid surface, with no view of the sky; in the other direction, the roof dissolves into the sky.

This new roofing strategy drew my attention to the programmatic role of the linking spaces just mentioned. Picturing workers, pausing to sit in the sun over a coffee, I programmed these spaces, so that they were synchronised with the passing of the day, around large ‘kitchen tables’ and associated them with rest, meeting, eating, and socialising.⁵ In the workshops, smooth, indirect light facilitates technical work.

The proposal thus began to emerge as a spatially and temporally oriented. Involving the perception of alternative temporalities, this was a more complex form of orientation than I had previously used. Orientation shifted, depending on how occupants moved and in what kind of activity they were engaged. As orientations shift, the surrounding things (tools, people, the sun, insects, a forklift, a slab of nail-infested mataī timber, or a packed lunch) are disclosed in slightly different ways.

6. HIGH-VIS INVISIBILITY

The tectonic language of the proposal was that of industrial and agricultural buildings: bolt-together steel framing, saw-tooth roofs, and metal panels. I wanted the buildings to balance on the edge of ubiquity, to be, from one perspective, commonplace light industrial buildings. This low-key strategy was to exploit the horizontal quality of infrastructure. Instead of grabbing and directing attention, I wanted to re-orient experience much more subtly.

I referred to work by Lacaton and Vassal, who often employ polycarbonate sheets, bolted steel frames, fibre cement, and standardised fittings. Their buildings assemble readily available components and minimise custom elements. Their Latapie House (1993) and House in Coutras (2000) are deliberately scruffy and look as if they were improvised. Lacaton and Vassal position them as experiments in creating large, flexible living envelopes emphasising environmental control. Characteristically, these houses have large semi-indoor spaces like conservatories or covered yards. In the case

5. I borrowed the idea of the table from the Maggie’s cancer centres, initiated by Maggie and Charles Jencks, which each have a kitchen table space that is “usually the main hub of the building” (Maggie’s Centres, 2015: 8).

Fig. 71. Latapie House. Lacaton and Vassal, 1993.
View from the garden of serre (greenhouse), and
plan. The serre is a multi-functional space made of
polycarbonate panels over a steel frame that takes up
half the volume of the house. Photo: Phillippe Raualt.

[→ view online](#)

of the Latapie House, half the plan area is given over to such a semi-indoor space: a double-height conservatory (Fig. 71). Large doors and high-level windows open to the garden, and flexible bamboo blinds form a lightweight overhead screen. The remainder of the house is a plywood box with two levels, which open into the conservatory. This space collects domestic objects and activities that overflow from the house; everything in it has the sense of being temporary, almost like a camping situation. Large, loosely programmed spaces recur in Lacaton and Vassal's projects (Fig. 73).

They deliberately employ un-prestigious materials, and profess themselves uninterested in articulating a sense of prestige through materials; when they speak of their work, they focus on ubiquitous conditions, and the importance of open space, light, air, and environmental control. This does not mean that they fall back onto functionalism:

Instead of defining banal space, without any attributes, it is far more interesting to create situations; a range of them, with different depths, transparencies and relations with the outside, providing intermediate spaces and connections with other floors, with the ground and the sky. (Lacaton and Vassal, interviewed in Moreno and Grinda, 2015: 17).

Lacaton and Vassal work in an industrial vernacular, a minimalism that is not obsessed with the *perception* of an aesthetic minimum, but with a *systemic* minimalism. They associate minimum of invention with the vigorous activity of making-do and the ongoing life of a project.⁶

Almost all photos of their work show it filled with an unsophisticated melange of furniture, household items, bicycles, open shelves, curtains, plants, and people (Fig. 72). In contrast with common practice, they do not seem to permit their work to be photographed in an empty or pristine condition. It is as if they pride themselves on the work's unaesthetic nature.

The life of the workshops in *Deposit* was intended to be the waste, vehicles, stained tea mugs, disassembled appliances, high-vis vests, the insights of know-how, and breezes that circulate through the site. My proposal's role

6. Lacaton and Vassal won a competition for renovations of a town square, Place Léon Aucoc, in Bordeaux (1996) by proposing that the square was already fine, missing only a maintenance programme and some slight modifications to traffic movement.

Fig. 72. Social housing, Trignac.
Lacaton and Vassal, 2010. Interior in
use. Photo: El Croquis.

[→ view online](#)

**Fig. 73. School of architecture,
Nantes.** Lacaton and Vassal, 2009.
Multi-purpose workshop in use. Photo:
El Croquis.

[→ view online](#)

was to provide references against which these things could be oriented, particularly in time.

7. IMMERSION

Since I intended in this cycle to confront immersion, I also experimented with an immersive drawing projection: cylindrical perspective. A cylindrical perspective is a panoramic view produced by a picture plane bent around a view axis into a cylinder (Fig. 74). To locate a point a line is drawn (in plan and section), connecting it to the viewing point, located on the axis of the cylinder. The point is marked where it passes through the cylinder. By developing the surface of the picture plane (unrolling it flat), the point is located in the panorama.

Vertical lines remain vertical in the projection, but all other lines, even straight lines, need to be plotted via a series of points (straight lines resolve as something close to parabolic). Computed and constructed by hand, this is a laborious process, monotonous and slow. As the points and lines build up, however, fascinating deformations appear (Fig. 75). The inherent slowness of the process mandates a careful selection of which elements of the view to draw.

Cylindrical perspective allows seeing all directions at once. In this sense, it could be considered a disorienting view: the viewer does not face anywhere; the visual field radiates outward. Interior spaces expand, bulging forwards and puckering towards the horizon. Things viewed from the outside, however, tend to become squeezed and diminished. In the case of the drawings for *Deposit*, a view from outside the workshops, looking up to their southern façade, compressed the long face into a few centimetres of horizon. In its reliance on the unrolling and stretching of a picture plane, the technique had some commonalities with my curve-offset map.

While I was fascinated by the process of production, I remained uncertain as to what this technique signified, or what opportunities it presented. The cylindrical perspectives highlighted proximities and horizons. Historically, panoramas presented the surrounding world as a spectacular scene.⁷ I

7. Panoramas “declare a revolution in the relation of art to technology [... and express] a new feeling about life” (Benjamin, 1978: 150).

Fig. 74. Cylindrical perspective of waste breakdown space. Vertical lines remain vertical, but all other straight lines become hyperbolic. Pencil on permatrace.





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Fig. 75. Cylindrical perspective of kitchen space under construction.

This projection allows things very close and very distant to figure in the same view. Pencil on layered permatrace.

wondered whether they could be used to convey the gathering and pulling together of relations in respect to the horizon. These considerations made me reflect on more notational approaches I could take to this drawing technique, as well as on possible future uses.

8. RETURNS

In this second project cycle, attention to *deposits*, particularly as they form and erode over time, led me to envisage infrastructural place in more heterogeneous terms. *Deposit* picked up particularly on the problem of *immersion*, which had been avoided in *Circuit*. It also responded to my rethinking of what it means for space to be *public*.

Deposit involved more participants (both human and nonhuman), and a more crowded space, than *Circuit*. This was particularly stimulated by my accumulation of artefacts and images, as well as by the fact that my drawing and making tended to turn towards clutter rather than clarity. I gave myself a “thicker” description of the site.⁸

Orientation acquired greater import in this cycle. In *Circuit*, I attended particularly to a single source of orientation: the path. The recycling centre and workshops I proposed in *Deposit* was a multi-linear complex, more like one of Ingold’s knotted places (2007: 98). The centre was more intricately woven into the existing threads of place. I first oriented the project in two directions: the longitudinal line of the path, associated with repetition; and the transverse line, associated with differences of speed and size. The sharply constructed northern boundary of the Māngere Inlet was re-interpreted as a transformative border zone; metaphorically and literally tidal. Counterpointing this flux, I floated a roof plane. Rather than organising activities through the articulation of the ground, I loosely collected them under a sheltering surface. Through its polarised treatment of light, this surface itself evolved into a means of orienting activities in time. As a public infrastructure, the recycling centre and workshops are open public spaces

8. Kanekar describes Perry Kulper’s drawings as “thick’ drawings where layers of information translated visually augment patterns of relationships, creating a complex web of maps” (Kanekar, 2015: 117). Thickness is a concept from Gilbert Ryle (2009: 494-510), taken up by anthropologist Clifford Geertz (1973: 3-30).

forming around waste as a matter of concern. Their openness, however, is not the kind of generic space Wachsmann proposed.

Rather than the *absence* of orientation, I propose *shifting orientations*. So, for example, after labouring over a workbench to make something, a person might pause for a cup of tea. Leaving the smooth light of the workshop, and taking a seat at the kitchen table, the sun cuts in, and the person realises that more time has passed than anticipated. In this moment, the relational field shifts and the meaningfulness of the surrounding things change. A similar shift might occur when an object in a waste bin suddenly reveals itself as just the right part for the job. Leaving the workshops and going down the stone stairs to the quieter edge of the harbour, where a person is pushing a pram, might also provoke such a shift. When a relation suddenly pushes its way to the surface as *significant*, it reorients existing relationships. Such shifts take place all the time, in any event; but a spatial setting might prompt and trigger them. Then, time is disclosed differently; the appearance of things might oscillate between fleeting and durable.

In reflecting on Project Cycle 2, I identified a particular opportunity for moving forward. The project configured itself as a built envelope, as a frame for people, things, and activities. There was still a separation between a relatively static container and its miscellaneous contents. The building was the orienting machine; the things within were merely oriented. I wondered whether it was possible to see the buildings themselves as temporary configurations, as just more things in a field of things. Could the building be displaced from its central role? What would be the tectonics of a network?

10

EXCHANGE: PROJECT CYCLE 3

Spatio-temporal choreography

1. REORIENTATION

In *Circuit*, I addressed smooth movement and the asymmetries of orientation. In *Deposit*, I refocused on accumulation and gatherings in relation to these circuitous movements. In the third project cycle, *Exchange*, (October 2017 – April 2017) I turned to considering transitions or inductive couplings. Thus, the three cycles address three kinds of infrastructure: conduits, storage, and interchanges.

Once again, I begin this chapter by discussing how I reoriented myself: how the new project cycle both continued and critically broke with the previous work, and how the new theme served to instigate a new direction. Topological models of place were pivotal in this cycle, manifesting in the form of drawn meshworks. I discuss my approach to forming these meshworks through nodes, links, and narrative annotations and reflect on the difference between sketching and rendering. Drawing out themes of multiple temporality, spatio-temporal choreography, and remote connection, I explore their ramifications for *grounding* and *immersion*. At the end of the chapter, I reflect on what returns I received from the project.

Some work from Project Cycle 3 was presented in a public exhibition in July 2017, and I will briefly discuss how this experience informed my ideas about how the completed design inquiry would be exhibited. A period of revision

and reflection on the three projects as a whole (in preparation for exhibition) followed this final project cycle, so that its insights could feed back into the earlier work.

1.1. Thematic reorientation

Exchanges form a web of connections. This web has its own form – relatively independently of the form of any particular site of activity or construction. Exchanges are not entirely separate from circuits and deposits, but interrelate with them. An exchange is a node in a network where things are *changed or translated*. Things passing through exchanges might change speed; slow down; pile up into deposits: or they might shuttle from one exchange to the next in an endless circulation. Exchanges not only include markets and transport interchanges, but many other sites where things meet, correspond, and mediate one another.

As meeting places, exchanges are also significant for public relations. In *Deposit*, I had explicitly thematised publicness, particularly through the idea of waste as a matter of concern. Conversely, interaction had been suppressed in *Circuit*, because the ideal of the path was an ideal of parallel movement. While there were also opportunities for interactions between people, their space was relatively vacant: an empty *agora*. In *Exchange*, I set out to amplify this sense of place as *full*, a plenum rather than an empty container: how many agencies and participants could I fold into a projection of place?

1.2. Reorientation of Practice

Deposit's working methods were consciously traditional – I drew and thought using thoroughly worked techniques and values: the large-scale hand-drawn section and plan, the constructed interior perspective. This deliberate archaism aligned with the general disposition of the project towards the *least means*. It also helped me keep in view the extent to which many of the calculative techniques of contemporary digital working processes are already latent in the techniques of descriptive geometry and architectural drawing. Nevertheless, despite what I continue to see as the ongoing relevance of these

hand-worked drawing techniques, there was undeniably a conservatism in these practices – even at times a therapeutic or comforting conservatism.

I felt I had pushed further, however, in two ways: in the peculiarly distorted panoramic drawings; and in my expanded conception of the sketch. On reflection, I came to see both of these as related to changes in how I saw the *picture plane* of the drawing. The picture plane of the plan and section in descriptive geometry is a sheet of glass or a blade, a mathematically flat surface. In the panoramic distortions, however, the picture plane itself becomes manipulable: able to be rolled up, as in the panoramas; or even warped and stretched, as in *Circuit*. The picture plane, I reflected, *grounds* a drawing, providing its preconditions, its low-level formatting. The design of the picture plane corresponds to the low-level reformatting of space by infrastructure.

In this cycle, the work would be more directly oriented towards exhibition. The previous two cycles had been hampered by a narrow range of interlocutors and commentators, and I reflected that they had thus been rather hermetic in nature. Accordingly, I planned *Exchange* to culminate in an exhibition and set an initial parameter for myself: the main outcome would be a very large format drawing.

1.3. Outline of project and key strategies

In this third cycle, then, I focused more tightly on a particular *drawing* idea, making no models, no plans or sections. The hypothesis for *Exchange* was simply the figure of the network, and the idea that the aesthetic / formal / architectonic / compositional register of the project resides in the construction of the project's relational network – rather than either the form of any individual material component, or the composition of the atmosphere of the project. This provided the motivating impetus and guide for the wandering trajectory of the cycle. In this, I returned to the aspiration expressed by Bruno Latour and Alben Yaneva:

we should finally be able to picture a building as a moving modulator regulating different intensities of engagement, redirecting users' attention, mixing and putting people together, *concentrating* flows of actors and *distributing* them so as to *compose* a productive force in time-space (Latour & Yaneva, 2008: 87).

The drawing would be “a meeting ground, a common place” that “can accumulate other places far away in space and time and present them synoptically to the eye” (Latour, 1981: 8, 10).¹

The project ultimately resolved as a ten-metre long drawing, *Meshwork 3*. The drawing projected a potential future for the Māngere Inlet through a *spatio-temporal choreography*. Allen writes that an ecological understanding of a city, “implies a complex choreography of agents, objects, and process, where time is a key variable” (2009: 175). Importantly, while a choreographer might map out the movements of a dance, new possibilities emerge when the dancer actualises this map. In the same way, *Meshwork 3* is choreographic, a notation for future events that are likely to be actualised in different ways.

2. NETWORK DRAWING

A topological diagram of the network thus became the basic organising system of *Exchange*. Bearing in mind Ingold’s criticisms of the “hub-and-spokes” model of networking (2007, p.98), I nonetheless found it useful to continue thinking of the network as consisting of linked points. Two issues arose from Ingold’s critique, however. How are the points (or nodes, or things) to be defined, qualified, constructed, and made visible? And how can their relations and transformations be thought of as in any way *separate* from the unfolding existence of these points? In simplified graphic terms: how would I draw the things that are relating, and how would I draw the lines that link them?

I looked at drawings from outside the architectural field to see what forms such relationality might take. Comic artist Chris Ware, for example, has developed a strongly non-linear way of story-telling that combine multiple timelines, synoptic graphics, and page reorientations. In a spread from *Jimmy*

1. Such a meeting ground is often, in practice, provided by economic analysis. In cost-benefit analyses, such as those described by the NZ Treasury’s Better Business Case Methodology (used in evaluating infrastructure projects), dollar-values are used as the means of making disparate things commensurable (The Treasury, 2015). The Auckland Council, for example, has commissioned research that places a dollar value on the presence of pedestrians, and therefore the value of ‘walkable’ urban environments (Rohani and Lawrence, 2017). This reductive method responds to the need to assemble heterogeneous things on the same conceptual plane.

Corrigan (2000), for example, Ware narrates four generations of a family (Fig. 76). The spare, diagrammatic, *ligne claire* drawing presents emotive moments: a man dying in World War II, a little girl picking a daisy and pressing it the family Bible, an implied sexual assault, a baby given up for adoption by her teenage mother. Short narrative sequences run in various directions across the page, and arrows or dotted lines link them. A document from a doctor's clipboard and a high school yearbook are used as locating devices. Text is diegetic (there are no comments from the narrator) and the narrative is built up by traversing the page in a non-linear way

Mark Lombardi shows how the sober lines of a network diagram can be used for ironic effect in his *George W. Bush, Harken Energy, and Jackson Stevens, ca. 1979-90* (1999; Fig. 77), which alleges insider trading and profiteering by the former U.S. president. The drawing charts links between a cluster of participants including the Bush family, Saudi investors, regulators, and key figures at the Harken Energy corporation. "Unburdened by figuration, the works have an elemental thriftiness" (Zdebik, 2011: 72). The restraint of the drawing – its smooth curves, tidy little circles, and neat handwriting – belie an obvious anger and burning fascination on the part of the artist. Their abstraction is also precision, the stripping away of superfluous detail to reveal a hidden pattern.

A networked drawing can describe a project as an ecology and reveal the existence of hidden movements. Could the aesthetic investment of the project, then, be in the organisation of a network rather than the stereotomy of an object or the perspectival form of a volume? In *Circuit* and *Deposit*, I had laid out the project primarily on a continuous horizontal plane. In *Circuit*, the plane was plastically deformed, in *Deposit*, it was polarised. What would a project look like when mapped discontinuously: topologically rather than extensively, and as a mesh rather than a body?

3. SKETCHES AND OBJECTS

Speculating about this, one of my initial sketches showed twelve objects (Fig. 78): an irregular block, a hand-saw, a vessel partly filled with liquid, the hull of a container ship, a cooking knife, a sphere, a bamboo shaft with its leaves attached, a curved and marked panel from some kind of vehicle, a Doric column, a mobile phone, a cinder block, and a self-tapping wood screw.

Fig. 76. Spread from Jimmy Corrigan:
The smartest kid on earth. Chris Ware,
2001. Multiple threads of a situation
are described in a non-linear narrative.
(Ware, 2001).

Fig. 77. George W. Bush, Harken Energy, and Jackson Stevens, ca. 1979-90. Mark Lombardi, 1999. A diagram of a meticulously researched conspiracy.

[→ view online](#)

The objects were not scaled, but drawn at roughly the same size, suggesting their equal importance. Between these, at random, I scrawled linking arcs to suggest some connection. These connections were questions or possibilities rather than predetermined: what synchronicity could there be between a cinder block and a Doric column? What alliance between a container ship and a mobile phone? What response might a kitchen knife make to bamboo?

The drawing implied a levelling-out of hierarchies of scale. I deliberately assembled a heterogeneous collection and placed different sizes of things into relation. In other sketches, I tested finer distinctions: on the same sketchbook page was a three-object meshwork consisting of a block of cut stone, a rough piece of scoria, and an irregular lump of stone bearing cylindrical marks from being drilled out of a quarry. To what extent could three different stages in an object's life be separate objects?² The non-hierarchical flatness of Latour's ANT informed my approach:³

[W]e have to invent a series of clamps to hold the landscape firmly flat and to force, so to speak, any candidate with a more 'global' role to sit beside the 'local' site it claims to explain, rather than watch it jump on top of it or behind it (Latour 2005: 174).

Latour's concern is the effect of unannounced hierarchies on sociological explanations, but I saw a potent aesthetic opportunity in the juxtaposition of large and small on the same plane. A sense of vertigo might result, prompting one's own subjectivity and situatedness to come into question. Linking familiar and nearby things to the distant, immense, or unseen could defamiliarise and denaturalise the former.

My emphasis at this stage was on things that could be easily understood as *objects*: relatively self-contained and localised things. I found it easy to

2. The mereological puzzles in Casati and Varzi (1999) suggest some of the paradoxes of the concept 'object'. They describe a tension between topological and mereological theories. They argue that mereological ideas cannot be simply boiled down to topological ones, concluding that "the demarcation between mereology and topology, depends on the ontological fauna that one is willing to countenance" (5).

3. ANT can be seen as one of the so-called "flat ontologies" described by De Landa (2002: 47) and Bryant (2011: 245-6); and critiqued as incoherent by Brassier (2015). A philosophical review of these positions is outside the scope of this thesis; they prompted thoughts but did not necessarily structure them.

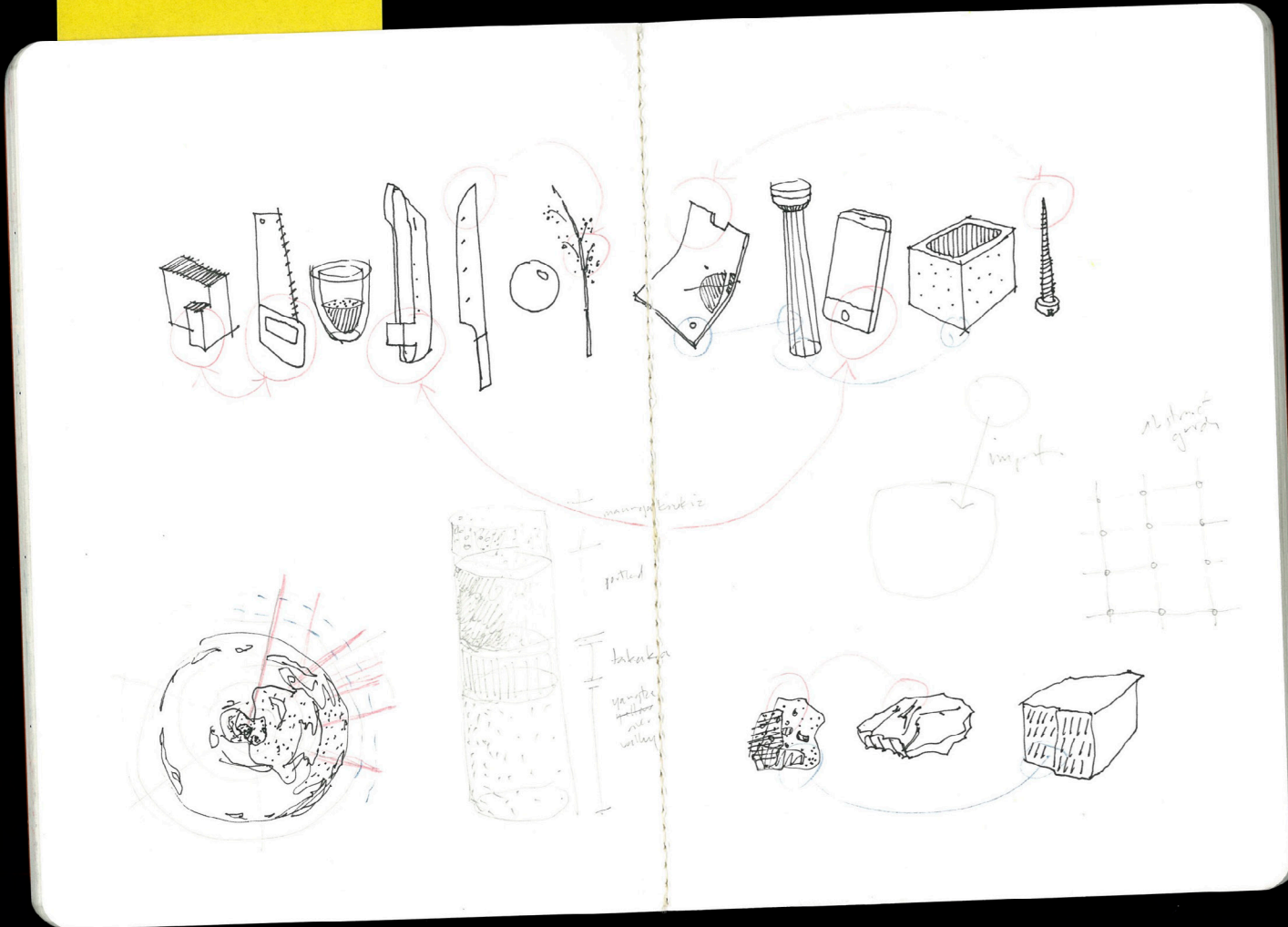


Fig. 78. Twelve objects. Ink and red pencil in sketchbook.

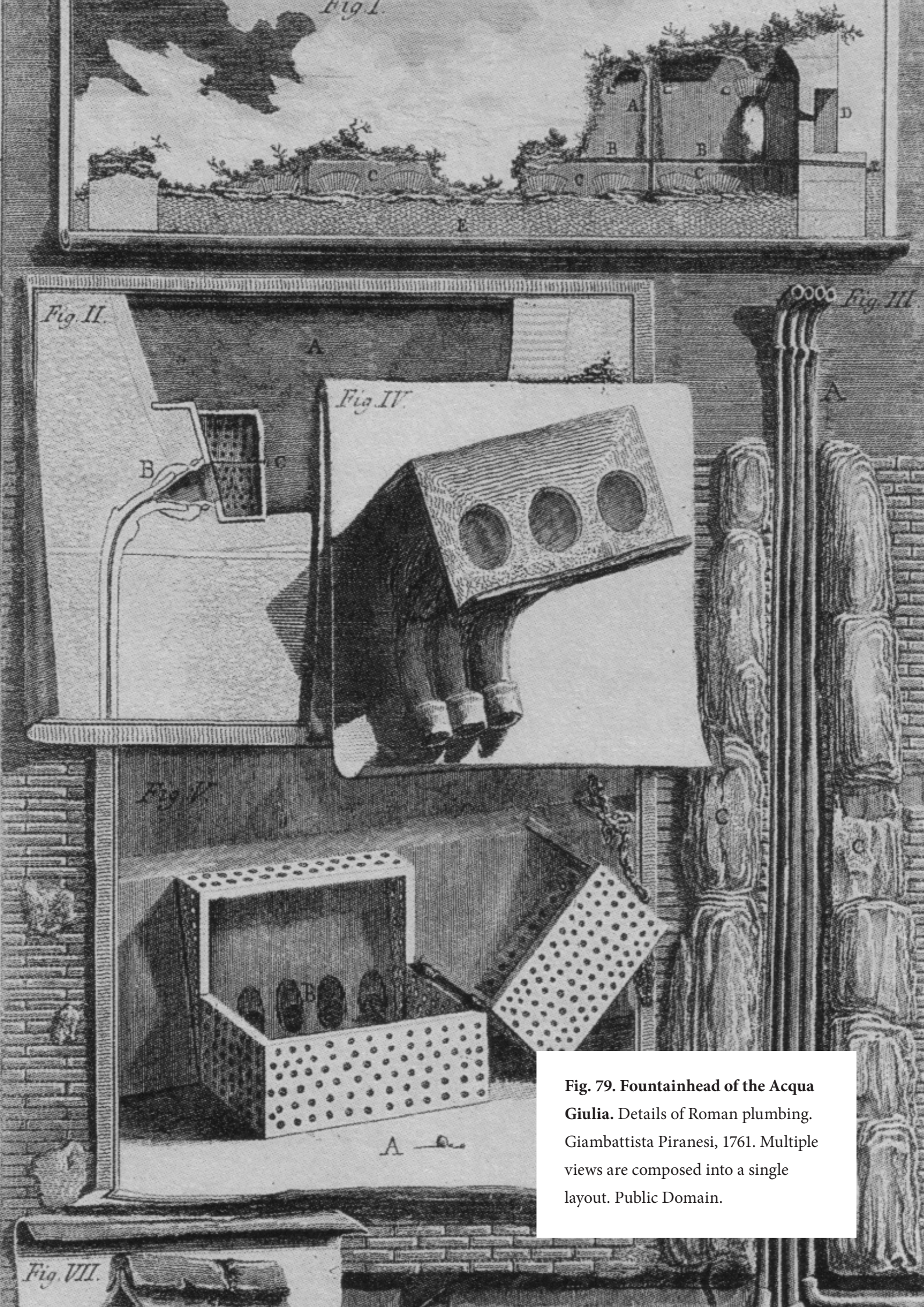


Fig. I.

Fig. II.

Fig. III.

Fig. IV.

Fig. V.

Fig. VII.

Fig. 79. Fountainhead of the Acqua Giulia. Details of Roman plumbing. Giambattista Piranesi, 1761. Multiple views are composed into a single layout. Public Domain.

include relatively discrete objects in my sketches: a car, a toothbrush, or a tree. But not all the participants in a meshwork are so sharply defined: think of a coal deposit, the El Niño weather pattern, or a radio signal. As a term, “object” seems to pair with “subject” as part of a Cartesian duality: “objects are the way things appear to a subject – that is, with a name, an identity, a gestalt or stereotypical template” (Mitchell, 2005: 156). I, however, thought of my drawn objects through Latour’s lens, as having coherence through performance. This might be performance in relation to a human subject, but it could equally be performance in relation to other objects.

Objects might form in various ways through various relations. They do not relate to one another indifferently:

“in a rudimentary way, if the paper did not somehow encounter knife ‘as’ knife, it could never be damaged by that knife. That is to say, the special kind of damage it undergoes show that it *does* encounter the knife *as a knife*, rather than as a flame or harmless pebble.” (Harman, 2006: 32)⁴

Things are configured in particular ways through their relations to other things: I think of this configuring as objectifying, giving a thing a specific figure. The linking lines in my initial sketches thus posed the question of how one object might objectify another. Broadening the scope of the objects that could find their way onto the page meant finding ways to articulate various kinds of figuration. Increasingly, my sketches exhibited a desire to evoke various kinds of objectivity, and the relations through which that objectivity was constructed.

Sketching, as a negotiation between fixed and unfixed (Ch.6, sec. 4.3), provided the means for my questioning. As I had noticed during *Deposit* (Ch.9, sec.3), sketches can be a search for concision. They can intensify some condition, draw attention to it, heighten a difference, articulate a significant edge. In sketching, I was often looking for the least constrained version of an idea. A sketch might chart a relation or

4. Harman makes this observation in generalising the structure of phenomenological intentionality to relations that do not involve humans. I do not follow his argument here, but simply pick up the idea that things condition or frame other things.

configuration that could manifest in many different ways. Belardi expresses this search for concision, writing that a sketch “tends to solve, within the context of the inventive kernel of activity, every complexity of what is still outside that kernel, however temporarily” (Belardi, 2014: 24). Working out how to sketch something concisely could also be working out what kind of objectivity it might have.

Objects arise from some kind of *figuration*⁵, and that figuration here took the form of a sketch. No single coherent strategy emerged, however. In some cases, the sketch was a placeholder or symbolic reference to something; in others, it was a pictorial representation. I often employed axonometric and isometric drawings because of their tendency to present things as isolated and compact (see Ch.6, note 5). Occasionally, I figured objects as samples and, in the case of geological features, the best strategy for figuration I could find was to arbitrarily extract a piece of the landscape as if with a giant cookie-cutter.

Due to the questions it raised, the idea of discrete *objects* was productive in this part of the project. The questions prompted continual revision and experimentation and drew my attention to the fact that the individuality or unity of an object may be acquired, attributed, or articulated in diverse ways, and therefore cannot be assumed. Sketching provided a testing ground for this heterogeneity.

4. COLLECTIONS AND LINKS

Layouts and collections, like those I assembled during *Deposit*, became significant as objects linked up into networks. Layouts and collections do not necessarily lock things into particular configurations. They are selective rather than universal, so they might include samples, exemplars, variations,

5. “This is exactly what the words ‘actor’ and ‘person’ mean: no one knows how many people are simultaneously at work in any given individual; conversely, no one knows how much individuality there can be in a cloud of statistical data points. Figuration endows them with a shape but not necessarily in the manner of a smooth portrait by a figurative painter. To do their job, sociologists need as much variety in ‘drawing’ actors as there are debates about figuration in modern and contemporary art.” (Latour, 2005: 54)

fragments, replicas, symbols, or souvenirs. Layouts or collections can almost always be added to: I think of them as open sets.

Most significantly, layouts and collections do not adopt the “symbolic form” of descriptive geometry (to redeploy Panofsky’s term; 1991): isotropic, isometric Cartesian-Newtonian space. Instead, they form a space through their interrelated elements. The table, wall, or page on which a layout is assembled is not like a picture plane. It is not a window onto a continuous geometric space. It is more like one of Piranesi’s composite engravings (Fig. 79), or Beaux-Arts “analytique” drawings (Harbeson, 1926: 7), in which multiple views of varying scales are artfully assembled and framed to demonstrate a movement across scales. In a series of sketches, and then in two larger (A1) drawings, *Meshwork 1* (Fig. 82) and *Meshwork 2* (Fig. 83), I adapted layouts as a drawing strategy.⁶

Layouts are held together loosely. Their elements are not fixed in their positions, but are arranged in such a way as to create resonance or an aesthetic effect. These loosely-bound networks usefully align with the looseness and discontinuity characteristic of infrastructure (see Ch.3, sec. 4.2). Although *Meshwork 1* does not describe an infrastructure (in the sense of the definitions in Chapter 3), its spatiality reflects the topological nature of infrastructural place. In some of the most interesting moments in the drawing, objects are triangulated by multiple links, becoming part of more than one narrative line.

How could I best articulate these loose joints? In my first attempts (Fig. 81), I used a double-ended red and blue mark-up pencil, scrawling a freehand arc in a single motion, with ellipses to anchor it to the objects at each end. Sometimes, the arcs were terminated with arrowheads, if directionality seemed significant.

I experimented with coding the links more specifically, to indicate different kinds of relation. A line indicating *origination* (this comes from that) could be notated differently from a line indicating *transportation* (this moves to that)

6. I termed these drawings *meshworks*, but my use of the term was not exactly Ingold’s (Ch.5, sec. 5). Ingold contrasts networks (as pure topology) and meshworks (as interwoven lines; 2007: 81). I use the two interchangeably, in spite of Ingold’s insistence that they are incompatible. I also note De Landa’s use of the term as a synonym for Deleuze’s “self-consistent aggregates” (De Landa, 1997: 500).

or *metamorphosis* (this changes into that). I used dashed, dotted, weighted, or coloured lines for this purpose. This led to a problem, however, because it suggested a taxonomy of relations with which I was uncomfortable. How many different types of line would I include? What qualities of relation would be demarcated?

Ultimately, I decided my naïve initial lines were best, merely indicating ‘this relates to that’, with an optional marker of direction. With less nuanced lines, there is no mistaking the drawing for expressing nuances it cannot hold.⁷ This satisfied the need for looseness and my preference for the least possible means, and also invited the drawing’s reader to interpret the relation.

5. *MESHWORK 1*

Meshwork 1 (Fig. 82) depicted a composite column, assembled from a series of circular stone drums derived from nearby and distant landscapes, to be situated on the reclaimed northern foreshore of the Māngere Inlet. I imagined this column as a visible manifestation of a network of relations between disparate landscapes, labourers, geological events. Cut into cylinders of uniform diameter, the stone drums are united as a single geometrically-defined object. Differences in the stones, however, act to index their distant origins. The assembly is a curation of links and a choreography of processes more than the giving of form to matter. The geometric form of the column (a simple cylinder) acts as a means to loosely link the stones that comprise it.

The first drum is of granite sourced, cut and shaped in the mountains of Fujian province in southeast China, shipped on board the *Maersk Edinburgh*. On the same ship is a block of Carrara marble transported from Naples, Italy, which is paired with a similar block from Takaka, Te Waipounamu (South Island of New Zealand), to form the second drum. The third drum is concrete cast in a section of steel pipe; the concrete includes chips from the marble blocks, the shells of Pacific oysters (*crassostrea gigas*) collected from the Inlet, black sand from the Waikato, and cement from Cape Foulwind. The fourth drum is synthetic obsidian made by vitrifying heavy-metal-

7. Tongue only partly in cheek, Healy irreverently argues that nuance can be “a pernicious and invasive weed” (Healy, 2015: 119).

Fig. 80. Mercaders House. Enric Miralles, 1995. Elevational details are laid flat onto the plan. Courtesy Miralles Tagliabue EMBT.

[→ view online](#)

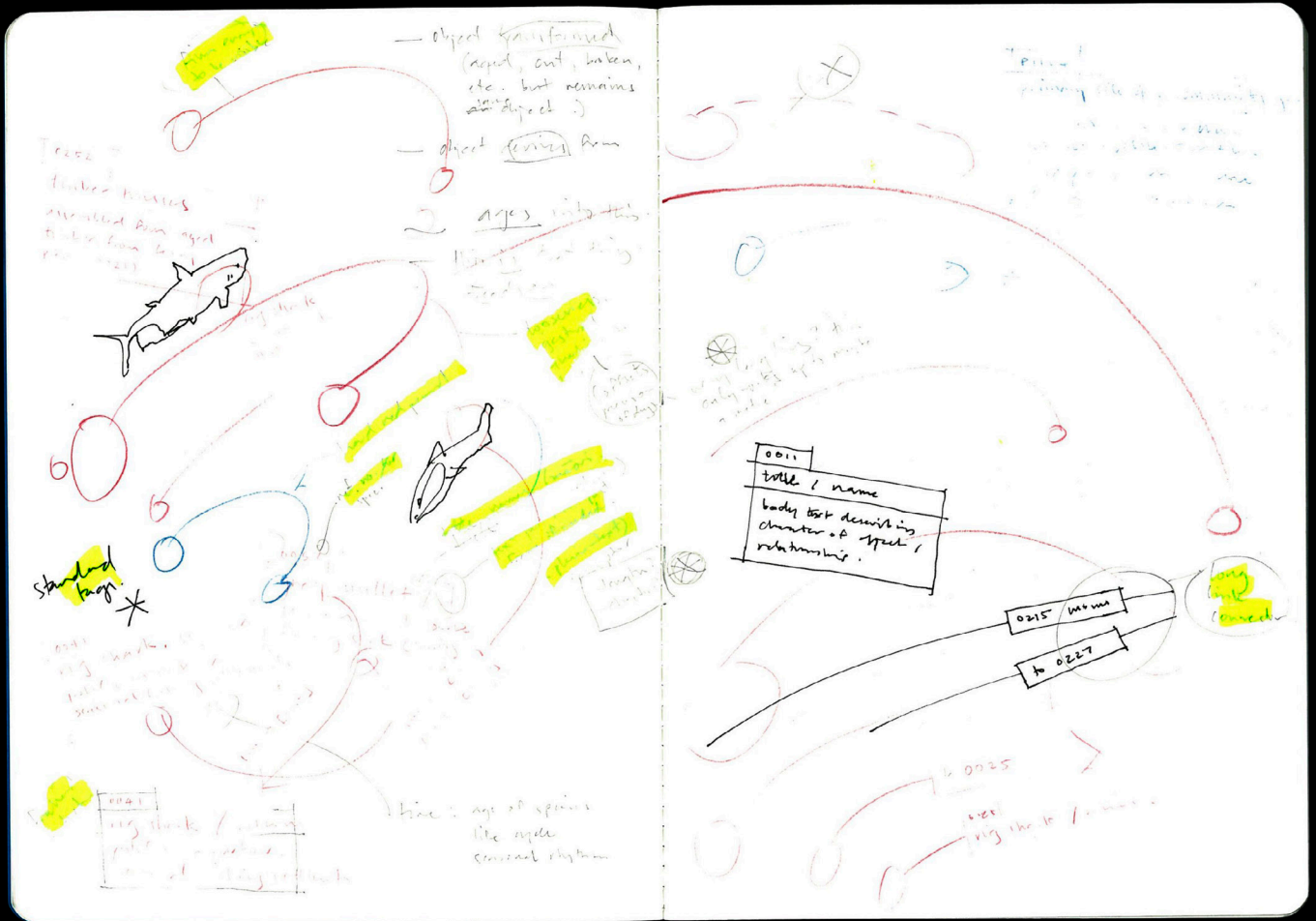


Fig. 81. Meshwork line and annotation studies. Pencil, ink, and red and blue pencil in sketchbook.

contaminated biomass (oioi grass, *apodasmia similis*) harvested where Miami Creek drains into the Inlet. The final drum is vesicular basalt cut from the lower slopes of Maungakiekie.

This is not only the design of a column, but a spatio-temporal choreography. Enric Miralles described designing his Mercaders apartment (Fig. 80) as “rummaging through the pockets of an old coat, setting the things one finds on a clean surface” (Miralles and Miralles, 2000: 45). Miralles’ description suggests designing as a process of disclosing, and negotiating with, found things, of projecting place by questioning, sorting, assembling. Likewise, the diverse and originally dispersed participants in the dance of *Meshwork 1* are variously found, disclosed, formed, aligned and reconstructed. Large and small, formed and found, directly and indirectly encountered things are equalised, made to appear roughly the same size on the page and rendered in the same monochrome pencil.

6. RENDERING SPEED

I worked primarily through sketches in the early part of this project cycle. In the move to larger format drawings, my technique changed. Rather than being sketched out, the larger drawings were *rendered*. Rendering, in a culinary sense, is cooking meat until the fat melts out. In producing images from digital models, rendering is the process of calculating and presenting a simulated appearance based on the geometry and properties stored in the digital model. It is often slow; a digital render can take hours to produce as the computer algorithms simulate light being emitted, reflected, and refracted around a scene. Rendering is yielding or giving something up, paying allegiance, as in “render to Caesar” (Mark 12:17; King James Version), or to “emit, give out, discharge” (‘render’, 2009). These new drawings were rendered by hand, using a soft pencil.

The slowness of rendering makes decisions consequential. Since rendering involves an investment of time and labour, it helps to filter the irrelevant, and also test the ability of the drawing to bear the gravity of that investment. This matches the experience of Billie Tsien and Todd Williams:

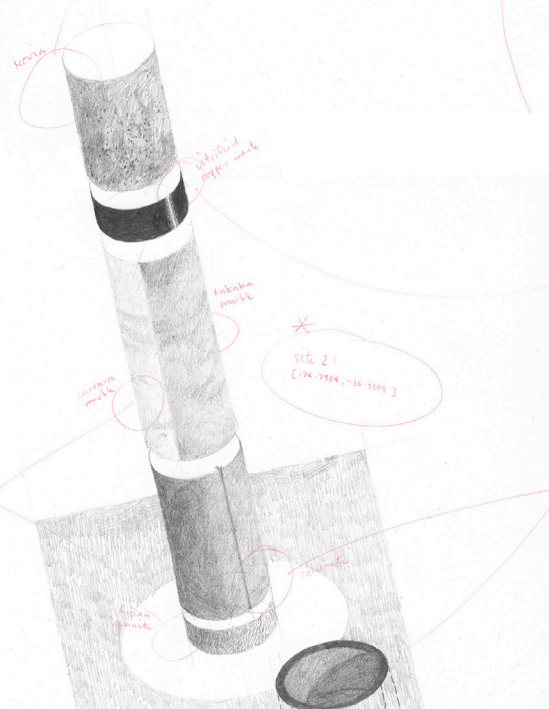
As our hands move, we have the time to think and to observe our actions. We draw using pencil and ink, on mylar and vellum. When we make changes, they occur with effort and a fair amount of tedious



manipulating
iron flow



recycled
glass



iron

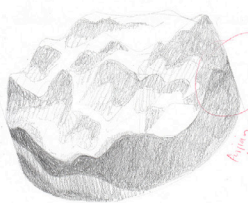
integrated
paper - wood

fabrika
marka

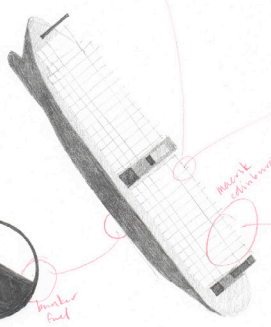
Site 2:
[174-7974 - 36-1004]

iron
marka

iron
marka



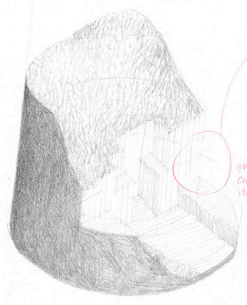
iron
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marka

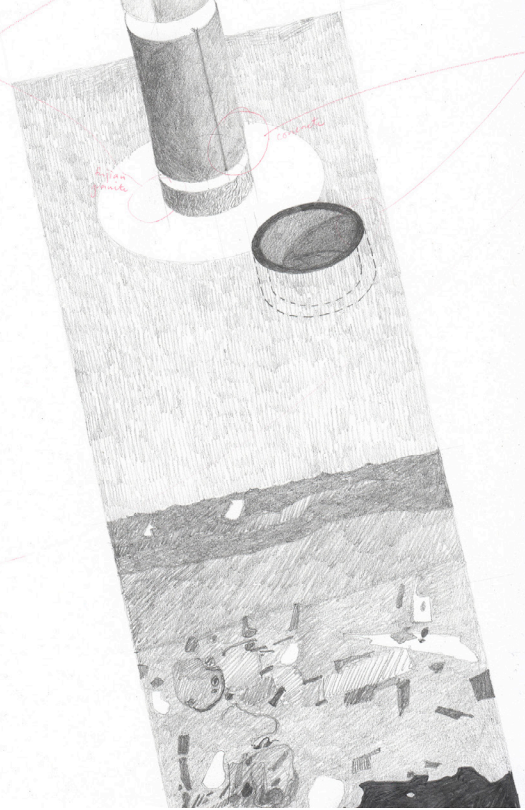


iron
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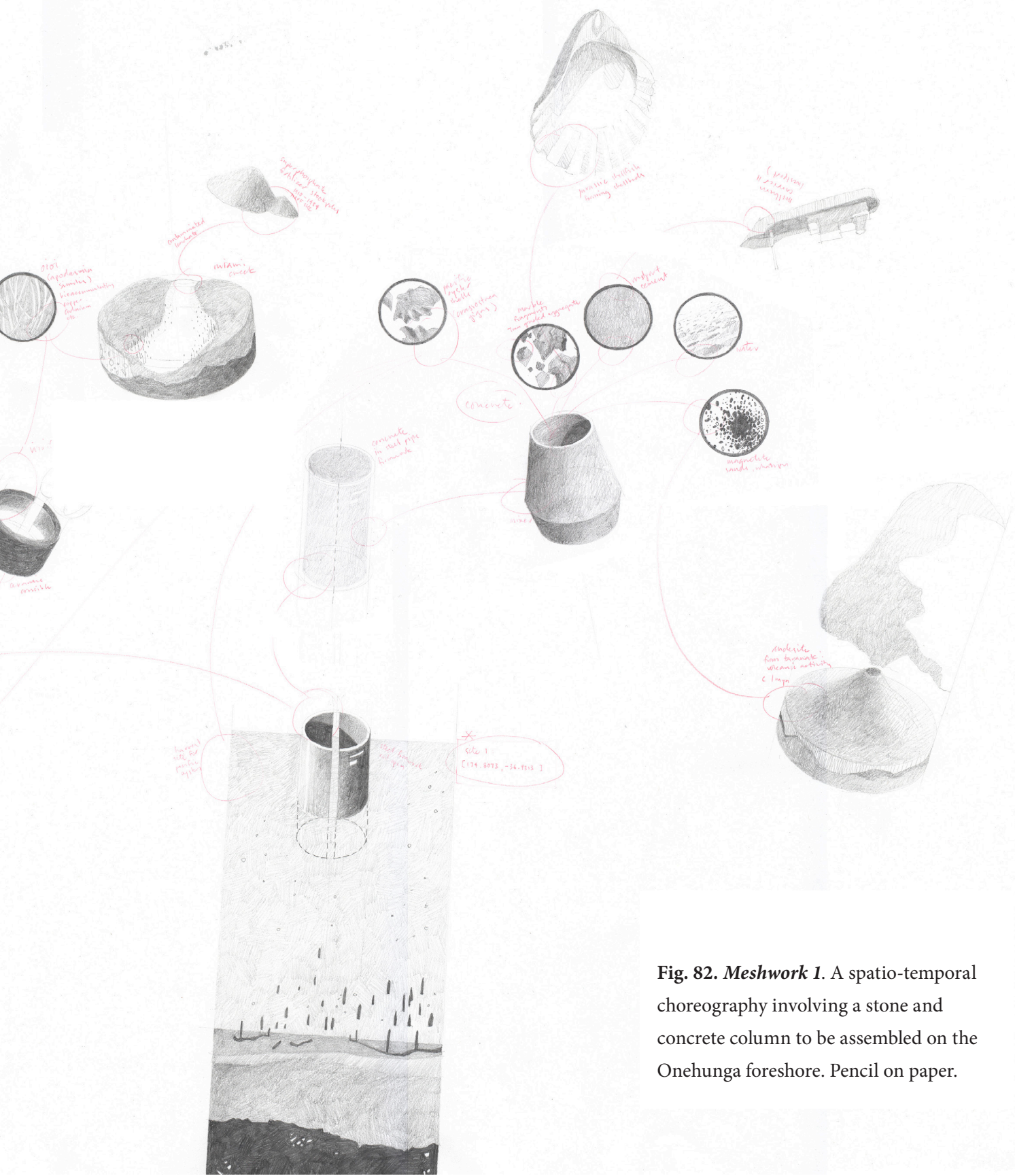
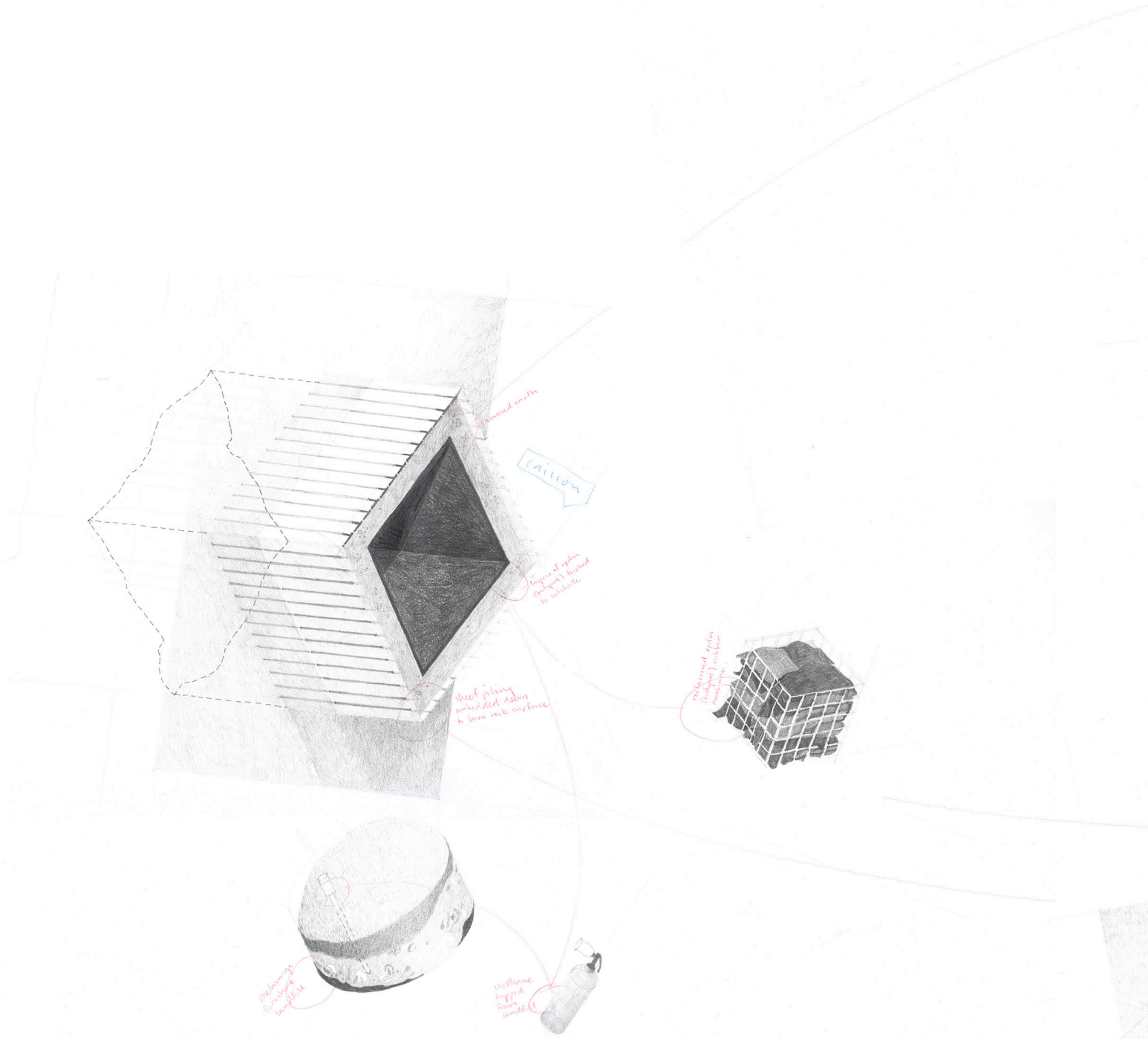
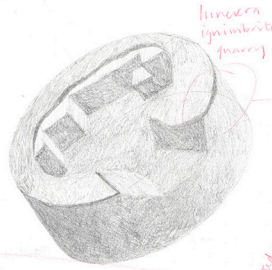


Fig. 82. Meshwork 1. A spatio-temporal choreography involving a stone and concrete column to be assembled on the Onehunga foreshore. Pencil on paper.

Fig. 83. Meshwork 2. A spatio-temporal choreography involving three sites. Pencil on paper.

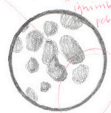




limes spainbrite powder



blended and mixed (spinel)

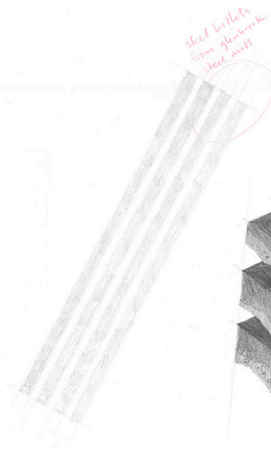
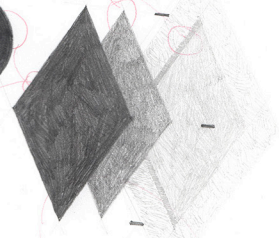


tumbled granulate particles



long exposed thermal expansion

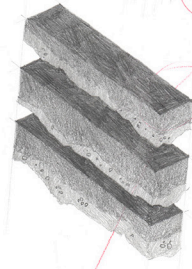
white dust



steel bolts from plastic steel wall



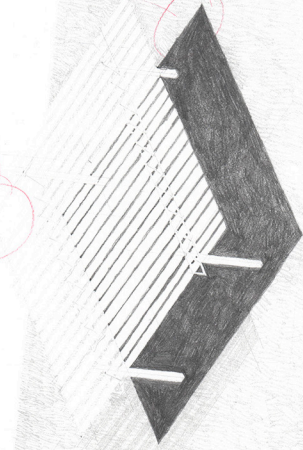
rolled metal facing



appliance with plates 100x100 and 150x150

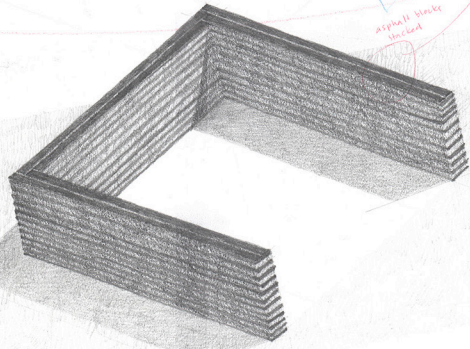
20mm steel plate 100x100

150x150mm plate



amphitheatre

applied bricks stacked



scrubbing with erasers, erasing shields, and spit... decisions are made slowly, after thoughtful investigation, because they are a commitment that has consequence. (Williams & Tsien, 1999)

Because drawing takes a long time, it precludes the rapid production of many drawings, and therefore decisions must be made. The idea cannot exist any longer in the flux of versions in a sketchbook, but takes on some form that I am willing to commit to. This does not necessarily imply finality, but it does entail the concentration of decisions, and an increase in *intensity*. As I slowly worked the drawing, I paid attention to the latent that might seep out, and gave the nascent room to unfurl. Rendering, for me, was a process of drawing out and polishing, striving for a lapidary quality.

Following *Meshwork 1* (and a second drawing along the same lines, *Meshwork 2*), I wanted to expand on scope and complexity. I particularly aimed to deal with multiple sites and a longer time scale. I imagined the largest drawing possible for myself, given the time available, and settled on a ten-metre long strip. I made a quickly-drawn draft in pen and ink and then rolled the sheet onto my board, scrolling it left and right to expose part of the drawing at a time. The sheet became a landscape, which I traversed back and forth, seeing only in part (Fig. 84). Burnishing part of the drawing, and then concealing it while I worked elsewhere, I was constantly leaving and returning to its elements. With each return, I found new possibilities for the elements that I had not seen in the draft. Links proliferated.

I also discovered the significance of leaving white space. It is difficult to make a large soft-pencil drawing without smearing graphite all over the white page. White space had to be vigilantly maintained. Where the draft had filled up almost entirely, the final *Meshwork 3* drawing retained a sense of openness and room for new participants to be discovered or introduced. The dark graphite blocks sat in relationship to this white space, and I explored various ways of framing them, including allowing white space to break into the objects themselves. White space was not *empty*, but *open*.

7. MESHWORK 3

The choreography of *Meshwork 3* centres on an exchange between three sites: the Port of Onehunga, the landfill explored in *Deposit*, and a site on the southern edge of the Māngere Inlet. Materials, people, organisms, and other things travel from one site to the next over time. They are recycled, reassembled and stockpiled for future uses. The traces of previous processes are carried forward as memories of past configurations of the Inlet's relational network. The three sites change over time, exchanging materials and objects, catalysing various public activities, and incorporating many agencies apart from my own.

Early in the programme described by *Meshwork 3*, a temporary ferry pier and a mason's yard covered by a steel canopy structure are installed at the port. On the landfill site, an asphalt surface is laid: partly used as a free materials yard, and partly as safe parking for homeless people living in cars. On the southern site, a temporary theatre is built overlooking the water. Its timber structure is lifted on posts above loose-stone scoria walls.

Workers at the mason's yard build a new stone pier, after which the old pier is disassembled and the materials stockpiled. The mason's yard is enclosed as a fish market, using concrete poured into reusable timber formwork. Assuming the need for homeless car parking has declined, part of the asphalt surface is replaced by a public workshop. The workshop's concrete columns have been salvaged from the old pier, and its timber room was once the temporary theatre. Trees planted on the site of the old theatre grow up, collapsing the scoria walls with their roots, leaving a clearing.

Further into the future, the fish market has to move elsewhere because of rising tides. Its steel roof is disassembled, and the concrete walls remaining form a tidal pool. A second temporary theatre, alongside the workshop, reuses the timber formwork. In the forest clearing (once the original theatre), annual tattooing events are held. Custom woven mats, stained with blood and ink, are reserved for later use.

Eventually, a new community hall is built, overlooking the flooded fish market and connecting to the stone pier (still in use). The marked tattoo

Fig. 84. *Meshwork 3*. Photograph of part of the ten-metre drawing, alongside the draft layout. Various framing strategies for the drawn objects are visible.

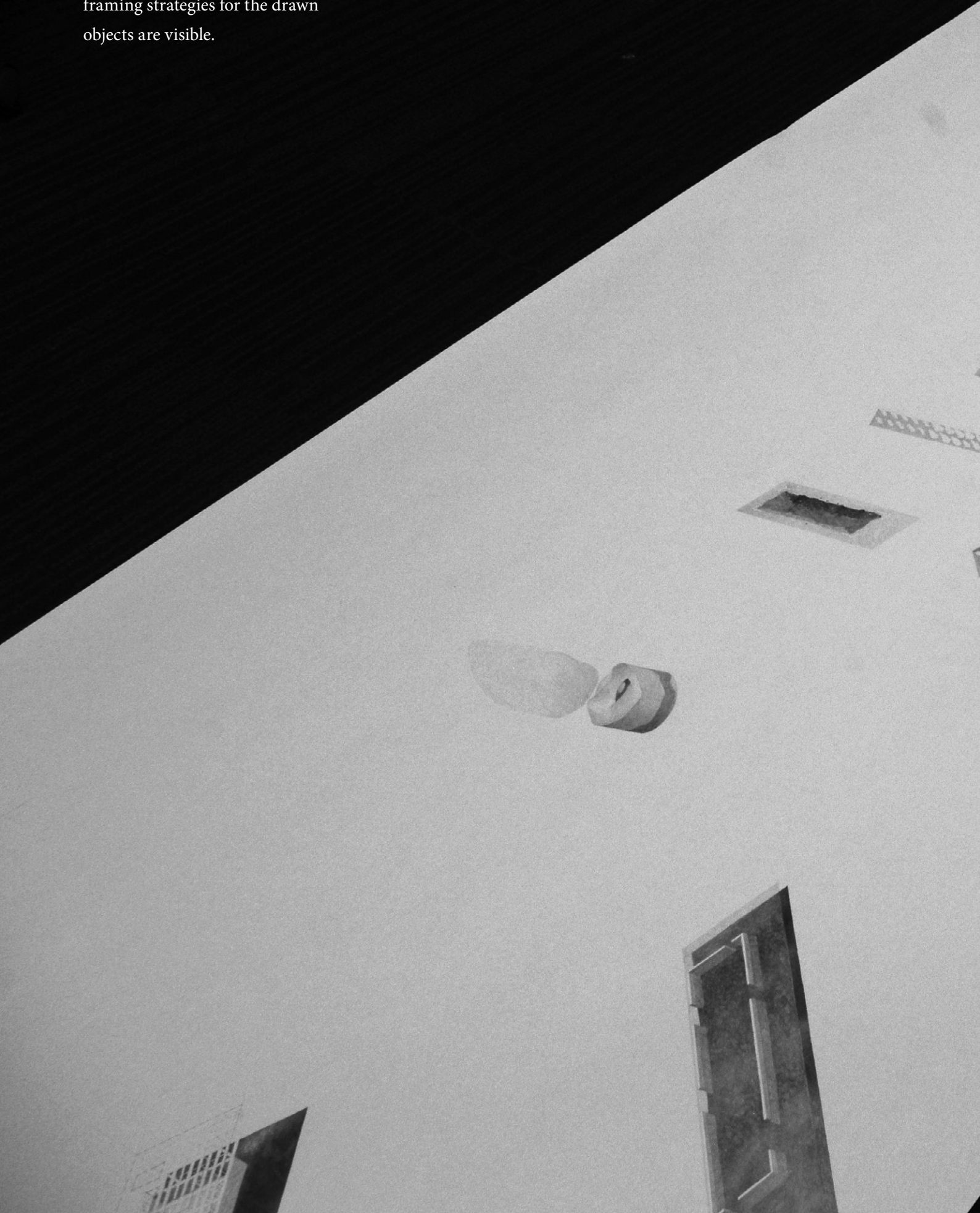
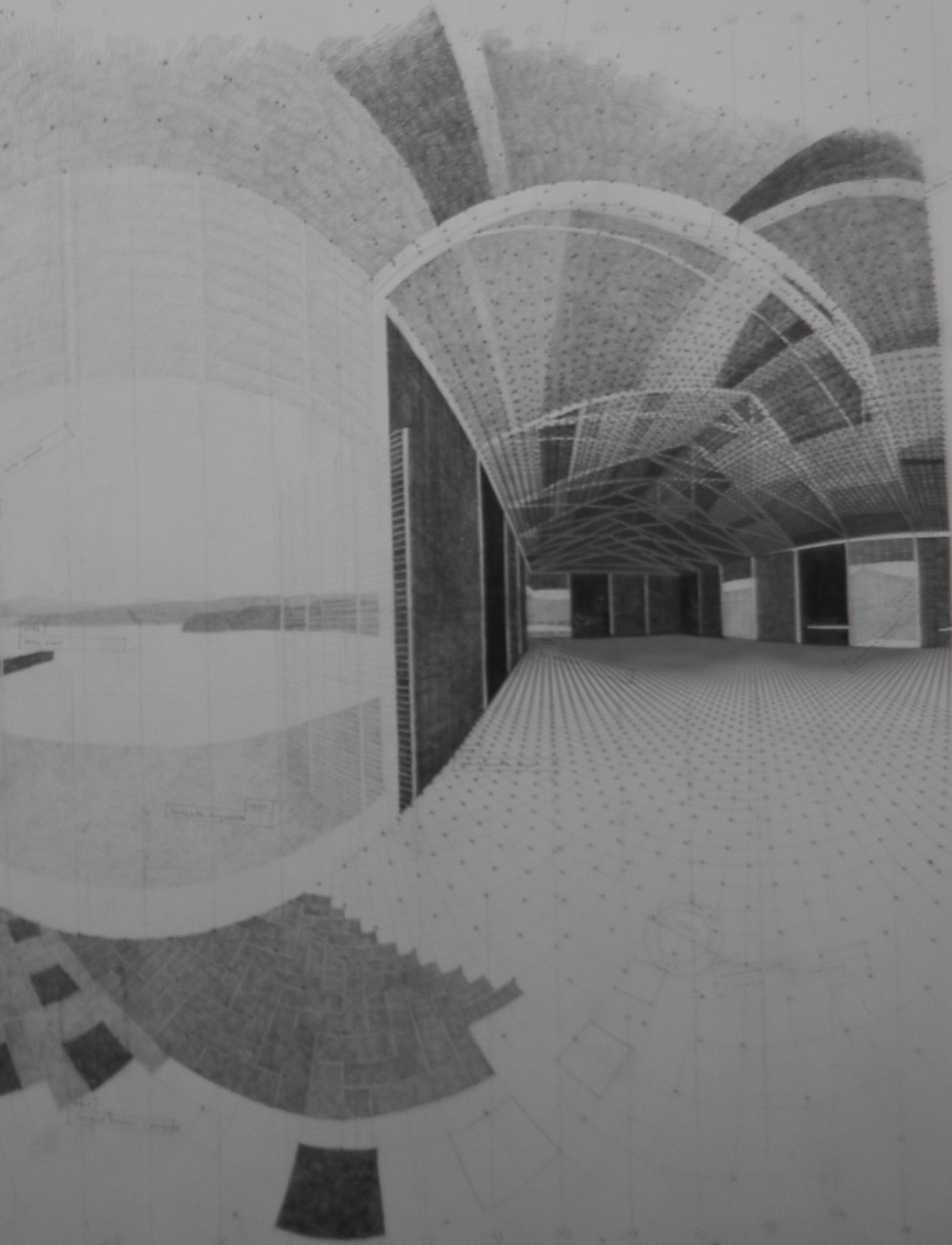






Fig. 85. Cylindrical perspective of community hall. To accompany Meshwork 3. Pencil on permatrace over underlay grid produced using Grasshopper plugin for Rhinoceros 3D.



mats line the interior. The public workshops are extended with a new building made from composite stone columns (similar to those from *Meshwork 1*) and the steel structure that once covered the mason's yard and the fish market. The tree plantation grows into a sustainably managed resource.

As drawn, the meshwork consists of around 150 objects. They interlock and change over time, mutating into new objects. In accordance with my understanding of choreography (Sec.1) as anticipatory but not definitive, the drawing charts one possible pattern through time. It is a projection of future place.

What does it mean to be *in* such a networked place? Does *interiority* remain relevant, or is it excluded altogether? I returned to the technique of cylindrical perspective I used in *Deposit* to test the immersive quality of the network. The panoramic view I produced collapsed the depth of the network onto a surface (Fig. 85). The view is situated at a particular point in space and time: it depicts a view from inside the community hall, late in the sequence of events described. The stained mats, the stone pier and the advancing sea are visible. Such a view locks onto a particular present; the network in these views recedes beyond the horizon (the visual horizon of the perspective view, but also a temporal horizon). Other places, times, objects, and processes of the meshwork are evoked. Hints and orientation allude to the remote and asynchronous.

8. NARRATIVES: MICRO-FICTIONS

To make the multi-threaded narrative of *Meshwork 3* legible, I relied on annotation. Conventional drawing sets for construction use annotations to connect with schedules and specifications that describe parts and processes. Where plans, sections, and elevations describe where elements are located and how they fit together, schedules and specifications list discrete components and activities. They are indexed by means of reference numbers and call-outs, and include diagrams, text, part numbers, names of suppliers, and references to manufacturer's catalogues. They tabulate the building in the graphic form of the spreadsheet's grid. They are significant in other ways, however, because they tie the world described by the drawing set into the wider world, connecting it outwards. Schedules and specifications

mobilise orders of parts from suppliers, set the processes and expected practices of contractors, define the tests that will be applied to the building in determining its completeness, its conformity to applicable codes and regulations. They *narrate* the project in a non-linear way.

I treated labels and annotations as poetic opportunities, rather than merely explanations, influenced by very short-form fiction: for example, Lydia Davis's "Getting to Know Your Body", which runs (in its entirety):

If your eyeballs move, this means that you're thinking, or about to start thinking. If you don't want to be thinking at this particular moment, try to keep your eyeballs still. (Davis, 2011)

Such epigrammatic writing can, in a few words, evoke sprawling thoughts. What is left out of the text is as significant as what is included: why might Davis want to stop thinking? Do my eyeballs move when I think? Am I ever not thinking?

Teju Cole's experiments with micro-fiction have been carried out through his use of Twitter. In a blackly comic series called "Small Fates", he retold stories from Nigerian newspapers in the 140-character limits of Twitter:⁸

In Ikotun, Mrs Ojo, who was terrified of armed robbers, died in her barricaded home, of smoke inhalation. (Cole, 2011)

And in "Seven Short Stories About Drones", famous works of fiction are abruptly and ironically truncated by drone strikes, suggesting brutal invasion and foreclosure of life:

I am an invisible man. My name is unknown. My loves are a mystery. But an unmanned aerial vehicle from a secret location has come for me. (Cole, 2013)

Though I was not able to equal Cole or Davis's compressed wit, I took their micro-fictions as a pattern for my annotations. Each note attempts to give some sense of the aesthetic or cultural particularity of the object. My annotations suggest the presence of an even broader field of relations than

8. "In this odd sort of way, bad news is good news because these instances of bad news reveal a whole world of ongoing human experience that is often ignored or oversimplified" (Cole, 2011).



Fig. 86. *Meshwork 3* exhibited at St Paul Street Gallery 3 as part of things that scale themselves, a joint show with Sue Gallagher. Exterior view.



AUT St Paul St G

Rosa Maresca Mitrak
AUT St Paul St Gallery Three
WB239





Fig. 87. Meshwork 3 exhibited at **St Pal Street Gallery 3** as part of things that scale themselves, a joint show with Sue Gallagher. Interior view.

the one depicted in the drawing, one laden with potential meanings. Like epitaphs of proverbs, they are fragments that hint at judgements, processes, and agencies. They provide enough information to follow the connection between one object and the next, but don't summarise or define. Labels *thicken* the drawing with values and evoke unseen entanglements (see Ch.9 note 8).

9. EXHIBITION: THINGS THAT SCALE THEMSELVES

Meshwork 3 employed customised drawing conventions. Conventions allow a certain kind of transparency in architectural drawings. This transparency is an "enabling fiction" (Evans, 1997: 154), facilitated by standard modes of representation and notation. I anticipated *Meshwork 3* might be experienced as opaque. To test this, and to seek input and commentary, I placed it on public exhibition. I mounted a joint exhibition with a colleague, Sue Gallagher, entitled *things that scale themselves*. It ran for a week in July 2017, at St Paul St Gallery 3, in Auckland (Figs. 86, 87), and finished with a panel discussion.

Gallagher and I arrived at the theme of scaling as a shared theme. Gallagher was working actively with scale as a structuring device for her work, linking city-scale, interior-scale, and jewellery-scale pieces. Scale for me, as I have discussed earlier (Ch.5, sec. 4) following Latour, is something that arises as an effect of a relational field. We both sought out relations and effects that crossed scales. I exhibited two drawings: *Meshwork 3* and the cylindrical perspective described above (sec. 7).

I observed that when people looked at *Meshwork 3* they were active. Because the ten-metre drawing was too large to take in at once, viewers tended to move back and forth along it, zooming in to look at details and stepping back to gain overview. I had anticipated this effect, but was fascinated to watch it play out: the erratic pacing, leaning in, tilting of the head, stepping back. This animation suggested that viewers were trying to hold two perspectives simultaneously: the general field of the composition, and the particularities of its moments. When the drawing was viewed from a few steps back, it appeared as a scattering of irregular black figures over a white plane. When it was viewed up close, the linking lines and annotations came into view. Although the drawing is a long strip, it does not simply

move left to right, but radiates out from the three main sites. Accordingly, it resists a linear reading. In the concluding discussion, panellists commented particularly on this bodily engagement as one of the main effects of the work.

The cylindrical perspective drew noticeably less attention, with most viewers satisfied at a glance. Because the drawing was smaller, it did not require any movement. I had installed the drawing across the gallery from *Meshwork* 3, and this broke the connection between the two drawings. In addition, the annotations were too subtle to form a useful link. I needed more clarity around this drawing's purpose and to articulate a stronger relationship to the larger sheet.

The panel discussion revolved around the relationship between my own design agency and the other sources of agency I had identified. In particular, the panel asked how tightly I intended the drawing to specify the future. Was the drawing a fictional history, an imagined story from a future perspective? Was it an anticipatory programme from the perspective of the present? Was it a *plan*? How could the particularity of the decisions made, and the meticulous care of the pencil-work be reconciled with the unpredictability of a complex network, particularly to the extent that it involved other people? For example, what if someone came up with an alternative plan along the way? These questions pointed to critical issues of design agency and the nature of loose planning.

10. RETURNS

This was my third and final scheduled project cycle. Through my practice-led inquiry, I have attempted to articulate strategies for projecting place in light of the strange relations and topological structure of infrastructural space. In *Exchange*, I proposed a public place that took the form of a network linking things across a broad swathe of time and space.

In *Circuit*, there was a tension between two kinds of public space: the empty pavement waiting for people to bring it to life; and the circulatory space of the path, which linked up existing sites and activities in a new way. In *Deposit*, I envisaged publics coalescing around waste as a matter of concern, and proposed a building capable of gathering and framing such publics.

Circuit's path was designed mainly in plan (albeit a warped version of the plan). *Deposit's* recycling centre and workshops were designed in plan, section, and perspective. In *Exchange*, I tried to operate specifically in the topological space of a network.

Exchange manifested two productive tensions. I experienced these tensions as contradictory but motivating tendencies. It is unlikely that I will find final and unambiguous resolutions to these tendencies. Rather than conflicts in need of resolution, I treat these tensions as offering two simultaneous possibilities. By weighting first one, then the other possibility, the project advances.

The first major tension was that between *objects* and their *relations*. That is, between things insofar as they are discrete, and insofar as they dissolve into their contexts. From one perspective, the world could be imagined to consist of discrete entities that move in and out of relation with one another (Latour's view tends this way). From another, the world could be imagined to be a relational field, from which things resolve temporarily as objects (this is closer to Ingold's view). As I worked, this tension typically manifested as a problem of figures and grounds. To figure something is to render it distinguishable from a background; to take a position on its individuality. Where descriptive geometry distinguishes things in terms of their shape, the freer space of the sketch allows for other kinds of figuration. Where descriptive geometry assumes a unified working space, the discontinuous space of the layout allows different kinds of figuration to exist on the same conceptual plane.

A second tension was between my agency as designer – my planning, foresight, anticipation, specification – and the other agencies to which the proposal opened up. 'To design' as a verb describes only a very loosely related set of anticipatory practices. In my meshwork drawings 'design' splintered into a constellation of verbs: to plant, to employ, to order, to lay out, to schedule, to wait, to store, to give, to collect, to find, to accumulate, to sell, to make use, to disassemble. For few of these verbs are ideas of intention and agency unproblematic.

With these tensions particularly in mind, I turned back towards my final revisions, and the reframing of my three project cycles for exhibition (only begun at the time of writing this). In the next chapter, I conclude this

exegesis by drawing out and pulling together the key insights of my inquiry and positioning these as my contribution to a design field.

11

CONCLUSION

Drawing out

1. CONTRIBUTION OF THIS RESEARCH

This research has asked how the strange relations mediated by infrastructure can be drawn into projections of public place. What is a designer to make of infrastructured contexts? How are we *placed* by infrastructure, and what conceptual, theoretical and technical apparatus might we use in *projecting place*? I have sought an understanding of how infrastructure could inform design practices involved in shaping public contexts; and conversely, how design practices could suggest new understandings of infrastructured contexts (Ch.1, sec.2). The inquiry has thus been circular: I considered the nature of infrastructured contexts as a means to generate new design practices; and I used design practices to generate different understandings of those contexts. It called both sides into question, but did not seek to ground or fix either. The mode of questioning at work in this inquiry did not expect unambiguous, simple answers. It was:

Not a Cartesian doubt that works by process of elimination to arrive at a core of unshakeable propositions, but a tactic for dealing with an imperfect reality with a catalog of tools that is itself always incomplete, imperfect, and inadequate. (Allen, 2009: xv)

The findings of this research as are, accordingly, not a list of propositions, but a list of interrogatory tactics: flexible strategies and concepts that are mobile enough to be adapted for new situations (Ch.1, sec. 3).

The practice work (in its exhibited form, as well as in the fluid, exploratory form expressed in this exegesis) demonstrates and evidences the value of these mobile strategies and concepts. Theory, concepts, objects and practices are inextricably woven. Generating concepts is part of the work of this thesis, and, accordingly, theories have been both analytical tools and a means to move the project by suggesting new analogies and associations. In order to bring out this interplay between “discursive” and “material” practices (Allen, 2009: xiii), my inquiry was structured around nested cycles of practice (Ch.2, sec. 5). Iterative processes (such as dialogic sketching and journaling) were integrated into Project Cycles, with earlier cycles ultimately revisited in light of later work and ideas. This exegesis text is part of the creative work of the inquiry. It details the genesis and context of my strategies, and assembles the concepts and theories with which they are implicated. The processes I have used are not necessarily novel, in themselves, but I employed them in new ways, by continually returning to previous ideas and unpicking them, revisiting decisions and constantly interrogating the grounding assumptions and logics at work. At the level of methodology, as well as design concepts, my approach to design has been *reassembly*. This cyclical reassembly is driven in two main ways. First, by refusing to reduce complexities of place, it continually disrupts unwarranted stabilities. Second, by exploiting theoretical and practical tensions (see sec. 3 below), new possibilities emerged within the scenarios. In fact, theoretical and practical strategies share aspects with the logistical choreography operating in *Meshwork 3*: concepts, methods, dispositions, practices and objects moved between the project cycles, drawing in new participants and being recycled, reassembled and stockpiled for future use.

The interaction between infrastructure and design practices is important because it pertains to the nature and quality of public contexts as fields of human activity. Who is included in public space? What scope do they have to come to appearance? How can that realm reflect more than existing power structures and dominant cultures? Does it enable meaningful encounters with strangers, who may be experiencing life in quite different ways? The quality of public contexts does not pertain only to the form and

materiality of public spaces, although these remain significant. Rather, it relates to activity in a broad field of relations (see particularly, Ch.8, sec. 3). Infrastructures condition this field as a background for human activity, potentially embedding assumptions, biases, theories and concepts. However, infrastructures do not only constrain; they also enable. This is the tension in which my inquiry unfolded.

The main contribution of this research is in using topological theories of place to set up interactions between infrastructure and design practices in which strange relations can be mobilised as factors. A shift in emphasis from extensive, formal space, to topological place involves an alteration in how a designer's agency is understood. I evoke this shift in agency through the idea of projection (Ch.1, sec. 4), recasting the design of public space as the *projection of public place*: the anticipation of new or reconfigured locales for public participation. The findings of my research (the knowledge it has generated) are situated in four significant locations: the critical and contextual discussions in this exegesis, design techniques and strategies described in the exegesis and embodied in the artefacts, the artefacts to be exhibited themselves, and they are inscribed in my own body (Ch.2, sec. 2).

Below, I review the key findings of this thesis, chapter by chapter. I then draw together the major threads of this inquiry as a collection of relational strategies, offered as recommendations for practice. This selection, which does not exhaust the ideas that arose in the course of the research, consists, first, of *concepts*, which I have understood as crucial sources of productive uncertainty. Second, they include *dispositions*, personal tendencies and approaches. Third, they take account of *practices*, specifically three drawing approaches. In Section 4, I consider the opportunities and gaps this research opens.

2. REVIEW OF FINDINGS BY CHAPTER

In Chapter 3, I drew attention to two characteristics of infrastructure: its environmentality and its production of strange relations. Beginning by understanding infrastructure as a logic of systematic and open-ended underpinning (Ch.3, sec. 1), I attended to the role of infrastructure in the globalised networks of late capitalism (Ch.3, sec. 2), finding that pervasive infrastructures complicate established ideas of environment and locale.

In particular, infrastructures have been observed to produce unevenness and discontinuity (Ch.3, sec. 3). This effect does not merely manifest in capitalism's inequities, however; it is principally essential to technology (as Heidegger's broken hammer and Latour's broken car attest; Ch.3, sec. 3.2, 3.3). An analysis of a selection of design approaches suggested three relationships to infrastructural background: voyaging into it (The Unknown Fields Division; Ch.3, sec 4.1), using it as a model (Allen; Ch.3, sec 4.2), and strategically adjusting it (Mathur and da Cunha; Ch.3, sec 4.3).

Moving from the general to the particular in Chapter 4, I described the region of the Māngere Inlet as a case study in the environmentality and strange relations of infrastructure. Travelling five routes, I (de) familiarised myself with the region as a relational meshwork. Guided by Ingold's distinction between wayfaring and transport, I found a significant distinction between moving longitudinally and transversally with respect to infrastructural lines (Ch.4, sec 2.3). Compounding this experiential discovery, my unsuccessful attempt to draw a site transect indicated the need for new relational drawing strategies (Ch.4, sec 2.5).

In Chapter 5, I drew on topological theories of place. Some theories of place, which are founded on an opposition between place and placelessness, are suspicious of technology and likely to conceive of infrastructure as corrosive of authentic place (Ch.5, sec 2). However I found three accounts that describe place using topological concepts. Malpas describes place, not as a reassuring source of identity, but as a means for constant uncertainty and thus a genuine openness (Ch.5, sec 3). Place is known in the way a surveyor knows a terrain: by traverse and triangulation, an objective but relative mapping is made. Latour, similarly, claims that complex situations cannot be reduced to the outworkings of hidden structures (Ch.5, sec 4) but, rather, can only be known by tracing the effects entities (interpreted as performative actors) have on one another. Finally, Ingold explicitly critiques the figure of the network (Ch.5, sec 5) and replaces its points and lines with winding paths that knot together into a meshwork. Rather than theoretically reconciling these accounts, I find them to be provocations for new design strategies. Theoretical issues drive explorative practices, which in turn yield experiences that I have assembled into mobile concepts.

Chapter 6 concerns drawing practices. Descriptive geometry, because of its close relationship to Cartesian-Newtonian concepts of space and the subject-object binary, does not lend itself to the inclusion of the formless, the remote, the discontinuous (Ch.6, sec 2). Without proposing to supersede descriptive geometry, or impugn its use, I identify two alternative traditions: cartography and sketching that are relevant in the context of infrastructure. A central problem of cartography is concerned with the question of how to unfold the surface of the globe so that remote places can be included on a single flat surface (Ch.6, sec 3). Sketching, as a circuitous, cumulative, and loosely-coded drawing practice, often involves a search for appropriate concision or economy (Ch.6, sec 4). In cartography's concern for background formatting, as well as sketching's play between fixity and unfixity, I find strategic avenues for projecting infrastructural place (I discuss cartography and sketching further in sec. 3.6 and 3.7 below).

In my first major project cycle, discussed in Chapter 7, I designed a path around the Māngere Inlet, visualising the orientating effect of the path through the development of a new cartographic technique (Ch.7, sec 2.2). This curve-offset projection incorporated longitudinal and transverse aspects, reflecting a space polarised by ambulation. By staging the tension between Cartesian-Newtonian space and topological movements, the technique suggested the possibility of being simultaneously oriented in more than one way, and concretised the link between place and activity. These ideas were revisited and revised in subsequent cycles. Along this path I proposed a set of pavements, lawns, and platforms as public spaces. I identified ideas of looseness and insufficiency as worthy of further attention (Ch.7, sec 3), because they provided an alternative to the one-to-one correspondence between design and function, or design and meaning.

In Chapter 8, I explored some aspects of the nature and formation of publics. I distinguished between *making room* for a public and providing *scope* for a public to manifest. Publics don't simply take up space, they form through specific contextual exchanges. Material participation is a response to a context, a means of shaping context, and a means of articulating one's own identity with respect to a context. It variously involves the redirecting, adjusting, or interrupting of practices (Ch.8, sec 3.3); but also the catalysing of activity around *matters of concern* (Ch.8, sec 3.1). I used the handling of

urban domestic waste to model what active material participation might look like (Ch.8, sec 4).

My second project cycle, *Deposit*, is discussed in Chapter 9. In this cycle, I responded to the new understanding of public space gained in Chapter 8 by designing a recycling centre and public workshops (Ch.9, sec 1.3). In the foreground was waste, as a matter of concern catalysing participatory publics. Rather than than generic unoriented space in which anything could happen, I exploited the effects of shifts in orientation (Ch.9, sec 3, 4). In the process, I found hints, suggestions, and allusions to be useful strategies for articulating strange relations, provoking recontextualisation of activities, people, and things. I particularly aimed at recontextualising things by shifting the temporal frames in which they register: the interminable suddenly disclosed as fleeting; the momentary protracted.

In my third and final project cycle, *Exchange* (Chapter 10), I proposed a public place that would unfold over time through the ongoing exchange between places. The projection manifested as a spatio-temporal choreography (Ch.10, sec. 1) or a layout (Ch.10, sec. 4) as ways to envisage the relationships between, on the one hand, specifying activities and, on the other, remaining open to contingencies and others' agencies. Figuring place as an network of objects was a strategy for including a diverse range of agencies. Far from homogenising things, the concept of "object" drew attention to heterogeneous modes of discreteness. I discuss my meshwork drawing technique further below (sec. 3.8); and will now turn to the key relational strategies that culminated in Cycle 3.

3. KEY RELATIONAL STRATEGIES

In this section, I draw out eight relational strategies for design practice. They are not a cohesive system or exclusive model of designing but recommendations for practice, based on my experience through this design inquiry. They represent what I see as my most significant findings.

The first three relational strategies are concepts, which I refer to as *sources of uncertainty*. These are articulated theoretically in this exegesis, and are embedded in the design productions to be exhibited. A source of uncertainty is productive: it generates problems, and attempts to resolve it entail new

understandings of a situation.¹ Rather than obstructing the free movement of a designer, sources of uncertainty produce repetition, provisionality, nuance, and the thickening of concepts.

The second two relational strategies are *dispositions*, that is, values I have adopted. By describing these dispositions, I endeavour to draw out some of the tacit knowing generated through this inquiry. As tacit, this knowing remains partly indistinct. It is embodied in myself, and in my design productions. These dispositions might be thought of as aesthetic preferences, in the sense of ways in which I have comported myself in the design process, which reflect something of my own character, values, and history. Because of this, they are not presented here as necessary or even ideal ways to navigate infrastructural space as a designer; they are simply the ways I have found to work.

The final three relational strategies are *practices*, drawing techniques I have worked with. They are not fully resolved as comprehensive systems, but are prototypes, described in this exegesis and exemplified in my design productions. I offer them as models or triggers for future practice (my own and others'). Drawing in these ways, in preference to the conventions of descriptive geometry, I suggest, opens up the model of infrastructural place described in this thesis and significantly different from current prevailing design practices.

These relational strategies fulfil the aims of my research by answering the question *how?* They also provide a platform for future design inquiry and practice, demonstrating possible approaches to projecting place in infrastructural contexts.

3.1. Source of uncertainty: Objects

What constitutes an object? It might be thought that objects point towards naïve realism, formalism, a Cartesian split between subjects and objects, and a reification of capitalist commodities. I make no ontological claims about object, but I have used their ontological ambiguity as a prompt for questions about topological place: how does an object achieve or receive discreteness?

1. For Latour, a source of uncertainty is ambivalent because “it is impossible to decide whether it resides in the observer or in the phenomenon observed” (2005: 22).

How does an object orientate human activity; and how is it disclosed by that activity? How do objects perform as matters of concern catalysing participatory publics? Diversifying the range of participants (human and nonhuman) in a project creates opportunities for new configurations and performances to be incorporated into the projection of place.

3.2. Source of uncertainty: Line

In Cartesian-Newtonian space, a line is pure extension. In topology, a line is a connection. What does a line connect? What does it pass through? Lines define at least two directions: across and along, longitudinal and transverse. What continuity is represented by a line? What discontinuities are implicit in moving across it? Ingold insists lines unfold temporally whereas, for Latour, they are given their character by the nature of the actors they join. For Malpas's surveyor, they accumulate over time as a series of readings. By allowing all these possibilities (and others besides), lines waver between being connections and trails, leaping across space, but also moving through it. Rather than prioritising any one of these possibilities over the other, I found a productive tension between them. As became increasingly clear over the course of the cycles, drawing a line (between two points on a map, between two concepts, or across a drawing) can be a way of questioning both the things it joins and the domain it passes through.

3.3. Source of uncertainty: Agency

Agency, as it has been used in this inquiry, is not a specifically human potential. Diverse and distributed agencies (both human and nonhuman) are involved in projecting place. This diversification can be represented as a multiplication of verbs. For example, in place of "functioning" we might consider the potentials of encouraging, resisting, offering, opening up, organising. Rather than "appearing", something might be alluded to, mumbled, found, or grown. Rather than "defined", objects might be sketched, prefigured, seeded, oriented, or equivocated over. To design might involve letting-happen, scheduling, inviting, hoping, or tweaking. It is difficult to sustain an ideal of *Gesamtkunstwerk* when these verbs are brought to bear on a project. In place of working on master-plan, vision and oversight, designers might anticipate, or orient the future in less rigid ways. Following Rancière, true politics is only possible when there is always room

for unexpected agencies to arise. To become uncertain about agency is to ask: what other agencies are at work? Where might unrecognised actors find their place?

3.4. Disposition: Loose fit

Looseness opposes the idea of perfect fit. A disposition towards looseness involves allowing for tolerances, variability, change, and the participation of other agencies. In particular, it turns away from *Gesamtkunstwerk*, the idea that all aspects of a situation might be included in a single design intention. Looseness allows for making do, but also involves *precision*. To be disposed towards looseness of fit requires a careful consideration of the interplay between the fixed and the unfixed, in order to work out which aspects make a crucial difference, and where there are degrees of freedom.

3.5. Disposition: Traces

I have taken an interest in the condition of vanishing or barely appearing, preferring the liminal, peripheral and backgrounded to the central and foregrounded. Traces index the existence of processes, agencies, and places that are not directly present, and indicate the presence of strange relations. They might be allusions, or perhaps ambiguous hints of something on the verge of comprehension. Through adjacency or analogy, traces can set up comparisons and suggest sympathies. By means of traces, we can sense that there is *more* involved in a situation than can be directly apprehended.

3.6. Practice: Warped cartography

In Project Cycle 1, *Circuit*, I developed a cartographic method (curve-offset projection) that warped the territory of the map with reference to a path across it. In the method I adopted a defined path and fed a raster data set into a pair of Python programs (Technical Appendices, 1–4), which generated the new map. Instead of a ubiquitous flat ‘site’, this warped cartography described an intensely polarised relational field radiating out from a drawn line. Warping maps allows for an interplay between extensive Cartesian-Newtonian space and a topology of connections, showing how the latter compresses and dilates the former. Instead of an isotropic,

isometric space through which things move, the curve-offset map described a space that unfolds around a moving thing. Reassembling raster aerial photography datasets to produce mappings relative to particular geospatial lines (represented by the code in Technical Appendices 2 and 3) generates novel projections (acknowledging precedents: Ch. 7, 2.3, 2.4, note 9), which allow design analysis to take place in relative rather than absolute spatial mappings.

3.7. Practice: Sketching

Sketching is commonplace in design. In this inquiry, without limiting its various potentials, I have come to understand sketching in a particular way (particularly in *Project Cycle 2, Deposit*): as a means to explore and articulate relations between fixity and unfixity. In this sense, a sketch is not only a preliminary and unfixed version of something that will later be more precisely fixed. Rather, it can be a means to delineate an envelope of acceptable conditions, or a seed from which a range of conditions might unfurl. A design that incorporates looseness might be defined entirely in the form of sketches. Multiplied, sketches lend themselves to curation, layouts, and shifting relationships. With scope to be diagrammatic or cartographic, sketches can concentrate, filter, and manipulate invisible, indirect, remote, or asynchronous relations. My inquiry validates sketching as a mode of conceptual thought, not merely a means to produce a rough draft.

3.8. Practice: Meshwork drawing

My meshwork drawing technique, developed mainly in *Project Cycle 3, Exchange*, envisages a place as a topological structure, a network of linked objects. It required deep engagement with the three sources of uncertainty listed above: objects, lines, and agencies. The practical graphic problem of finding a way to make complex and entangled things into clear figures, distinct from a background, drew attention to the diverse kinds of unity that things might possess. Figuring objects into empty space also raised questions about what those objects could *do*, which of their potentials could be drawn out by relations with other objects. White space on the page, particularly in *Meshwork 3*, did not correspond to Cartesian-Newtonian space, but was like the space of a table on which things could be laid out and moved around in anticipation. The drawing narrates the future of a place non-linearly.

Logistical and temporal diagrams are commonly made by designers. My contribution here is to describe an approach for such drawings that uses particular diagrammatic representations and projections to circumvent grounding assumptions about space and place; to mobilise the uncertainties described above (sec. 3.1, 3.2, 3.3) as productive tensions; and to require a more fundamental renegotiation of what is included as part of a project. Strategies such as slowness, relative scale, and the narrating of vectors prompt me to discover and conceive of relations differently, creating a design space for new processes, relations, effects, objects, and spaces to appear.

4. LOSINGS: GAPS AND OPPORTUNITIES

We inhabit an urbanised condition. I have suggested that infrastructure is cannot be isolated, is not a subsystem of urban space but, rather, its defining spatial paradigm. A key symptom of this paradigm is the presence of strange relations. Strange relations are remote and asynchronous effects that are experienced indirectly or unconsciously, if at all. The deleterious effects of daily activities on the planet's atmosphere or distant landscapes are emblematic of strange relations. If I choose a particular brand of chocolate or detergent at the supermarket containing palm oil, I come into relationship with plantations, burned rainforest, smog, orangutans, water supplies, and human inhabitants in places I have never visited, never seen, and whose name I may not even know.

What, then, to repeat my research question, does it mean for designers of place – architects, landscape architects, urban planners, engineers, interior designers – to work within this paradigm? To the extent that they are invested in techniques and concepts that situate experience, meaning and aesthetic value in localised effects (particularly form and sensory experience), designers' ability to address the strange relations symptomatic of infrastructures is limited. In this thesis, I have endeavoured to extend designers' repertoires by developing relational strategies that re-situate experience, meaning and aesthetic value in a broader field. I have not conceived of this as *de*-localising, as moving towards global rather than local perspectives; but as adjusting the idea of *place* at work.

I have reframed both the notion of infrastructure and my design processes to include distant, dislocated, miniscule, enormous, future, past, invisible,

and intuited things. I intend the relational strategies outlined above to allow others to explore the implications of this inclusion. Rather than determining in advance what constituents of place – people, organisms, machines, artefacts, ideas, activities, systems, institutions, spaces, and effects – can come to appearance, I have sought a means to frame design as an open and ongoing negotiation. Theoretical and practical tensions (working through design cycles) continually unsettled prematurely stabilised ideas of place. There will always be new factors to mobilise. My aim has been to provide relational strategies and exemplars by which to accelerate the development of new hypotheses and experimental practices.

The research envisages a more central role in the future for designers in generating public places, but also one that is more plastic in the kinds of agency it exhibits. If there is a villain in this thesis, it is reductive, disciplinarily-blinkered and arbitrarily systematic design. The prevalence of infrastructure in public places, I have shown, creates a need for designers to be engaged in more ways, at more levels, and in more situations than professional and conventional disciplinary frameworks allow. This might include seeking a voice in governance, policy, and planning; in infrastructural engineering; in social and environmental justice; in ad-hoc, informal, community projects; as well as in the design of landscapes, buildings, and individual spaces. In these situations, designers could be involved in *problem formation*, not merely problem solving. In this thesis, I demonstrate possibilities for such a problematising approach.

This raises unanswered questions, however. What credibility do designers have in these situations? How can the value of designers as problem-finders be recognised as valuable in a cultural context dominated by the desire for problem-solving? These questions are outside the scope of this inquiry, and point to a need for sociological studies as well as inquiries into institutional (re)design. The research for this thesis has also generated useful insights and questions related to design teaching. How can the relational strategies described here be taught? How might students be encouraged to develop their own relational strategies? I hope there is also value here for local publics who seek to understand the immediate challenges of the Auckland context, particularly around the Māngere Inlet. There may be similar value for global publics by analogy with their own contexts.

Accompanying this more comprehensive engagement is a broader sense of what a designer's agency might be. Rather than operating on the paradigm of form, material, and experience, designers will need to become comfortable with the thickened sense of agency described above. I have proposed the idea of *projected place* as a way to foster this thickened agency.



Fig. 88. Pencil lead shavings.
April, 2017.

APPENDIX 1

Exhibited Works

The creative practice work carried out for this thesis was exhibited from 28 February to 8 March, at St Paul St. Gallery 3, 63 Wellesley St. East, Auckland, New Zealand. The exhibited works were:

Cycle 1: Circuit. Digital print. 7920 × 910mm.

Cycle 2: Deposit. Pencil on drafting film, photocopied sketches and prints. Overall dimensions approx. 10000 × 600mm / Arrangement of found objects, sketches, paper and cardboard models, topographical models of volcanoes. Overall dimensions approx. 1980 × 910mm.

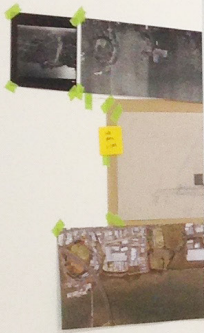
Cycle 3: Exchange. Pencil on cartridge paper. 10000 × 841mm.

This appendix includes images of the work as exhibited. High-resolution scans and digital files are available online in the supplementary files included with this exegesis, or can be accessed by contacting the author.

STRANGE RELATIONS

A design inquiry into infrastructure as topological place.

Carl Douglas



Cycle 2 / DEPOSIT



Fig. 90. Strange Relations exhibition.
Room 1. February, 2018.





Fig. 91. Strange Relations exhibition.
Room 2. February, 2018.



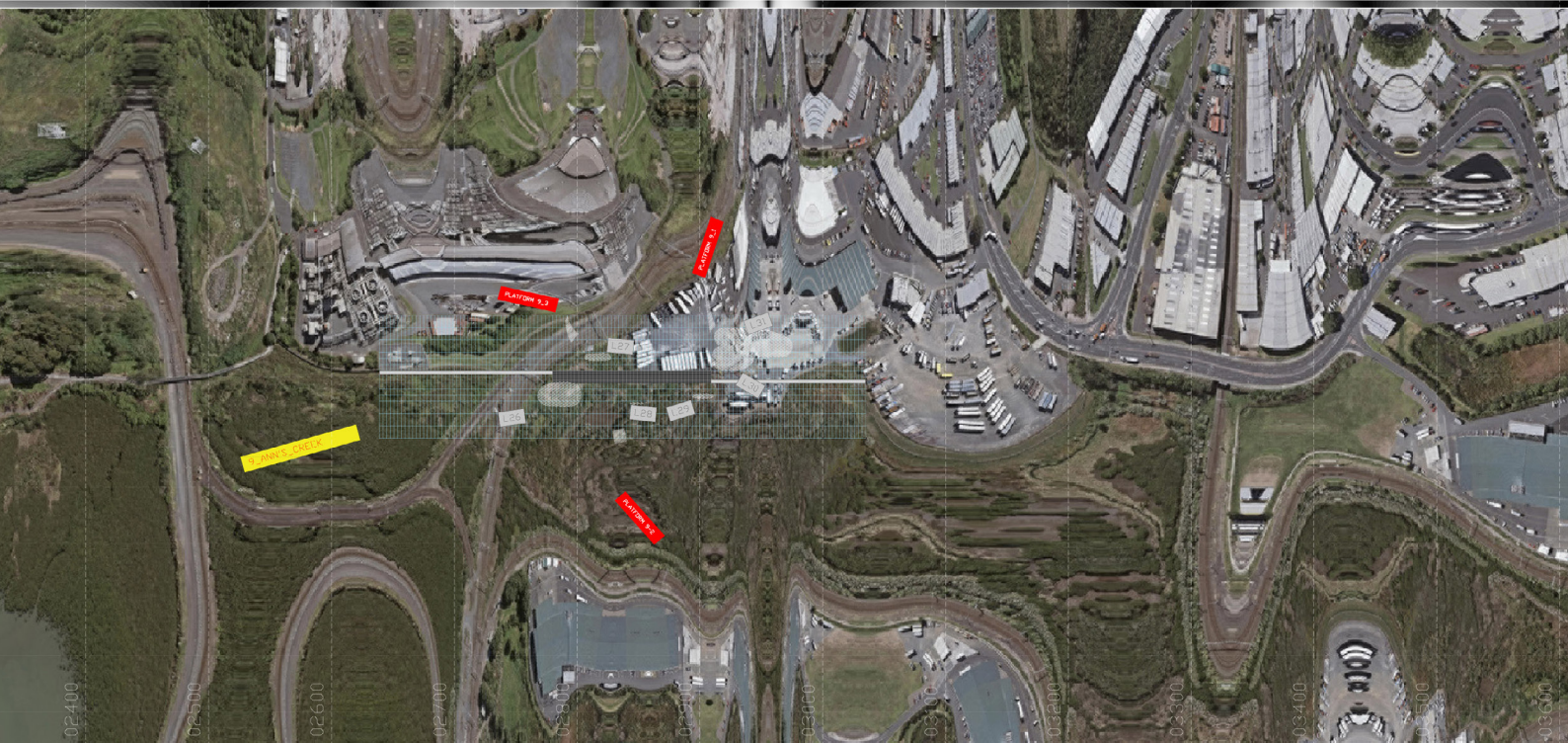
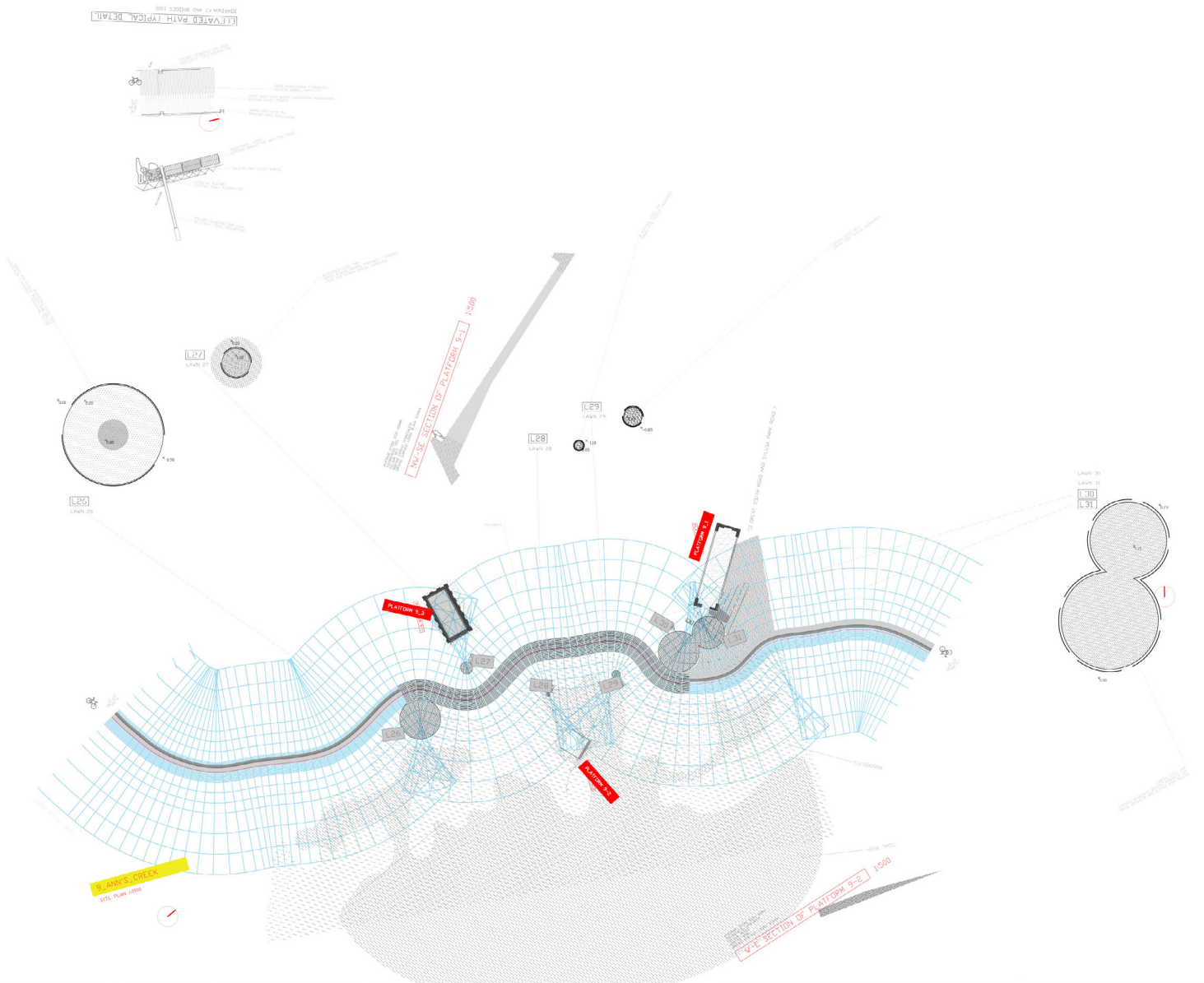


Fig. 92. Cycle 1, Circuit. Detail

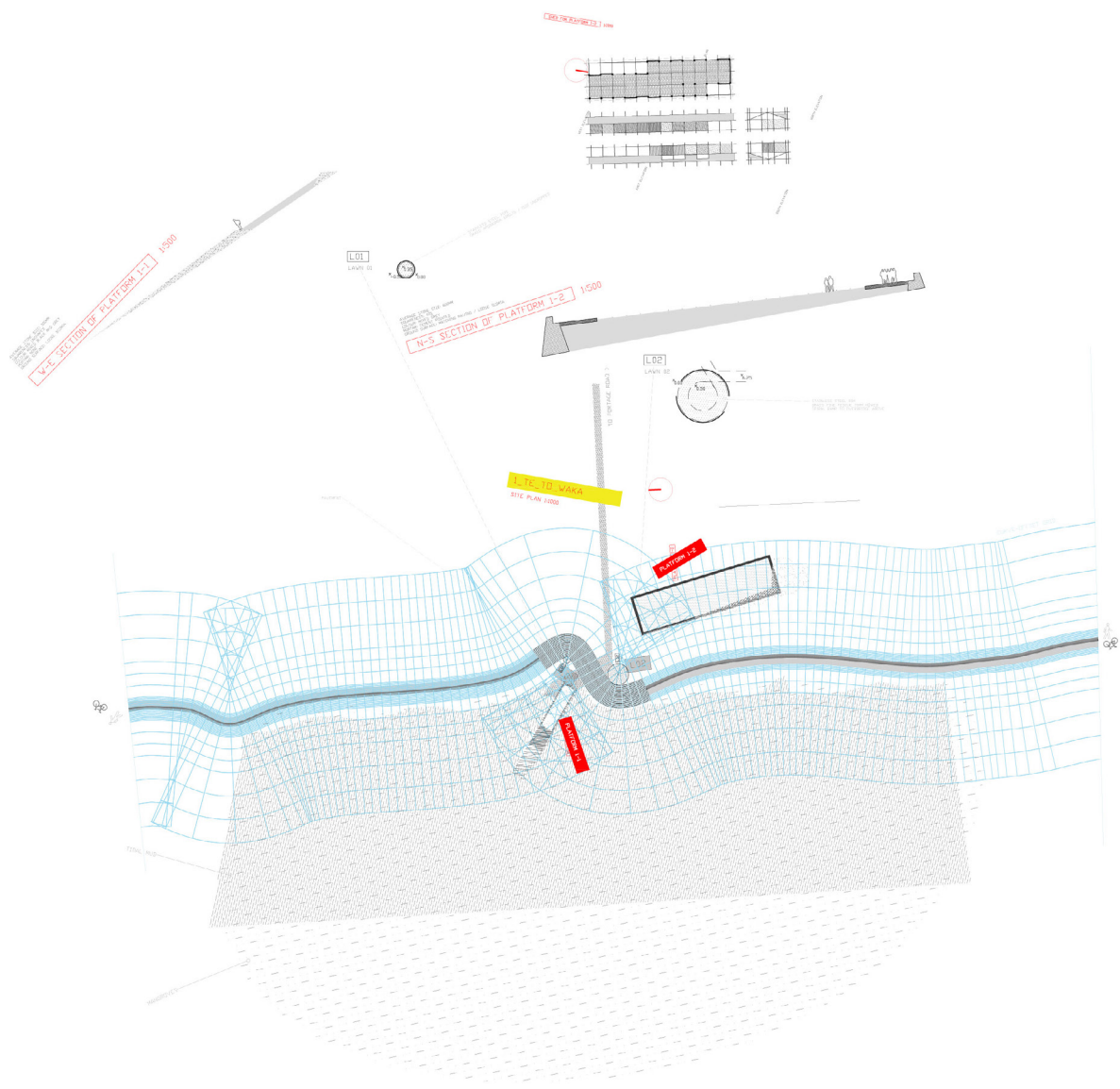
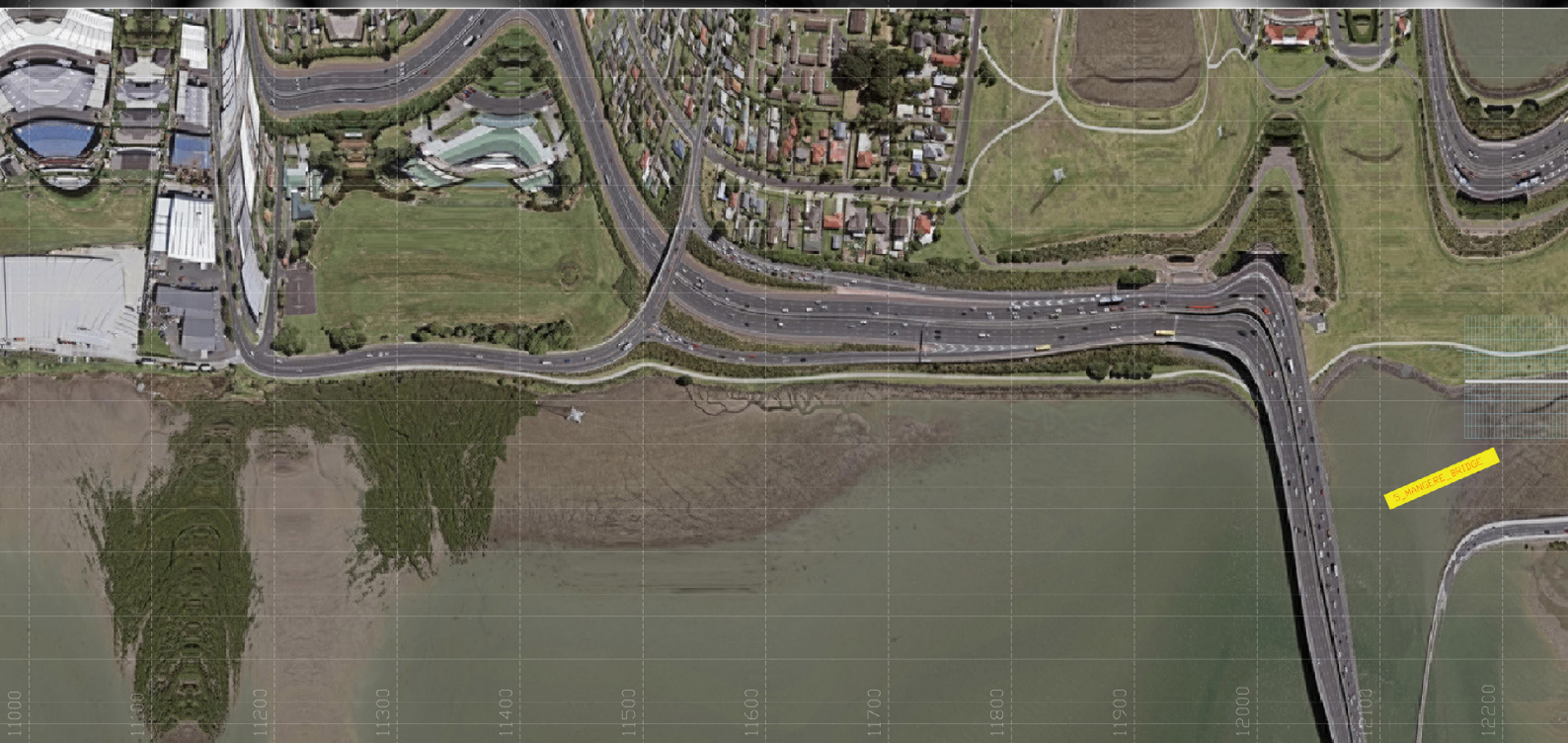
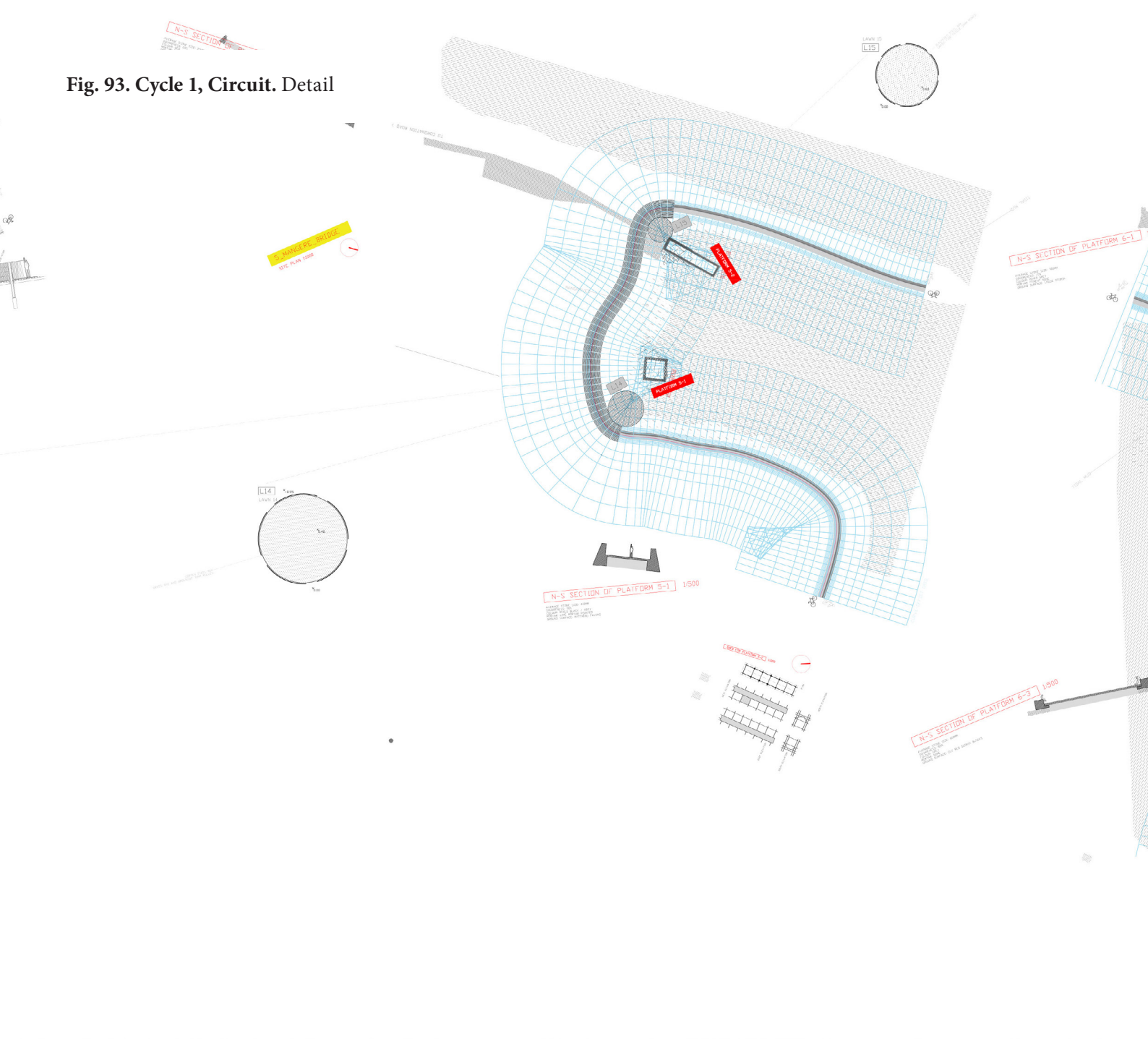


Fig. 93. Cycle 1, Circuit. Detail



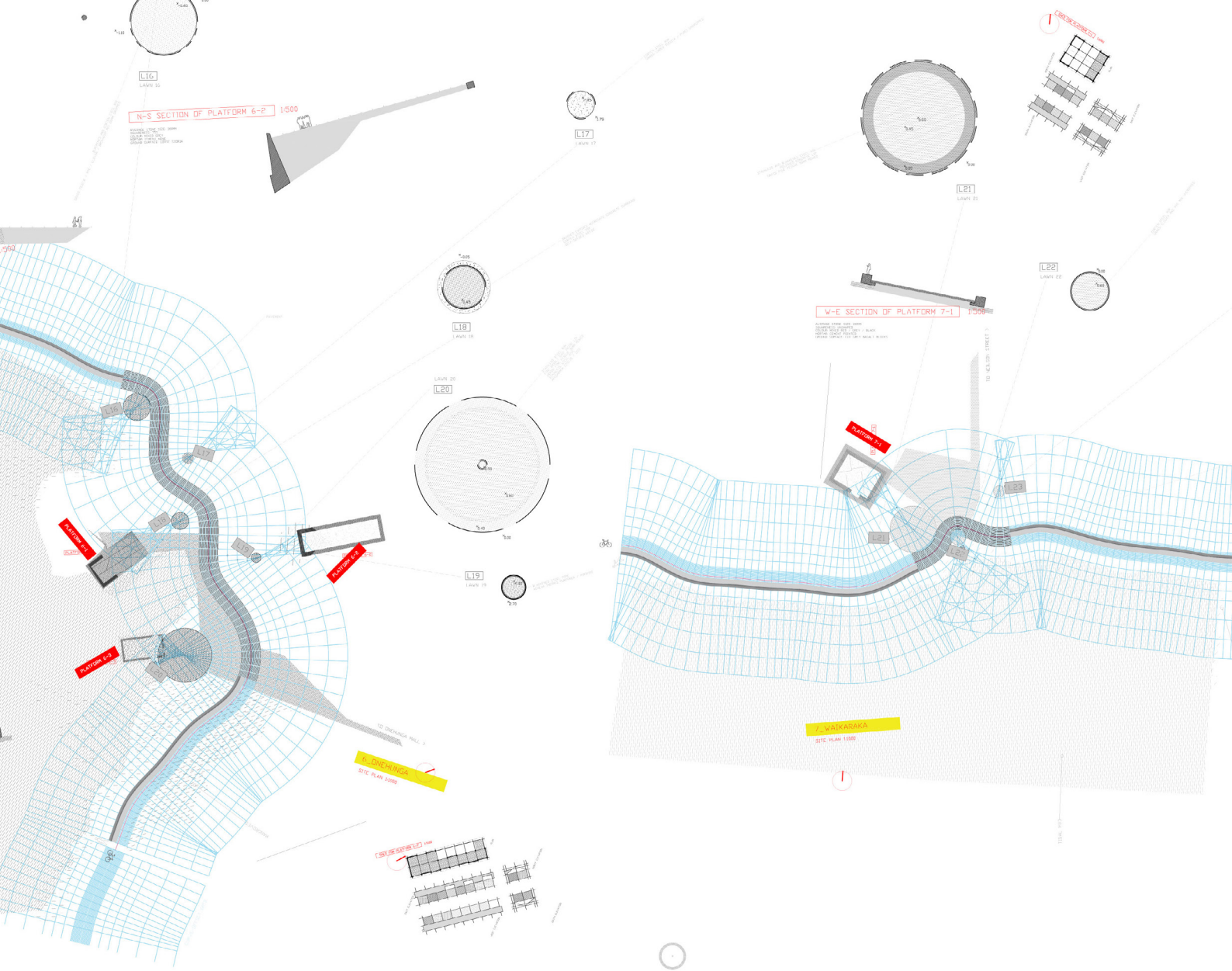
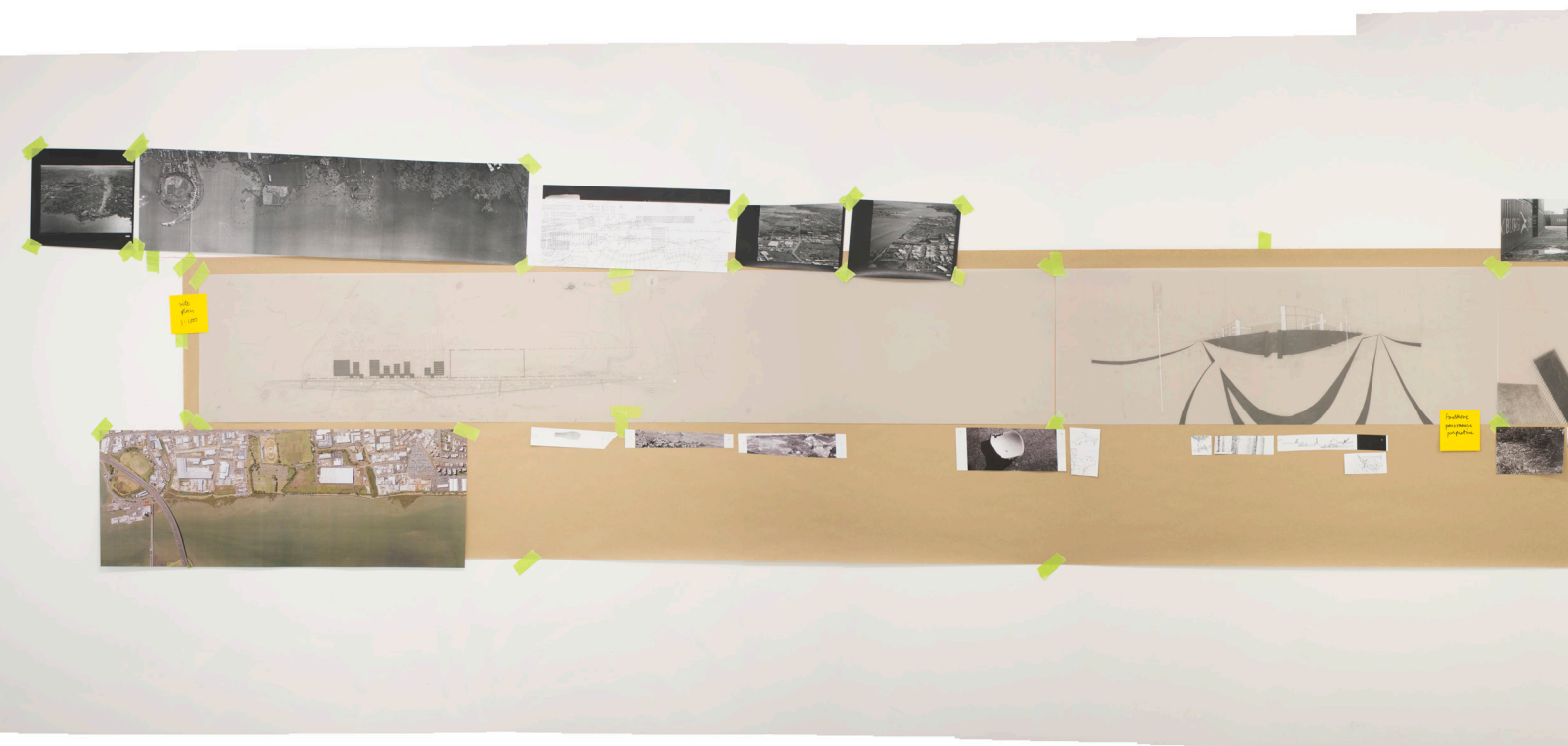


Fig. 94. Cycle 2, Deposit. Layout of southeast wall (above). Layout of southwest wall (below).



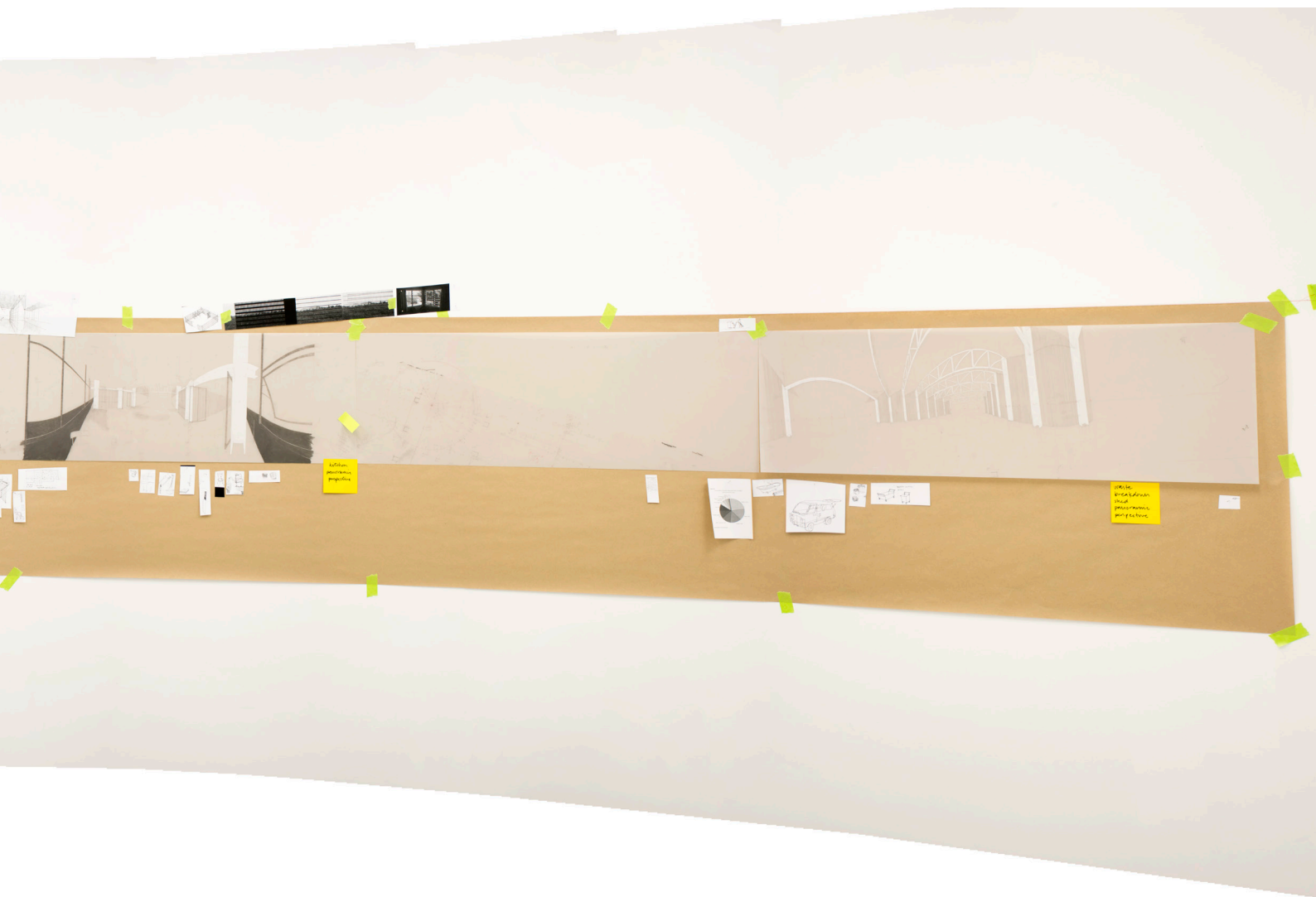
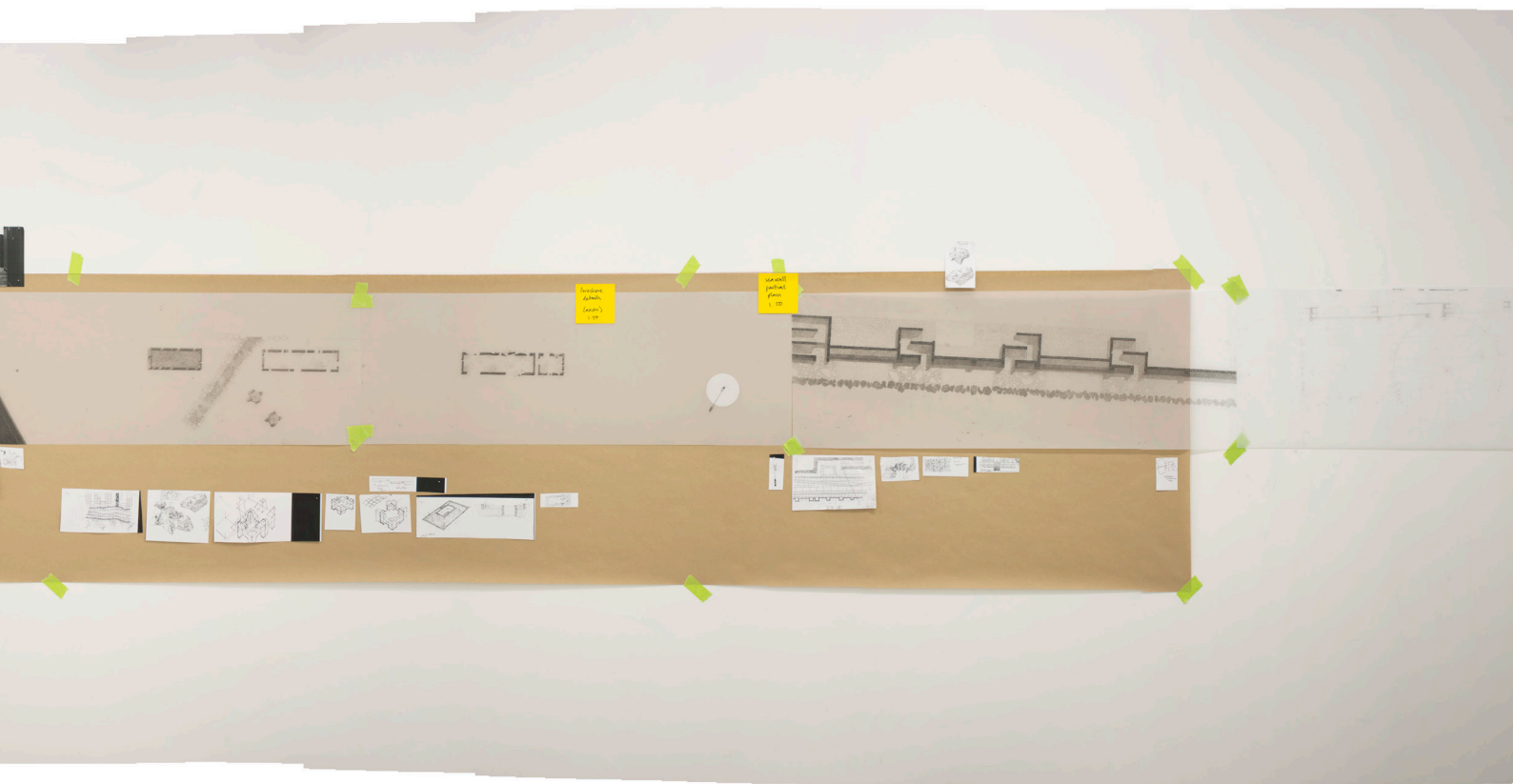


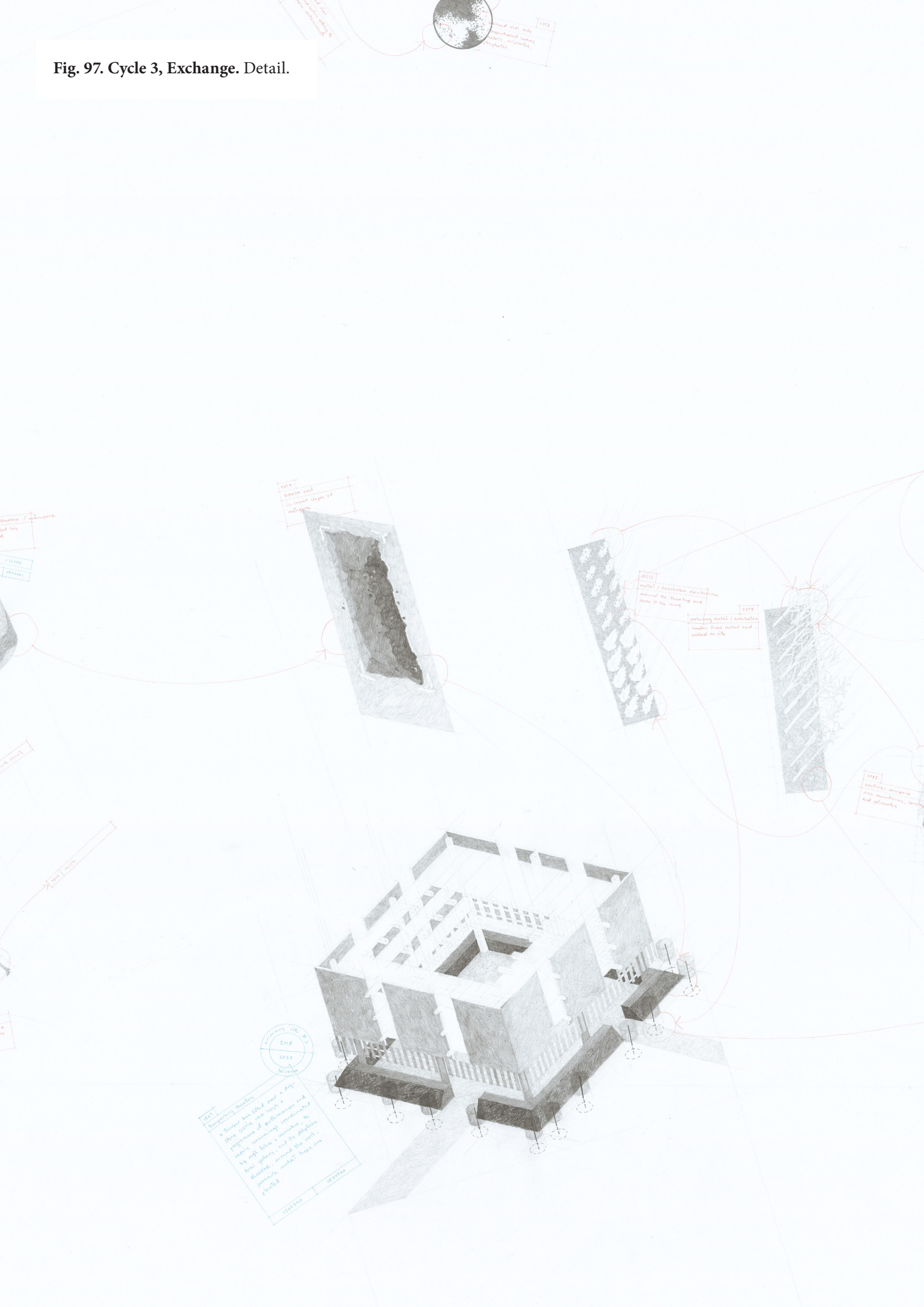
Fig. 95. Cycle 2, Deposit. Objects.



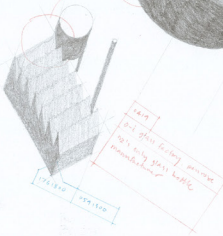
Fig. 96. Cycle 2, Deposit. Objects.



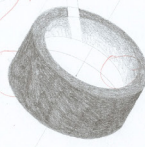
Fig. 97. Cycle 3, Exchange. Detail.



1919
near glass bottles
from the recycling
center

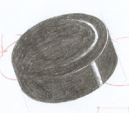


1920
the glass bottles are
recycled into
new bottles



1921
recycled glass
mixed with dirt ash
in a cement mixture

1922
recycled waste
chemical waste
incubated in synthetic
straw

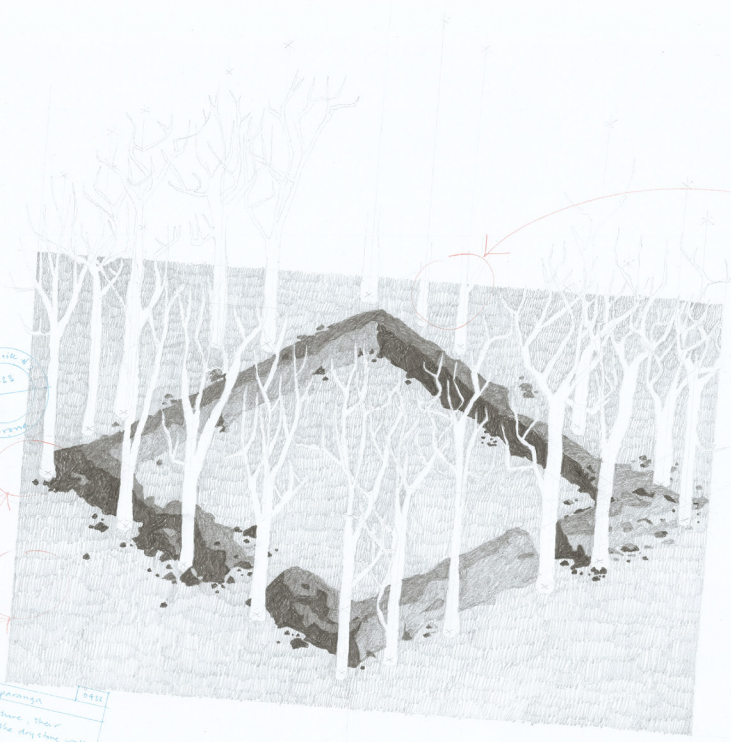


1923
transport

1924
diversified plantations
pine, oak, spruce,
beech, poplar



1925
primary forest
cutting

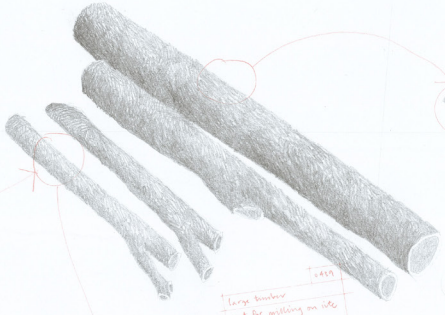


1926
clearing / planning
As metal machine, they
can collapse the dry pine wall
the plantation gets cleared
and the clearing is used for
public work, including
annual harvesting festival

1927
natural forest

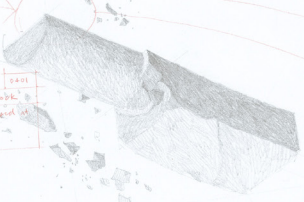


1928
small timber
prepared for charcoal
burning



1929
Large timber
cut for milling on site

1930
Soviet market timber is
shipped and stored in
market yard



1931
transport to market



1932
market yard
1933
market yard
1934
market yard

APPENDIX 2

Python code for generating curve-offset data

```

# UV Reprojector
#
# Works in conjunction with qgis_reprojector.py to reproject a georeferenced
# raster image from lat-long coordinates to parameter-offset coordinates.
#

import rhinoscriptsyntax as rs
import json
import time

# function to calculate the absolute coordinates of the point
# perpendicular to curve at uParam, at y distance
def perpOffset(curve, uParam, vOffset, vOffsetMin):
    curvePoint = rs.EvaluateCurve(curve, uParam)
    tangentVector = rs.CurveTangent(curve, uParam)
    zVector = (0,0,1)
    normalVector = rs.VectorCrossProduct(tangentVector, zVector)
    vOffsetPoint = normalVector * (vOffset - vOffsetMin)
    lat = curvePoint[0] - vOffsetPoint[0]
    lon = curvePoint[1] - vOffsetPoint[1]
    return (lat, lon)

# set up initial variables
# drastically slows execution, prints info about each point for debugging
verbose = False
# create (a LOT of) point objects in Rhino
pointDump = False
# initialise data file
f = open("/path/to/reprojection_data_2.txt", 'w'); f.close()
curve = rs.GetObject("Select a curve to sample", 4, True, True)
destinationScale = 5000 # 1:10000
destinationResolution = 2 # pixels per mm. 12 is approx 300dpi.
vOffsetMax = 500
vOffsetMin = 200
vOffsetRange = vOffsetMax + vOffsetMin

# calculate destination image size
curveDomain = rs.CurveDomain(curve)
curveLength = rs.CurveLength(curve)
uPixels = int((curveLength / destinationScale) * 1000 * destinationResolution)
vPixels = int((vOffsetRange / destinationScale) * 1000 * destinationResolution)
uStep = (curveDomain[1]-curveDomain[0])/uPixels
vStep = (vOffsetRange / vPixels)
uParam = []
vOffset = []
lat = []
lon = []
distortion_baseline = curveLength / uPixels

# iterate through pixels to build data
start_time = time.clock()
counter = 0
for u in range(uPixels):

```

```

for v in range(vPixels):
    counter = counter + 1
    uParam.append(u * uStep)
    vOffset.append(v * vStep)
    (x, y) = perpOffset(curve, (u * uStep), (v * vStep), vOffsetMin)
    lat.append(x)
    lon.append(y)
    if pointDump == True:
        if counter % 20 == 0:
            rs.AddPoint(x,y,0)
    if verbose == True:
        if counter % 8 == 0:
            print "\n", counter, " of ", (uPixels * vPixels)
            print "  uParam ", uParam[u],
            print "\n  vOffset ", vOffset[v]
            print "  lat ", lat[u]
            print "  long ", lon[v]
            print "  lat(prev) ", lat[u-1]
            print "  long(prev) ", lon[v-1]
            print "  distortion baseline ", distortion_baseline

# write data to reprojection.data.txt file
f = open("/path/to/reprojection_data_2.txt", 'a')
json.dump((uPixels, vPixels, lat, lon, uStep, distortion_baseline), f)
f.close()

# print summary
print "-----"
print "Length of curve is: ", curveLength, "m"
print "Curve domain is: ", curveDomain[1]
print "Maximum offset is: ", vOffsetMax
print "Pixel dimensions of destination image: ", uPixels, ",", vPixels
print "Total number of pixels: ", (uPixels * vPixels)
# print "Total number of value sets saved in data file: ", (len(uParam) + len(vOffset))
# print "uStep ", uStep, ", vStep ", vStep
# print "uParam contains ", (len(uParam)), " values"
# print "vOffset contains ", (len(vOffset)), " values"
print "Completed in %s seconds" % int((time.clock() - start_time))
# print "\n\nLat: ", lat[0], lat[1], lat[3], lat[4]
# print "\n\nLong: ", long[0], long[1], long[3], long[4]

```

APPENDIX 3

Python code for generating map from curve-offset data

```

# UV Reprojector
#
# Works in conjunction with rhino_reprojector.py to reproject a georeferenced
# raster image from lat-lon coordinates to parameter-offset coordinates.
#

import numpy
import PIL
from osgeo import gdal
from gdalconst import *
import json
import time

# query selected raster to fill image array
def reprojectUV(layer, uPixels, vPixels, uParam, vOffset, lat, lon, verbose):
    # print summary
    print "-----"
    print "Destination image size: %d, %d" % (uPixels, vPixels)
    print "Total pixels %d" % (uPixels * vPixels)
    print "-----"
    print "Building image array...",
    # initialise loop
    counter = -1
    rowCounter = -1
    rasterFile = open("path/to/raster_data.txt", 'a')
    rowStop = 40
    for x in range(uPixels):
        for y in range(vPixels):
            if (counter/vPixels) == rowStop:
                print "STOP\n(Loop reached preset max after %d pixels.)" % counter
                print "-----"
                rasterFile.close()
                rasterShape = (rowStop,vPixels,3)
                return(rasterShape)
            counter = counter + 1
            sourcepixel = layer.dataProvider().identify(QgsPoint(lat[counter],
                lon[counter]), 1) #QgsRaster.IdentifyFormatValue)
            pixelRGB = sourcepixel.results().values()
            pixel = string.join((str(pixelRGB[0]) + ',' + str(pixelRGB[1]) + ',' +
str(pixelRGB[2]) + '\n'), '')
            if verbose == True:
                if counter % 1 == 0:
                    print "\n%d of %d" % (counter, (uPixels * vPixels))
                    print " - Coord: %d, %d:" % (x, y)
                    print " - Lat %d, Lon %d" % (lat[x], lon[y])
                    print " - R %d G %d B %d" %
                    (pixelRGB[0],pixelRGB[1],pixelRGB[2])
                    # print " - lon[%d] is %d" % (x, lon[x])
                    # print " - lat[%d] is %d" % (y, lat[y])
                    # print lat[x], lon[y]
                    # print pixelRGB
                    # print pixel
                rasterFile.write(pixel)
            if counter == (uPixels * vPixels):

```

```

    print "done."
    print "-----"
    rasterFile.close()
    rasterShape = (rowStop,vPixels,3)
    return(rasterShape)

# write array to image file
def arrayToImage(rasterShape):
    print "Writing file...",
    rasterFile = open("/path/to/raster_data.txt", 'r')
    raster = numpy.genfromtxt(rasterFile, dtype='uint8',
        delimiter=',').reshape(rasterShape)
    rasterFile.close()
    im = PIL.Image.fromarray(raster, "RGB")
    im.save("/path/to/output.tif")
    print "done."
    print "-----"
    return

# initialise
verbose = False # True makes it super slow
start_time = time.clock()
rasterFile = open("/path/to/raster_data.txt", 'w'); rasterFile.close()
# get selected layer
layer = iface.activeLayer()
# import data file generated by rhino_reprojector.py
reprojectionDataFile = open("path/to/reprojection_data.txt", 'r')
(uPixels, vPixels, uParam, vOffset, lat, lon, distortion) = json.load(reprojection-
DataFile)
reprojectionDataFile.close()
# call reprojectUV function
(rasterShape) = reprojectUV(layer, uPixels, vPixels, uParam, vOffset, lat, lon, ver-
bose)
# print "rasterShape is ", rasterShape
# convert array saved in raster_data.txt to image
arrayToImage(rasterShape)
# done
print "(Completed in %s seconds)" % int(time.clock() - start_time)

```


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