Research Report
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Transitional Territories 2019-2020

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Introduction

A Manifesto

In Greek mythology, the old Gods (Titans) ruled the world. They fought a battle with the new generation of titans over who could the reign of the world. The battle was won by the new titans, and they sent the old titans to the Tartarus in the underworld. This Titanomachy (War of the Titans) from Greek mythology stands central for many of the current issues we are facing today. Capitalism and globalization have been the feedstock for a Titanomachy on economic and political level, with powerful people and corporations as Titans. The vastly complex systems that we work with today, has as a result that consequences of global power shifts penetrate these systems to the smallest branches, where the people that are using them receive the impact. This has consequences on a socio-economic level, on an environmental level, but also on a sociocultural level. Our modern Titans likely won't be the ones that suffer most from these consequences and they approach these issues like a business case with a cost-benefit analysis.

One of the places where this is most apparent is in port-city interfaces. Such ports historically have strong relations with their cities, on an employment, financial, environmental and cultural identity level. But these ports changed in modern times and they are now the realm of the Titans instead of the local people/ enterprises. These ports have evolved in hubs for pollution, commodity trade and process efficiency, while ignoring the genius loci more and more. Their identity ties with the cities are lost, because they moved out of inner cities, automated, are gated and owned by private non-local corporations. This fostered loss of trust and loyalty between ports and cities. In decision making around developments, biblical vices like greed and gluttony are winning from virtues such as wisdom.

Many of these ports are in environmental or economic danger zones. With the current virtues and vices of our corporations they are bound to leave when it's not viable enough for them anymore. What they leave behind are the remains of a sunken ship, that is hard to get rid of. Among the first types of infrastructures where this will happen are fossil energy structures. For many ports in the world the fossil energy industry is one of the cores of their ports. What will happen to them when they leave? Their 'ships' could be repaired, but their raison d'être can also be reconsidered with our future in mind. The currently starting Titanomachy of the future, won't be between human titans, but will be between the world and its inhabitants, partly caused by the titans of the past. We can try to engineer our way out of these problems like we have done until now, but it's better to restore the natural balance. To achieve this, we must pursue a change in mindset, so a Titanomachy won't be necessary. This means assimilating the virtues of nature and each other, to restore harmony and equally distribute our commons instead of commodities.

A Titan (Atlas) searching for balance between human and natural systems. Source: Author

Research Questions

Research questions

Territorial level

How can fossil energy infrastructure be repurposed to facilitate a healthy port-city interface in transition?

Architectural level

In what way can we gradually adapt obsolescent refinery infrastructure to reconnect them to urban ecological and social systems?

Sub-questions:

In what way can we achieve this while transitioning to a less growth-oriented economy?

for the purpose of creating self-sustaining, resource-conscious communities?

How can obsolescent refinery port-sites be reintegrated in the original regional landscape?

How can obsolescent refinery port-sites act as transitional zone between closed industrial systems and social city systems?

How can obsolescent refinery port-sites connect the metabolism of the port to the metabolism of the city, from a human perspective?

Wicked problems

Origins of wicked problem theory

In 1962 Thomas Kuhn introduces a theory that challenges the objectivity of research paradigms and states that scientists work from models that are based on community paradigms. Kuhn (1962) describes community paradigms as a set of recurrent and quasi-standard illustrations of various theories in their conceptual, observational, and instrumental applications. He emphasizes that scientists often do not know the underlying set of rules and assumptions of a paradigm and that scientists can agree on the existence of a paradigm without agreeing on the set of rules (Kuhn, 1962).

Therefore, paradigms can't be fully rational and unequivocal. Later during that decade, Herbert Simon sets apart the design profession from science in The Sciences of the Artificial, by stating that design is always aimed at creating artefacts that are adapted to human needs, while natural sciences focus on natural laws (Simon, 1996). In that era and context science was not so much linked to societal systems that, which reduced his arguing about design research to a formula (Koskinen, Zimmerman, Binder, Redström & Wensveen, 2011).

In the 1970s Rittel & Webber first disconnected the planning profession from the rest of science by stating that a standard scientific problem definition does not account for planners, due to the modern, complex open societal systems in which they operate (Rittel & Webber, 1973). In their paper, they define 10 properties of wicked problems that planners should take into account. This was an important change in design thinking. In the 1990s Buchanan generalizes wicked problems to all design tasks, contrary to solely planning. Buchanan writes that designers must create something that does not exist yet, in the context of wicked problems, where the development path of the wicked problem is uncertain, which create a difficulty when designing (Buchanan, 1992). Buchanan argues there cannot be a rigid boundary between different design disciplines or between different sciences when it comes to dealing with wicked problems. He concludes that we must recognize and work with the uncertainties of design, since design has no special subject matter like other sciences and can be applied in any area (Buchanan, 1992). Koskinen et al. (2011) add to this that modern, constructive designers do not 'see design as an exercise in rational problem solving', but that design researchers use their imagination to create and build new realities to test their theory, which is especially relevant when working with wicked problems.

Sustainability is a wicked problem

In more recent times, wicked planning and architectural problems are linked to sustainability more often, because sustainability arguably is a wicked problem. Such problems often balance on the edge of natural and social systems (Dryzek, 1997). Wicked problems are often planning and policy issues that directly influence the design profession. Van Bueren, Klijn & Koppenjan (2003) linked wicked problems to networks and policy games. They presented three types of uncertainties around wicked policy problems, i.e. cognitive, strategic and Institutional uncertainty. Cognitive uncertainty is related to the amount of causal relations in wicked problems. The strategic aspects relates to the huge amount of actors that are involved in such problems and the institutional aspect to the varying places, networks and policy arenas where decisions are made (van Bueren et al., 2003). They demonstrated this with an analytical framework for networks to analyse wicked environmental issues and show interdependencies between actors in policymaking around the zinc debate in the Netherlands.

The same sort of issues can be identified with recently popular wicked concepts such as circularity. In many cases the wickedness of circularity is used as a way to legitimize or push agendas of stakeholders in urban area development, from a commercial, political, or societal point of view (van den Berghe, Vos, 2019). They demonstrated this with 2 case studies around the redevelopment of former port areas within port-city interfaces. The amgibuity of operationalizations of the concept and the execution were used in the institutional game between all actors in the urban redevelopments. Their different rules of the game, discourses and resources/powers were mapped to expose the interactions between stakeholders in the redevelopment process.

Fundamentals of capitalism

Definition of capitalism

Capitalism theory was first outlined by Adam Smith in his 1776 book the Wealth of Nations, describing the invisible hand that coordinates distribution of capital through pricing mechanisms in a free market (Scott, 2011). The Merriam-Webster dictionary (n.d.) defines capitalism as *"an economic system characterized by private or corporate ownership of capital goods, by investments that are determined by private decision, and by prices, production, and the distribution of goods that are determined mainly by competition in a free market".* Historically, capitalism has had different conceptions and has been evolving (Barnes, 2006, Scott, 2011). Scott (2011) describes capitalism as "an indirect system of governance for economic relationships", where governance refers to laws and rules for the economic actors in the capital system. Barnes (2006) describes 2 stages of capitalism in his book, where the first version was based on shortages and the second on surplus of goods and services. Barnes outlines how capitalism got out of hand because of this surplus. He argues that from the 1950s citizens of the USA didn't experience a scarcity of basic needs anymore that corporations started producing things that people want but don't need so to maximize their companies' profit for their shareholders. Scott (2011) also outlines the political side of capitalism. He demonstrates how capitalism and democracy are strongly interdependent, because actors of both are mutually dependent on and part of each other's systems. Both Scott and Barnes point out that corporations through their position and assets within the system have the power to influence politics or individuals.

The commons

Our earth has resources, creatures and (cultural) artefacts that are meant to be for everyone. These are what we call the commons. More contemporary research around environmental issues, intellectual property or politics is related to the commons (van Laerhoven & Ostrom 2007). Commons can be many entities, both tangible and intangible, and new ones are defined every day. Barnes (2006) described commones as assets that are a gift and are shared. In Figure 1 he shows examples of commons divided in three categories. He argues that commons feed the creation of capital and that we should preserve the commons to make them available for future generations, because they are gifts for everyone. The commons became popular in relation to capitalism through an article by Garret Hardin, where he described the so-called tragedy of the commons. Hardin (1968) sketches the image of a common field where the herdsman of cattle grazing seek to maximize their gain by increasing the amount of cattle on the field until it is over capacity and depletes the field, ruining all herdsman due to their own self-interest. He states that all commons are doomed to follow this path when there are no regulations for how we use our common goods.

The tragedy of the commons also relates to how we as a world deal with global warming and inequality. It links to capitalism because capitalism aims to create a situation with as little regulations as possible through privatizations. Add to this the current globalization and we can deplete resources to such an extent and at such speed that we can destroy the planet. We are using capitalism to create a surplus of goods that we don't need (commodification),

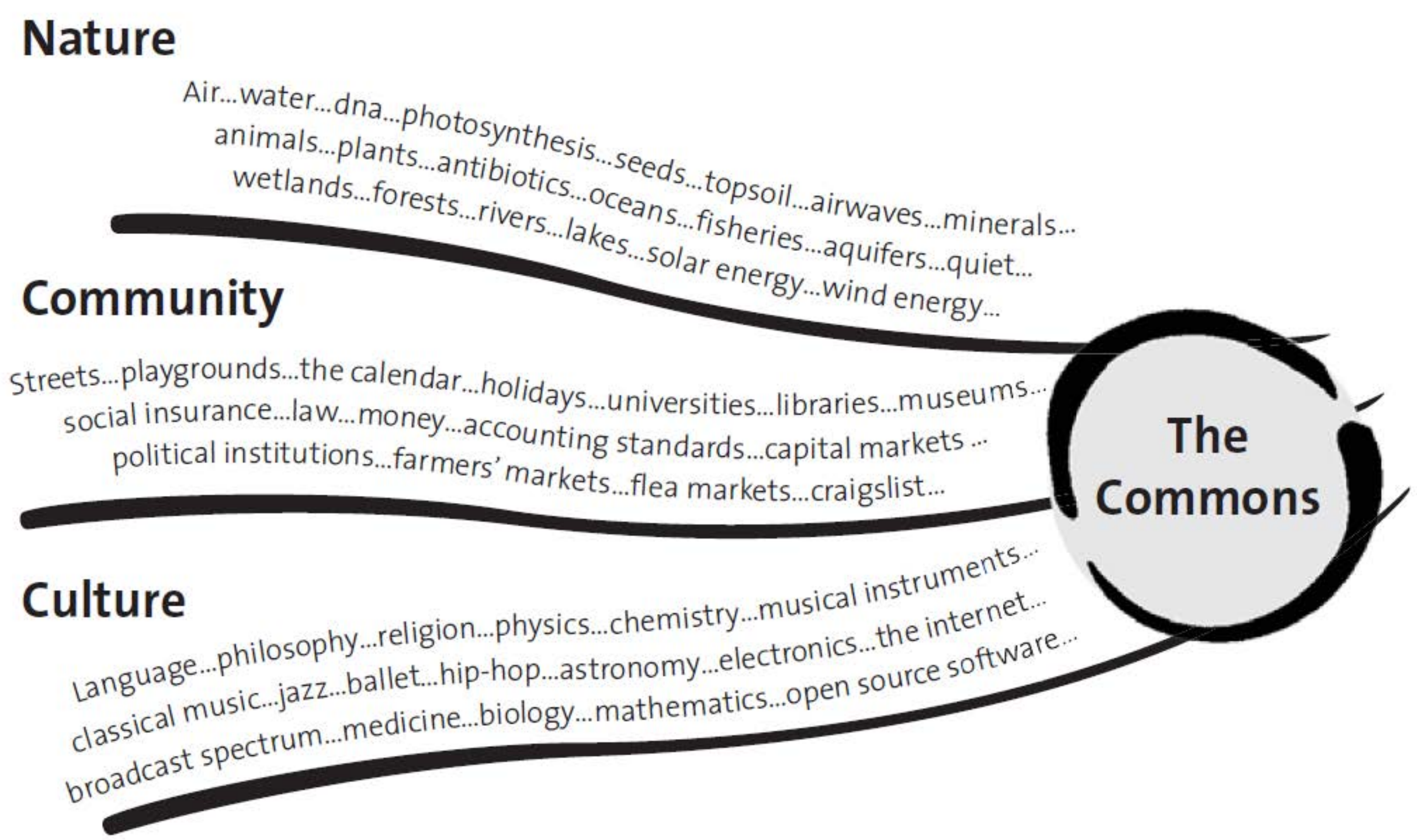


Figure 1: The river of Commons (Barnes, 2006)

depleting our common resources for it, for the sole purpose of profit-making.

Globalization and capitalism

Many of the underlying issues with capitalism lie with how our system is structured, especially with big corporations. Big stock-listed corporations have their obligation to return as much profits to their shareholders as possible. For this reason, big corporations will almost always choose the most cost-effective way of achieving this goal, over consciousness (Barnes, 2006). Our urban life and infrastructure is completely based on improving the profits (Brenner, Marcuse & Mayer, 2009). Ports play a major role in this system. The root of globalization is companies looking for cutting costs by shifting labour countries where labour is cheaper to cut costs (Barnes, 2006). Because of the size and assets and locations of these corporations have, their power is far-fetched, beyond national politics (Barnes, 20016, Brenner et al., 2009, Scott, 2011).

Industrial Ecology & Urban Metabolism

According to Gleye (2015), planning has two different arms, i.e. physical planning – relating to urban design and placemaking – and policy planning, not relating to physical aspects of city. We can distinguish between space as a location for the former and organization of space for latter. In the 1960s a shift occurred towards more policy-oriented planning and the notion that the physical city could take care of its own design became prevailing among planners, resulting on a focus on socio-economic aspects rather than physical space. However, since a few decades, in many cities design-oriented planning is prevailing once again (Van den Berghe & Vos, 2019). The growing influence of neo-liberal policies is a contributing factor to this, as it has led to a more economic-oriented way of policymaking (Allmendinger, 2009), with a more entrepreneurial style of planning from governments (Gilliard, Wenner, Lamker, Van den Berghe, Willems, 2017). This formed the basis for a focus on design-oriented planning to enhance the value of land, by improving a location, while this same economic model caused disappearing importance of the intangible planning aspects. These local economic planning decisions have led to entanglement of urban planning with large global systems.

It is now important to introduce the concept of urban metabolism in relation to this planning theory. The concept of urban metabolism is first described by Wolman (1965, p. 179). He defines the metabolic requirements of a city as “all the materials and commodities needed to sustain the city’s inhabitants at home, at work and at play.” This also includes the construction materials needed to build and rebuild the city and the removal of wastes and residues of daily life. Wolman also writes: ”As man has come to appreciate that the earth is a closed ecological system, casual methods that once appeared satisfactory for the disposal of wastes no longer seems acceptable. He has the daily evidence of his eyes and nose to tell him that his planet cannot assimilate without limit the untreated wastes of his civilizations.” This reflects the contemporary ideas that are associated with concepts such as circular economy. Integration of urban metabolism touches both the design and policy side of planning. Duvigneaud and Denayer-De Smet (Cited in Kennedy, Cuddihy & Engel-Yan, 2007) conducted one of the first urban metabolism analyses on a city, i.e. Brussels (Figure 2) To link urban metabolism to sustainability I refer to the three ecologies of urban metabolism as presented by Wachsmuth (2012): In the first ecology during the 20th century (Chicago School) the city was treated as an ecosystem in analogy to external ecosystems. They referred to urban metabolism as the process of social change inside a city. The second ecology is called the era of industrial ecology. This is where the definition from Wolman stands out. It adds the external nature as raw input source and as destination for social wastes to the social ideas from the Chicago school. The third ecology entails the Urban Political Ecology era where the city is seen as product of internal and external (social and natural) flows.

There is a relationship between the growth of a city and the city’s metabolism, and the future vitality of cities is dependent on the connection to it’s hinterland (Kennedy et al., 2007). Wachsmuth’s (2012) three industrial ecologies already take more than just the city into account. Fischer-Kowalski & Hüttler (1998) researched the society’s metabolism by projecting material flows on a national level (Figure 3) and linking this to contemporary sustainability issues. In a study of the French port-city interface of Saint Nazaire the material and resource flows were linked to social aspects, by identifying key actors that represent a flow (Bahers, Tanguy & Pincetl, 2019). They conclude that metabolic relationships between a city and hinterland cannot be separated from the power and economic relationships between actors representing a flow, affecting the spatial relations between cities and their hinterlands.

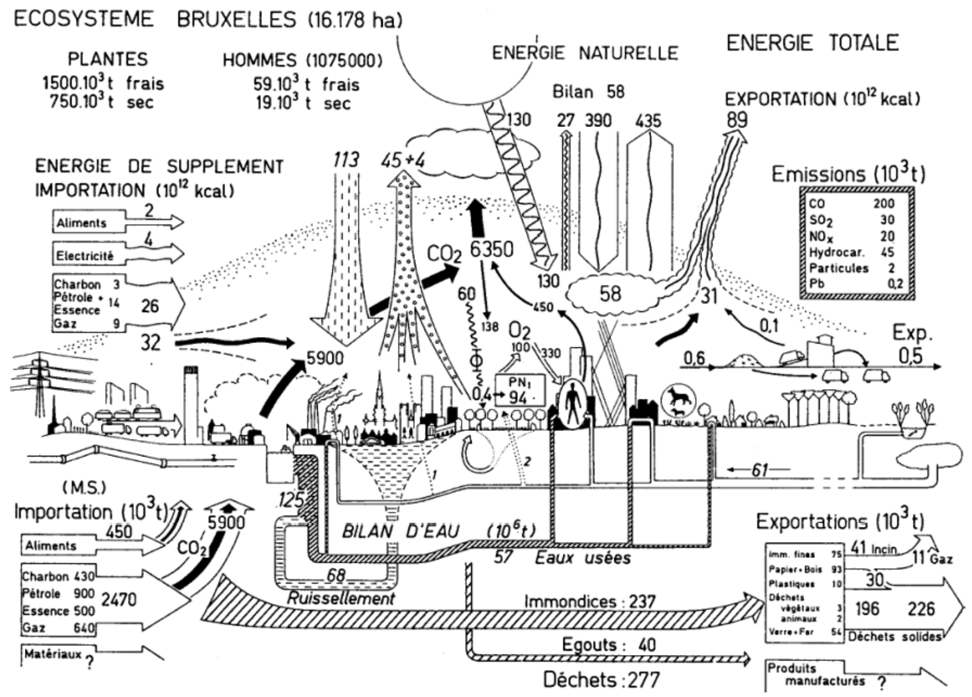


Figure 2: The Urban Metabolism of Brussels, 1977 (Duvigneaud & Denayer-De Smet in Kennedy et al, 2007)

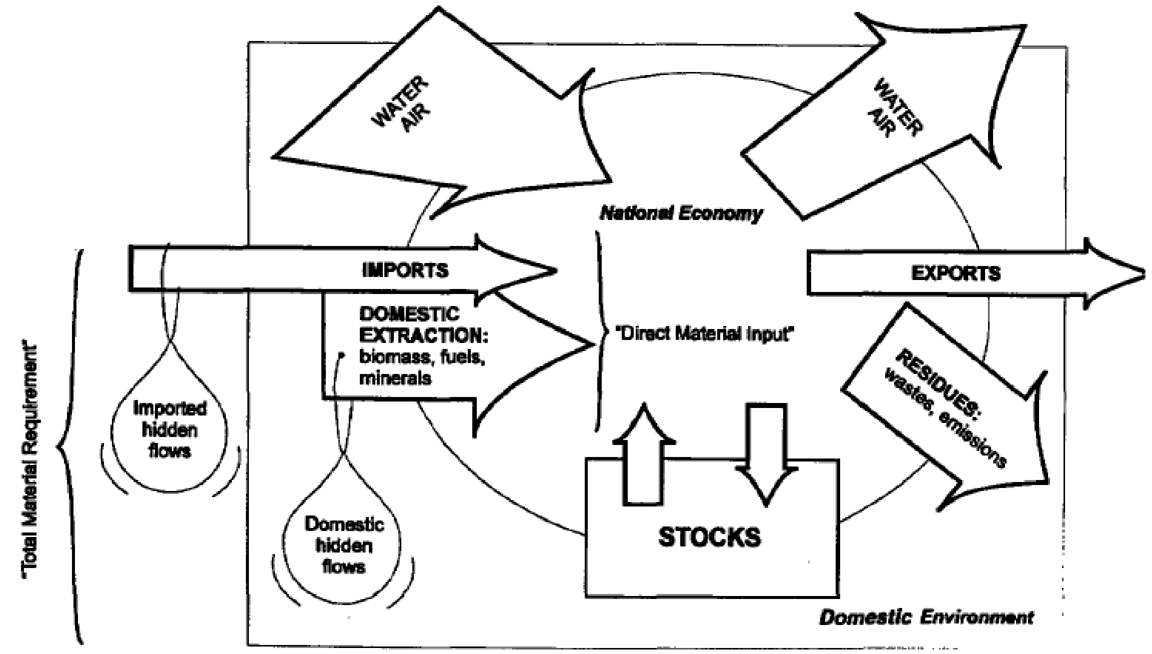


Figure 3: Metabolic flows on a national level (Fischer-Kowalski & Hüttler, 1998)

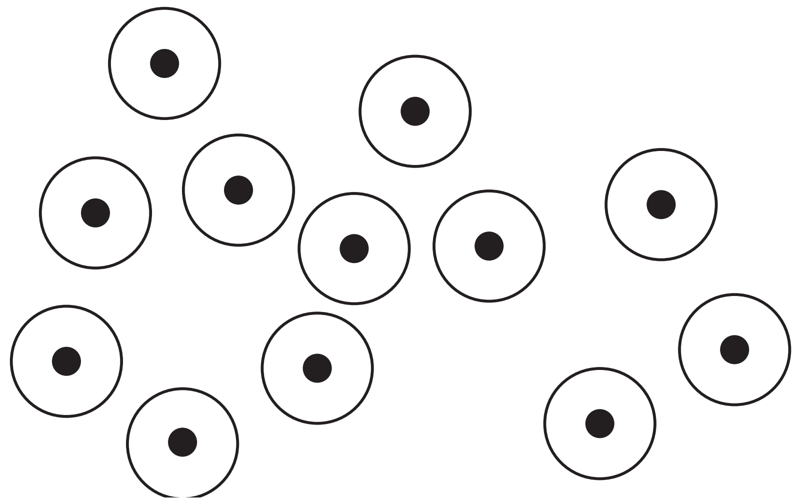
Changing relations between ports and cities

To understand how port-city interfaces developed into the systems as we know them today, a short introduction will follow about the emergence of cities. It is not by chance that most major cities are based next to rivers or oceans. Gordon Childe (1950) wrote a famous paper on the origins of cities. He explained the growth of cities in a few steps that are summarized here with the schemes on the right.

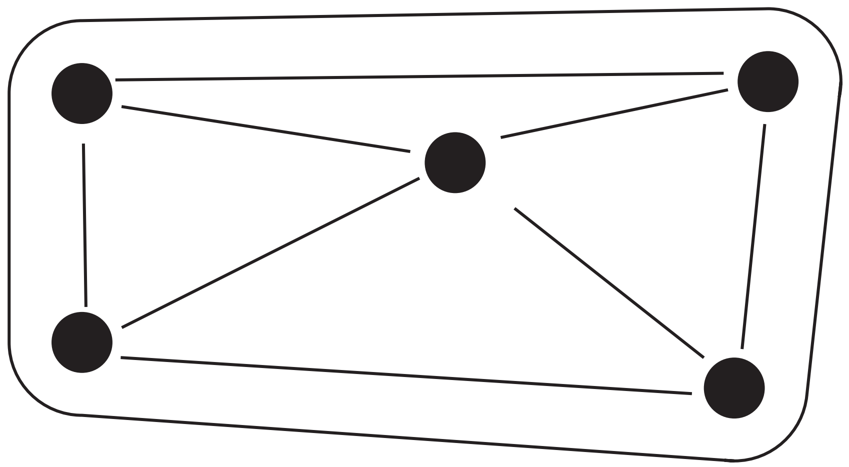
The first moves towards settlements start in the Neolithic period, before that the way humas lived could not be classified as civilized. As is well known, human experienced a shift from mainly hunter-gathering towards an agricultural food production. The hunter-gatherers lived in small groups moving around, except for some successful fishing villages, where there could be up to a few hundred people, but these people would leave the villages in winter as well.

Childe explains that when Neolithic farmers first started cultivating land, settlements still couldn't grow, due to technical limitations. The farming lands had to be in walking distance of the settlements. When the settlement grew bigger than could be provided for by the surrounding cultivated land, the surplus inhabitants moved to a new settlement. However, the technique of cultivation did allow farmers to produce more food than for their own family alone, which Childe calls the 'social surplus'. At this time there was no such thing as specialization yet for settled people. Some craftsmen that did specialize, would be travelling around from place to place, and they would live off the social surplus of the settlement they were visiting. This means they could only stay for short periods due to the limited surplus at that time.

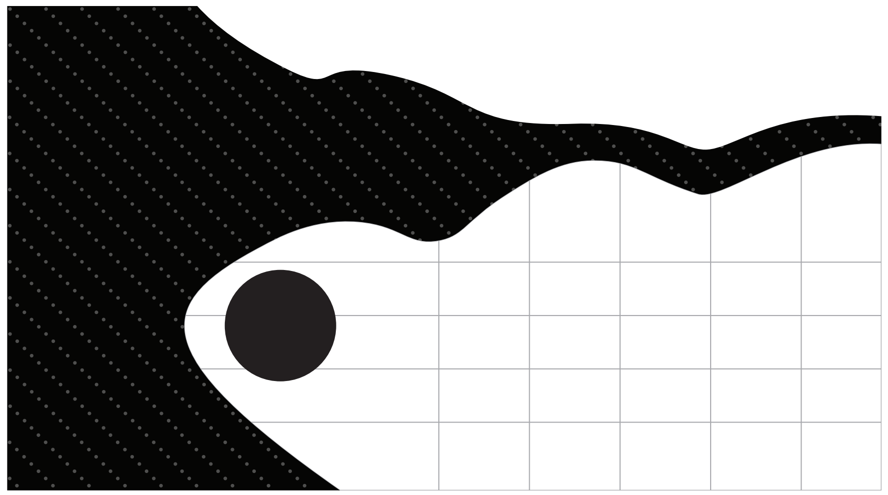
Some 5000 years ago this social surplus production started to grow to such a stage that the settlements could supports some specialized residents without having them helping with food production. This was possible due to techniques like land irrigiation, stockbreeding, large scale fishing and invention of wheeled vehicles. However, the need for irrigation did limit these settlements to places with access to rivers. The craftsmen would get a place in the social structure of the city and it could continue to grow.



Small settlements due to limited movement, food gathering in walkable area around settlement



Specialist craftman going from town to town to live from their social surplus returning services in advance, allowing those settlements to grow.



Large scale irrigation cultivation, stock breeding and fishing from rivers allowed for efficiency and social surplus, allowing cities to grow and giving craftsmen rescue from their dangerous nomadic lifes.

Changing relations between ports and cities

Childe summarizes what defines a city in 10 points which were summarized in 5 main themes by Harold Carter (1977):

- Size
- Population Structure
- Public Capital
- Records and the exact sciences
- Trade networks

This theory about the emergence of cities is also called the Hydraulic theory. Carter (1977) discusses three more theories about how cities came into being:

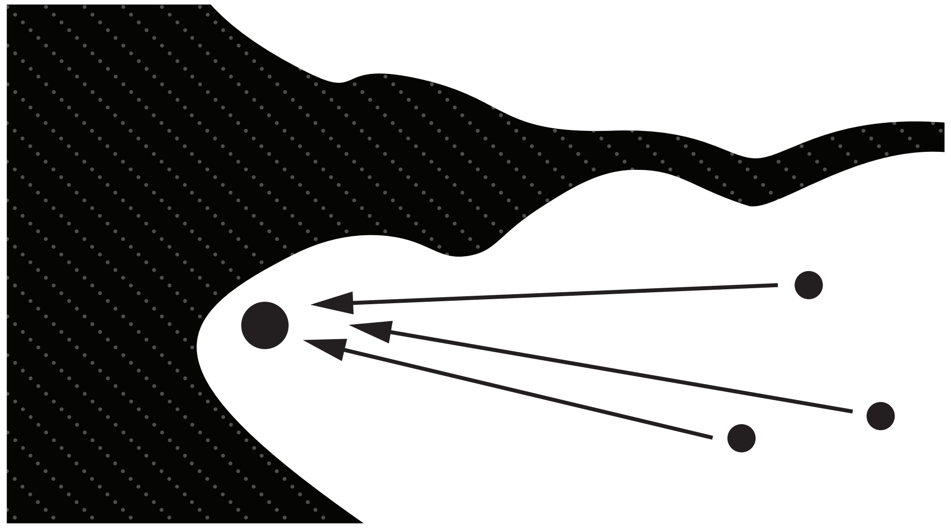
- Economic theories or the growth of markets
- Military theories or growth about defensive strong points
- Religious theories or growth about shrine

Because of the scope of this project, I will not go into detail about the last two ones. Arguably economic theories or growth of markets could be the reason for the emergence of some cities, especially ports, because these cities are built on trade and mercantile activities. Carter (1977) argues based on work of Jane Jacobs that in some cases agricultural production could be the the result of a growing city. This could be the case with places that started as trading post and due specialization in foods trade started agricultural production outside city boundaries.

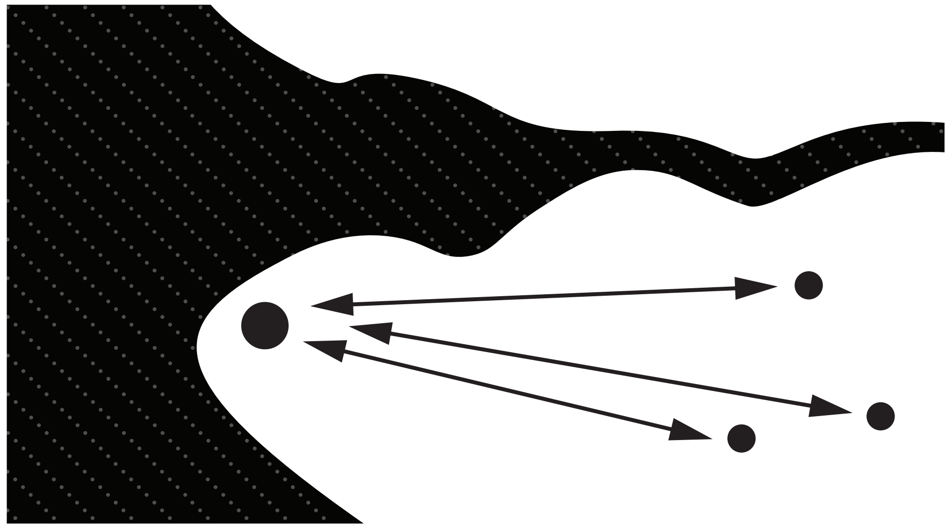
While this is a valid argument, this is too specific, and probably the hydraulic theory is applicable to more cities than the economic theory. Lampard (1995) stresses the importance of social organization for the emergence of modern cities writing: “From a socio-ecological standpoint, city growth is simply the concentration of differentiated but functionally-integrated specialisms in rational locales”. In other words, more integration of functions (within social and ecological systems) means more effiency, which can drive growth.

What about the growth of ports?

Many of the world’s largest cites are on waterfronts. Not all of these cities have thriving world ports nowadays, but many cities had the potential to grow due to their waterfront location and sea trade as we have seen. Until the 1950s big cities were the results of succesfull, large ports, often in places where rivers meet the oceans or in sheltered habours with a river flowing into the sea (Norcliffe et al., 1996). According to Norcliffe et al. (1996), there are three main reasons why ports could grow, which are visualized in the diagrams on the right. The specialization in multiple productive sectors and the trade allowed the port and cities to grow simultaneously (Hilling, 1988).



People move to port city for labour



Port is expanded because of hinterland trade

Ports as main location for ship labour and related companies

Changing relations between ports and cities

From symbiosis to disconnection.

From the former paragraph, we can conclude that in the past there was a strong symbiosis between ports and their cities, this is now not always the case. Nowadays, some massive cities have small ports, and some giant ports have small towns. Before there was symbiosis between the activities in the port and the city as well. We could call this spatial relationship a port-city interface. BIrd (1963) presented his Anyport model, describing the development of modern ports in the UK after the containerization. Some 2 decades later, Hayuth (1982) describe how from a spatial and functional point of view ports have become disconnected from their cities. Norcliffe et al. (1996) translated this spatial disconnection in three steps in Figure 4. Where there was first a spatial and functional symbiosis (t1), ports loosened their grip on cities and Non-port places could emerge (t2). During the industrial revolution urban economies diversified, and some cities didn't need a port as much (for example inland industries such as coal), and the other way around could happen as well. Next, with growing trade and production, ships started to grow and the scale of many industries became to big for the city. As a result, the traditional waterfronts started to get abandonded and the port activities moved out of the city, as the waterfronts couldn't meet the standards for shipping anymore (t3). The main driver for this spatial shift was the containerization that started after the war.

Norcliffe et al. (1996) noted three headings for contemporary port-city relationships which are in short:

1. Ports try to survive by investing in cost-reduction and efficiency, so labour decreases and hinterlands have expanded and merged, so there is less local distribution of cargo.
2. Financial trade sector in ports is flourishing. The origin of this lies in the historical local trade, but nowadays this financial trade is global and not bound to the city belonging to the port anymore.
3. The relocated port industries to the outports have attracted businesses are not suitable for the city anymore, due to noxious activities or in need of sites have access to large quantities of water for their industrial processes. This led to the abandoned waterfronts in the cities.

Hoyle (1989) described the spatial disconnection from the ports in a 5 stage model that is shown in Figure 5. It has similarities with Norcliffe et al.'s work, but other than describing what is the spatial-temporal relation between sizes of ports and cities, he really looks at the separation between ports and cities, rather then the growth.

In a more recent article Wiegmans & Louw (2011) make their version of Norcliffe's model (Figure 6) and present a contemporary conflict between ports and cities. They observed how after departure of ports from the cities, currently the city is developing towards the port and starts reclaiming land from the port again to redevelop it.

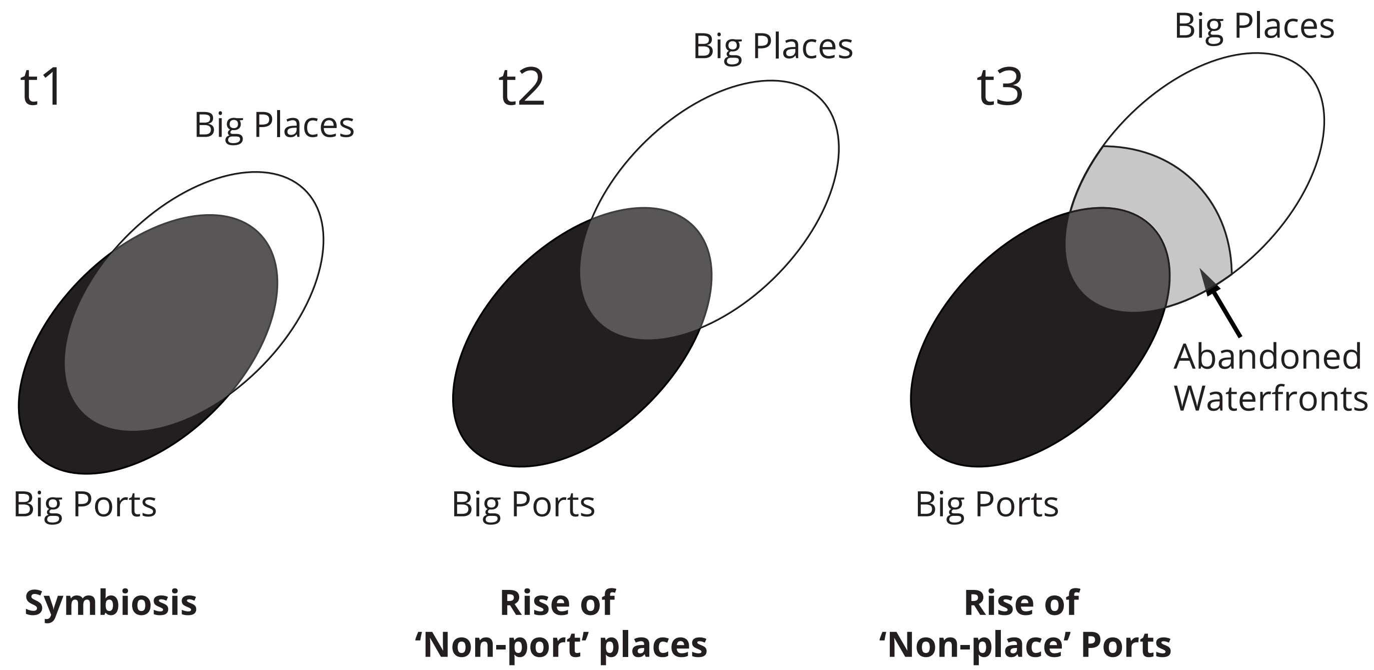


Figure 4: Norcliffe et al (1996): Big places and big ports: evolution and separation over time

Stage	Symbol (○ City ● Port)	Period	Characteristics
I Primitive port/ city		Ancient/ medieval to 19th century	Close spatial and functional association between city and port
II Expanding port/ city		19th - early 20th century	Rapid commercial/ industrial growth forces port to develop beyond city confines, with linear quays and break-bulk industries
III Modern industrial port/ city		mid-20th century	Industrial growth (especially oil refining) and introduction of containers/ ro-ro require separation/ space
IV Retreat from the waterfront		1960s-1980s	Changes in maritime technology induce growth of separate maritime industrial development areas
V Redevelopment of the waterfront		1970s-1990s	Large-scale modern port consumes large areas of land/ water space, urban renewal of original core

Figure 5: Hoyle (1989): Evolution of the port-city interface

Changing relations between ports and cities

The port with the better infrastructure, location and more resources starts outcompeting other smaller ports in the area (Figure 7). Before the 1960s, those ports could live from more local industries and trade, but with a change from production to consumption, the commodity trade has become the prime port business. Other global bulk industries such as oil refining, now also prefer deep water access for their ships and need vast amounts of land. Many of these industries also moved to the ports that offer these facilities. The smaller ports merge with the bigger ports. For some cities this is not a problem, for some it is. From literature (Hoyle, 1989, Norcliffe et al, 1996, Hayuth, 1982) at least four types of temporal port-city transitions could be identified looking at the economic size of a city and port (size of circles in Figure 7). In case we have a big port (A) with good infrastructure and a number of smaller ports in it's competition zone and with either a big or small city attached, possible outcomes due to globalisation and related centralisation are:

1. A small port with a big city could end up with a port in reduced size, not enormously affecting the city's economy due to other industries that guarantee continuity, an example is Amsterdam.
2. A small city with small port could lose its port entirely due to unlucky infrastructural conditions or industries that demand different or larger type of spaces then the city can accomodate. This in turn has effect on the growth of the city, due to its strong dependency on the economic activities in the port, which will likely cause a multifaceted decline of the city. An example is Bremerhaven at the end of the 20th centurty, that did not lose its port in a spatial way, but did lose all port activities that were controlled by and of benefit for the city itself, such as the migration trade (Berking, 2012).
3. In case the port stays, but shrinks due to competition the city is likely to shrink with the port due to loss of jobs and the points mentioned in 2, an example is Dunkerque in France.
4. A large city with a small port could also lose its port identity, but is likely to even grow due to global migration to big cities and since they are not as dependent on their port they can easily redevelop the port area and integrate it in the urban fabric, an example is London.

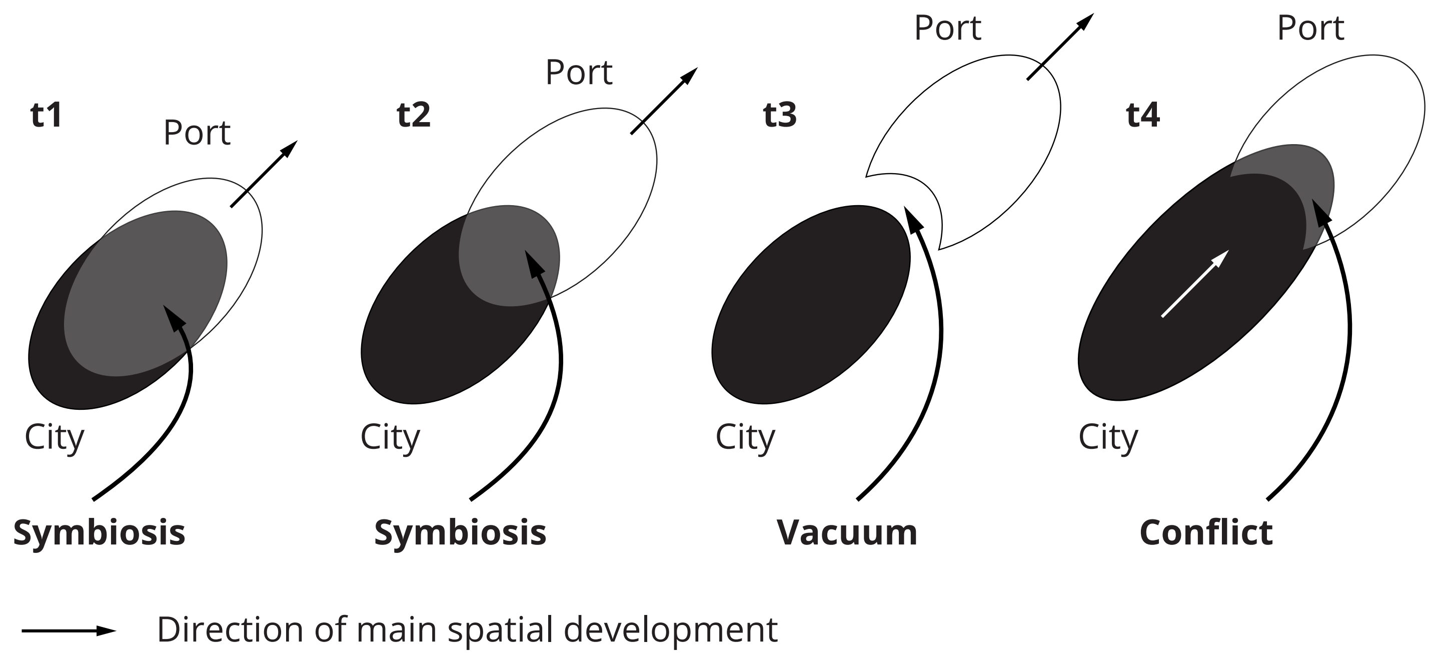


Figure 6: Wiegmans & Louw (2011): Spatial model for the port-city interface

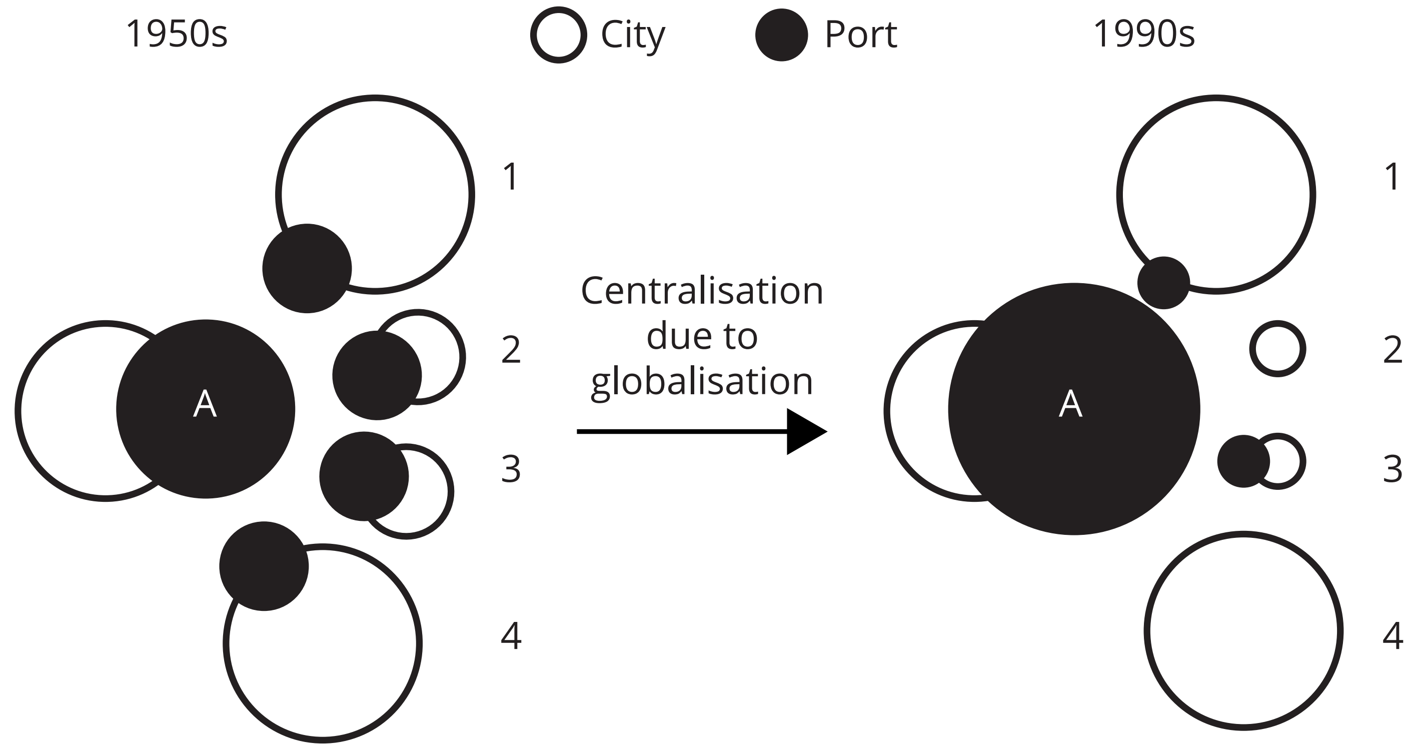
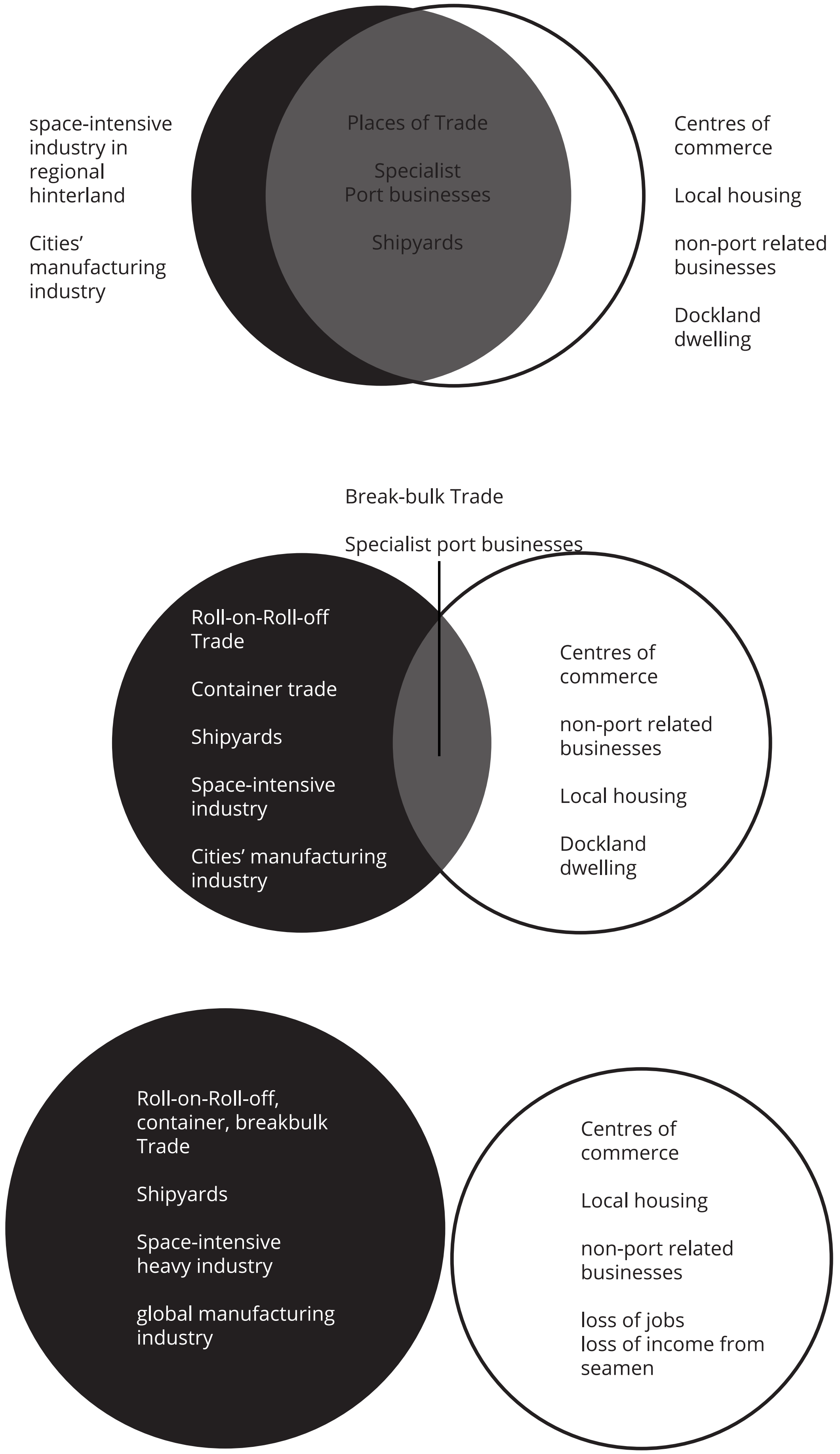


Figure 7: Competition between ports in a regional port systems

Changing relations between ports and cities

Wich activities in a port-city interface belong to the port and which to the city?
The images on the right show the changing types of activities in ports (black) and cities (white) with the changing relations between ports and cities in time.



The Petroleum Industry Value Chain

This diagram of the petroleum value chain is based on research of Christian O.H. Wolf from the World Bank (2009). It describes the petroleum industry chain from discovery of hydrocarbons to marketing & distribution of products derived from the raw resource. Common in the petroleum industry is a distinguishing between upstream, midstream and downstream activities. Upstream activities encapsulate the exploration and production processes and the auxilary services/ equipment such as drilling (equipment) , seismic/ engineering services and the supply of equipment to create the infrastructure for production. The midstream activities focus on logistics, i.e. the infrastructure links between producing (upstream) and processing (downstream) of petroleum products. Examples are operation/ construction of pipelines and transport services via oil tankers. The downstream activities are focused on the processing of the raw hydrocarbons into usable products. This is done in refineries. Outputs can be sale-ready products such as gasoline or intermediate goods that can be processed further in petrochemical plants. As an addition to Wolf's diagram, the transport and marketing of petrochemical products is also incorporated into the value chain diagram to give a complete overview of the chain from resource to end-user.

Note: This text and diagram were created by me for the Group Research phase of the Transitional Territories Studio and also appear in the Atlas.

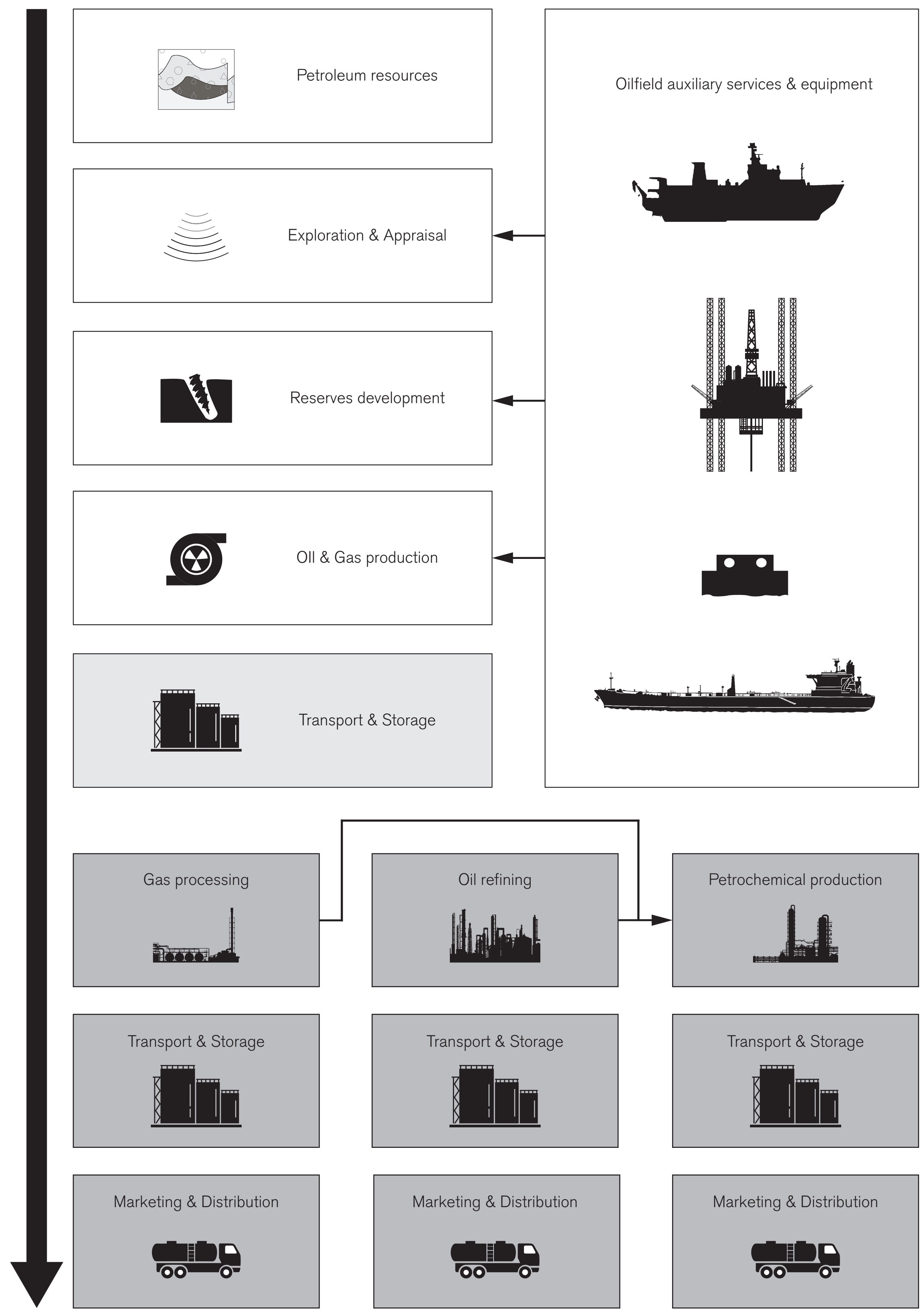


Diagram adapted from Wolf (2009)

The Petroleum Industry Value Chain

Visualisation

To clarify the value chain and it's elements, this diagram shows what elements belong to the offshore petroleum value chain and how they are interrelated. The icons depict different processes and the infrastructure that is needed for these processes. To create a value chain, there must be value creation along the chain as well to make it viable (Wolf, 2009). There are two main types of value creation in petroleum: Value creation on resource level, or on company level. On resource level this relates to the quality and quantity of the hydrocarbons, on company level this mainly comes from cost efficiency and quality improvements (Wolf, 2009, Tordo, Tracy, Arfaa, 2011). There are many more drivers and factors that influence value creation along the chain and they differ for each company and country.

The different numbers correspond with the following:

1. Geographic survey vessel
2. Movable drilling platform
3. Fixed/ Floating oil platform
4. Oil/ Gas tanker
5. Single buoy or submerged mooring
6. Pipeline
7. Oil/ gas (transit) terminal
8. Oil refinery
9. Oil chemical plant

€ Value Creation

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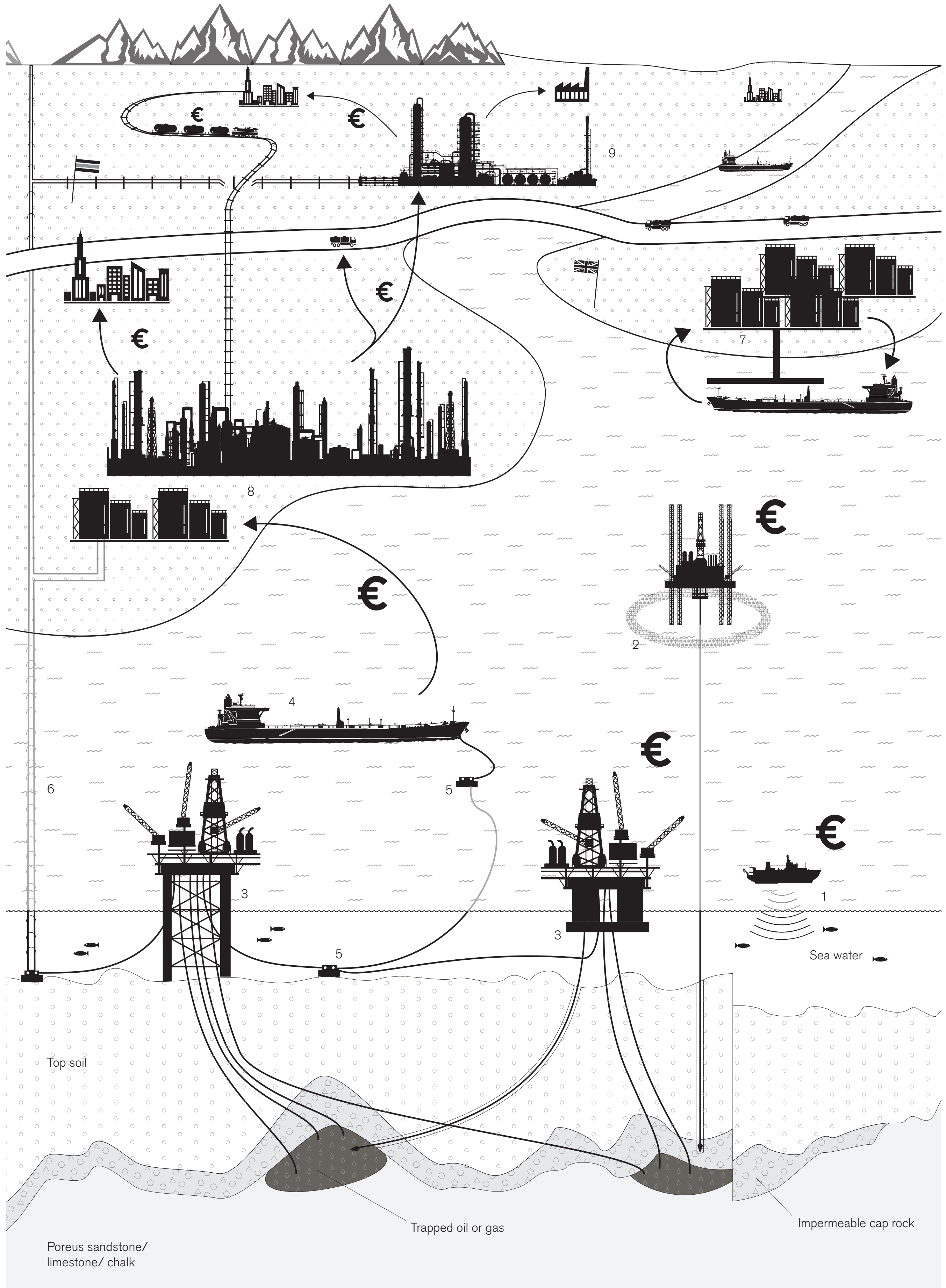
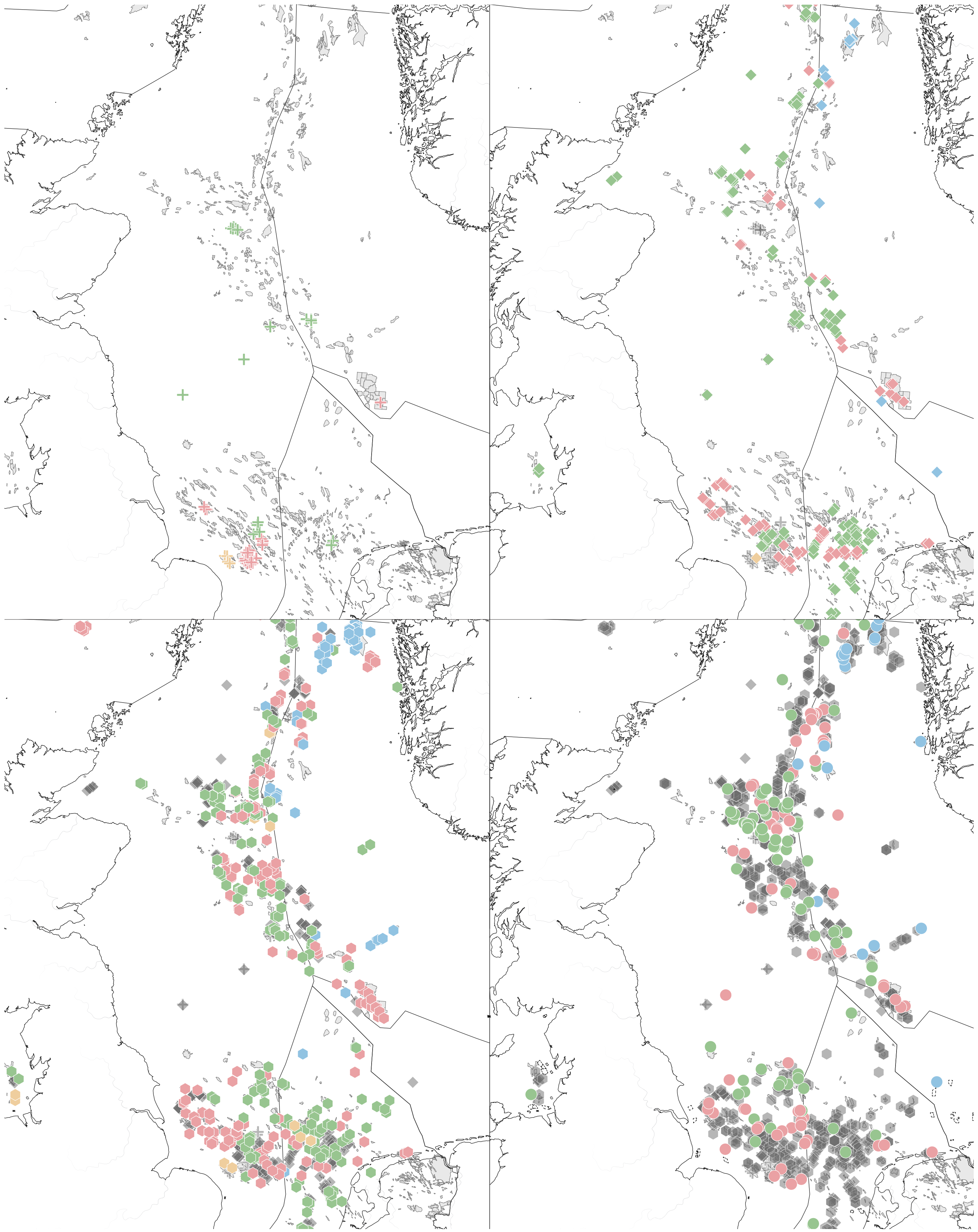


The North Sea Petroleumscape

Historical development and ownership of offshore installations

This map shows the historical development of offshore installations for wind and petroleum in the North Sea, as well as the current ownership situation for the petroleum installations. The ownership situation varies strongly from country to country. The map shows that Norway keeps their installations local and state-owned, while in the Netherlands all platforms are operated by international corporate companies. The UK also has privatized all installations, but they're still mainly operated by national corporations. The map shows the accelaration of the amount of infrastructure over the past decades clearly.

Source: EMODnet (2016, 2018), ENS (n.d.), NLOG (2019), NPD (2019, OGA (2019)



- National corporate
- National governmental
- International corporate
- International governmental
- Windfarm built 1990 - 2005
- Windfarm built 2005 - 2020
- Known oil & gas fields

- Construction1960 - 1975
- Construction1975 - 1990
- Installations1990 - 2005
- Installations 2005 - 2020

100 km

The North Sea Petroleumscape

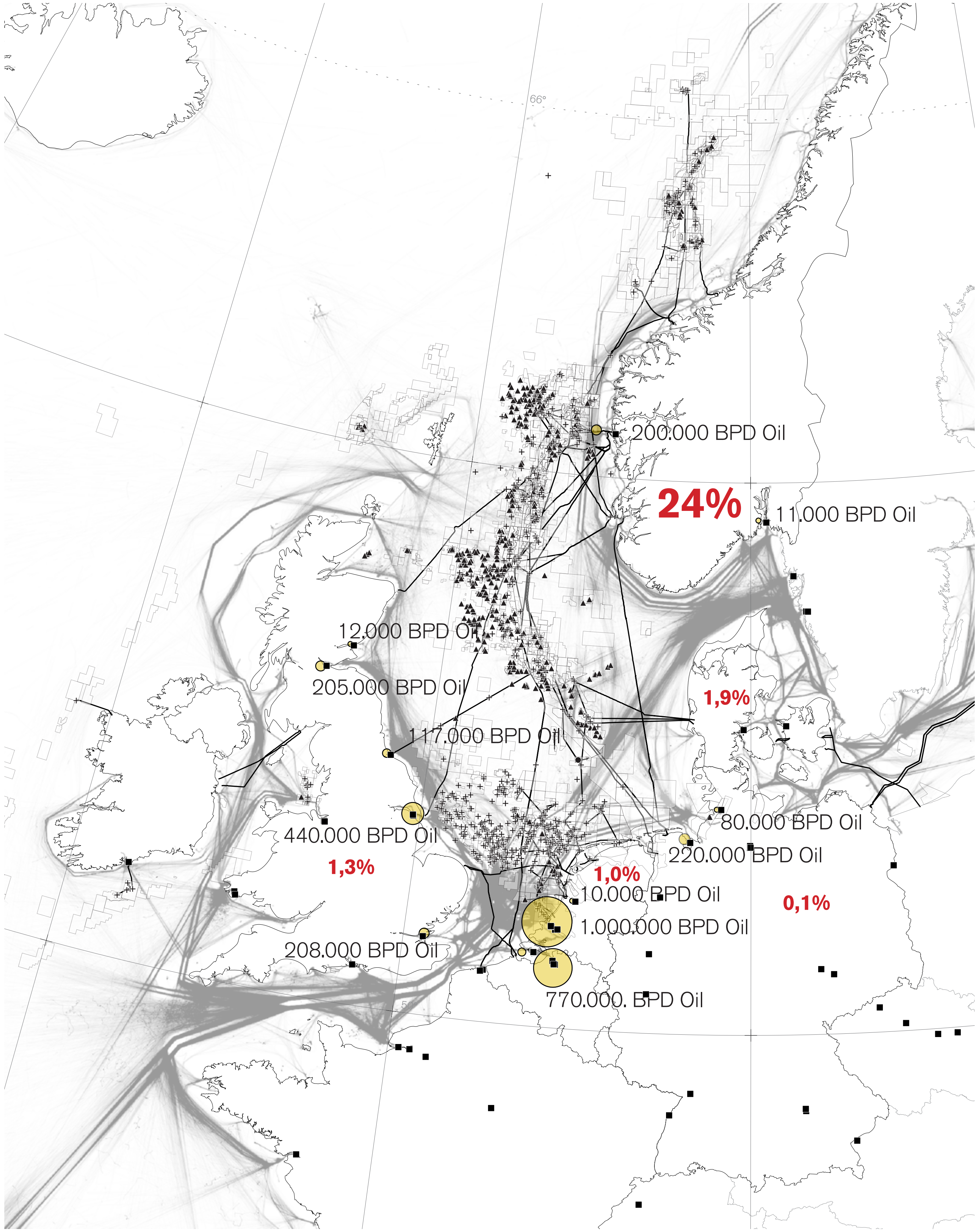
Economic size of hydrocarbon extraction and quantitative size of petroleum refining

Oil and gas extraction have the biggest spatial impact within the territory of the North Sea. With a total of 184 offshore rigs, the North Sea has the most oil/gas installations world wide (Statista, 2019). The map shows also the unequal distribution of petroleum-activity. The Port of Rotterdam facilitates the most active refineries within the region (1.000.000 barrels per day). In the Netherlands, the value of crude petroleum products in relation to the GDP is not high. However, due to the large number of refineries and expertise in the field of petroleum extraction/ exploration techniques, many private companies have big stakes in the construction and decomissioning services of petroleum assets, resulting in a high indirect contribution to the GDP.

For the UK the situation is almost the same regarding direct contribution, but due to a smaller size of the industry compared to the population, the indirect contribution of the petroleum sector is smaller.

In norway the situation is inverted, as the upstream industry has an exceptionally high contribution to the GDP, with net value of crudes reaching almost 25% of the GDP. Most assets are also state owned. However, the downstream industry is almost non-existent.

Sources map: Source: Danish Energy Agency (2019), Eurostat (2019, EMODnet (2016, 2017, 2018, 2019), Fractracker (2017) , Landesamt für Bergbau, Energie und Geologie (2019), Ministry of Economic Affairs & Climate (2019), Norwegian Petroleum Directorate (2019), Statista (2019), The UK Oil and Gas Industry Association Limited (2019),



- Platform Gas
- Platform Oil
- Platform Gas/Oil
- Active licenses
- Barrels per day (oil)
- Refineries
- Container shipping (average 2017)
- Pipelines

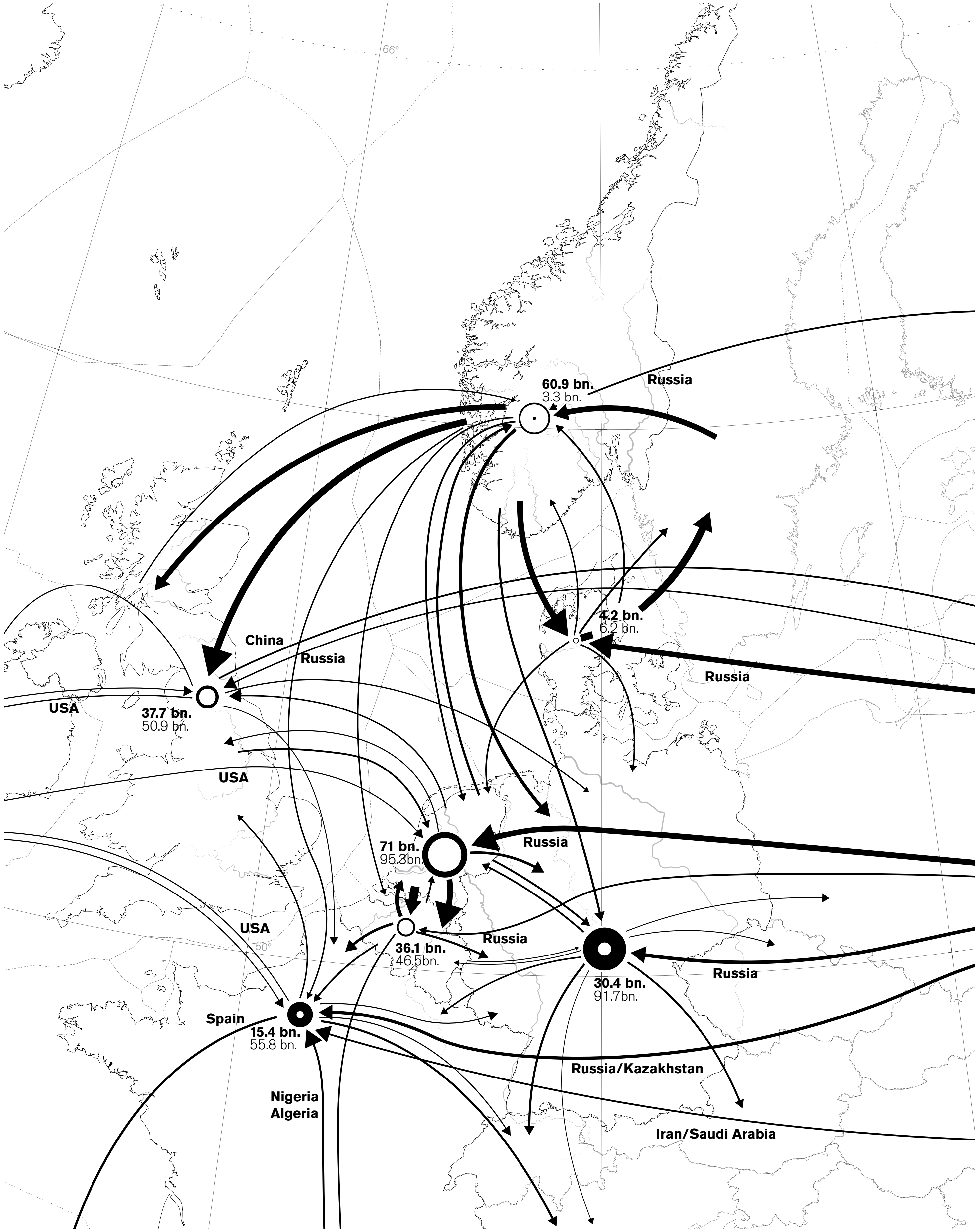
100 km

The North Sea Petroleumscape

Oil/ Gas Export/ Import - Importance of Oil and gas for european economies

This map shows the total export and import of oil and gas in numbers for each North-Sea-Country as well as implicates the space-related economic flows between the different countries as a percentage of the overall countries ex- and import. The map identifies Norway as Europes main exporter, especially for oil. The country imports only 5% of its total export and mostly delivers other EU countries around the North Sea. Import numbers of Germany and France are extensively higher than their export number. Germany recieves oil/gas mainly from Russia, Norway and The Netherlands, and distributes a small part towards its neighboring states, like Italy, Austria and Poland. France imports a high percentage of oil and gas from Middle Eastern states, like Saudi Arabia and Iran but also from Africa (Algeria and Nigeria). Belgium, The United Kingdom and The Netherlands have a quite similare ex- and import rate.

Source: The Growth Lab at Harvard University (n.d.)

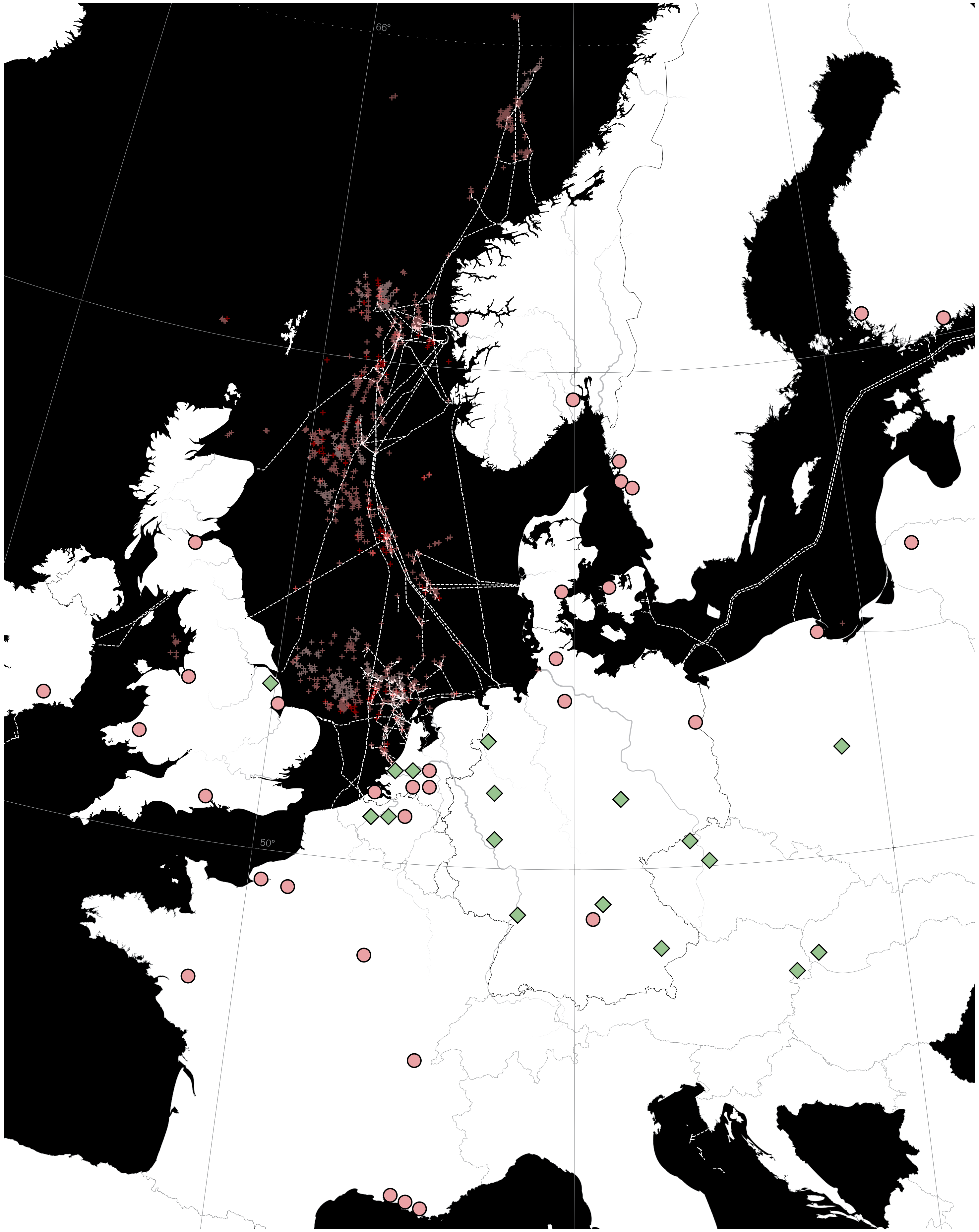


←○	Export	▬	40%
→●	Import	—	20%
▬	60% and more	—	10%

The North Sea Petroleumscape

Future outlook for the refining industry

This map shows the all the currently open refineries in Europe. Clingendael Institute (2017) researched the long-term propspect for the refining industry in Europe. They mainly researched whether refineries are exposed to competition and thus in danger of closure. As is visible in the map, the majority of refineries is in ‘danger’ of closure due to competition or other factors. The refineries that are safe, are benefitting from far-fetched integration into the entire petroleum value chain and strategic trading conditions (Clingendael, 2017). In a different report (Clingendael, 2016) aimed on the Northwestern European market, they concluded that the Northwestern European refinery sector is not competitive after 2025 and that only 12 out of 34 currently open refineries in North West Europe are likely to withstand the global pressure, in the best scenario (for the refining industry).



- + Offshore installation
- - - - Pipeline
- ◆ “Safe” Refinery
- ● Refinery in “Danger”

100 km

Hazards associated with the petroleum refining industry

In 2007, the Verdigris River in Kansas, USA flooded due to heavy rainfalls. It overtopped the levee (protective wall) around the City of Coffeyville with more than 1 meter (EPA, 2007). Next to the river the Coffeyville refinery is situated, and south of the refinery the city of Coffeyville. The river was flowing downstream from North to South. The river flooded the refinery (Figure 8) as well as the city. Due to bad training of employees, an overflow of tank filled with crude oil could happen (Potter, 2011), unleashing almost 90000 gallons or 2100 barrels of oil equivalent into the floodzone, as well as coke fines (EPA, 2007). This was all carried towards the city and beyond. 300 homes had to be demolished and many more were damaged, and 700 residents - of a 10000 people population - left the city (Potter, 2011).

Many of the European refineries are also located in areas with flood risk, in river estuaries, deltas or near the coast. They have to be located next to large sources of fresh water due to the refining process. The average fresh water use for a refinery ranges from 0.34-0.47 liter of water per liter of oil and gasoline even 0.60-0.71 liters of water per liter of gas (Sun, Elgowainy, Wang, Han, Henderson, 2018). They may be managing their refinery safety better, but there's still a chance of externalities such as natural disasters.

Pollution and toxicity of refinery (by)products

Rosenfeld & Feng (2007) give an overview of the emissions and wastes related to the petroleum industry, noting that most emissions come from leakage, venting and evaporation of crude and refined products. These type of pollutants are so called volatile organic compounds. They also list the solid wasted as listed by the US Environmental Protection Agency (EPA). This is shown in Figure 9. On top of that there is waste production from wastewater treatment, which in turn is disposed of by urning it as fuel, dumping in the ground, processing to other products (Rosenfeld & Feng, 2007).

People that live close by or work on a refinery may also experience increased health risk, by being expoded to substances lie, benzene asbestos, silica dust and more, possibly leading to cancer Kirkeleit, Riise, Bjorge, Moen, Bratveit & Christiani, 2009).

A study by Dahlgren, Takhar, Anderson-Mahoney, Kotlerman, Tarr & Warshaw (2007) shows that living on top of soil from (uncleaned) decomissioned oil sumps have higher concentriations of several organic compounds related to hydrocarbons. Dahlgren et al. found that these people are more likely to develop auto-imune disseases affecting several vital organs and joints.

Figure 8: Coffeyville refinery flooding. Source: Orlin Wagner.
Retrieved from https://oklahoman.com/gallery/articleid/3077450

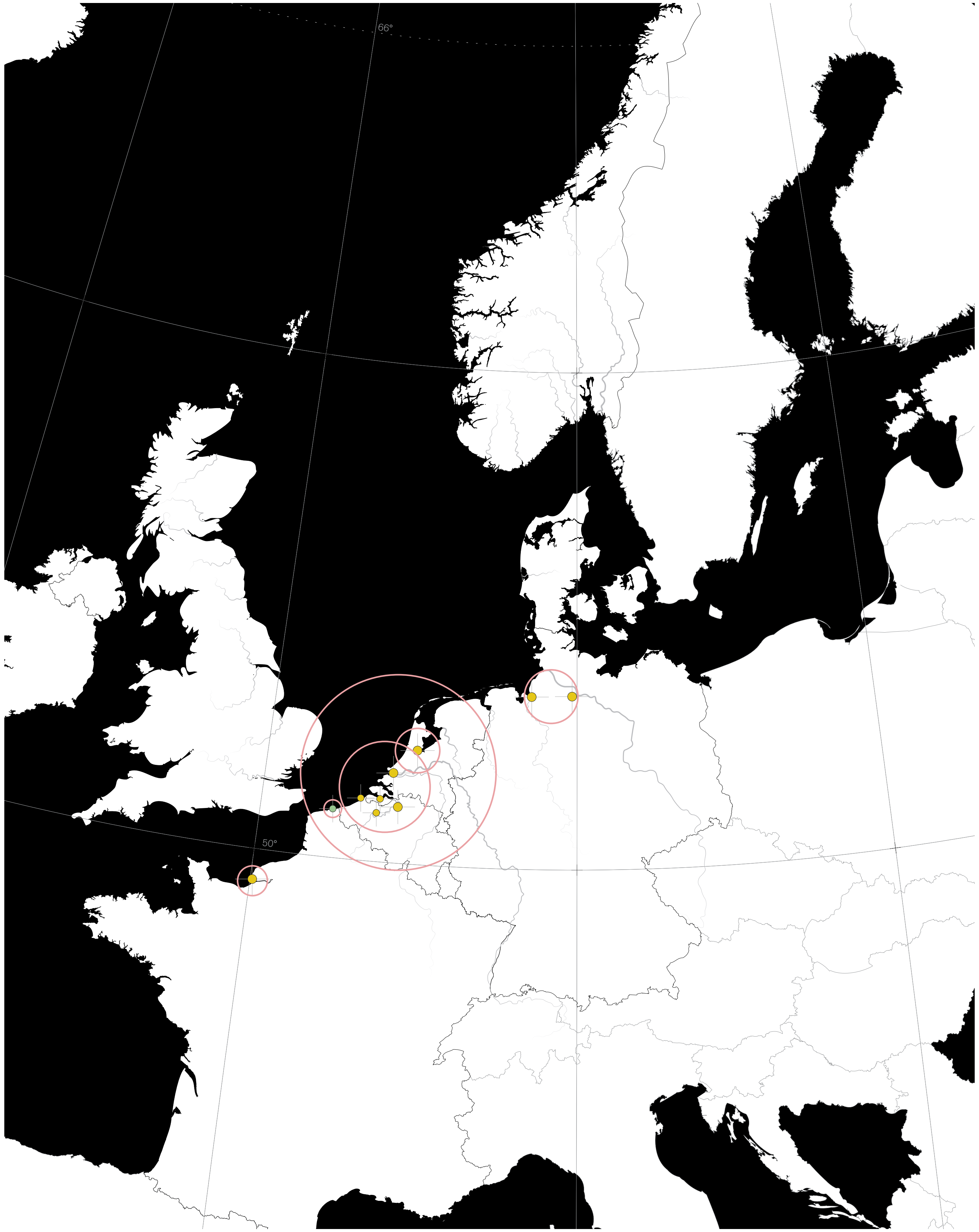
Industry and EPA Hazardous Waste No.	Hazardous Waste	Hazard Code
Petroleum Refining		
K048	Dissolved air flotation (DAF) float from the petroleum refining industry	(T)
K049	Slop oil emulsion solids from the petroleum refining industry	(T)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry	(T)
K051	API separator sludge from the petroleum refining industry	(T)
K052	Tank bottoms (leaded) from the petroleum refining industry	(T)
K169	Crude oil storage tank sediment from petroleum refining operations	(T)
K170	Clarified slurry oil tank sediment and/or in-line filter/ separation solids from petroleum refining operations	(T)
K171	Spent hydrotreating catalyst from petroleum refining operations, including guard beds used to desulfurize feeds to other catalytic reactors (this listing does not include inert support media)	(I,T)
K172	Spent hydrorefining catalyst from petroleum refining operations, including guard beds used to desulfurize feeds to other catalytic reactors (this listing does not include inert support media)	(I,T)

Figure 9: Solid Wastes Generated in Petroleum Refining Listed as Hazardous Waste by the EPA (Cited in Rosenfeld et al, 2011).

The Project Location

In port-city interfaces we have a few important conflicts right now, especially in the transitional areas between heavy, industrialized port-activities and more dense urban environments. The conflict becomes apparent in the case of strategic port areas. This can be triggered by a need from the municipality (e.g. they need more space for dwellings in a [former] port area) or by the departure of a large company, such as a manufacturer. In the first case, what is overlooked often is the importance of industrial areas in a city, especially if we want to transition to independent, self-sustaining sustainable economies. To minimize the use of waste and resources we need to process a lot of our flows on a more local level. If a (local) government pushes out industry for their design-oriented planning, it will become harder to achieve this. On the other hand, large parts of the modern global-oriented ports are controlled by just a few global corporations. They operate in a global network and must deal with international shareholders that expect a return of investment and more. As mentioned before, our current socioeconomic way of thinking and planning means that for these corporations, arguably profits are foremost important. With their centralized operation of the company, they will not attach to a production location too much, because decisions are taken top-down, with little rationale in mind. In some cases, this can lead to the demise of complete cities or regions. An example for this is Dunkerque in France where several oil companies and other industry left the city, leaving an unemployed and decaying working class city behind. Moreover, in case this happens, there's another conflict. Often these premises are heavily polluted by the industrial activities that took place. Nothing new can be built right away, due to environmental or zoning regulations. Debates lacking a solution about who needs to pay for the expensive clean-up can last for years. In other cases, another polluting venture is taking over the site/installation, which has a positive side from a socioeconomic point of view, rather than from an environmental point of view.

The port-city interface of Dunkerque is a typical for all problems that were presented in the preceding theory, from an environmental, social and economic point of view. The port of Dunkerque has moved west, out of the city, a process that started in the 70s with the construction of a new open sea container terminal, which was paired with a decreasing occupation of the traditional finger docks that are on the cities waterfront. However, unlike other cities such as London or Amsterdam, there are no resources or interest in large scale waterfront redevelopment for demographic reasons. Some of the old docks have been successfully redeveloped, but many are still empty, or very little used. The current port of Dunkerque is suffering from competition from other ports in the Hamburg-Le Havre range (Map on the right) and are struggling to keep up, despite continuous investment in the port. At the same time, while the port cargo handling may be increasing, the amount of jobs is decreasing, due to automation and a port that is less focused on industry and more on logistics.



100 km

- Import/Export flow size of port region
- Port of Dunkerque
- Other ports in Hamburg Le Havre Range (size of cross/circle indicates port size)

Historical development of Dunkerque

There is very little known about the exact origins of Dunkerque, but legend says the city was named after a church in the dunes, hence the name Dun = Dune & kerque = church. It appeared on a map from 1730 (Figure 10). It used to be part of a flemish empire. The first written mention of Dukerque is from 1067. Until the 12th century Dunkerque was a small village. Dunkerque is - just like the Netherlands - situated in a swampy area. The area also knows strong tidal differences and some parts behind the dunes were below sea level. These problems were tackled in the 12th century by digging channels, building locks, piers and dyes. Trade in wool and leaves with the English helped with the growth of ports in the region and ensured power for the flemish empire.

Dunkerque stays in the hands of the Flemish peopl until the late 14th century until it is handed over to the house of Bourgogne. In 1400, Dunkerque is fortified against invasions from the English, including 28 towers (Figure 11). The only still remaining part of this fortification is the Tour du Leughenaer. At the end of the 14th century Dunkerque starts to grow from small fishing port to commercial size with lots of import trade. Barley from England, Beer from Holland, wine from other parts of France, wood from Denmark, fur and suede from Guérande in France. They start exporting local agricultural products, cattle and fish.

Some centuries of war follow, where Dunkerque has been in the hand of the French, the Spanish, English. Fort Mardyck was built in 1622 to protect the port from invasions. In 1640, the forticfications are reinforced for the battle against the French (Figure 12). In 1658 the city surrenders against the French, who in turn gave the city to the English. In 1662 the city becomes French again, and from that point it will remain French.

The port is in the 19th century mainly focused on fishing. In the middle of the 19th century the port starts to thrive. It gets connected by rail to Paris. At the end of the century, the port starts to modernize, and the great lock is opened in 1896. At this time also the first four docks are built (of 6 today) (Figure 13). During this era also large industry arrives in the city and it becomes popular among rich industrials and agricultural producers, bringing buildings like hotels, casinos, the Kursaal and large villas. Also a social movement emerges, that tries to establish a union.
During WWI and WWII Dunkerque was heavily bombed by the Germans and large parts of the city were destroyed, as well as large parts of the port.

The above text is my summary from the book: Dunkerque: 1000 ans d'histoire (Boniface, Curveiller, Goris, Harbion, Lebel, Mélis, Oddone, Pfister & Villiers, 2001).

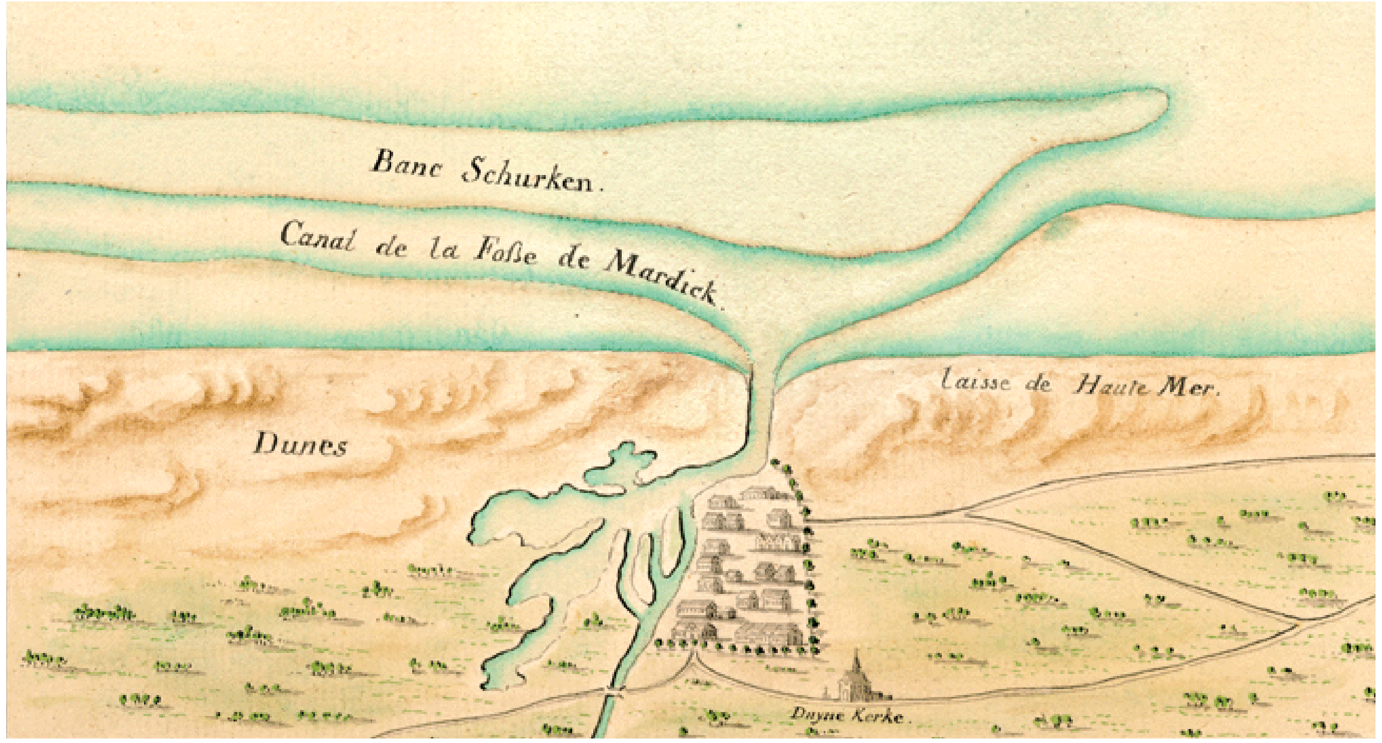


Figure 10: Dunkerque in 646 (map from 1730).

Figure 11: Dunkerque fortified around 1400

Historical development of Dunkerque

Development into a large industrial port and the decline

A few years after the war the BP refinery was opened (BP, 1952) on the place where a different refinery was that was destroyed during the war. In 1963 USINOR opened the steel factory in the Port of Dunkerque (US Government, 1963), that is today operated by ArcelorMittal. The construction of the steel plant was also the driver for the construction of the digue du braek, the concrete sea barrier that today connects the port from west to east (Noui, 2016). From the late 70s deindustrialization of Dunkerque and other regions started due to the loss of coastal iron and steel industries (Zukin, 1985). In the late 90s a revitalization project was started to reconnect the city to the port. This resulted in the First of the six docks being redeveloped and more recently the dock close to the beachfront. Museums, housing and offices are placed on these new docks. Redevelopment projects are ongoing on the second dock.

Figure 13: Dunkerque at the end of the 19th Century

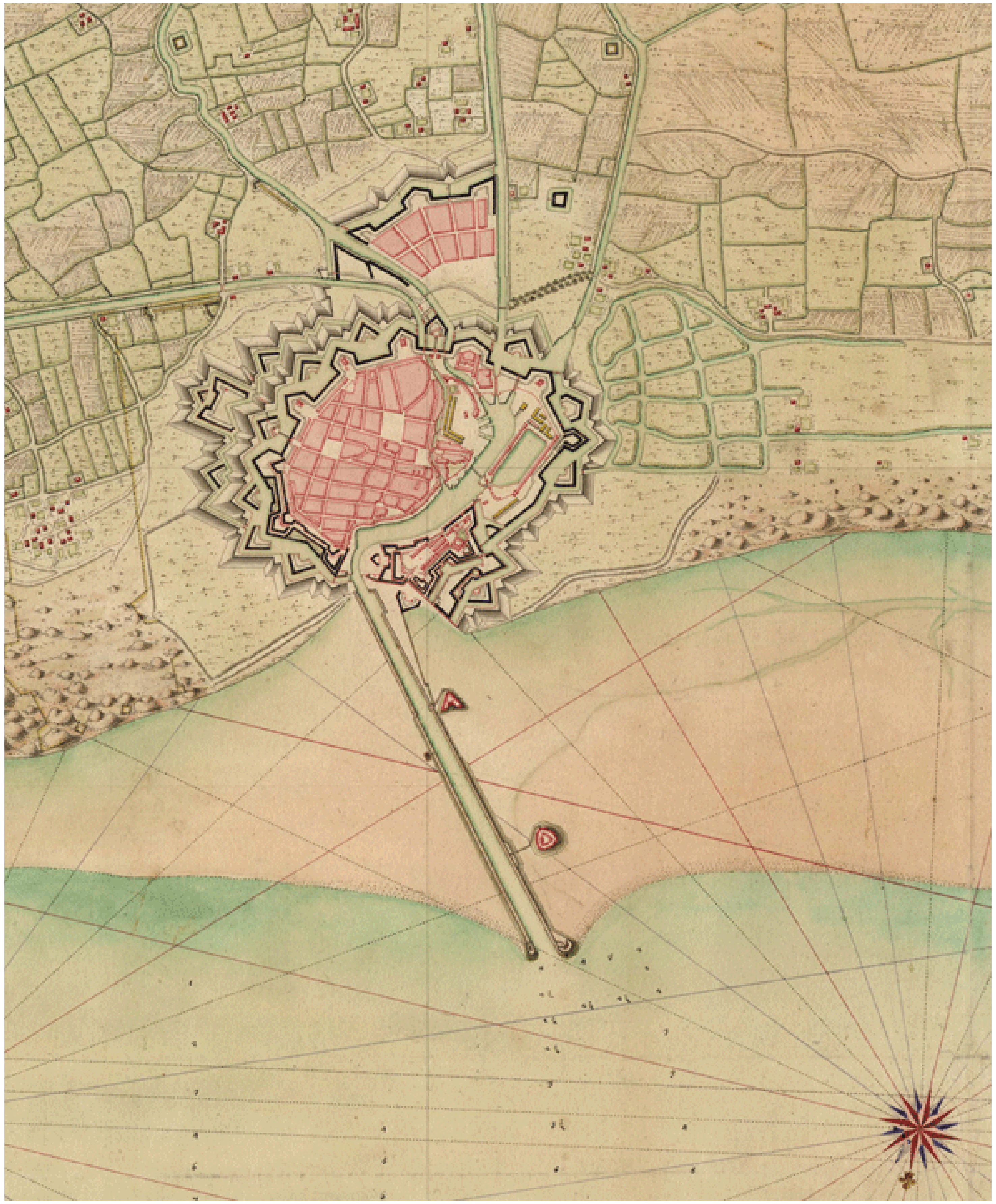
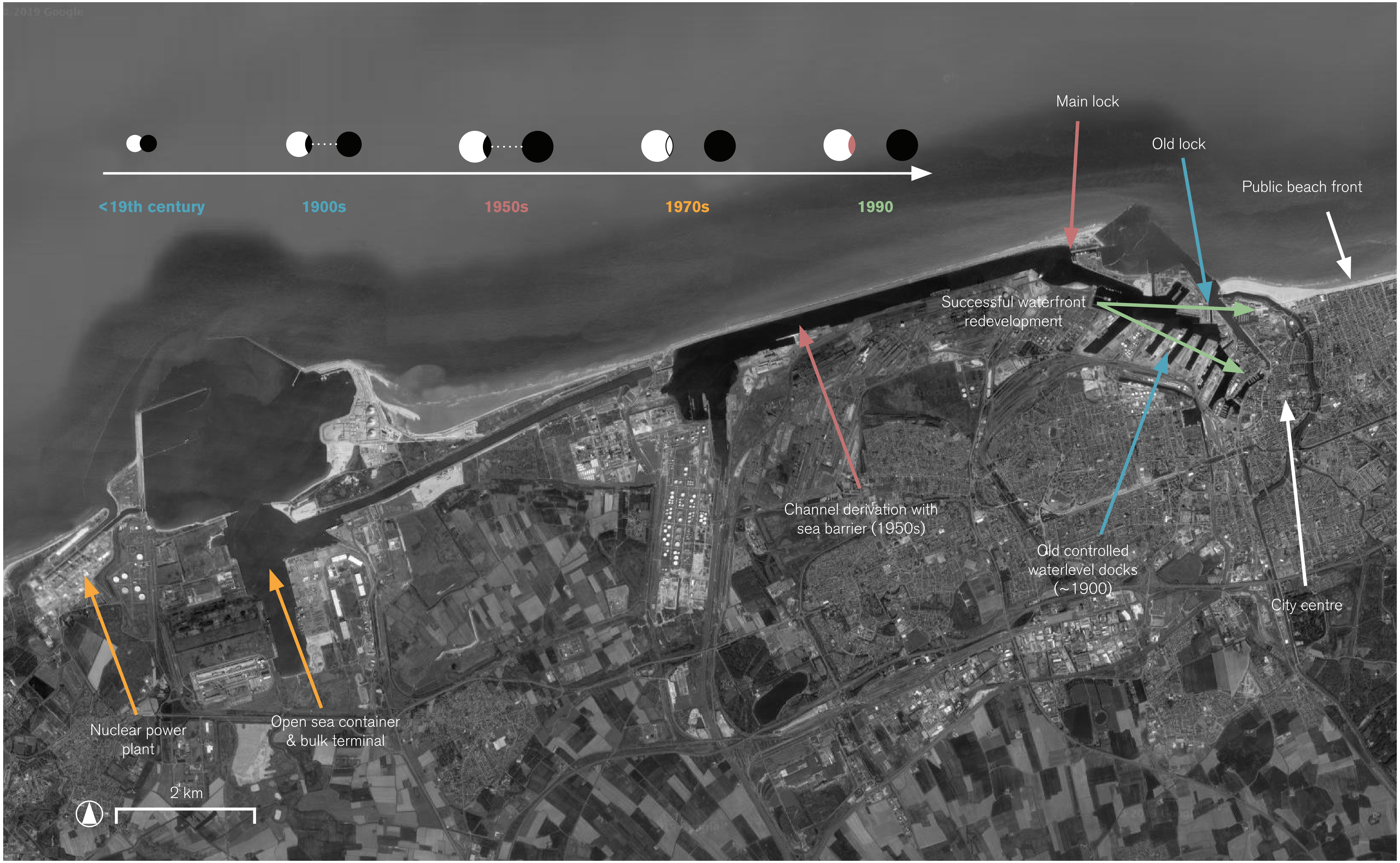


Figure 12: Dunkerque at the end of the 17th Century

The Port of Dunkerque today

On the next pages there will be some analysis map of the site location and entire central and eastern port-city interface.

An overview of the port-city interface



Overview of the Dunkerque Port-City interface Image: Google. Top diagram: Hoyle, 1989.

Central and east harbour zones

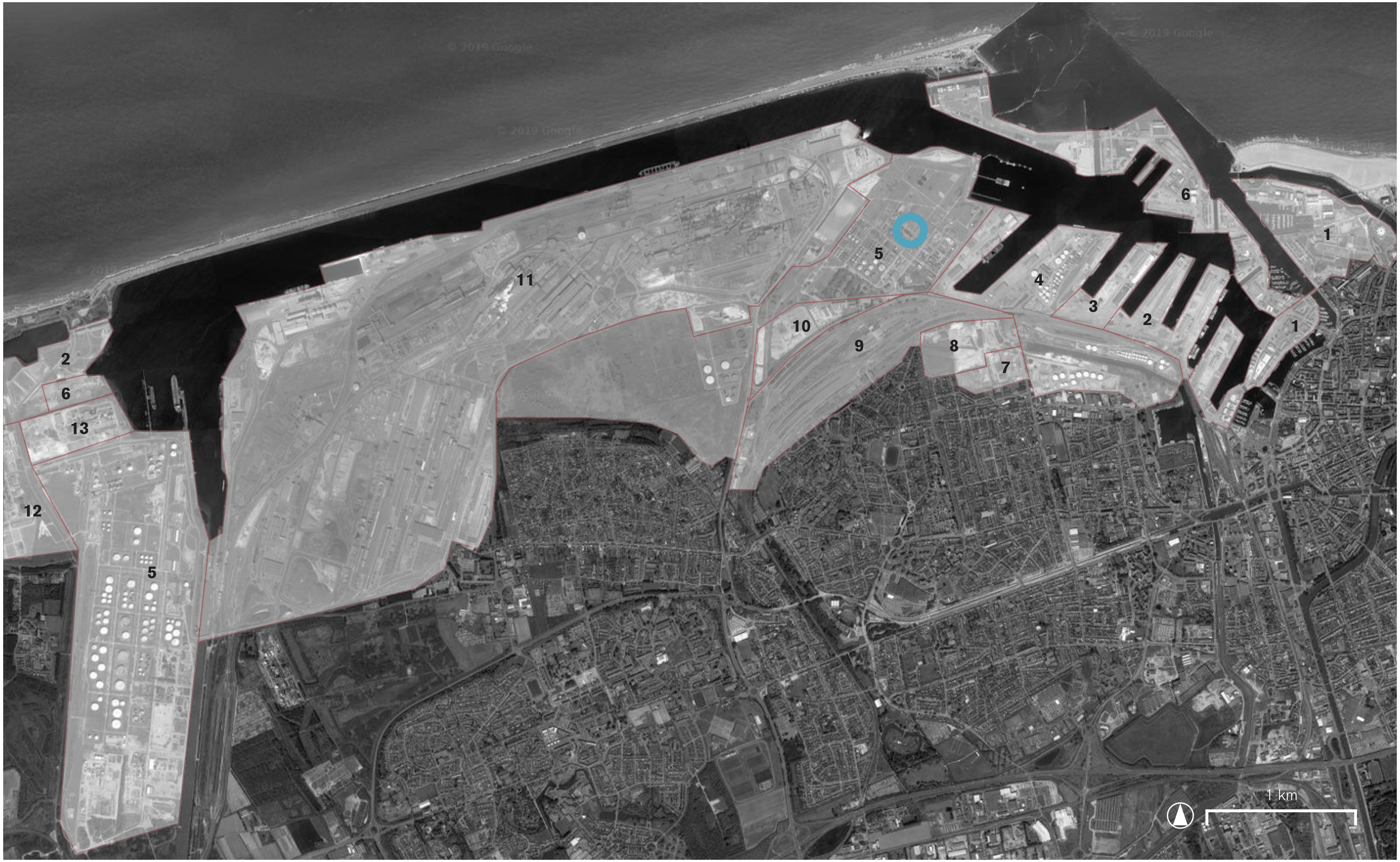
Abandonded port zone

Productive port zone

Redeveloped port zone

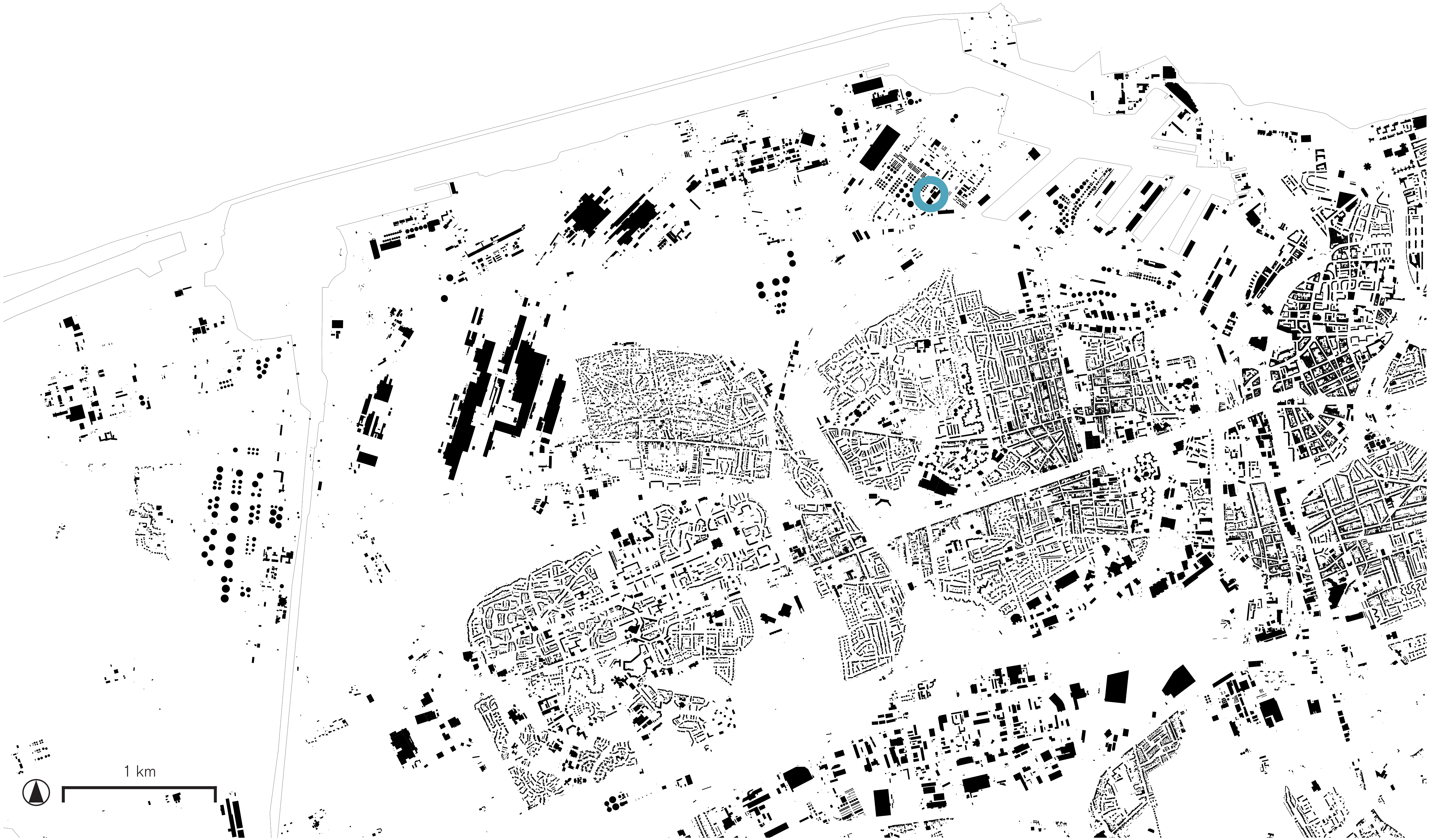
Project site

Central and east harbour usage types



1: Museums/Dwellings/Commercial, 2: Abandoned plots, 3: Grain terminal, 4: Dry/Liquid bulk terminal, 5: Decommissioned refinery, 6: Shipyards & small ship industry, 7: Commercial, 8: Bulk Logistics, 9: Railyard, 10: Pipe coatings, 11: Steel factory, 12: Petrochemical plant, 13: Aluminium Factory, 14: abandoned plots

Buildings and port outline



Waterways and port service area

Infrastructure for motorized transport

Railway | Car road | Small channel | Large channel/ ocean | Port entrance point (road, rail & water) | Area serviceable by sea port

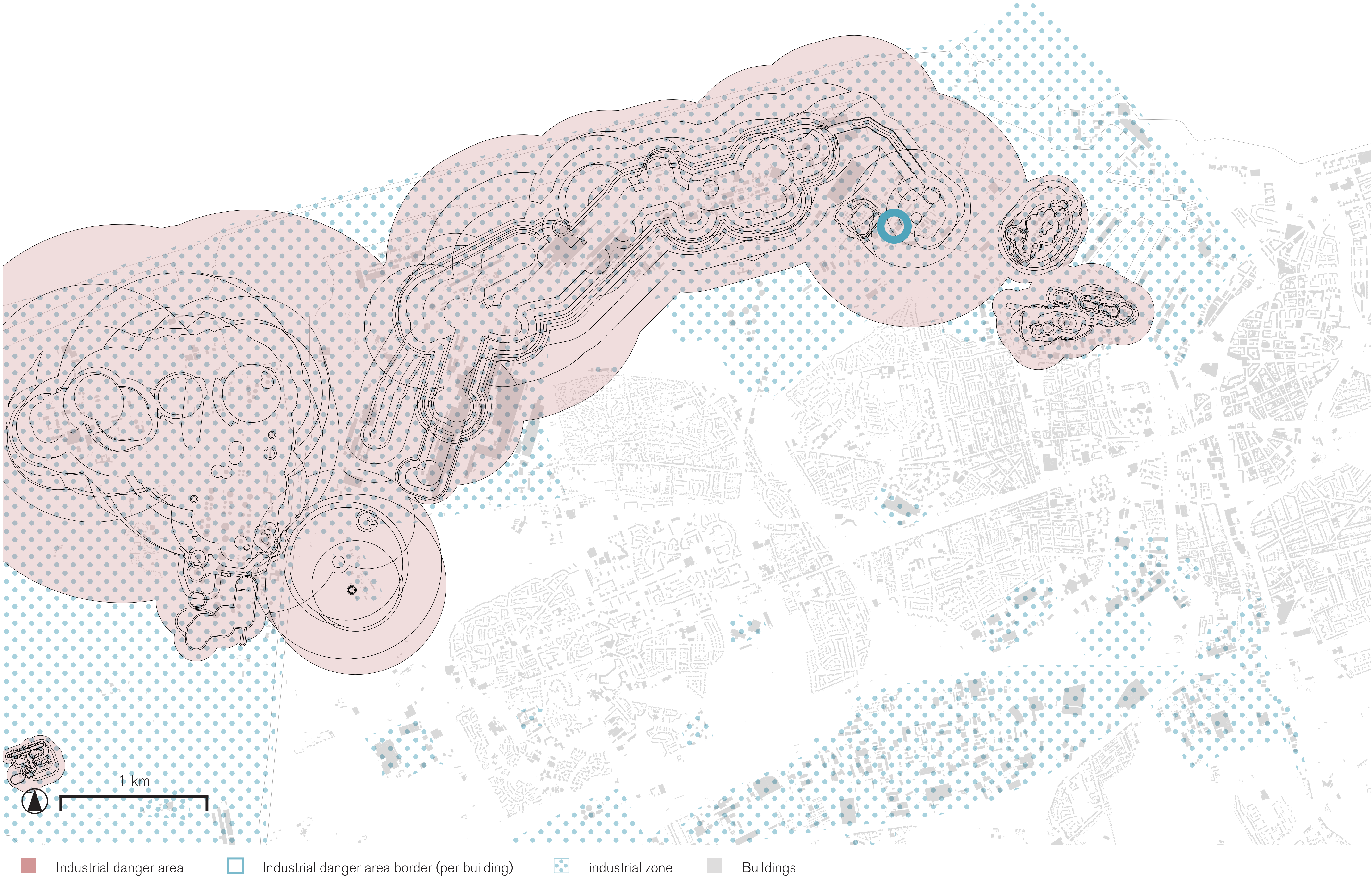
Recreational and Agricultural green

Urban park | Large outskirts park | Nature reserve | Agricultural land | Railway | Car road | Small channel | Large channel/ ocean | Buildings

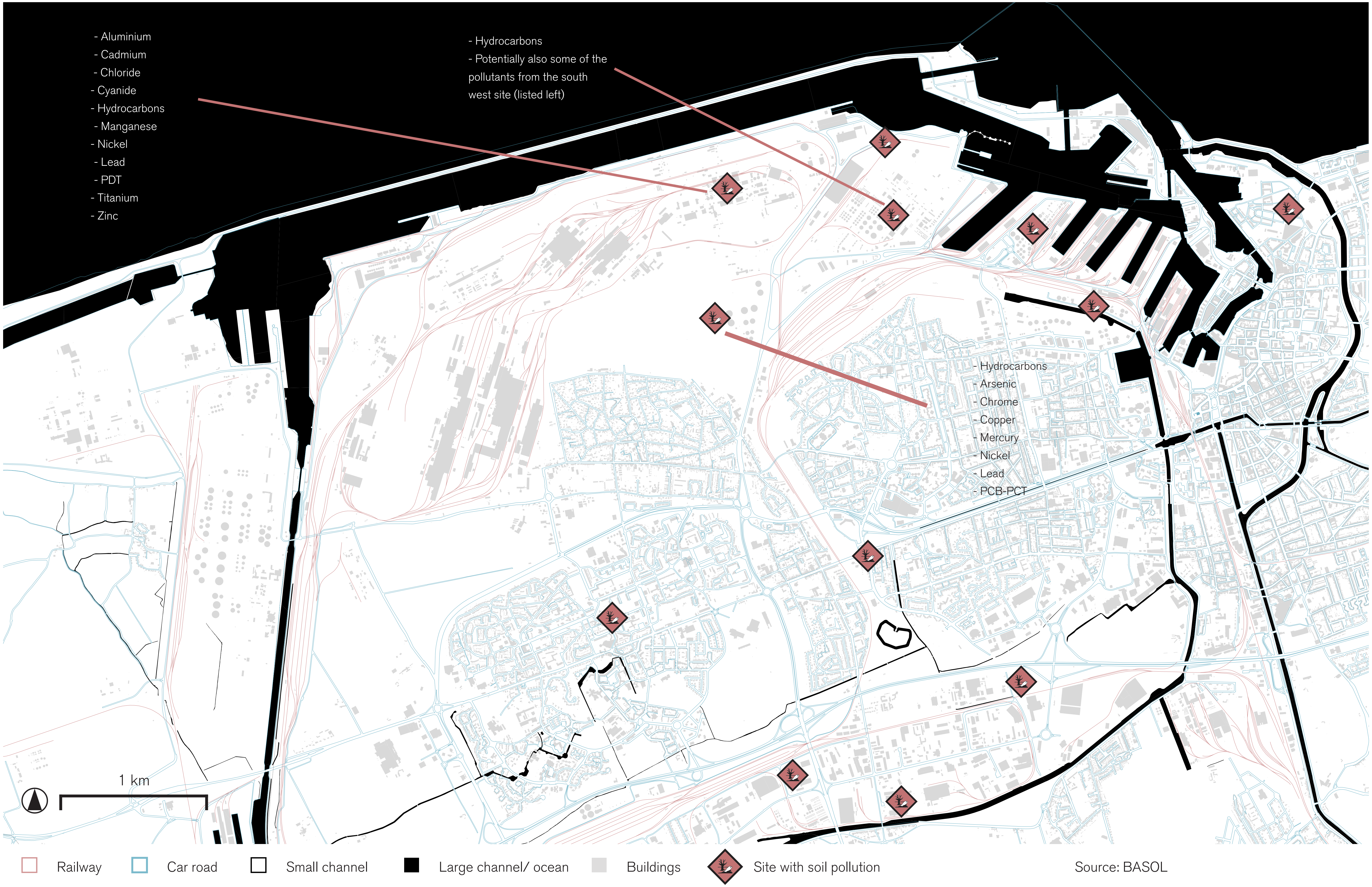
Energy and substances transport system

Gas pipeline | Refined petroleum pipeline | Liquid air pipeline | Hydrogen pipeline | Argon pipeline | Oxygen pipeline | Electricity | Electricity transfer station | Buildings

Industrial danger zones

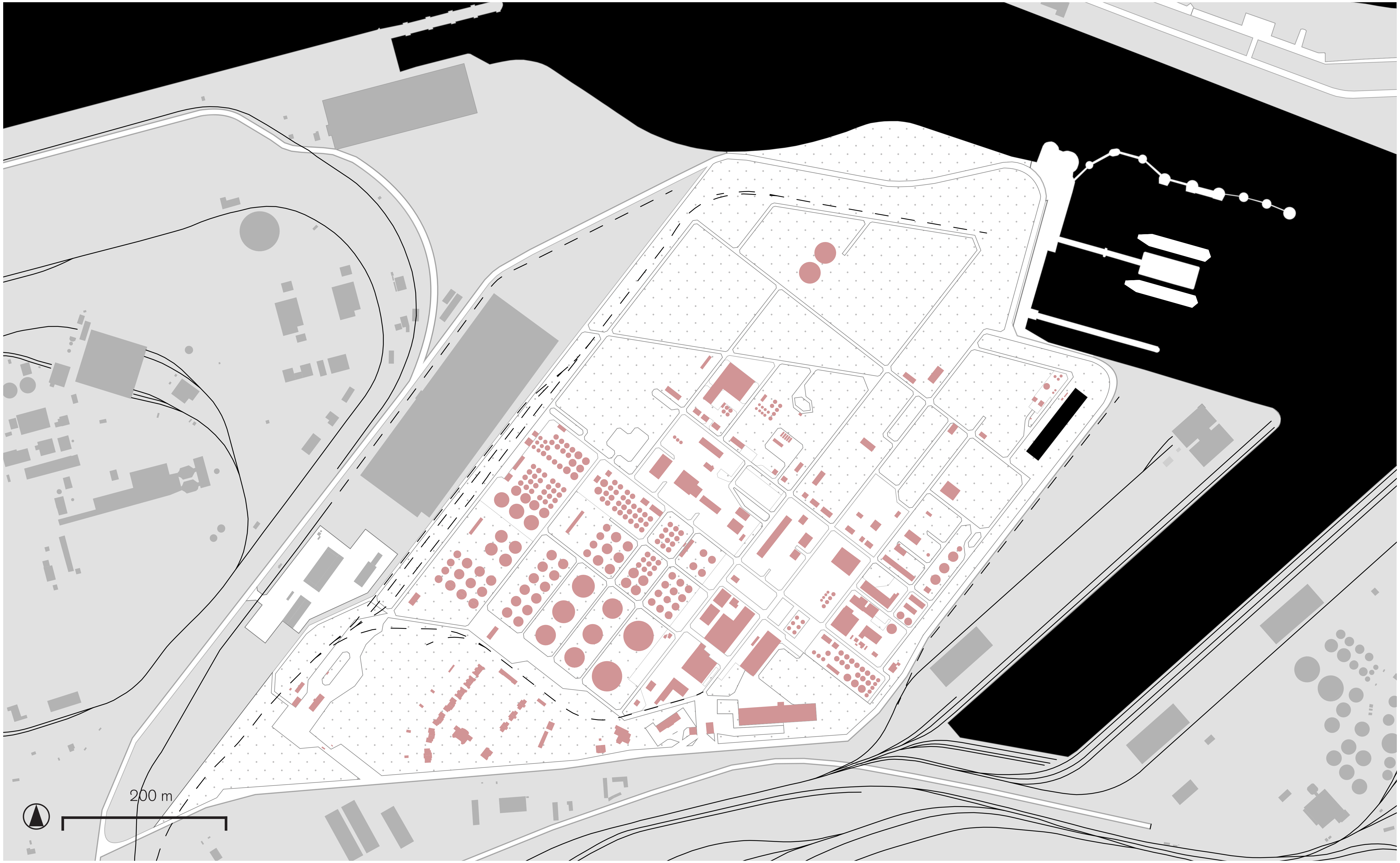


Soil pollution



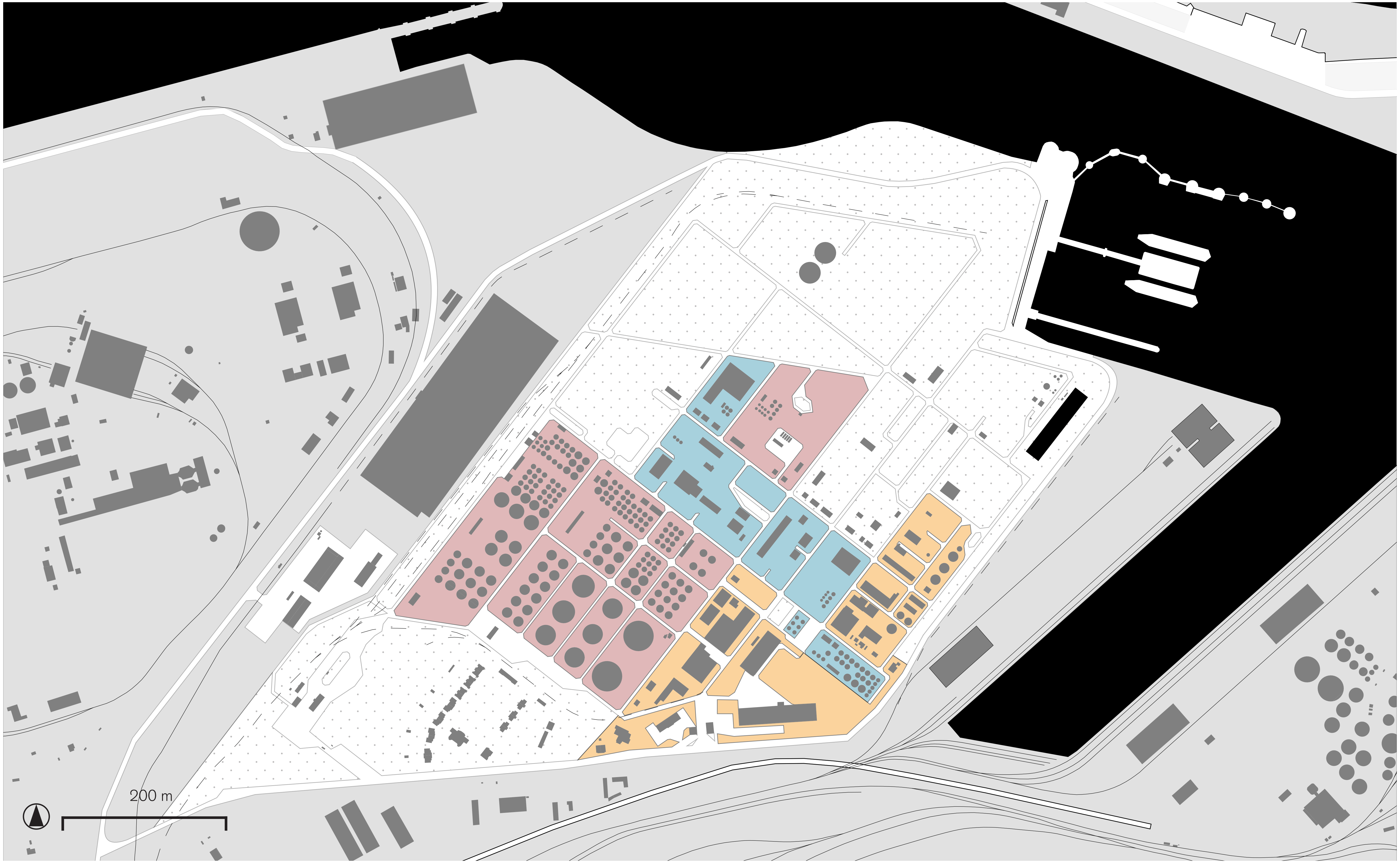
Source: BASOL

The project site



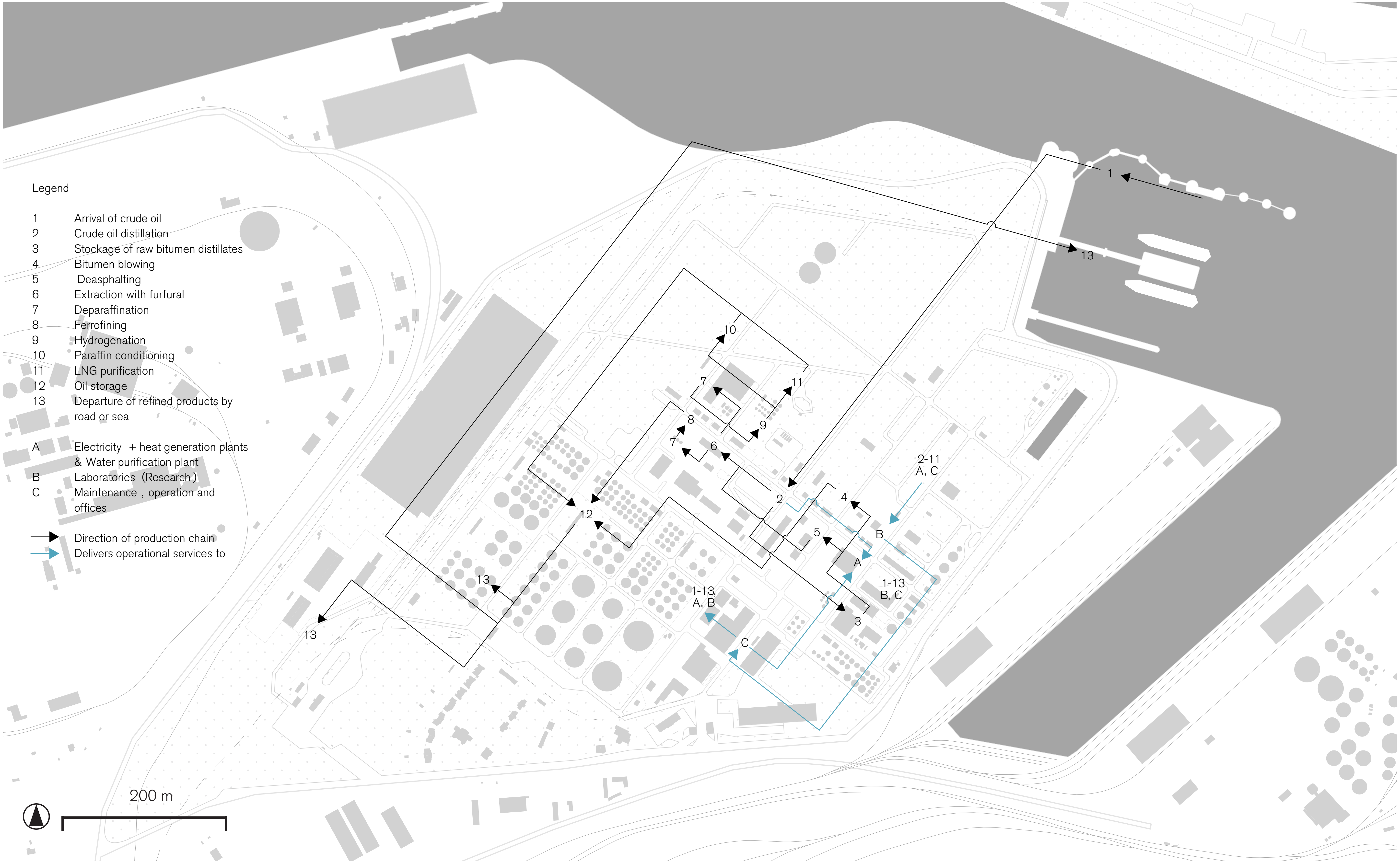
Structures (Buildings, installations) | Grassy area | Roads | Existing railway | Removed railway | Water | Outside plot

Programmatic zones

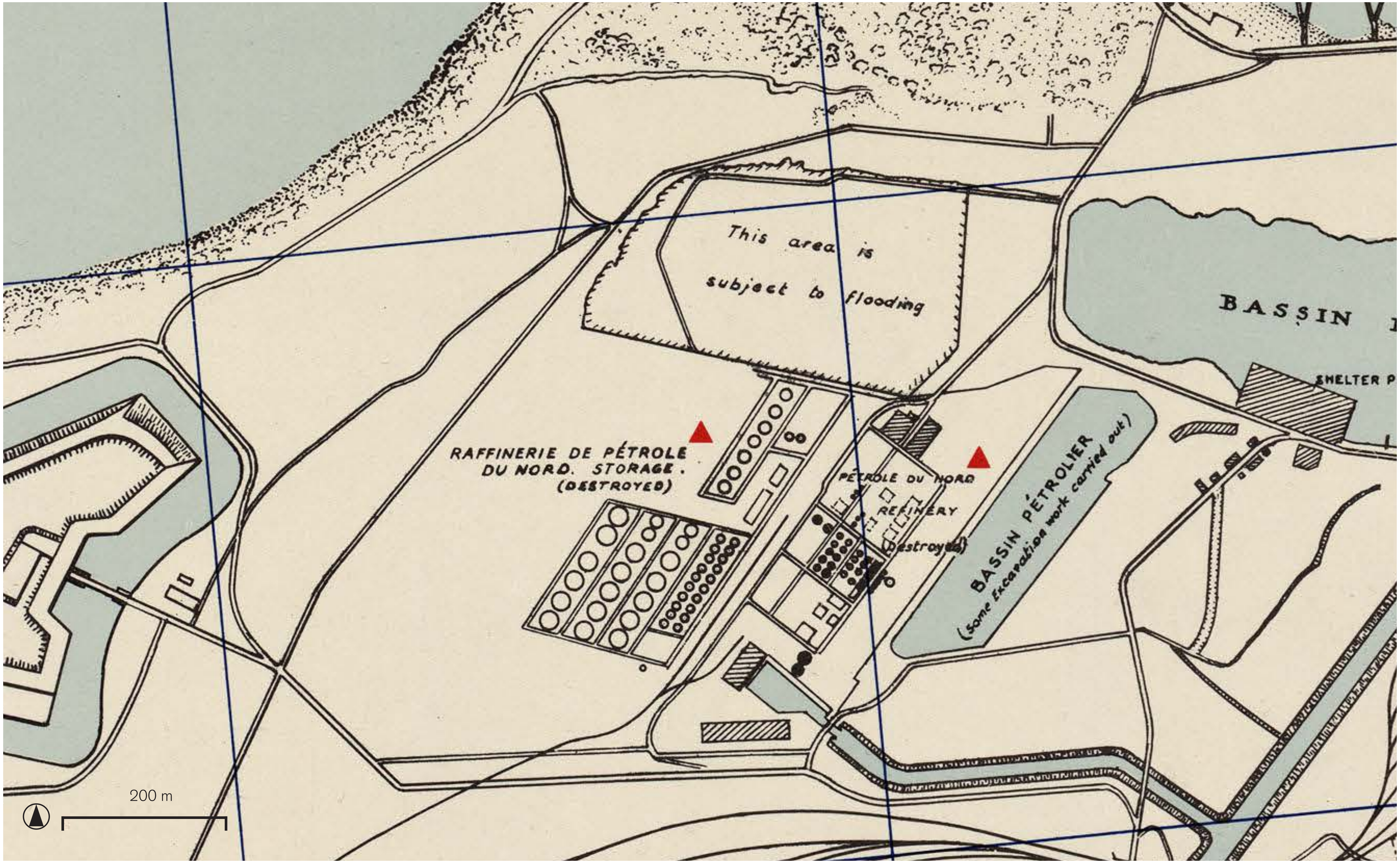


Structures (Buildings, installations) · Grassy area · Stockage drums · Petroleum refining factories · Ancillary buildings (labs, maintenance, operation) · Water · Outside plot

Path of the oil on the refinery

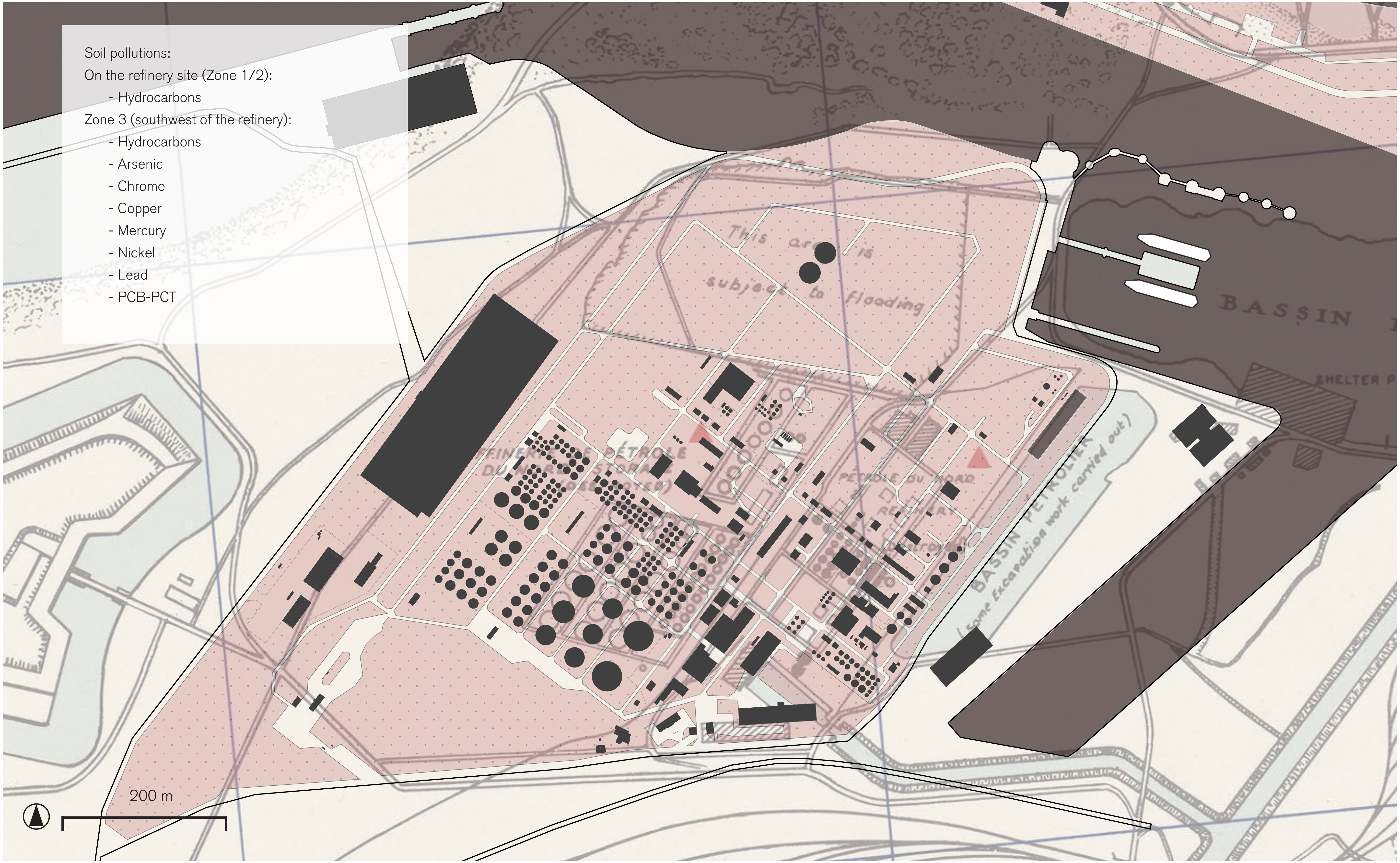


Pre-war refinery



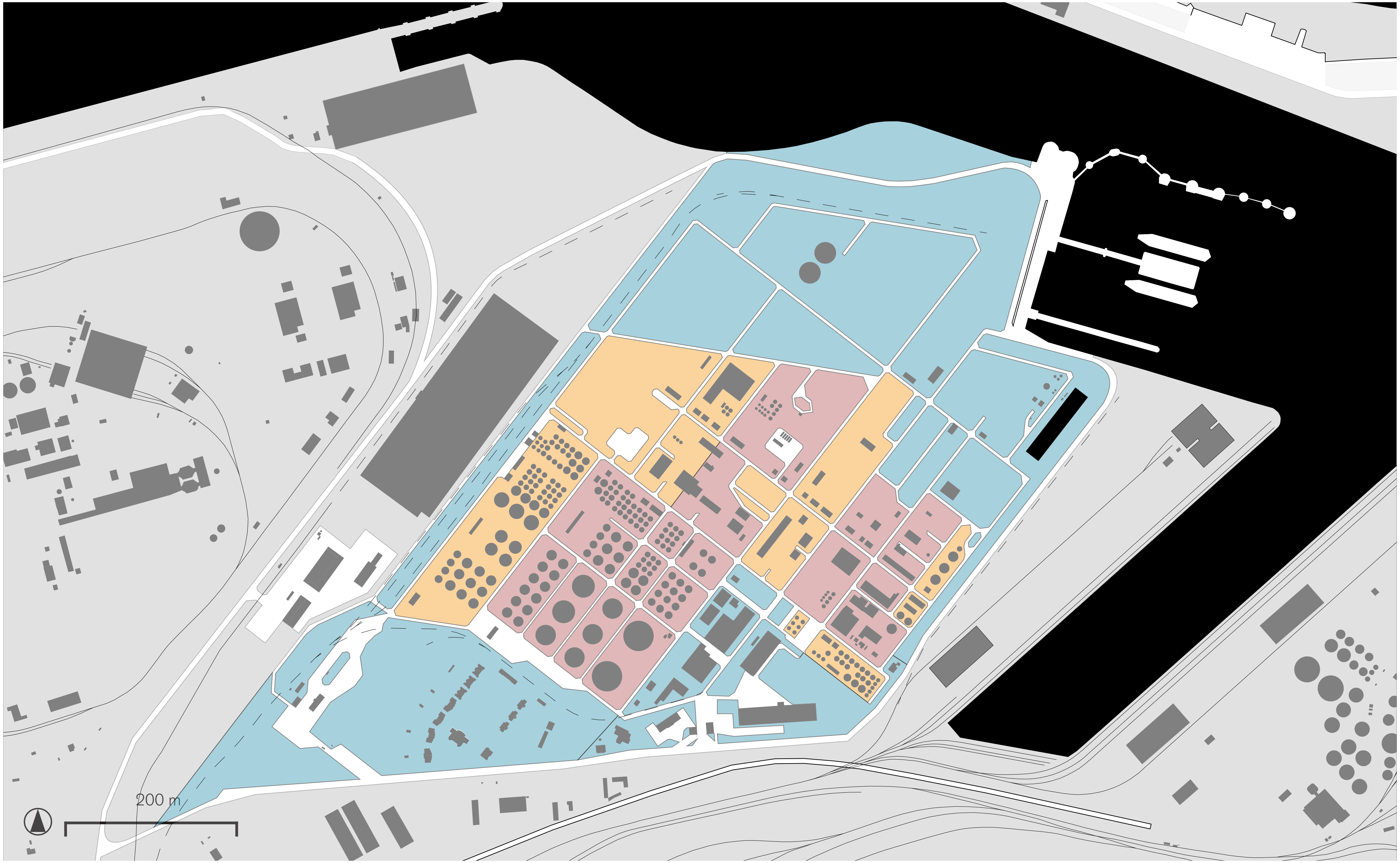
Excerpt from a 1943 map created by the U.S. Army

Pre-war refinery vs. Post-war refinery



Excerpt from a 1943 map created by the U.S. Army

Suspected soil contamination

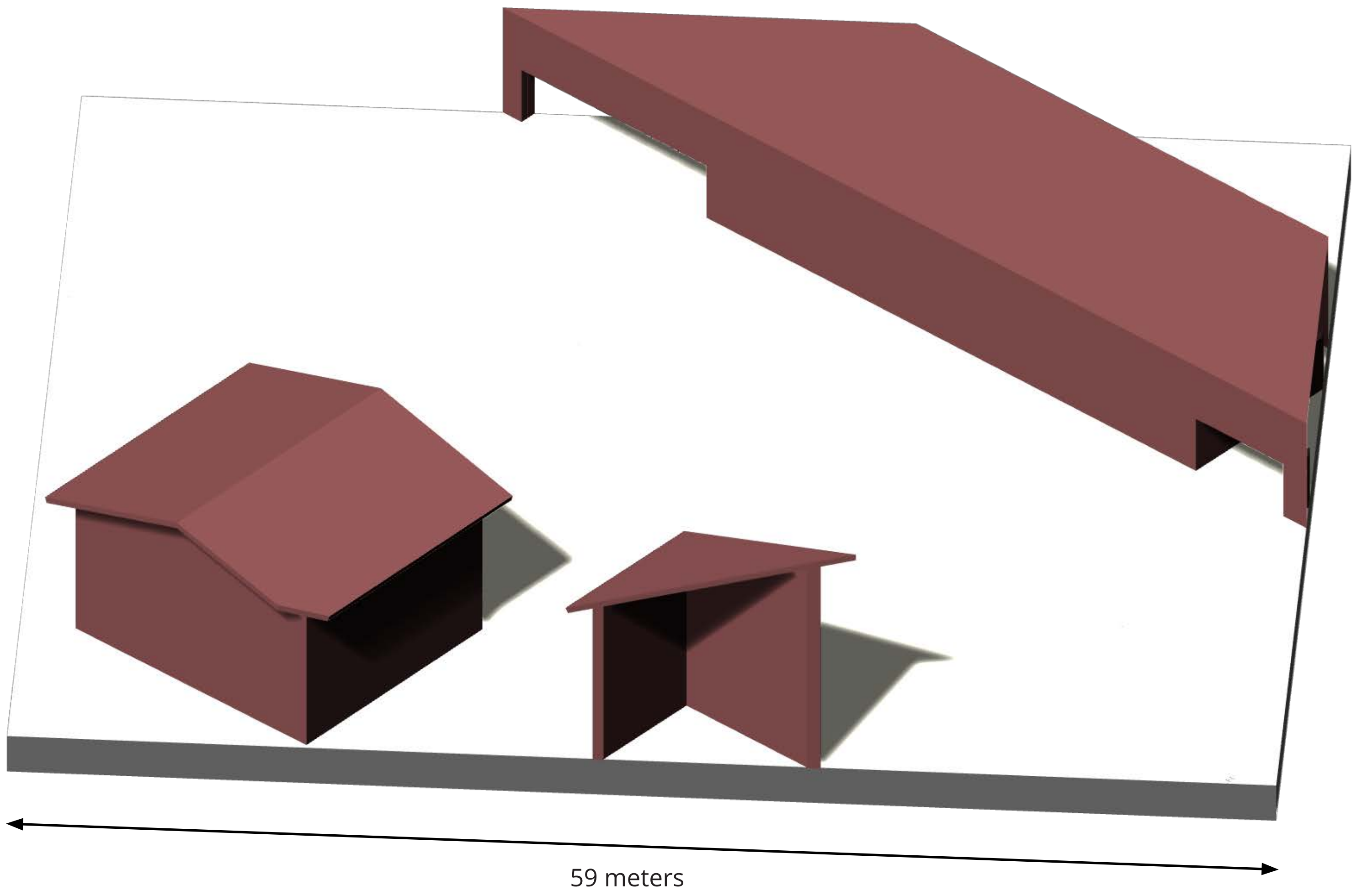


Structures (Buildings, installations) | Heavy polluted soil | Some soil contamination expected | No major soil contamination expected | Water | Outside plot

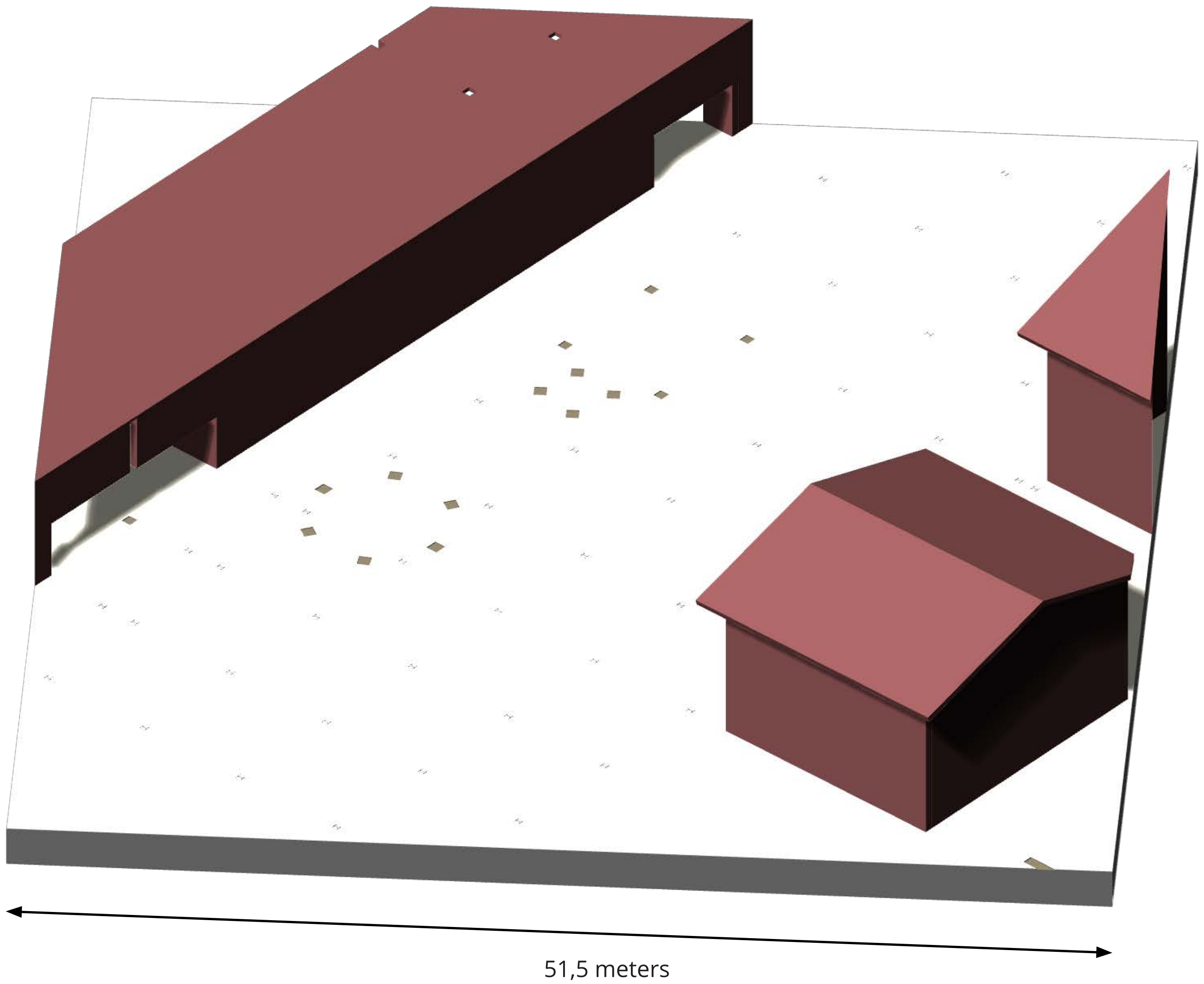
Refinery installations at The SRD Refinery of Dunkerque

On the next pages there will be an analysis of a typical refinery installation at the refinery of Dunkerque

Pump / Monitoring buildings (brick / concrete)



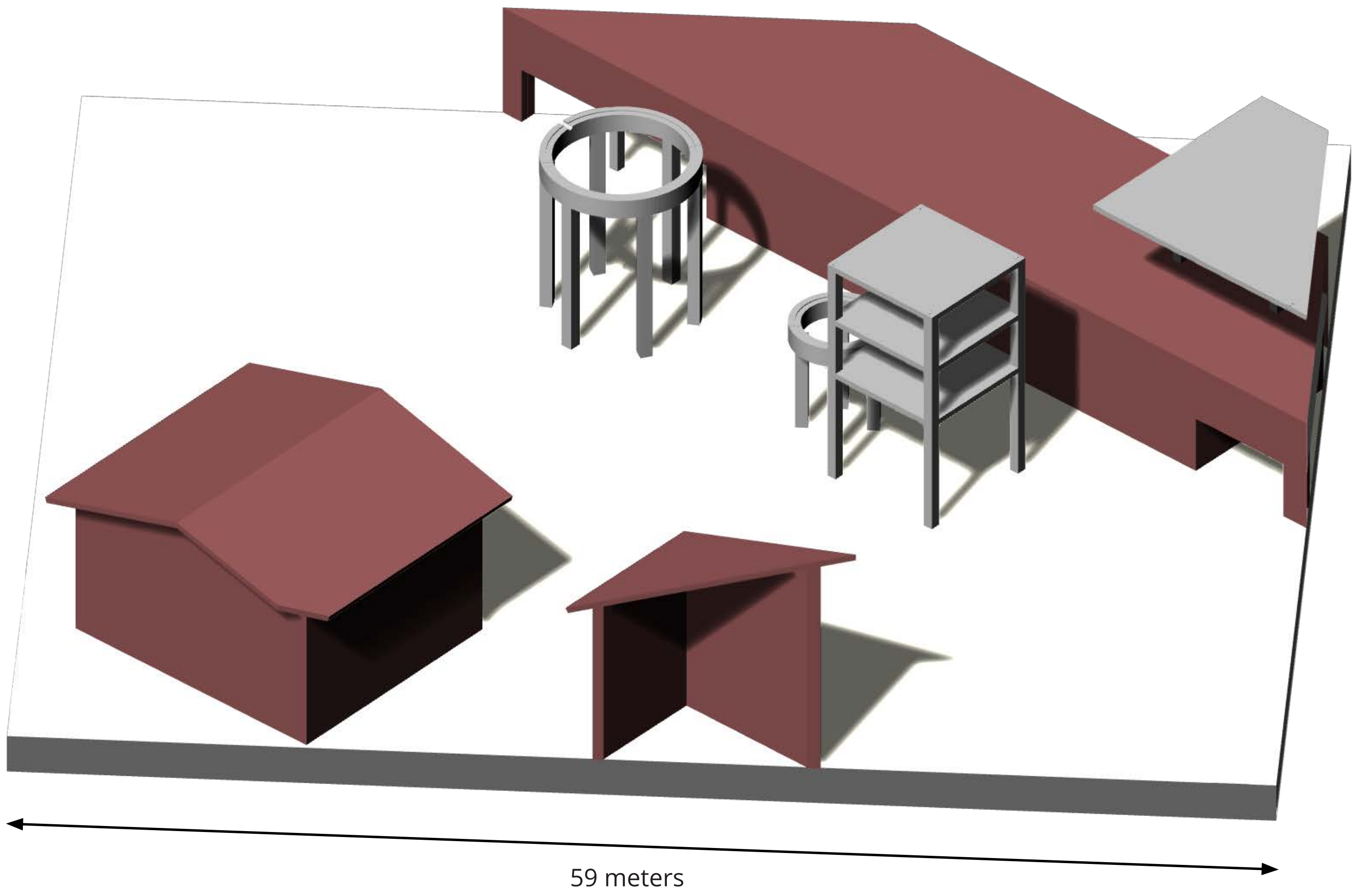
East isometric view



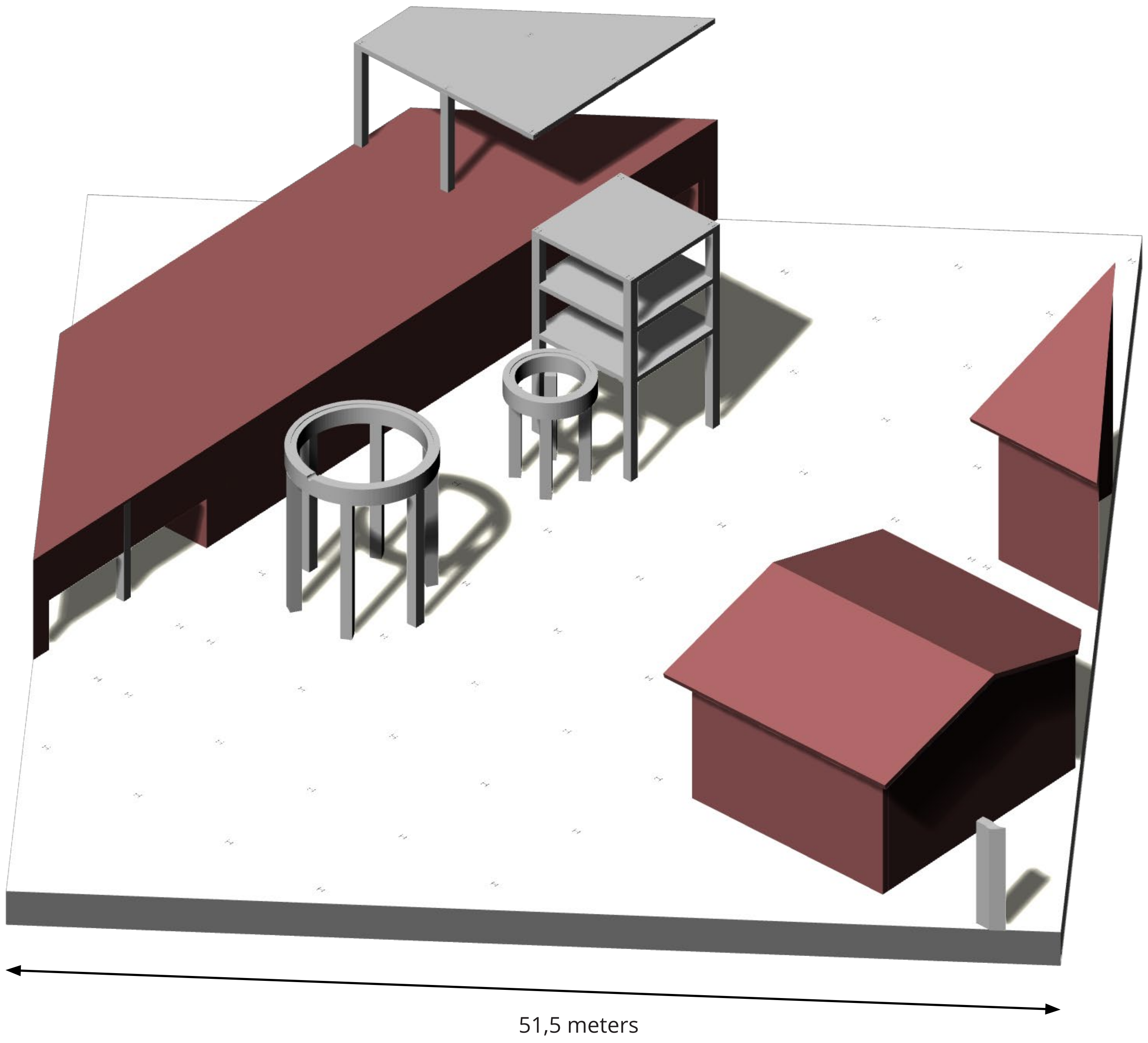
South isometric view

1:400 @ A3

Concrete foundations for installation



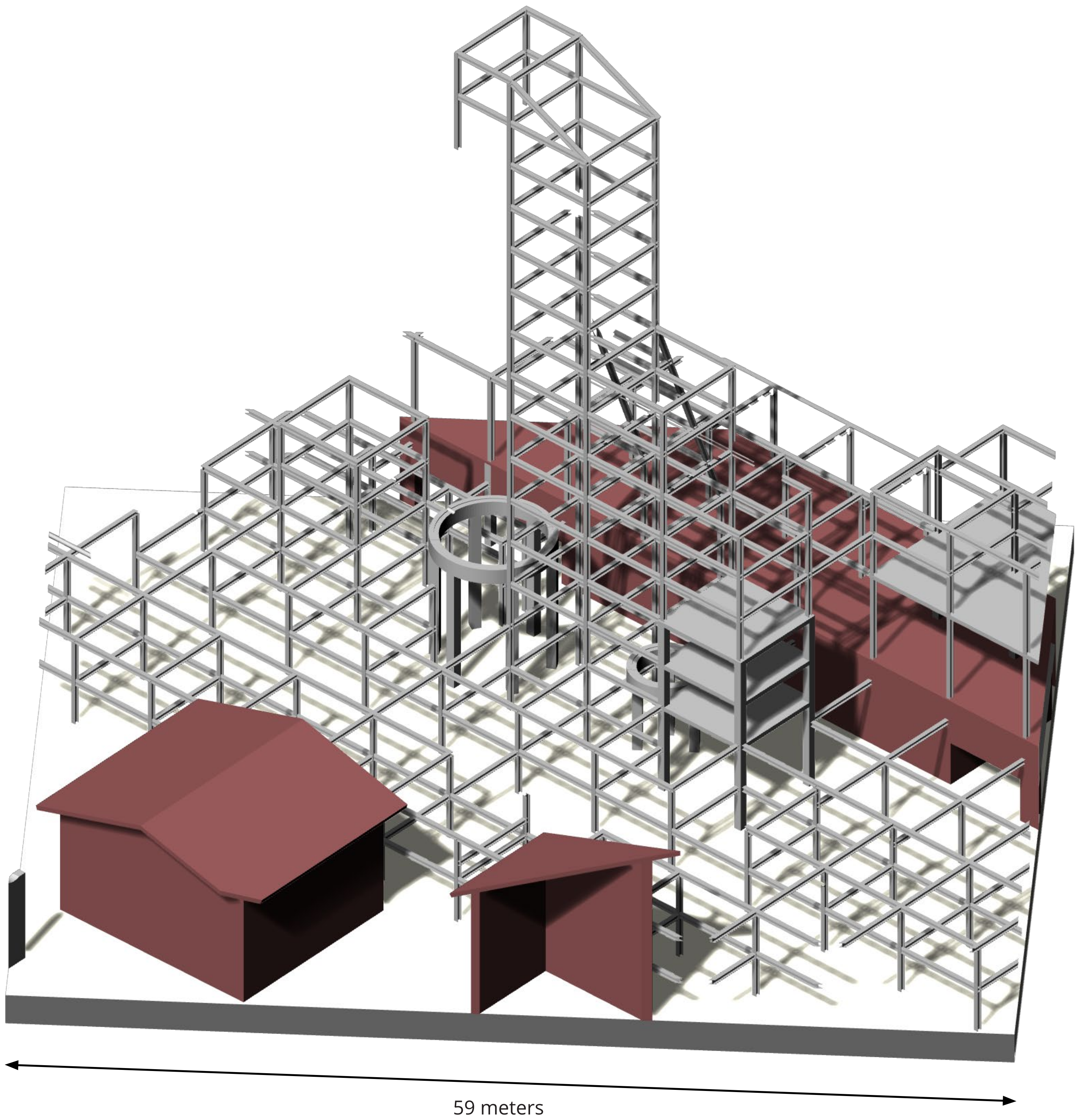
East isometric view



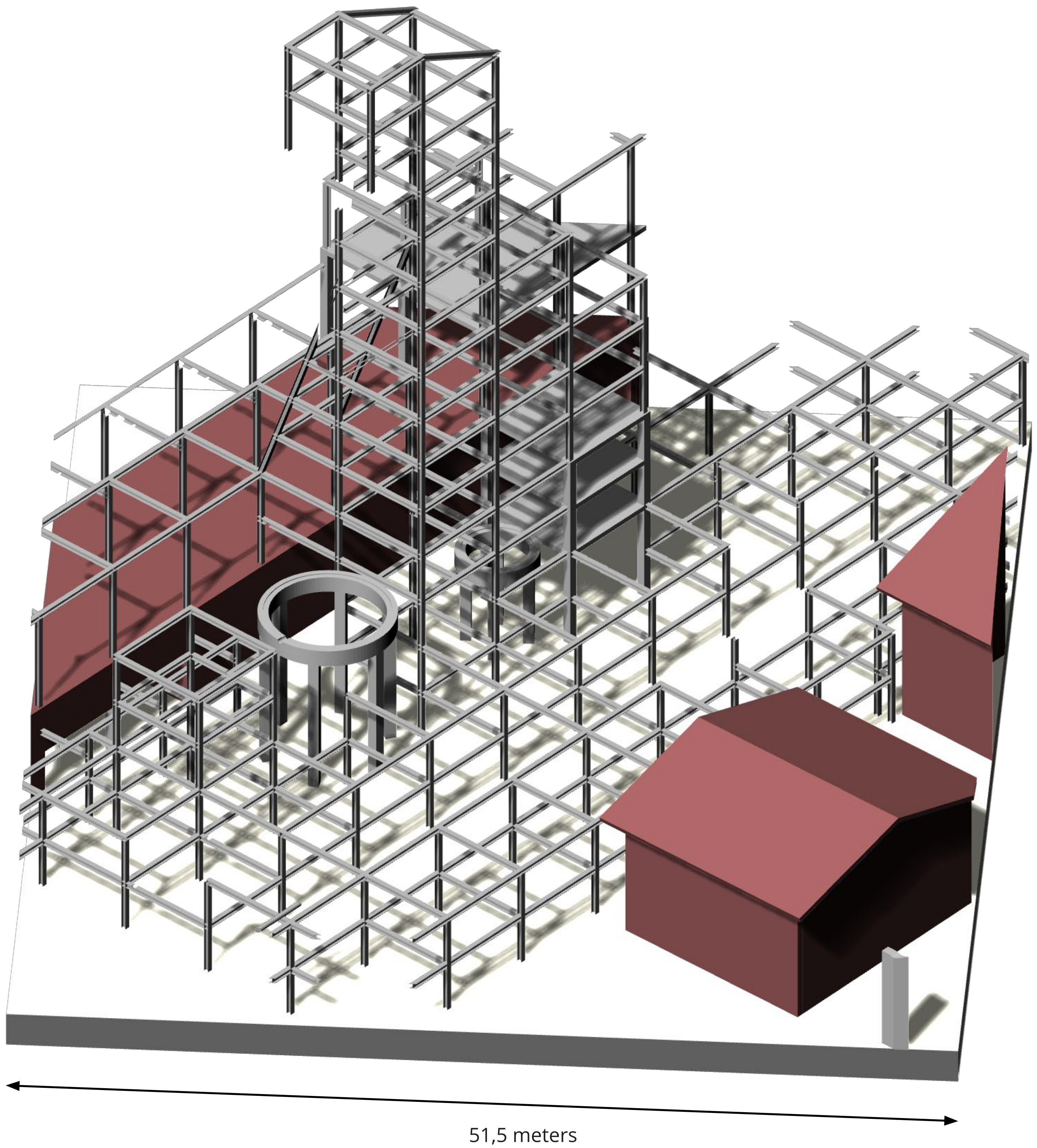
South isometric view

1:400 @ A3

Steel H-beam skeleton

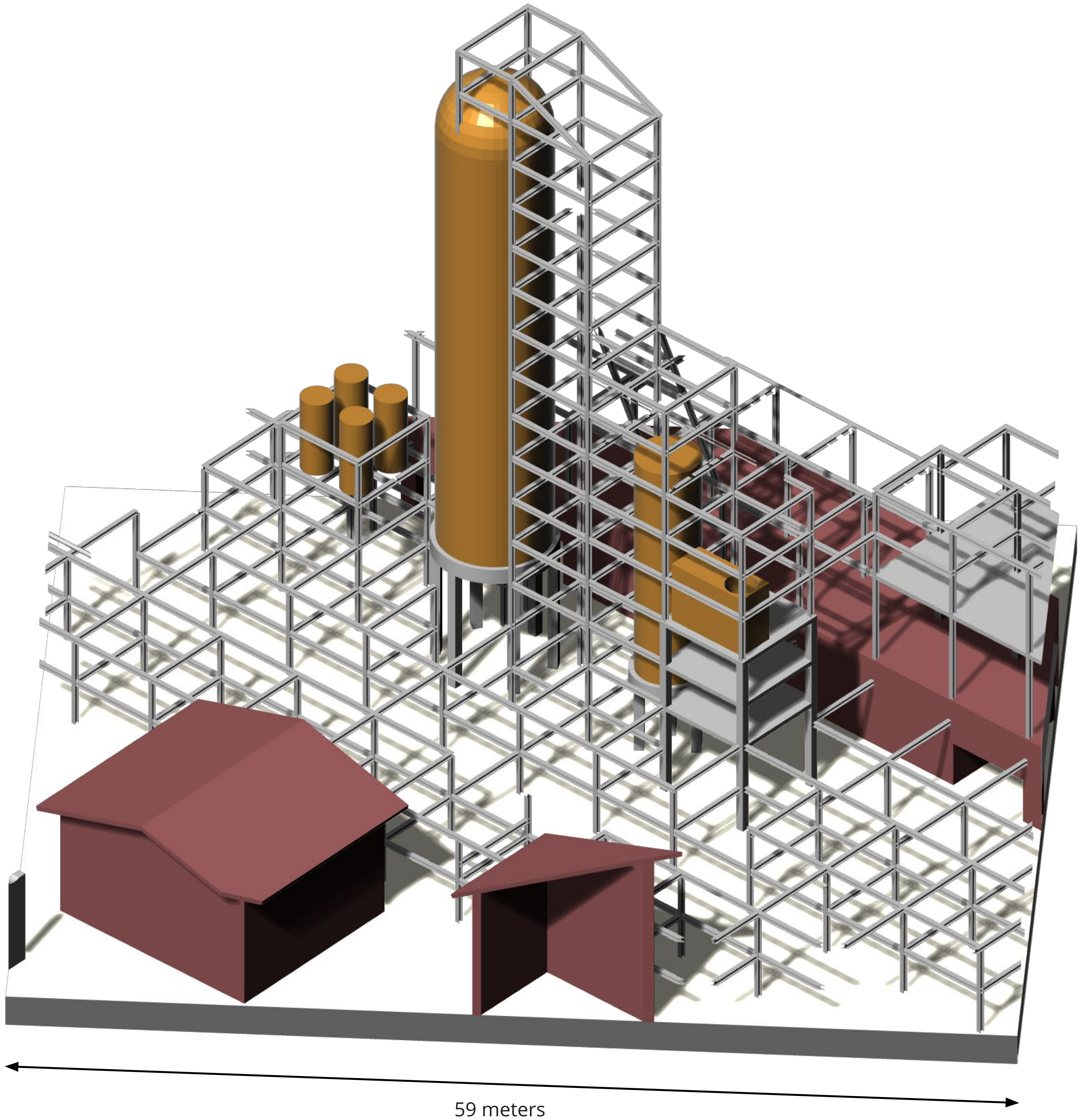


East isometric view

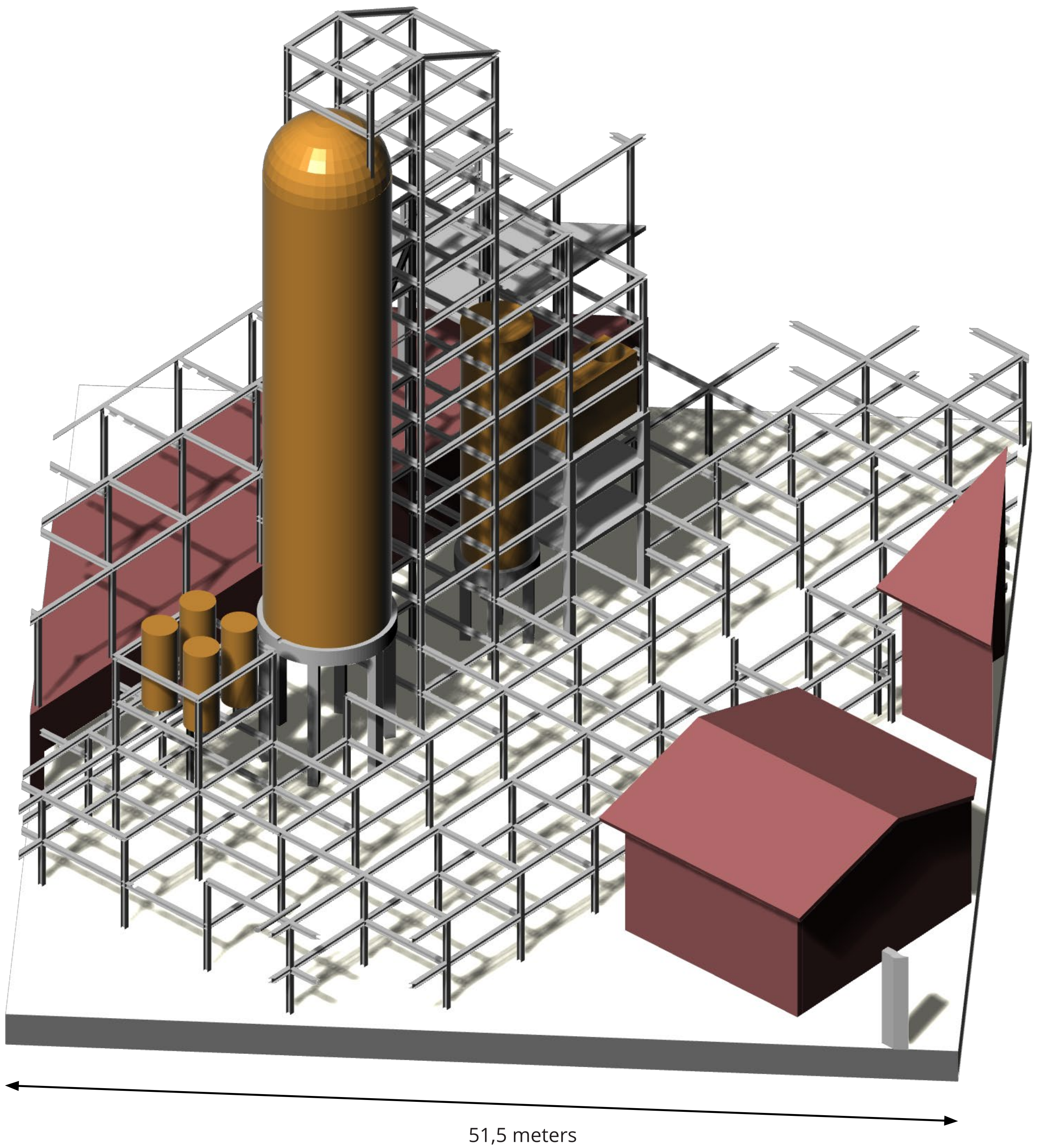


South isometric view

Furnaces, cracking / distallation drums



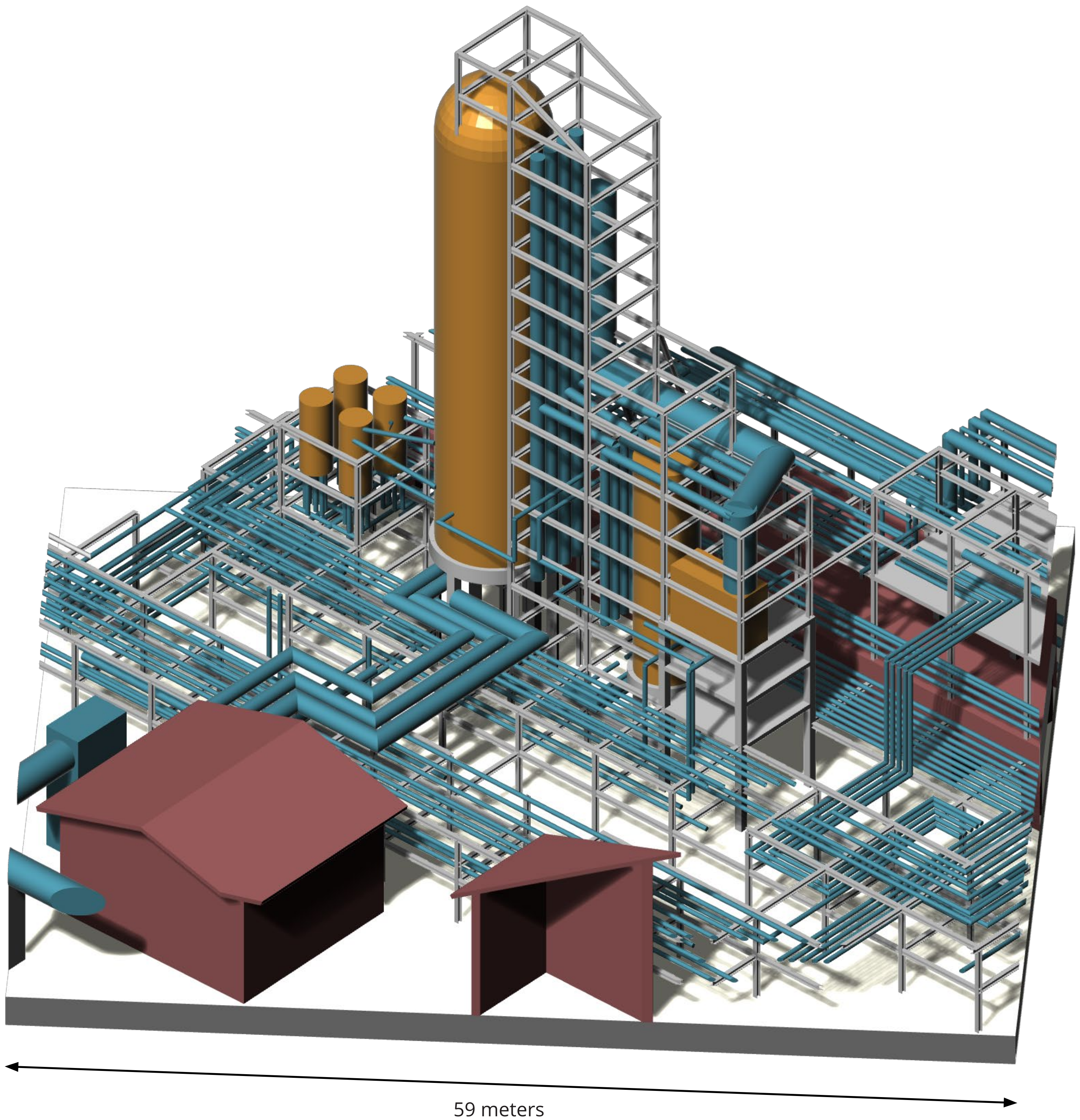
East isometric view



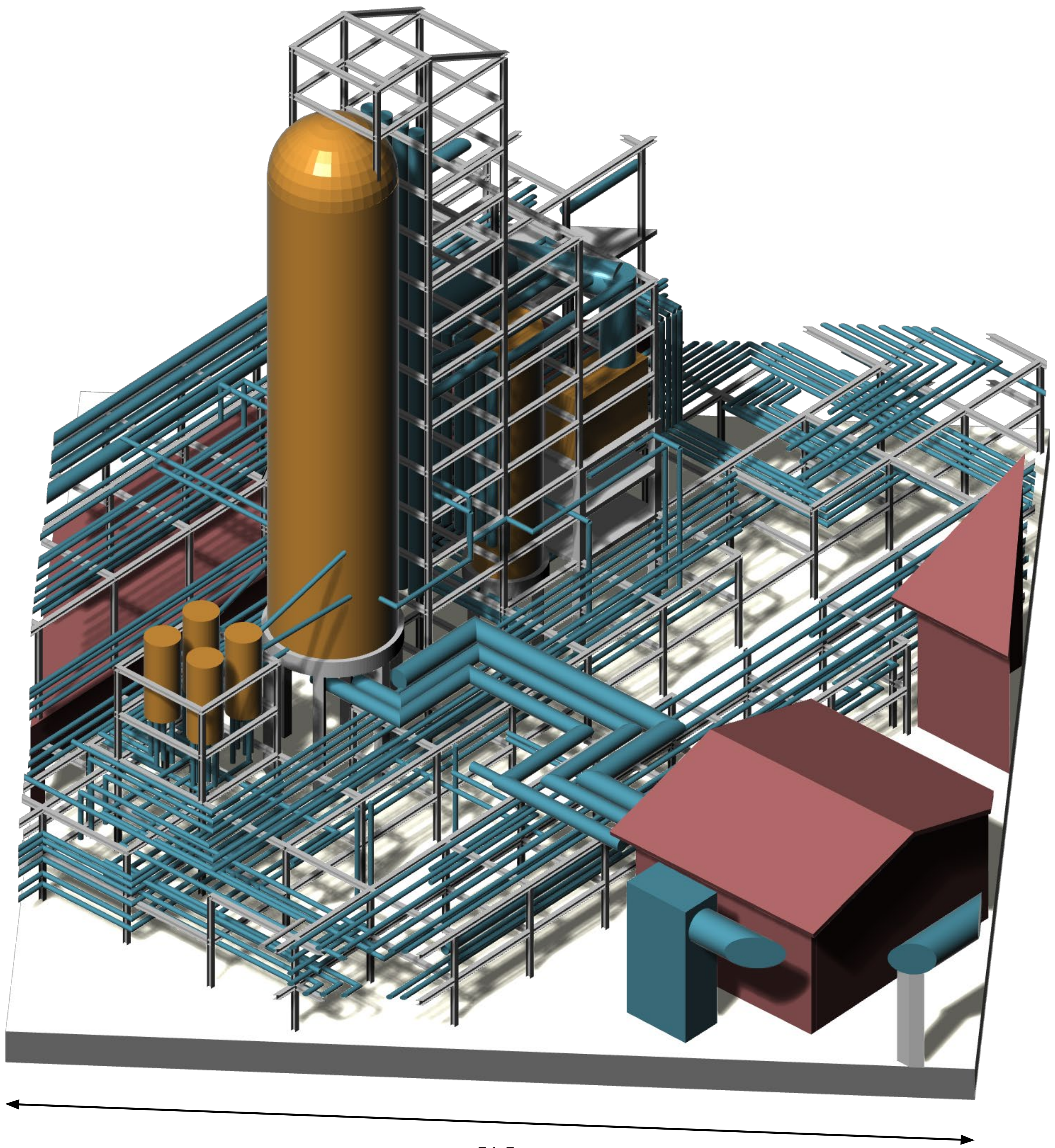
South isometric view

1:400 @ A3

steel piping for various purposes



East isometric view



South isometric view

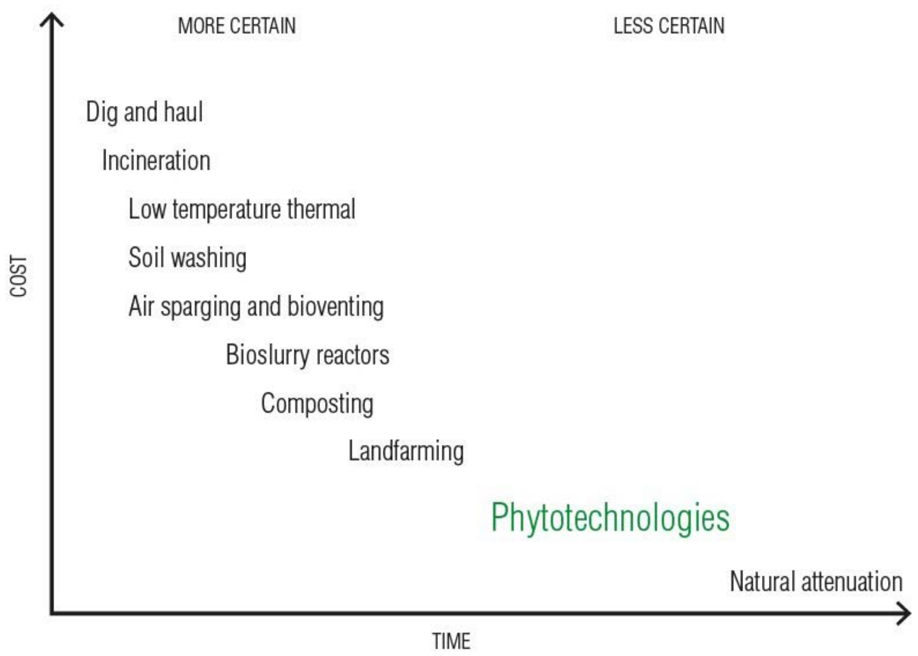
1:400 @ A3

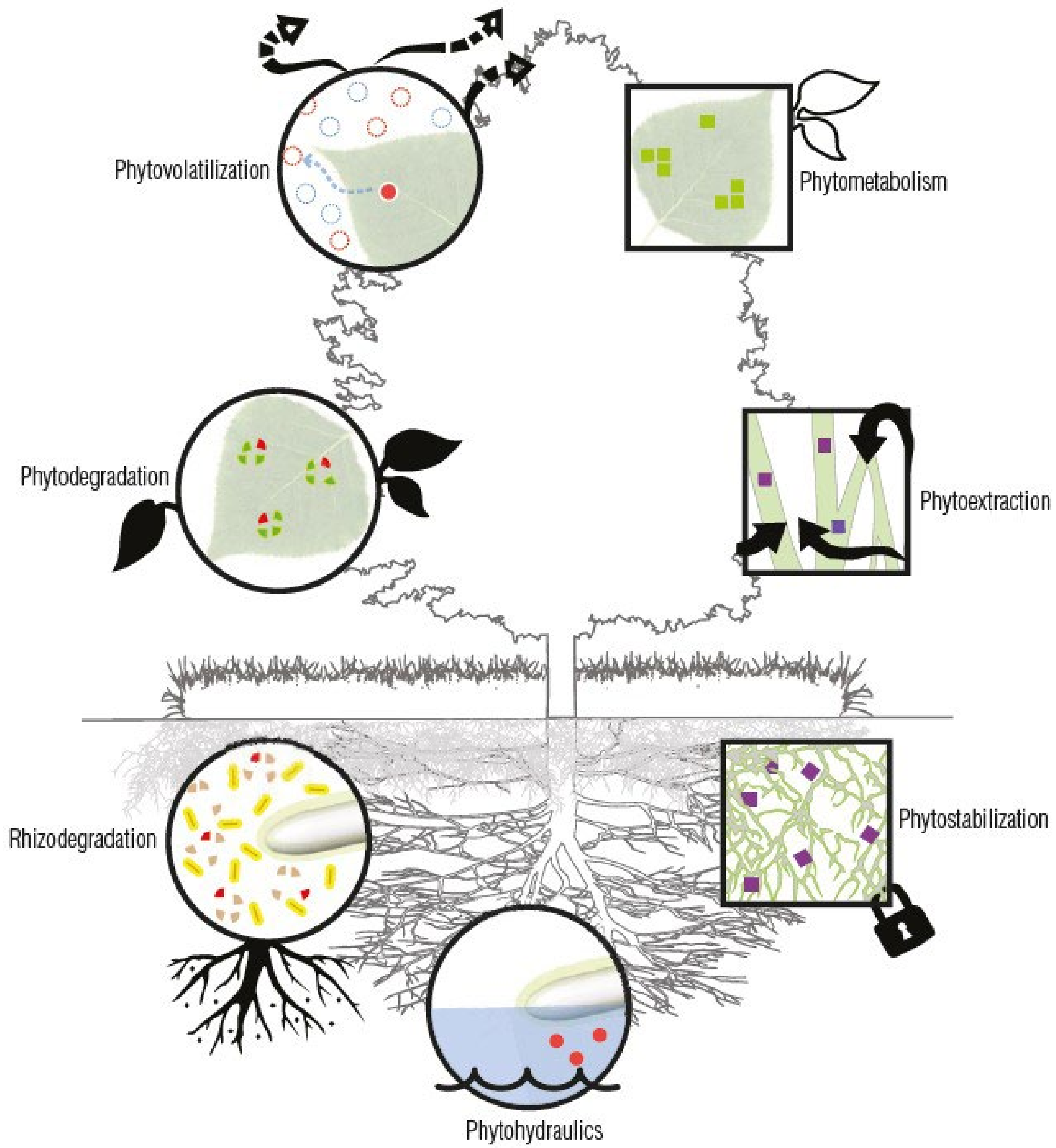
Phytotechnologies

A way of cleaning up the soil pollution is by means of phytotechnologies. Phytotechnologies can be used to remediate, keep in or keep out contaminants of soil and groundwater (Kennen & Kirkwood, 2015). One phytotechnology is phytoremediation, which is the removal of contaminants from polluted soil by plants.

Phytoremediation can be used to clean up polluted industrial sites, but it's a time consuming process, however it is much cheaper than most other contaminant removal methods. One of the main issues with phytoremediation is the time aspect, as well as the maintenance. Many phytotechnologies takes a few years to mature and than up to multiple decades until completion, and it is thus not suitable for sites that need quick remediation (Kennen & Kirkwood, 2015). Another problem is the uptake of contaminants by the roots of the organic matter. With some phytotechnologies this is stored in the plant and could be a potential hazard for the environment, but with some this is released into the air via the roots.

There are several phytotechnologies available, each with different purposes. Contanmiants can be in water, soil or air, and can be organic or inorganic. In the case of the refinery site of Dunkerque, we mainly deal with organic contaminants. The areas around the refinery have sites that are contaminated with heavy metals as well, due to different industrial processes taking place there. However, the site of the current day refinery has always been in use as a refinery site, so the pollutants list is limited and consists mainly of hydrocarbon pollution (Ministère de la transition écologique et solidaire, 2019).
Kennen & Kirkwood (2015) describe 8 phytotechnologies that can be implemented for remediation of contaminants. For organic contaminants all mechanisms can be used and for inorganic most. The start of the design report will give some more details about the different phytotechnologies and how they are used in practice.





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