BALANCE 4P: Balancing decisions for urban brownfield regeneration – people, planet, profit and processes

Technical report I

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1 Introduction

1.1 Background

Land take as a result of urbanization is one of the major soil threats in Europe. One of the key measures to prevent further urban sprawl and additional land take, is redevelopment of urban brownfields: underused urban areas with, in many cases, soil and groundwater pollution. The latter issue can be a bottleneck for redevelopment of brownfields instead of green fields. A difficulty for brownfield redevelopments is that in urban projects the responsibilities, tools and knowledge of subsurface engineering and urban planning and design are not integrated; they depend heavily on each other but work in sectors. The urban designer usually deals with opportunities for socio-economic benefits while the subsoil engineer deals with the technical challenges of the site.

The global-wide trend of urbanization increases the importance of careful spatial planning in cities (OECD & CDRF, 2010). When considering climate change, population growth and increasing human demands for the living environment, the sensibility of sustainable development and redevelopment of the urban area is clear (Roberts & Sykes, 2000). Whereas urban (re)development is a very old concept, *sustainable* development has more recently gained awareness worldwide (Hsu, 2014) (van Donk & Smit, 2009) (Gauzin-Muller, 2002), quickly gaining in popularity (Lakkala & Vehmas, 2013). In literature, several reasons have been named for this sudden increase in popularity of sustainable development: bad practices have led to sub-optimal solutions and unsustainable situations; population growth and the depletion of natural resources call for a change in development practice; and sustainability is now a well-known marketing strategy (Kumar, Rahman, Kazmi, & Goyal, 2012). This increasing trend in sustainable development can be seen in most aspects of society: food production, clothing, energy use, architecture, and more and more in the spatial planning field as well. In order to prevent urban sprawl, decrease of property value and to increase the future livability of the city, the redevelopment of derelict and often contaminated land within the urban area is needed (Chakrapani & Hernandez, 2012).

In the remediation sector, there is a broad on-going work to develop methods and tools that supports *sustainable* remediation. Remediation was earlier viewed as a sustainable action in itself, but today negative impacts of remediation are acknowledged, e.g. transport emissions and fatality risks, health risks during remediation, consumption of energy and materials as well as being costly (Vegter et al., 2003; SuRF-UK, 2010). There is today an increasing demand for assessing remedial activities with regard to all three of the commonly mentioned sustainability dimensions: environment, economy and society. The International Standard Organization (ISO) currently works on a standard for sustainability evaluation of remedial actions (ISO, 2014) and there are several SuRF (Sustainable Remediation Forum) organizations worldwide (USA, UK, Australia & New Zealand, Canada, Italy, the Netherlands, Taiwan and Brazil) that support this development. SuRF-UK suggested a general framework for assessing the sustainability of soil and groundwater remediation, broad enough to apply across different timescales, site sizes, and project types (Bardos et al., 2011). In accordance with Bardos et al. (2011), there are several attempts to incorporate sustainability in early phases of projects, as there is a general idea that the largest (sustainability) gains are achieved early in projects where they are still flexible.

The background to the Balance 4P project is the idea that a better cooperation between urban developers and sub-surface specialists in early phases of the redevelopment process can accelerate brownfield redevelopment and potentially identify more sustainable redevelopment strategies.

1.2 The Balance 4P project: objectives and participants

The Balance 4P project is mainly funded by the SNOWMAN network[1], together with funding from the Municipality of Rotterdam and in-kind contribution from VITO and Deltares, and the municipality of Göteborg. The overall aim of the project has been to develop a holistic approach that supports redevelopment of brownfields by integrating technical, economic and social aspects, and provide means for clearly communicating challenges and opportunities of site-specific subsurface qualities. By linking the holistic approach to rules and regulations implementation in practice will be enabled. The different technical work packages of the project aim to:

- apply and assess methods for *design of urban renewal / land redevelopment strategies* for brownfields that embrace the case-specific opportunities and challenges (WP3);
- apply and assess *sustainability assessment methods* of alternative land redevelopment strategies to evaluate and compare the ecological, economic and social impacts of land use change and remedial technologies (WP4)[2];
- develop of *a practice* for redevelopment of contaminated land in rules and regulations to enable implementations (WP5);
- describe the holistic approach in a concrete form in a decision process framework, pointing to steps to take, suggestions on existing tools and methods as well as important communication and participation tasks in the different phases of an urban renewal project (WP6).

The official project team consists of researchers with a diverse background, e.g. land management, urban design, urban planning, environmental economics, remediation & contaminated sites. Next to that, an important method in the project has been to work in a number of case studies (see Section 6), where also practitioners with different background has participated and contributed. During the course of the project, these practitioners have typically been categorized as surface and subsurface experts, but these two groups are in fact consisting of people with different expertise areas, e.g. urban planning, landscape architects, archaeology and cultural heritage, waste and waste water, geotechnics, remediation to mention some. Thus, at the core of this project has been the pronounced aim to try to bridge across competencies: research – practice and surface – subsurface. All participants have been forced to turn their views and to compromise, which in fact, has been a true resource for the project as a whole.

[1] http://www.snowmannetwork.com/main.asp. The SNOWMAN network is a transnational group of research funding organizations and administrations in the field of Soil and Groundwater in Europe. The Balance 4P project was funded in the 4th SNOWMAN call, by **SKB** - Sustainable development of the subsurface (NL), **OVAM** - Openbare Vlaamse Afvalstoffenmaatschappij Flanders (BE), and **Formas** - Forskningsrådet för Miljö, Areella näringar och Samhällsbyggande (SE).

[2] Originally WP4 aimed at developing a new method for sustainability assessment of redevelopment strategies, but this objective was slightly changed during the course of the project due to the multitude of tools and methods already available and applied in the three countries and a greater focus on when and how available tools are suitable.

1.3 Aim and scope of report (Final report Part I)

This report aims to describe the work done during the period 2013-10-01 – 2014-12-31 in the Balance 4P project. Specifically, the report contains:

- The outline of the holistic approach and a proposed decision process framework (Section 2);
- A comparison between the planning systems in the Netherlands, Flanders and Sweden and identification of chances to enhance the subsurface in the current planning systems (Section 3);
- Methods for stakeholder analysis and generation of sustainable redevelopment strategies including the subsurface (Section 4);
- Methods for sustainability assessment of redevelopment strategies with special focus on social aspects and ecosystem services (section 5); and
- Presentation of three case studies of brownfield redevelopment where the interactions between surface and subsurface have been considered in different ways (section 6).

This report is the first part of the final reporting to the SNOWMAN network, and will be complemented by a second part with detailing on the decision process framework (Section 2.2), a work that will be carried out during spring 2015.

1.4 Target groups

There are a number of different target groups the results of the project are aimed at:

1. The project partners and the "SNOWMAN community", i.e. the direct stakeholders, end users, professionals and students involved in the project;
2. The professional community, i.e. as practitioners close to, but not joining the project, primarily related to the environmental and spatial planning fields and includes, among others, commercial developers;
3. The scientific community on the European level;
4. The wider community, i.e. people not involved in the environmental and spatial planning field, but interested in the project (e.g. national or regional regulators) and especially the cases (e.g. local regulators, local community in vicinity of cases, etc).

Although the project results are interesting for the above target groups, the main user envisaged for the Balance 4P framework are municipalities or regional authorities, as many brownfield redevelopment cases start with the intervention of municipalities or regional authorities: "Their actions, or inaction, have a decisive impact on the manner and pace at which brownfield land is brought back into beneficial use, or the degree to which it might remain under-used or derelict" (HOMBRE project). Illustrative: for two (Rotterdam City harbour, The Netherlands and Fixfabriken, Sweden) out of three Balance 4P cases, the municipality is in the lead for the redevelopment. If a site is easy to redevelop, market parties will take the lead. In one case (Fixfabriken), the developer has initiated the process for one part of the site, but the municipality is in charge of the planning process necessary to redevelop the area. The municipality has an important role in the more difficult cases and can contribute to the overall goal to improve quality of the surroundings by supporting

brownfield redevelopment. For municipalities, it is important to focus on broader sustainability targets, and that locations fit in the surroundings to contribute to the municipalities' long-term ambitions and program. The Balance 4P framework can support the municipalities in this task. For the third case (Alvat, Flanders) the regional authority also plays an important role in remediating the site up to a level so that market parties get interested to redevelop and take the lead. Without intervention of the authorities, the site will not get redeveloped.

1.5 Terminology

1.5.1 Circular land use and management

Circular land management is the process of handling developed land, from the viewpoint of a continuous land use cycle that is aimed at facilitating smooth land use transition, thereby preventing unnecessary brownfield emergence.

Also the different management phases are interlinked in a continuous management cycle that does not just cover the transition phase itself, but starts already during the use phase, when changes in the benefits of the current land use and actual demand for services can be anticipated. Planning a well-managed transition can then be taken up in an early stage. Similarly, a forward looking perspective is used in the management and monitoring of the sustainability of the services provided by the new use, to prevent that its benefits will be too short-lived. (HOMBRE Brochure, 2014)

Figure 1.1. The HOMBRE Zero Brownfield framework: administrative land management cycle (right cycle) addressing land use transitions in the land use cycle (left cycle). (HOMBRE project: Gaans & Ellen, 2014)

The land use cycle is considering developed land as a resource in a continuous rotation of development, use, abandonment, redevelopment and re-use. The end of a given use phase may or may not be a formal and adequate decommissioning of activities and clearance of the site. Ideally, it should be followed by the onset of development activities to realise subsequent use. Where the end of the current use phase and the transition to the subsequent use are not well managed, there is a risk that the site may turn into a brownfield.

1.5.2 Different colours

There are a number of different terms in the literature in the field of land regeneration and redevelopment, e.g. Greenfield, Greyfield, Brownfield and Blackfield.

Greenfield

A greenfield is a site in undeveloped, natural condition or one that is in agricultural use (Aurbach, 2005).

Greyfield

The term greyfield is not commonly used in Europe, but in the USA (EPA) it is an official term, defined as:

> *Greyfields are economically obsolescent, outdated, failing, moribund and/or underused real estate assets or land (EPA water office, 2012). Typical greyfield sites are commercial properties, previously used as parking lot, shopping centers and shopping malls, hotels or office buildings or multiple family residential buildings (Aurbach, 2005 and Wurzler & Diluigi, undated).*

Brownfield

The underneath definition and elaboration is taken from the CABERNET network (Cabernet website, undated). Definition:

> *A brownfield is a site that has been affected by former uses of the site or surrounding land, is derelict or underused, mainly in fully or partly developed urban areas, require intervention to bring it back to beneficial use; and may have real or perceived contamination problems.*

Brownfields result from changing patterns of industry and development in many regions. The loss of the industry, the resulting unemployment and the reluctance of new investors to take on the technical problems and liabilities associated with brownfield sites, affect the economic prosperity of the region, particularly in urban locations. Municipalities are often unable to revitalise brownfield from within their own resources, and their city centres and environments remain degraded and under-utilised.

In common usage, brownfields refer to previously developed land or derelict, encompassing a range of sites in terms of size and location. Specifically, CABERNET has defined brownfields as sites which:

- have been affected by former uses of the site or surrounding land;
- are derelict or underused;
- are mainly in fully or partly developed urban areas;
- require intervention to bring them back to beneficial use; and
- may have real or perceived contamination problems

CABERNET has reported different definitions for brownfields used in different member states of Europe (Oliver et al, 2005).

Blackfield

"Blackfield" is throughout Europe and the USA not a commonly used term. In Belgium however, OVAM uses it as an official term for the very difficult to redevelop brownfields (a "C-site", see the description of ABC sites in the next section 1.5.3).

OVAM defines blackfields as follows (OVAM website, undated):

> *Blackfields are underused sites that need redevelopment but where the soil is so contaminated that private initiatives do not take place. Without intervention of governmental organisations, these sites will remain. This is considered as a serious problem, because pressure on open spaces will grow. The blackfields are as well large former industrial sites as well as smaller sites, often in the centre or on the boundaries of cities. These sites have a negative influence on their surroundings.*

1.5.3 ABC sites

The current ease (and hence speed) at which brownfield sites are being redeveloped, depends largely on the perceived cost/benefit ratio of a redevelopment project (Type A, B, C site; Figure 1.2). For type A-sites, circular land use is realised through market mechanisms. For B sites, market mechanisms are normally not enough to start the redevelopment. Public-private partnerships are a solution to start up redevelopment. C-sites are the most difficult brownfields where a multitude of problems (eg heavy contamination, unfavourable location or conditions, etc) hamper the redevelopment. Public intervention is needed to start redevelopment. Sustainable land management should ensure that all land is used well and facilitate that also type C-sites move faster through the land use cycle (Ferber et al., 2006).

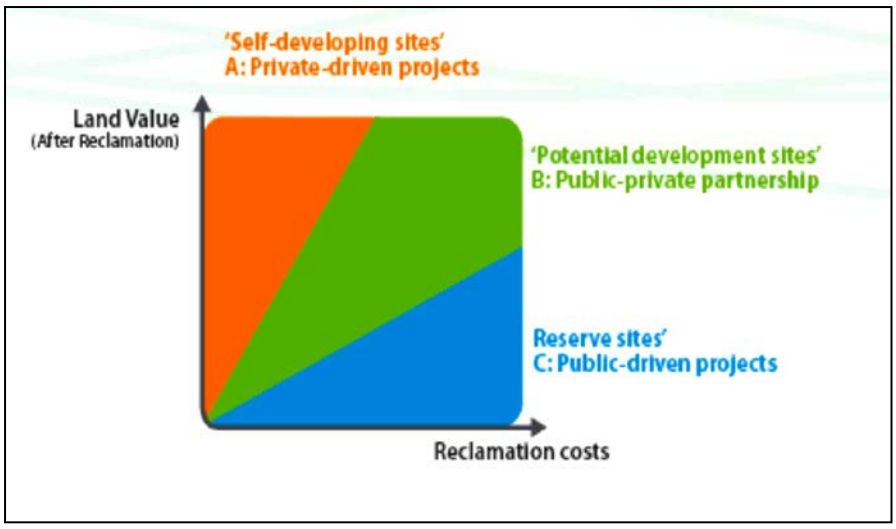


Figure 1.2. Schematic overview of A, B, C type brownfields (Ferber et al, 2006).

Currently in Europe it is unknown how many brownfield sites exist that are difficult to redevelop (sites type C) as each country has own definitions for brownfields. (e.g. in Belgium, the term “blackfield” is used for a C-site). A site can therefore be identified as a persistent brownfield in one country whereas in other countries the brownfield labelling remains absent.

2 The Balance 4P holistic approach to brownfield redevelopment

2.1 The holistic approach

Unifying the subsurface and surface in a holistic approach according to Balance 4P is based in a strategy for action. The leading strategy of action in the project itself has been finding balance and synergy between the three P's of the Triple Bottom Line (Johannesburg 2002); People, Planet and Profit/Prosperity, that are at the base of an urban project. This complex process requires innovative and strategic action, with in-depth knowledge of aspects and new conceptual ideas on their integration in a given situation. This crucial strategic activity, that we consider at the base of sustainable urban development, is captured by Van Dorst and Duijvestein (2004) by introducing the fourth P of Project and/or Process to the triple bottom line, representing the strategy of action (Figure 2.1).

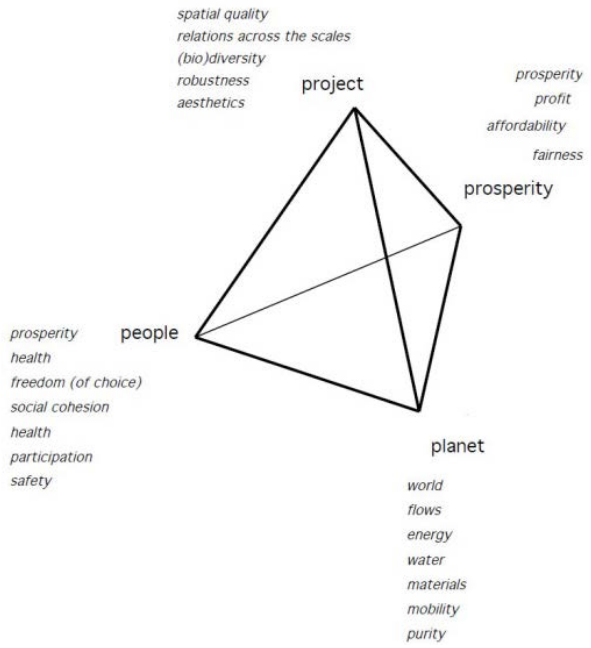


Figure 2.1. The tetrahedron of sustainable construction based on the sustainability triangle, after Johannesburg 2002: People, Planet, Prosperity and associated themes. (Van Dorst & Duijvestein, 2004)

The fourth P represents Project in which the skill is represented that integrates sustainability aspects in a balanced design that warrants spatial quality. The skills that are referred to with Process are about the interaction between stakeholders and their institutional context to realize this design (Van Dorst & Duijvestein, 2004). Important part of the Balance 4P research is therefore the analysis of the possible chances or challenges for integrating the subsurface engineering and urban planning sectors by formal institutions (regulations), informal institutions (how things are usually done) and technological entrepreneurship (process of cooperation between the professionals). The planning systems and building practices in the three participating countries, the Netherlands, Sweden and Belgium (Flanders), are studied resulting in the contribution to the holistic approach.

The holistic approach according to Balance 4P is a conscious act/activity of integrating subsurface aspects in the redevelopment process for the purpose of more sustainable land management. This approach should be applied to all aspects of the urban planning system. Figure 2.2 shows how the

planning system is a process in which the radars of law, regulation, policy and institutions work together on different scales the influence each other and set the planning conditions for urban (re)development. The urban (re)development consist of four phases that are interrelating. The initiate and plan phase are part of the plan process, the realization and maintenance phases of the implementation process. The plan phase has been made more specific in dividing it into a definition, design and preparation step. The design process is done during this phase. This mainframe is applicable to the three countries in the study (see Figure 2.3)

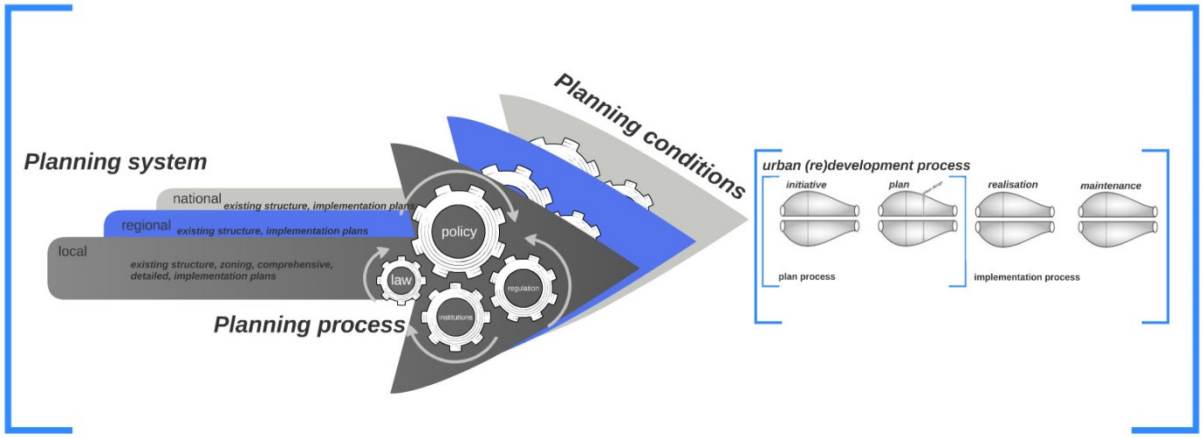


Figure 2.2. The holistic approach is operating within planning conditions that are the result of all levels in the planning system (local, regional, national) and their respective laws and regulations, policy and institutions.

The holistic approach that Balance4p proposes the integration of the subsurface in day-today-planning and urban development practices. There are four spatial planning subjects, which are in common in the three planning systems (NL, BE, SE) and which can be expanded to subsurface: heritage, environment, nature and water.

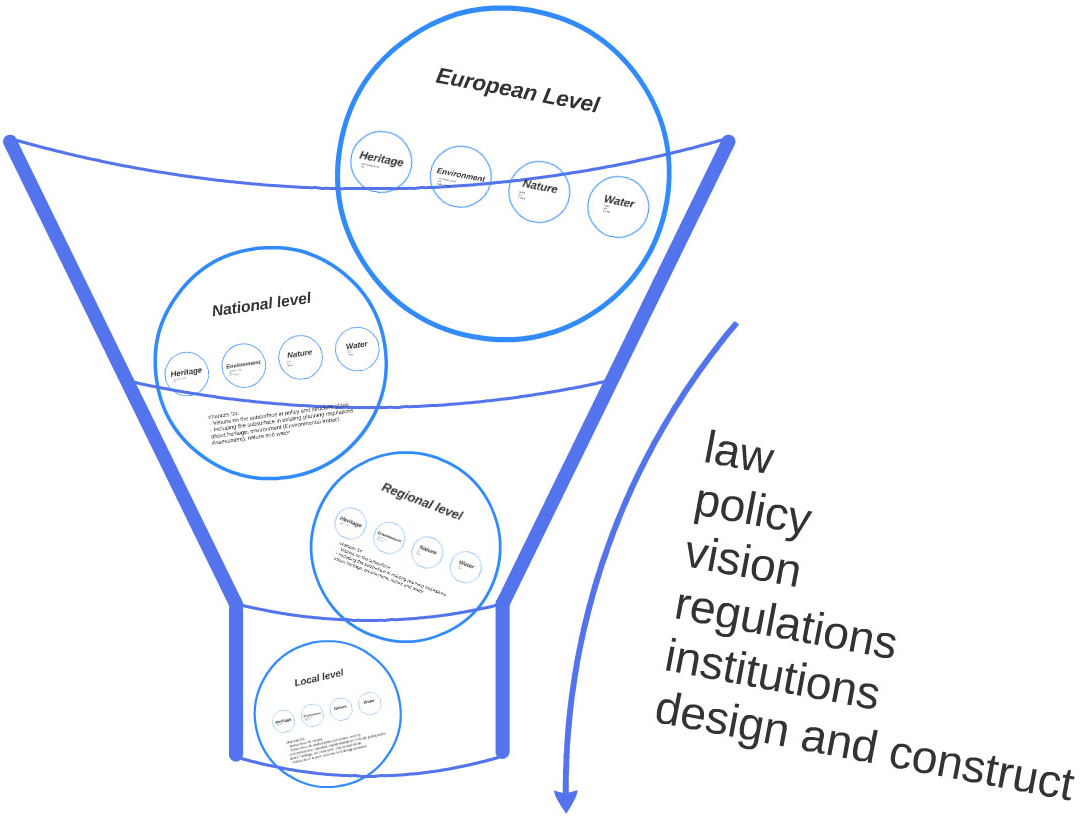


Figure 2.3. The levels of governance in which the spatial planning subjects heritage, environment, nature and water already, have a strong position.

For these four urban aspects the integration of above- and underground aspects can be enhanced in different ways: 1) in law and regulation, 2) in policy and vision, 3) by structured knowledge exchange, and 4) in the design/construct process), see the summary in Table 2.1. (This is further elaborated in Section 3.) For each regular planning theme different aspects of the subsurface can be integrated; here the four categories of subsoil qualities (Hooimeijer & Maring, 2012) are used to give an indication of the possibilities. The categories are:

1. Civil Constructions (archaeology, underground building, cables and pipes, foundations)
2. Water (storage and filtering capacity, drinking water)
3. Energy (ATES, geothermal and fossil energy)
4. Soil ecology (clean soil, morphology, ecology, landscape diversity, minerals)

Table 2.1. Summary of chances for enhancing subsurface into the current planning systems with regard to four aspects: heritage, environment, nature and water.

World of Planning →	Heritage	Environment	Nature	Water
Law and regulation	Chances for: - Including the subsurface in planning regulations about heritage, environment, nature and water - Including the subsurface in Environmental Impact Assessment and Water Assessment Test - Subsurface in zoning plans through paragraphs about heritage, environment, nature and water			
Policy and vision	Chances for: - Visions on the subsurface in structure plans			
Knowledge exchange	Chances for: - interdisciplinary cooperation - developing new knowledge - knowledge management to handle uncertainties in qualitative manner			
Design/construct	Subsurface in plan process and design process needs: - Better frame of reference - Better instruments (subsurface potential map) - Culture change from how it is done now			
World of subsurface→	Civil constructions Soil	Civil constructions Soil Water Energy	Water Soil Energy	Water Soil Energy

For a truly holistic approach to be able to operate, subsurface is ideally enhanced by all four ways. Law and regulation can enforce subsurface aspects and this would be demanded of the people in charge of the planning process if included in policies and visions. Thus, a holistic approach to integration of the subsurface in planning will be operating within the context of the existing planning systems, see Figure 2.2. Next to the view on how an holistic approach in the whole planning system could be implemented, the focus Balance4p is on knowledge exchange as a key for better integration of the subsurface in to surface urban development: it enhances interdisciplinary cooperation, it could lead to new knowledge

Crucial for efficient knowledge exchange is to deliver *the right information in the right format, at the right time and at the right place*[3]. The information should be delivered in a format that is understandable to the receiver ("show the maps but be the legend yourself", Postma, 2011). As the format of the knowledge exchange is typically not regulated, there is also a need for someone to orchestrate this knowledge exchange, i.e. there must be someone consciously including this activity within the planning process. Thus, the holistic approach is depending on the people involved in the planning process.

[3] *This conclusion was derived from the BIELLS project, 'Bodem Informatie Essentieel voor Landelijke en Lokale Sturing' (The Netherlands) eg Busink & Schouten, 2006*

2.2 A proposed decision process framework within the holistic approach

The decision process framework concentrates on chances for knowledge exchange within the redevelopment process, i.e. to enhance knowledge exchange between the two worlds of the subsurface and the surface sectors. Specifically, it aims at supporting the user with regard to WHO should be involved in the knowledge exchange and HOW the knowledge exchange can be realised, i.e. with regard to which tools and methods can be used to enhance knowledge exchange between surface and subsurface. The WHO and HOW is depending on the phase of the redevelopment process. The aim of Balance 4P is to integrate subsurface in early phases, the initiative phase and the planning and design phase of the redevelopment process, to enhance chances for sustainable brownfield redevelopment, see Figure 2.4.

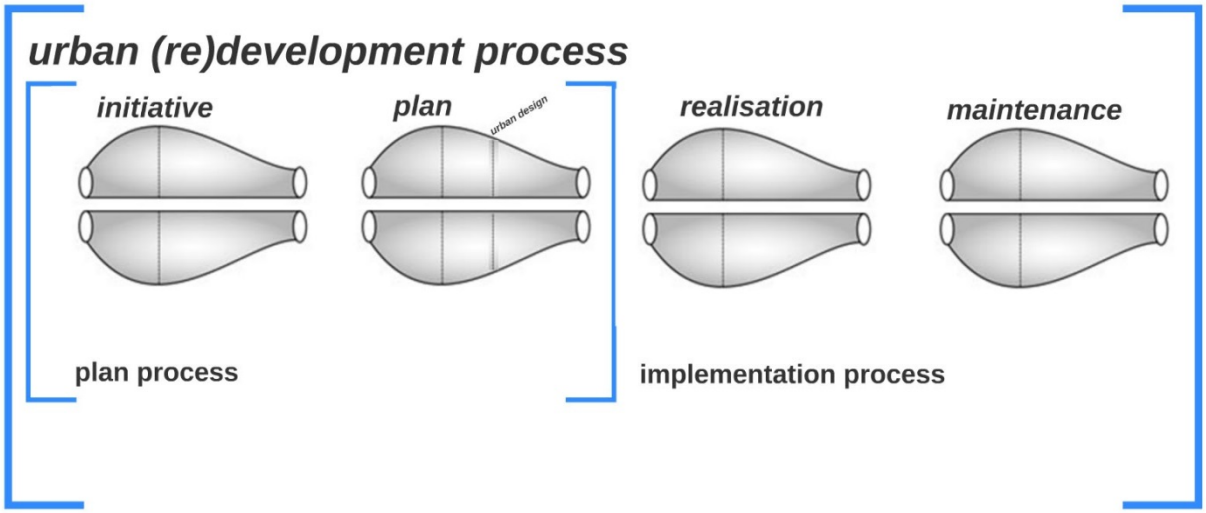


Figure 2.4. The urban (re)development process has a regulatory context (the planning conditions) and includes a plan process and an implementation process, each with different phases.

In the redevelopment process the holistic approach is defined by an iterative process of project phases that are characterized by the 4p strategy of action, in which stakeholders, planning conditions, site conditions, ambitions and future use, and the development of products (like visons, urban plan or implementation plans) are investigated and/or activated. This counts for the surface as well as the subsurface. The focus within the phases is first diverge and then converge, aiming at next steps and decision-making. Knowledge exchange between sectors and within sectors is key. This principle returns in every phase within the urban (re)development process (see figure 2.5).

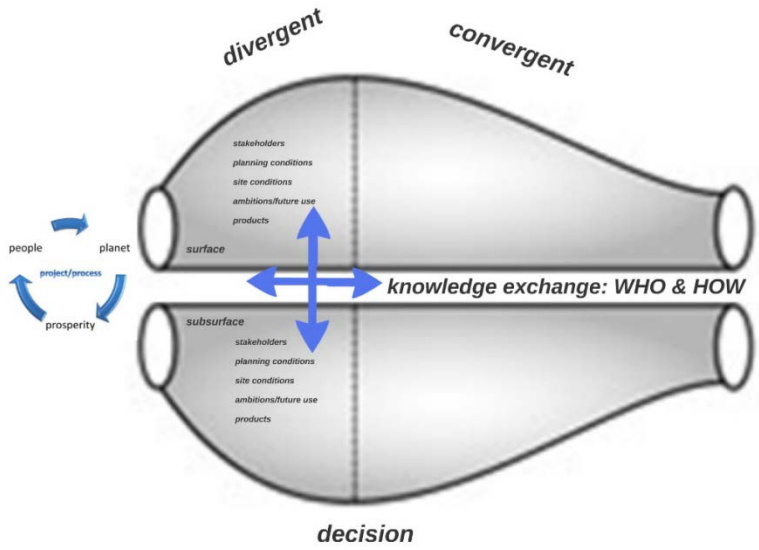


Figure 2.4. General characteristics of each project phase.

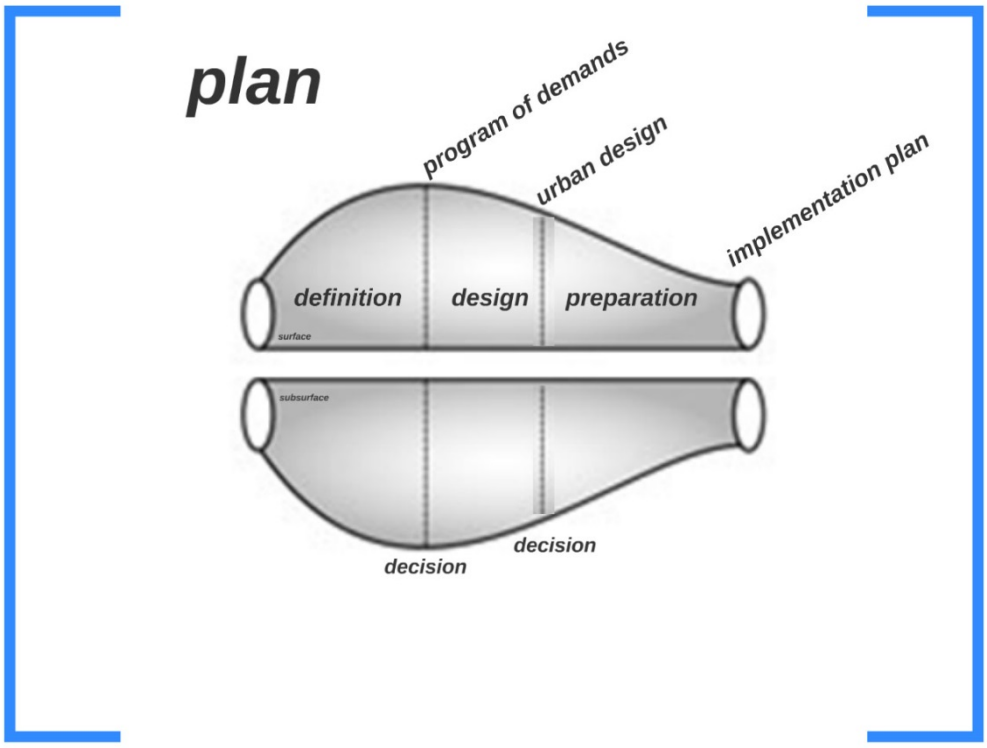


Figure 2.5. The plan phase itself has three steps: definition of the program of demands, the urban design and the preparation of the implementation plan.

The general outline of the proposed framework is shown in Figure 2.6 below. Although it can be seen as a stepwise approach, the nature of the work is iterative. Suitable methods and tools are depending on in which phase of the redevelopment process the project is, and also how much information is available. The choice is highly project-specific. So here, the four P:s are symbolised by People, Planet, Prosperity (or Profit) as part of the sustainability idea, with the addition of Project.

For each phase, one need to identify who is going to take part in knowledge exchange and what tools or methods that can mediate the knowledge exchange effectively. The question of who is also depending on what type of activity is going to take place. Therefore, the stakeholder analysis is repeated for each new activity where the objective of the activity is guiding who should participate. For more detailing on stakeholder analysis, see Section 4.1.

In the field of decision analysis, the generation of alternatives is as important activity as the assessment of alternatives. In planning and design practice, focus is in general on identifying one alternative by mediating between different interests. The idea to find a solution that fulfils a set of objectives a good as possible while at the same time not violating other interests too much is in line with decision analysis. Decision analysis on the other hand, tries to be very explicit about the advantages and disadvantages of a set of alternatives, in a way it documents the way to reach a final decision. But similar to a mediating process, decision analysis can also be used as a way of refining options. What matters in a holistic approach is how the subsurface aspects are included in the process of generating redevelopment alternatives of an urban brownfield, see further Section 4.2 and the three case studies in Section 6.

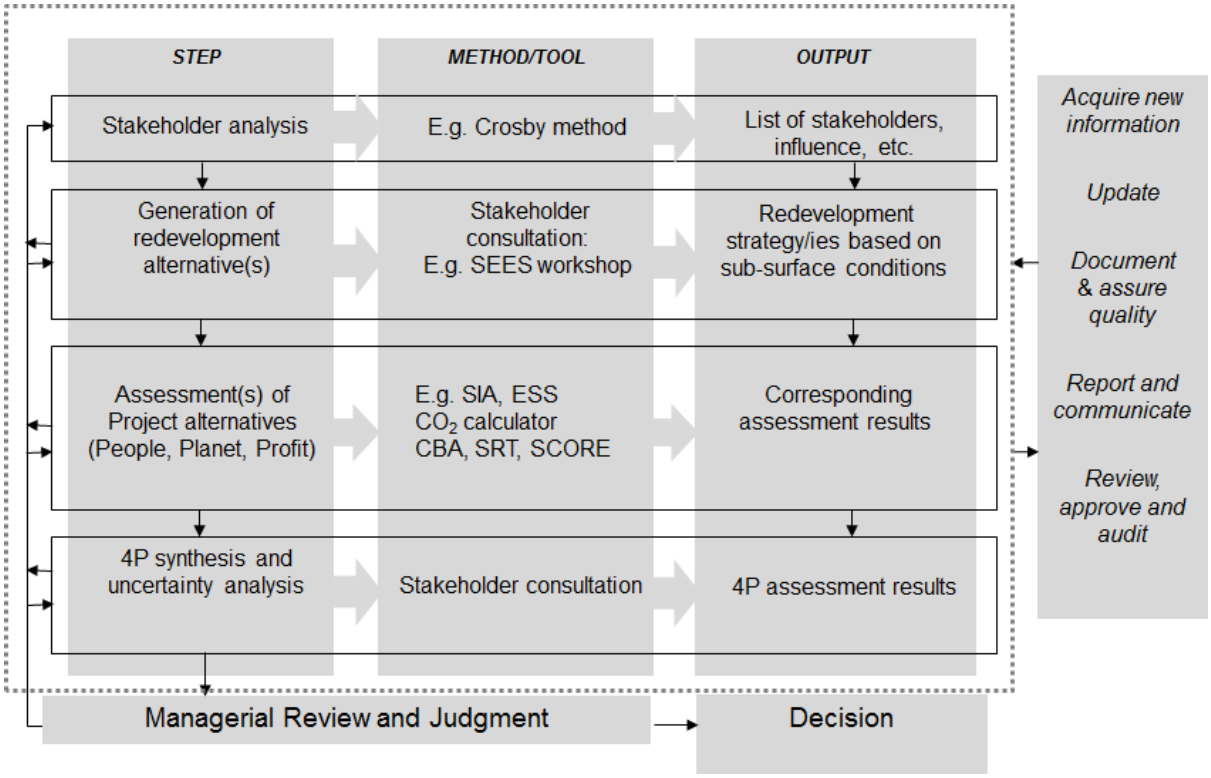


Figure 2.6. The proposed general decision process framework to support and enhance knowledge exchange between the surface and the subsurface sectors, with focus on WHO and HOW.

Sustainability assessment of alternatives is of increasing interest in the remediation branch. In the construction branch, sustainability assessments are increasingly carried out, but often after or during the implementation of a project by e.g. BREEAM or CEEQUAL (Brinkhoff, 2014). Performing a sustainability assessment of redevelopment plans including subsurface aspects requires taking

several different aspects into consideration. There are several tools available but none which cover all aspects that are needed to consider in a redevelopment plan, see Section 5. Balance 4P did not develop a new tool but aims to highlight how different tools can contribute in sustainability assessments of redevelopment plans integrating the subsurface. When applying different tools with different perspectives, there may be a challenge in how to make a synthesis of the assessment results. Here, it is suggested to be a qualitative analysis together with stakeholders.

Important with regard to all tools and methods is that a tool can never take a decision; it can only give information or advice to a decision-maker. Therefore, managerial review and judgement are necessary elements in a decision process framework.

2.2.1 Initiative phase

In the initiative phase, vision-building is often the main objective and the available information is typically not very detailed. Figure 2.7 shows the proposed framework with items highlighted that are important in the initiative phase, i.e. WHO is going to contribute in the process of generating a redevelopment vision. The Merwevierhaven case study (Section 6.1) demonstrates HOW this work can be carried out with subsurface in focus. The Merwevierhaven have used the System Exploration Environment and Subsurface (SEES) methodology to explore what chances and challenges the subsurface can provide at the site, and explicitly tried to use this in the vision-building. The SEES-methodology is explained further in Box 4.1.

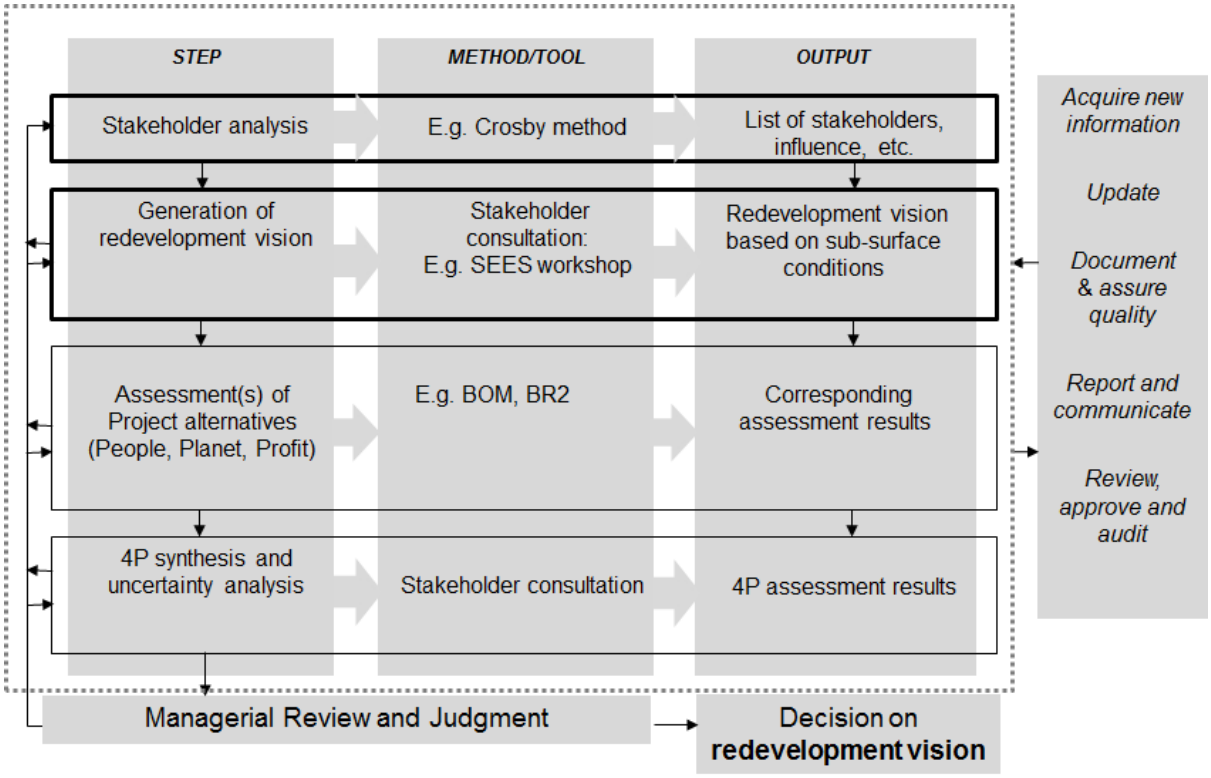


Figure 2.7. In the initiative phase, the stakeholder analysis (WHO) and the development of redevelopment ideas including the subsurface (HOW) is important and highlighted in the framework.

2.2.2 Plan phase

In the plan phase, the main objective is to decide a plan for a site. The exact procedure differs between countries but some elements are common, e.g. a public review which is in the legal framework. With regard to available information on the subsurface, the level of detail in this information can vary a lot. Typically, the information is not on a very detailed level, but there are exceptions, as can be seen from the case on Alvat where the driver has been the soil pollution (see Section 6.2). In Alvat the available information on the soil contamination conditions is very detailed, as opposed to the Fixfabriken case (Section 6.3). Thus, to choose suitable tools and methods for integrating and assessing sustainability of the redevelopment plan will be project-specific; depending on the phase, the ambitions, data available, and the current subsurface regulations, see Figure 2.7.

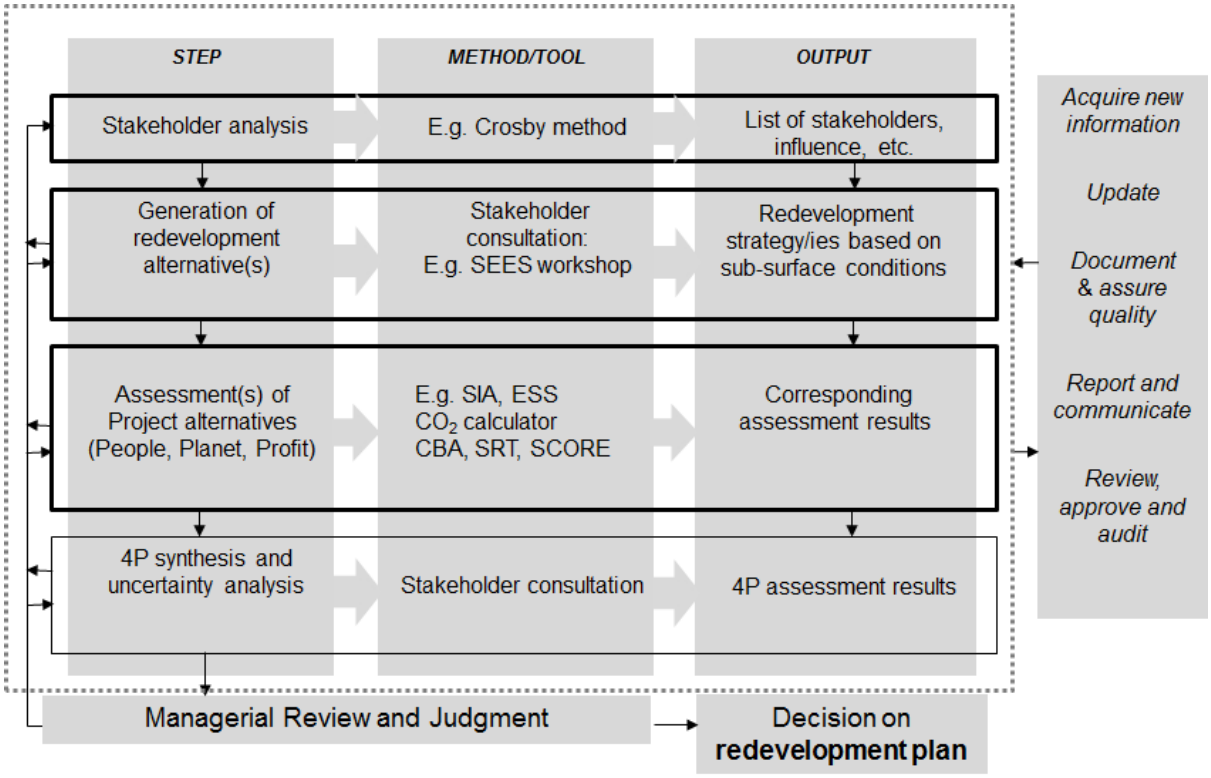


Figure 2.8. In the plan phase, the same items as for the initiative are highlighted but with the addition of assessments of alternatives (HOW).

2.2.3 Realisation and maintenance phase

The realisation and maintenance phases are not in focus in the Balance 4P project, although the same general framework applies, see Figure 2.9. To identify sustainable remediation strategies based on a decided future land use, technical feasibility is one important aspect, but today the need for consulting stakeholders, which includes neighbours, is acknowledged. Several tools are developed for this phase with regard to realisation of sustainable remediation, e.g. SCORE, SRT, GoldSet, see further Section 5.1.1. In the realisation and maintenance phases, the benefits derived from a better design will be enjoyed.

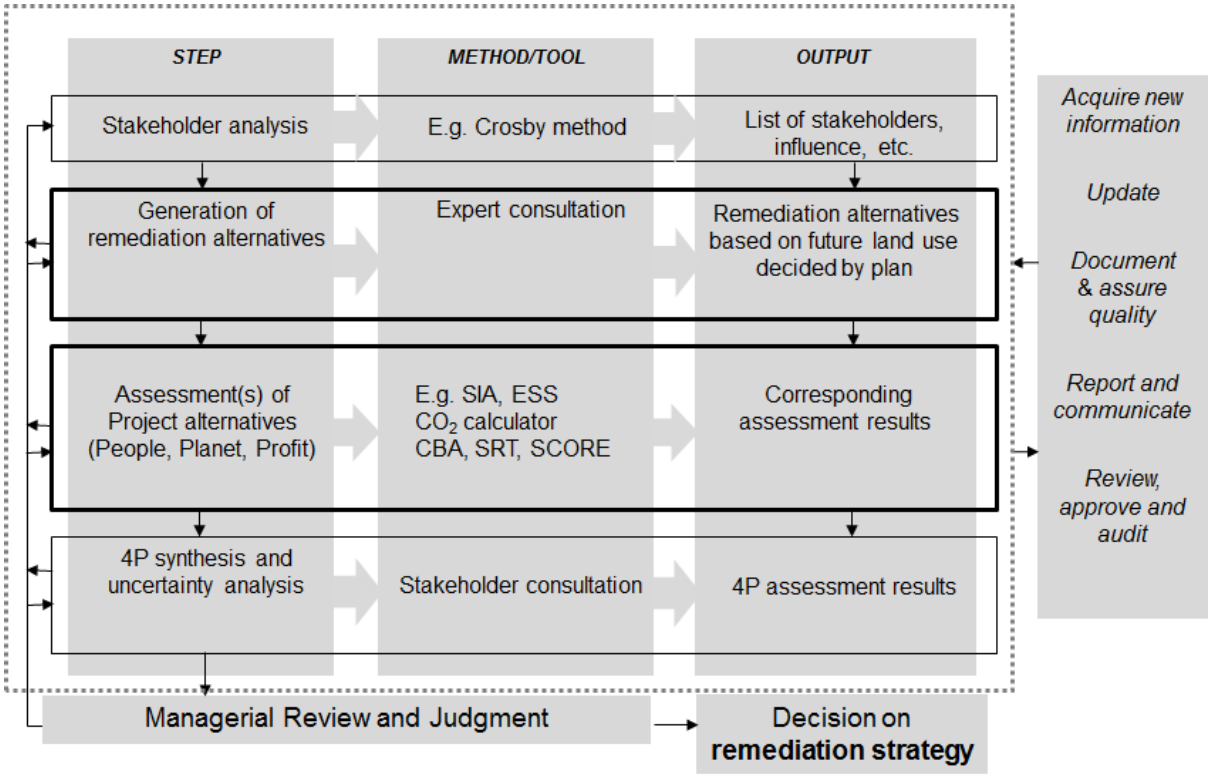


Figure 2.9. In the realisation phase, the same framework applies, with focus on sustainable realisation. Here, the framework is exemplified by a decision on sustainable remediation strategy.

3 Spatial planning integrating subsurface

There are numerous definitions of spatial planning. One of the earliest definitions is as follows:

> *"Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy."* [4]

This comprehensive definition from the European Regional/Spatial Planning Charter, adopted in 1983 by the European Conference of Ministers responsible for Regional Planning (CEMAT), is not workable, but it illustrates the complexity of the discipline. Planning is at the same time policy and practice; and it needs to be concerned with all aspects of social, environmental and economic development in a coherent way. Moreover, the different developments each have their own rhythm; for example financial conditions change much faster than demographic profiles or eco-systems and planning decisions that involve large investments or infrastructure take a long time to realize while the needs of society may change rapidly. To plan 'according to an overall strategy' at all scales is therefore an illusion. Nevertheless, policy-makers set priorities that shape planning decisions and are steering to urban development when implemented. The term 'spatial planning' is often used at the same time for both these decisions (the substance of planning) and the governance system (the process of planning). For example the European project for planning and climate change adaptation ESPACE states:

> *"Spatial planning is a process that assimilates and interprets evidence-based knowledge to inform those activities that aim to ensure spatial development takes place in an appropriate, sustainable way, from a functional, social, economic and environmental point of view."*[5]

For Balance 4P, the main interest lies in the processes of planning, and this is what is referred to when discussing 'planning systems' [Nadin & Stead, 2003]. Moreover, the professional structure of planning does not only consist of formal, written procedures and regulations. The unwritten assumptions and concepts, for example about the role of inhabitants, the reliability of government or the importance of nature, form the planning culture. These influences, as far as they are important for subsoil engineering, are investigated in the project Balance4P. This has been done in workshops where stakeholders are looking into the integration of subsurface and surface together (see Section 6 on Case studies).

Several organizations have made compendia (means: concise compilations of a body of knowledge) of spatial planning systems in Europe. To structure the investigation Balance 4P uses the Isocarp International Manual which features all partner countries of Balance 4P [Ryser & Franchini 2008].

4 From: European Regional/Spatial Planning Charter adopted in 1983 by the European Conference of Ministers responsible for Regional Planning (CEMAT) www.coe.int/t/e/cultural_cooperation/environment/cemat/list_of_conferences/071_resol1983.asp January 2014

5 www.espace-project.org/part1/part1_intro.htm#what March 2014

Furthermore, a comparative table created by the COMMIN Interreg IIIB project provides a useful framework to structure the comparison, see Figure 3.1.[6]

To describe planning systems, COMMIN uses 5 categories:

- Constitutional
- National scale
- Regional scale
- Local scale
- Participation

For understanding the planning context, in the following sections its main features are described for the respective countries.[7] First the guiding principles and the objectives defined for planning are analysed. Second, the principal planning institutions are identified. Then the Planning Acts and other legally binding contexts are investigated and finally a summary of types of planning documents that are commonly used and generally recognised is provided.

To fit the framework better to the Balance4p project some crucial questions were added. For each scale the question if and how soil management here is handled. In order to make the link to the building practice, as an important part of urban development, the following questions are added under the heading practice:

1. Who initiates urban development?
2. What type of process is used?
3. What role does the government play?
4. How is knowledge integrated in the plan and design process?
5. How is subsoil inserted in the development process?

These questions are important in order to understand how the planning system is brought into the plan process of an urban development.

The COMMIN system is quite general for the descriptions of planning systems and works very well for a comparison. However, to get a better grip on the relation between subsurface and surface in each country, a more detailed description of these systems was necessary. Here, the same levels are used for planning as for the four categories in the subsurface water, soil, civil constructions, energy (Hooimeijer & Maring, 2103). For each category the institutions, laws, policy/instruments and regulations are gathered, resulting in the mainframe shown in Table 3.1.

[6] www.commin.org accessed 16 Dec 2013
[7] For details, see the Excel table that we completed between the project partners.

Table 3.1. The mainframe for understanding and comparing the planning systems with regard to subsurface, expanding the COMMIN system.

	Institutions	Law	Policy/instruments	Regulations
Planning Europe, National, Regional, Local scale				
Water Europe, National, Regional, Local scale				
Soil Europe, National, Regional, Local scale				
Civil constructions Europe, National, Regional, Local scale				
Energy Europe, National, Regional, Local scale				

The three tables, one for each country, were used for a more detailed understanding, and comparison of the three planning systems. The tables can be found in Appendix A, Tables A.1 – A.4.

3.1 The planning system in the Netherlands

Because of its wet and soft territory, The Netherlands has a strong tradition in governance from an early age [Hooimeijer 2011, van der Cammen 2005]. Especially flood management, a main condition for spatial development, has been institutionalized and considered of national concern since the start of the Monarchy in 1814 [Van der Woud 1987]. It is said that the creation of polders brought with it the necessity for collaboration and the resulting '*polder model*' characterises the negotiation process of which 'poldering' is the verb [Lendering 2005].

Spatial planning in the Netherlands is seen as a public task for centuries and put into law in 1901 in the Housing Act. Traditionally, next to flood prevention a major issue concerns balanced territorial development. Since the 1970s planning had to respond to the new environmental policies and in the current neo-liberal era we see the government reconsidering their central role and diverting responsibilities to lower governments and the market. Presently a process of integrating sectorial domains is taking place in the Netherland. This is done at all governmental organizations: on National level e.g. by merging the ministries of water and spatial planning; at provincial level by combining departments of soil and spatial planning; and at municipal level by merging engineering and urban development departments.

On the national scale, in 2012, the Dutch Ministry of Infrastructure and the Environment (MinIE) issued the *Structuurvisie Infrastructuur en Ruimte* (Vision Infrastructure & Space; SVIR) to set priorities for the development of the territory until 2040. This is the main frame for structure plans of the provinces on the regional scale, and the structure visions of municipalities that are made specific on the district scale in zoning plans. Planning has a long tradition expressed in the institutions, laws, policy, instruments and regulations that supports the system. In recent years deregulation is the trend. Responsibilities are shifted towards the municipal scale and regulations are made simple and more interconnected. For area development, that is reduced to only excising

city (brownfiels), also private developers are invited to work in public private partnerships to engage in urban development. An important institution that is under pressure in the more liberal approach of urban planning is the *welstandscommissie*, a committee that does a qualitative check of the urban plans on architectural scale. It is an important check to have a private developers adjust to a public consensus, a typical aspect of the polder model. The committees were started at the beginning of the twentieth century when the municipalities by the Housing Law of 1901 were obliged to make an expansion plan, and housing cooperations were started to build large scale social housing. However, in the current shift towards a more liberal urban development it is experienced as an undesirable controlling body.

Another important institution that is to warrant the quality of spatial development is The Environmental Impact Assessment. The *Structuurvisie* and Zoning Plans need to go through the Environmental Impact Assessment (EIA) procedure. The main purpose of the EIA is to ensure that decision makers have all necessary information. Even though the advice of this national advisory institute is not binding, a negative advice is usually a strong base for preventing these plans through a court order. However, when a plan is assessed to have negative effects on the environment, it may still be realised, depending on how the decision makers value other opposing effects.[8]

The shift in institutions, policy, regulations and instruments is also visible in the organization of institutions. In order to regain a more integrated approach of urban development, departments are merged. This has also resulted in integrated products, a National Spatial Planning Strategy for the subsurface – STRONG – a provincial vision on soil and on a local level, municipalities are also looking into how to integrate subsoil aspects into zoning and master plans.

Urban development in the Netherlands has for the past century been governmentally driven, and filled in by private developers of housing corporations who were the semi-governmental body for social housing. There has not been a large tradition of individual house owners building their houses. This is however stimulated by the government, called the participation society (covering more areas than urban development).

3.2 The planning system in Flanders (Belgium)

In practice the Flanders, Brussels, and Walloon regions are considered national level. In the Balance 4P project the comparison and cooperation is done within the Flanders context, and the focus lies on spatial planning and soil management of that region.

Spatial planning in Belgium has been a complex balance between local initiative and a liberal government. First infrastructure and later also social housing were done by the central government that created the conditions and supplied the budgets. The very small scale scattered landscape of municipalities were responsible for the realization of the policy. This situation has been even more complicated because of the division into three regions: Flanders, Brussels and Walloon. Since the state reform in 1980, the Federation has no constitutional powers regarding spatial planning and de facto there exist nowadays three planning systems based upon regional autonomy. At the

[8] www.mer.nl (Access date 2014-11-24)

background of all three lies the (then national) Planning Act of 1962, which inheritance is still present in legislation and district plans [IMPP 2008]. Until the 1970s spatial planning in Belgium was a national issue. Guiding principle from that time was the functionalist approach of separating industrial, residential and leisure areas. Before the Urban Design Act (1962) Environmental Impact Assessment decrees belonged to the Municipal Law and there was no assessment procedure to see if they were carried out. Building and parcelling decrees made between 1962-2000 had to be checked by the King, and later the Flanders government. Since 2000, these urban design decrees are formalized by the provinces.[9] For changing parcels and changing function of a building a permit needs to be issued by the municipality.

The basic principles for Flanders Spatial Policies Plan (2012) are: the 'Productive Landscape', 'The Long Term, Uncertainty and Governance' and 'Welfare and Well-being'.[10] These principles are steering in the system of three planning levels: the region, provinces and municipalities that work together on principles of subsidiarity and - topdown - framework control and translated into RUP's (spatial implementation plans). The institutions, laws, instruments, policies and regulations that surround this system are very comparable to the Netherlands. Like in the Netherlands, spatial plans are subject to Environmental Impact Assessment procedures, however, in Flanders, only certified agencies can perform EIA's. Unlike the Netherlands, a *Watertoets* (Water Impact Assessment) is needed not only for governmental pre-plans but also for private developments that apply for building permissions.

Even though the planning system is comparable, the elaboration of these is very different due to the planning conditions described above. Next to the fact that the already small scaled landscape was urbanized in a scattered way and the strong role of the municipalities, it was also stimulated from the nineteenth century on to build your own house with the result that only 6% lives in rental houses and 75% of the people own their house.[11] Result of this practice is that the urban development is much more scattered over the landscape, the so called *Nevelstad* being urbanized roads with large landscape lots on the backside of these houses.[12]

3.3 The planning system in Sweden

The planning system in Sweden was established in the 1900s in order to ensure through the control of the State the balance between public and private interests with respect to land use (Blücher, 2013). Public interests that are promoted and included in planning are health and safety, cultural and ecological values, environmental and climate aspects, social issues, aesthetics, resource efficiency and growth (Hedström and Lundström, 2013). The Environmental Quality Standards (*miljökvalitetsnormer*), which are mostly based on EU requirements, serve as an important instrument for achieving environmental objectives (*miljömål*) of the State in planning. These objectives are e.g. "good built environment" (*god bebyggd miljö*) assuming consideration of the

[9] www.ruimtelijkeordening.be/NL/Beleid/Vergunning/Vergunningnodig
[10] www.beleidsplanruimte.be March 2014
[11] Michel Dehaene, Maarten Loopmans (2003) De argeloze transformative naar een diffuse stad. Vlaanderen als Nevelstad. Agora jaargang 19 nummer 3 – 2003
[12] http://176.9.39.46/nl/Issues/60

above mentioned public interests in planning, and “non-toxic environment” (*giftfri miljö*) promoting the environment free of toxic substances. In Sweden, municipalities (*kommuner*) have historically a planning monopoly, i.e. spatial plans are formulated, approved and adopted on the local level. The municipal planning monopoly was established by the Town Planning Act (*stadsplanelagen*) of 1907 and further revised in the substituting Planning and Building Act (*plan- och bygglagen*) of 1987, revised in 2011. Planning is therefore carried out on the local level by municipalities with consideration of the national interests which are defined on the national level, and promoted and coordinated on the regional level by the County Administrative Boards (*länsstyrelser*).

Examples of Swedish national policies documents are the national transport plan, prepared by the Swedish Transport Administration, or the establishing and management of nature protection areas by the Swedish Environmental Protection Agency. These set out the larger scale guidelines that are filled in on a municipal scale.

The institutions on a national and regional scale are working close with the ones on municipal scale. On the municipal scale, the plans are made and the different checks to the quality of the built area is done. In contradiction to the Netherlands and Belgium, the EIA is only performed if the municipality judges (*behovsbedömning*) that the proposed development may cause “substantial environmental impact” (*betydande miljöpåverkan*). EIA is usually carried out by the municipality in consultation with the County Administration Board and the neighboring municipalities.

In Sweden, urbanization only started to take off after the 1930s, today 85 per cent of the population lives in urban areas (STATISTICS SWEDEN, 2007). The leading cities are in international comparison still quite small, except for Stockholm. During this process of growth, dense townscapes have changed into low density urban landscapes that surround the historic cores. The urban landscape is separated into large districts of housing, industry, retail, leisure and education. Two thirds of the Swedish population live in buildings that are less than fifty years old. (Nyström in Guinchard, 1997) As in many European cities in the sixties, buildings and site layout follow modernist planning principles: sunlight, natural surroundings and neighborhood community poured into single family houses and peripheral tower blocks in park like settings. The road, the open landscape and the shopping center replaced the street, the city park, and the square. During this period – between 1965 and 1974 - one million houses were built with as aim affordable houses for everyone. This period is in Sweden also known as the ‘Miljonprogrammet’. In the 1970’s and 80’s a strong public opinion came up against the Miljonprogrammet that only gave priority to basic human needs as health and shelter. Context, identity, cultural meaning and diversity became important as well as the importance of historic place. As a result of that, the abandoned city core was revitalized into working and living environments, which became popular among small households and professionals. Next to that, the post-industrial society is higher educated. This results in two groups of people in Sweden. ‘The new agrarians’ who want to live close to nature and ‘the new urbanites’ who want to live in the city centre close to all the facilities a city could offer. (Nyström in Guinchard, 1997) The last group can be seen as a target group for the redevelopment of brownfields around the center of the city. The former brownfield of Hammarby Sjöstad is a good example in that respect. It shows the possibilities of living close to the city core and the reduction of car-use of its residents by investing in public transport.

3.4 Comparison of the three countries

3.4.1 Planning systems

In comparing the Netherlands, Sweden and Flanders with Belgium, the first conclusion is that they are incomparable as entities. There is basically no Belgium with a national planning culture, tradition, laws etc. Moreover, the Flanders citizens consider Flanders as their national government. Therefore, within the project Balance 4P the comparison is made between the Netherlands, Sweden and Flanders.

Planning is culture! Even though in the structure of institutions, law, policy, instruments and regulations the three countries do not differ that much, there are quite different cultures in them that organizes the planning system and is determent of the outcome, see Table 3.2. The culture has to do with historical developments, the geography of the territory and population density. Netherlands and Flanders are comparable in historical developments and geography. This is for example shown in the fact that water is an important spatial component in these countries, this is much different in Sweden. That size matters is recognizable in the level on which spatial planning control is manifested. Sweden is such a large country that it is also sensible to have municipalities in control. The Netherlands is such a small country that is has been sensible to have strong spatial planning on a national scale to make maximal use of the land. In Flanders this has been the same, with the distinction that even though the planning is top-down the urban development has for the dominant part been in the hands of private developers supported by local policy. This also influences the scale of development, and the final output. The main conclusion is that the Netherlands is moving to a more governmental bottom-up system that is executed in Sweden and also a more bottom up development practice as it is executed in Flanders.

Table 3.2. Overview of approaches to planning and building in the three countries.

	Planning system	**Building practice**
The Netherlands	Top Down > Bottom up	Top Down > Bottom up
Sweden	Bottom Up	Top Down
Flanders	Bottom up > Top Down	Bottom up

3.4.2 Subsoil management

For the management of the subsurface, several planning instruments have been developed in the Netherlands, but none in Sweden and Flanders. Dutch national interests in the subsurface will be arranged in the National Spatial Planning Strategy for the subsurface STRONG. For other subsurface functions the provinces or municipalities will be responsible. However, the national government will facilitate the regional-local authorities by the development of decision frameworks, and making data and information available.

National Spatial Planning Strategy for the subsurface STRONG

The National Environmental Policy Plan of 1997 stated that all sites with soil pollution should be known before 2005 and that all sites with serious risks shall be controlled prior to 2030. The Ministry of Infrastructure and the Environment (MinIE) is responsible for the organization of the soil remediation operation. In the fourth National Environmental Policy Plan, published in 2001, the

Dutch government reconfirmed its intention to end the transfer of environmental costs to future generations. In 2003, the scope of soil regulation was also widened from quality to soil management with the "soil policy letter" (*beleidsbrief bodem*).[13]

In May 2007 the INSPIRE EU-Directive entered in force, establishing an infrastructure for spatial information in Europe (among which: soil) to support Community environmental policies and policies or activities which may have an impact on the environment.[14] Following INSPIRE, soil information (not soil quality) are centrally being administered and enclosed in the Dutch *Basis Registratie Ondergrond* (BRO, in progress).[15] DINO and BIS give data and information (maps, services) for respectively deeper and shallow subsurface and will be integrated in BRO.[16]

Figure 3.1. Comparison of the planning systems and the subsoil management systems in the three countries.

Box 3.1. Future developments in Dutch soil policy (Lamé & Maring, 2014).

At the moment the Dutch environmental regulation and legislation is being transformed with the objective to facilitate spatial development by simplifying and combining many existing acts and decrees. As a consequence most of the Environmental Management Act (in total 15 existing laws) will be integrated in the Environment and Planning Act. Expectations are that the Environment and Planning Act will be empowered in 2018.

Currently, the major responsibility for soil is being decentralised. With a covenant (2010-2015) between the state government, provinces, municipalities and water authorities ambitions were formulated concerning remediation and sustainable use of the subsurface. Arrangements were made to reach these goals together. With the covenant, the major responsibility for soil is decentralised. A succeeding covenant is now being prepared and will be effective in 2016. One of the ambitions of the new covenant is to involve the private sector in the new arrangements.
The transition in soil regulation can be divided in two main streams:

1. Taking charge of the remediation operation

[13] www.bodemrichtlijn.nl/Bibliotheek/beleid/beleid-van-centrale-overheid/landelijk-beleid/beleidsblad-beleidsbrief-bodem
[14] inspire.ec.europa.eu/
[15] www.broinfo.nl/
[16] www.dinoloket.nl/ and www.wageningenur.nl/nl/Expertises-Dienstverlening/Onderzoeksinstituten/Alterra/Faciliteiten-Producten/Bodemkundig-Informatie-Systeem-BIS-Nederland.htm

In the first covenant period, many sites are investigated and remediated, including most of the urgent sites. The next step is the management phase, aimed at contaminations that cannot be excavated, and that have a risk to spread.
This phase focuses on innovative management of these sites, e.g. on the application of different in-situ techniques and area based management of contaminated groundwater.
The link with spatial development is vital to the future of soil remediation in the Netherlands, as new ways of soil usage will initiate additional funding for remediation activities, especially if these can be combined with another land use, e.g. aquifer thermal energy storage (ATES). Soil remediation unrelated to spatial development is becoming redundant and is replaced by area based sustainable soil management.

2. Using the possibilities of the subsurface
Objective of the amendments is to focus on the sustainable use of the subsurface. This means that the use of the subsurface cannot be seen separated from spatial developments and societal challenges such as climate, energy, (ground)water and economic developments. The covenant addresses different functions of the subsurface. Themes such as sustainable use of resources (eg. strategic groundwater resources) and energy (shale gas, effects of gas winning, soil energy) are topics of interest.

Because not all aspects can be arranged on the local or regional level, strategies are being prepared on the spatial planning of the subsurface. In 2012 this was done for subsurface pipes. In 2013 the national government started, in cooperation with local and regional governments, the preparation of a national strategy for the subsurface "STRONG". In STRONG decisions will be made with respect to spatial planning with a national interest. It also should help local or regional governments to make decisions on spatial planning, both in urban and rural areas. The STRONG is planned to be ready in 2015. A strategy for shale gas (also expected 2015) will be an integral part of STRONG.

The envisaged transitions will involve different governmental organisations as well as private parties and research organisations. This collaboration aims to come to agreement on the use of the subsurface, the generation of knowledge and the necessary financial arrangements. Final objective is the implementation of sustainable use and management of the subsurface in daily practice.

Provincial Soil Visions
The first soil vision by the Province Zuid-Holland was part of a policy plan about ecology, water and environment (2006). It took another seven years to make the official Soil Vision (2013) that introduces a new approach towards soil, more based on spatial planning. One of the main conditions in order to do that was also by merging the departments of soil and spatial planning in the organization of the Provence. Only a year after this Soil Vision, a new Structural Vision was presented in 2014. This new policy document completely integrates the former soil vision in its attitude towards soil and integrating it into spatial planning. One major instrument that supports better weighing of soil value and better decision making is the *Bodemladder* (see Figure 3.2). There are two main strategies: (1) soil use should be renewable, and if not possible, at least it should be manageable, (2) all uses should be acceptable. All Provinces have made soil

Figure 3.2. The Dutch "Bodemladder".

visions[17] and several provinces are or have been working on a provincial "*structuurvisie*".

3.5 Input for the Holistic Approach

The holistic approach according to Balance 4P is a conscious act/activity of integrating subsurface aspects in the redevelopment process for the purpose of more sustainable land management. This approach should be applied to all aspects of the urban planning system. Figure 2.2 shows how the planning system is a process in which the radars of law, regulation, policy and institutions work together on different scales the influence each other and set the planning conditions for urban (re)development. The urban (re)development figure 3.3 consist of four phases that are interrelating. The initiate and plan phase are part of the plan process, the realization and maintenance phases of the implementation process. The plan phase has been made more specific in dividing it into a definition, design and preparation step. The design process is done during this phase. This mainframe is applicable to the three countries in the study (see Figure 2.3)

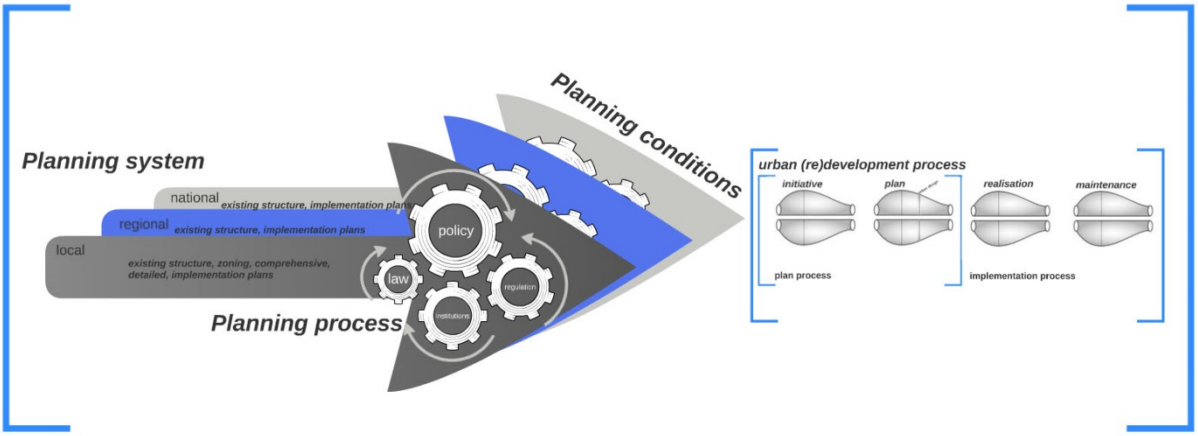


Figure 3.3 The holistic approach is operating within planning conditions that are the result of all levels in the planning system (local, regional, national) and their respective laws and regulations, policy and institutions.

The aim of Balance 4P is to integrate subsurface in early phases, the initiative phase and the planning and design phase of the redevelopment process, to enhance chances for sustainable brownfield redevelopment, see Figure 3.4.

[17] *An overview (in Dutch) of all provincial soil visions from 2009 can be found on: http://www.expertisebodemenondergrond.nl/upload/documents/Platform%20Bodembeheer/archief/overzicht_posters_visies.pdf*

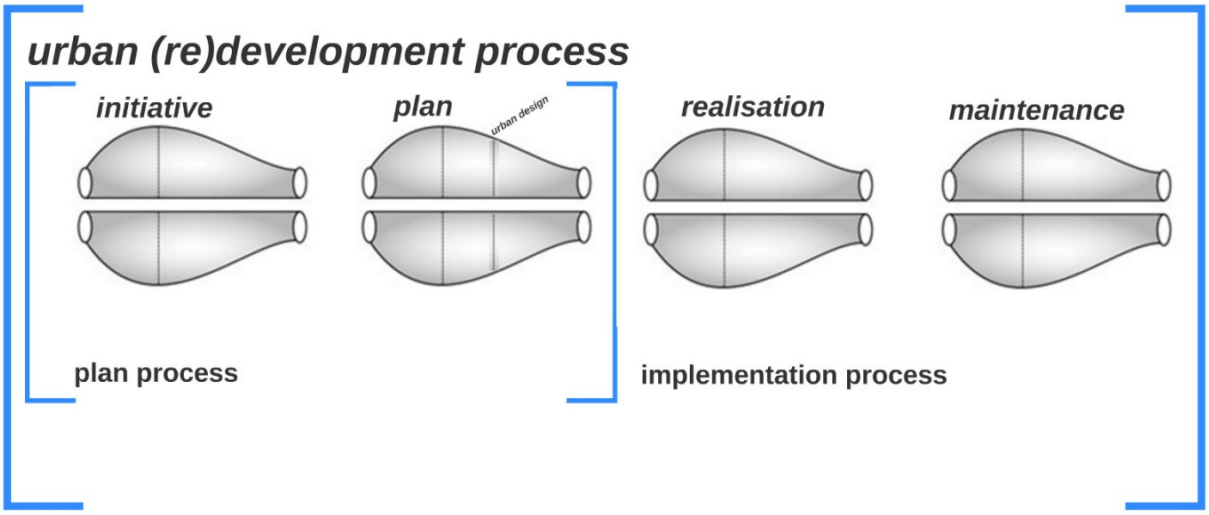


Figure 3.4. The urban (re)development process has a regulatory context (the planning conditions) and includes a plan process and an implementation process, each with different phases.

In the redevelopment process the holistic approach is defined by an iterative process of project phases that are characterized by the 4p strategy of action, in which stakeholders, planning conditions, site conditions, ambitions and future use, and the development of products (like visons, urban plan or implementation plans) are investigated and/or activated. This counts for the surface as well as the subsurface. The focus within the phases is first diverge and then converge, aiming at next steps and decision-making. Knowledge exchange between sectors and within sectors is key. This principle returns in every phase within the urban(re) development process (see figure 3.5).

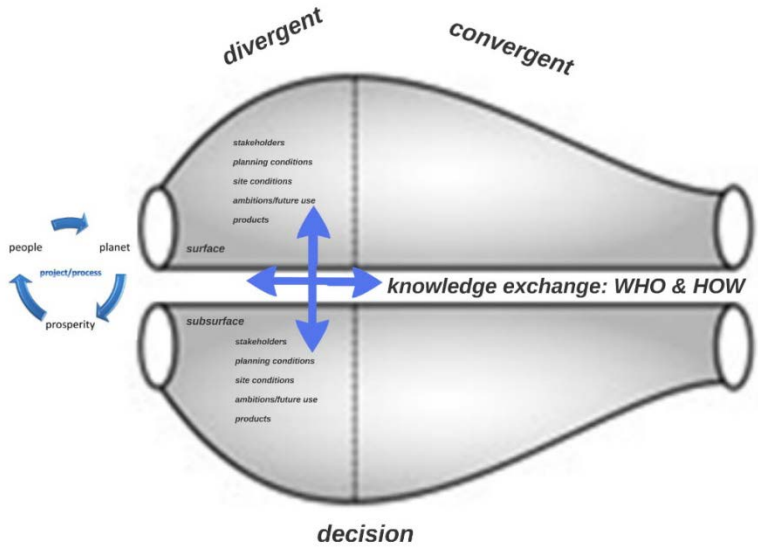


Figure 3.5. General characteristics of each project phase.

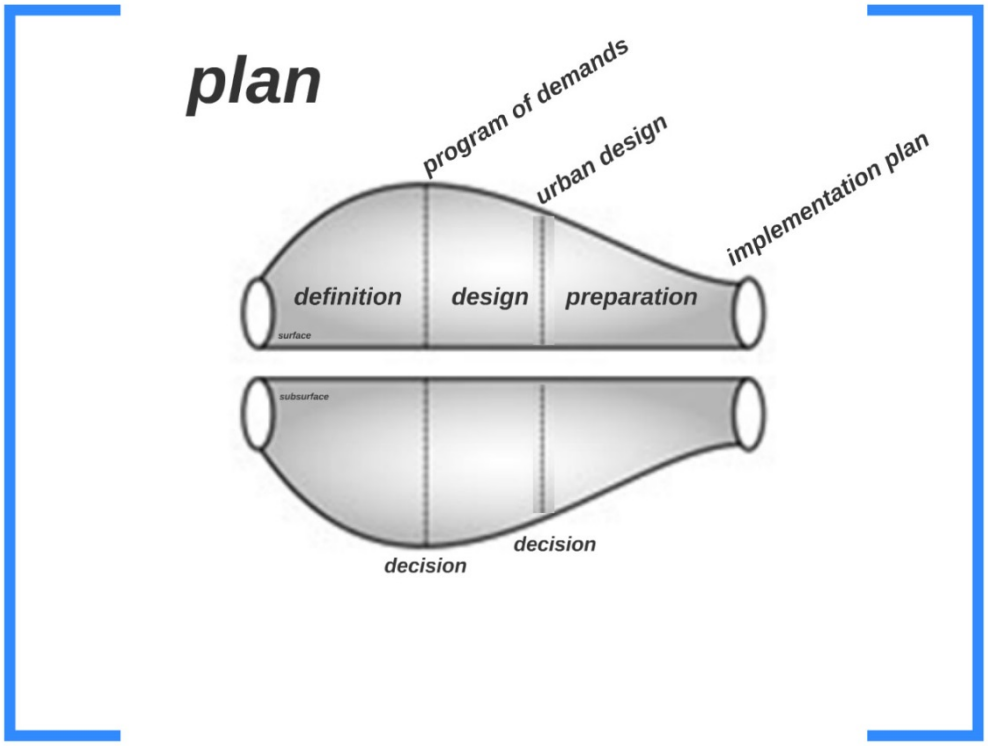


Figure 3.6. The plan phase itself has three steps: definition of the program of demands, the urban design and the preparation of the implementation plan.

3.5.1 Connecting to current planning themes

The holistic approach that Balance4p proposes the integration of the subsurface in day-today-planning and urban development practices. There are four spatial planning subjects , which are in common in the three planning systems (NL, BE, SE) and which can be expanded to subsurface: heritage, environment, nature and water.

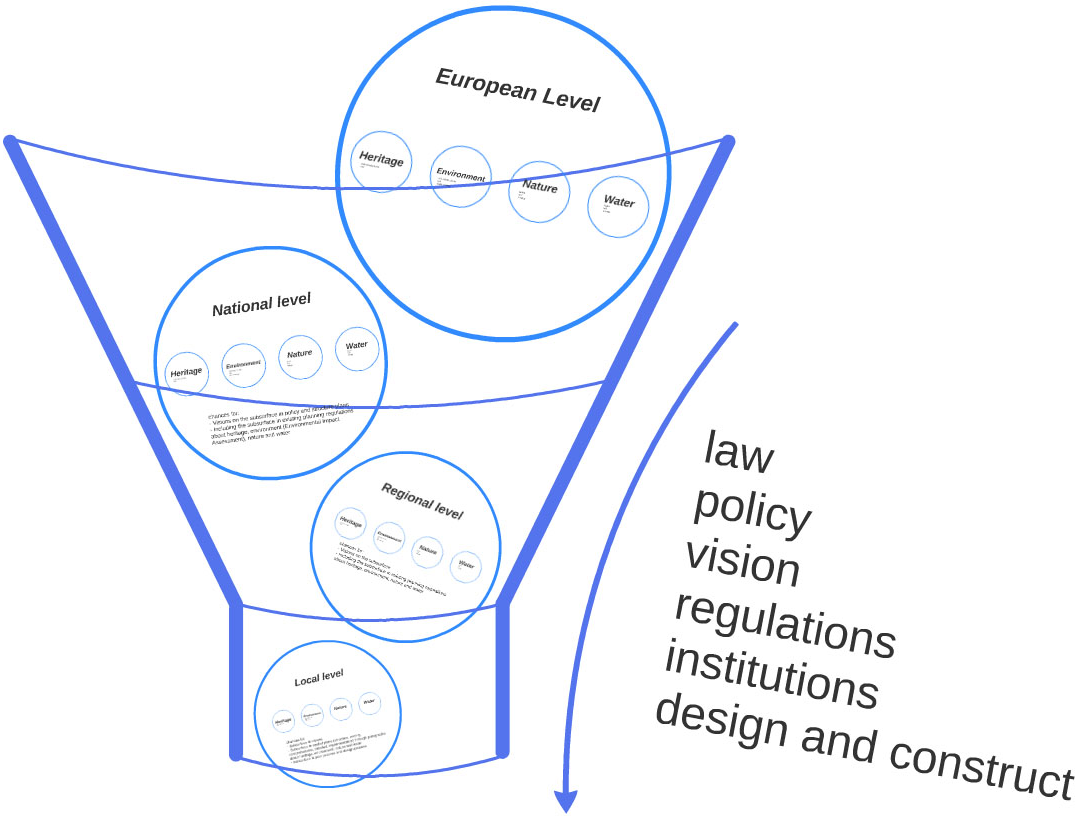


Figure 3.7 The levels of governance in which the spatial planning subjects heritage, environment, nature and water already, have a strong position.

For these four urban aspects the integration of above- and underground aspects can be enhanced in different ways: 1) in law and regulation, 2) in policy and vision, 3) by structured knowledge exchange, and 4) in the design/construct process), see the summary in Table 2.1. (This is further elaborated in Section 3.) For each regular planning theme different aspects of the subsurface can be integrated; here the four categories of subsoil qualities (Hooimeijer & Maring, 2012) are used to give an indication of the possibilities. The categories are:

1. Civil Constructions (archaeology, underground building, cables and pipes, foundations)
2. Water (storage and filtering capacity, drinking water)
3. Energy (ATES, geothermal and fossil energy)
4. Soil ecology (clean soil, morphology, ecology, landscape diversity, minerals)

Table 3.3. Summary of chances for enhancing subsurface into the current planning systems with regard to four aspects: heritage, environment, nature and water.

World of Planning →	Heritage	Environment	Nature	Water
Law and regulation	Chances for: - Including the subsurface in planning regulations about heritage, environment, nature and water - Including the subsurface in Environmental Impact Assessment and Water Assessment Test - Subsurface in zoning plans through paragraphs about heritage, environment, nature and water			
Policy and vision	Chances for: - Visions on the subsurface in structure plans			
Knowledge exchange	Chances for: - interdisciplinary cooperation - developing new knowledge - knowledge management to handle uncertainties in qualitative manner			
Design/construct	Subsurface in plan process and design process needs: - Better frame of reference - Better instruments (subsurface potential map) - Culture change from how it is done now			
World of subsurface→	Civil constructions Soil	Civil constructions Soil Water Energy	Water Soil Energy	Water Soil Energy

3.5.2 Law and regulation

In law and regulation there are chances for including the subsurface in planning about heritage, environment, nature and water. Especially heritage in current redevelopment of cities is considered a chance for reuse, which is considered more sustainable, and a chance for using meaning and context (identity) in new developments. The heritage protection is set by law and made a self-evident part of the planning and plan process. Usually there are specific paragraphs dedicated to heritage in structure and zoning plans. Expanding this practice to archaeology and other human structures in the subsoil could be a chance. In Sweden, law and regulation is already strong with regard to protection of archaeological remains.

Taking the environment into account is secured in all three countries with the Environmental Impact Assessment (EIA). It is also applicable to plans of different scale in which also the subsurface is relevant. Through EIA, synergies between the natural system, the (civil constructed) conditions of the site, and the development plans can be brought together thus promoting integrated planning.

Nature protection is well organized starting on the European level with Natura 2000 and then for each country on all scales. Considering the subsurface as part of this natural system is quite evident and there is a chance to make a logical connection when making these laws and regulations.

In the Netherlands and Flanders there is the Water Assessment Test, also this current regulations could be expanded with the subsoil considering that groundwater is part of the water system as a whole.

3.5.3 Policy and vision

As the Dutch case shows, there is a great chance for visions on the subsurface in structure plans, but also taking the subsurface into policy in order to stimulate early consideration in the planning and plan processes. On different scales, these visions could emphasize other qualities of the subsurface, and together they could offer a sound base for structure plans. The connection to the planning themes of heritage, environment, nature and water could be made here as well.

By including the subsurface in policies and visions, practitioners on the municipalities will be "forced" to consider the subsurface explicitly in plans. A parallel example is from Göteborg where in 2011 social aspects in planning were included in the visions of the City and also in the budget. This has today developed into a new practice, where social aspects are considered in the planning process explicitly (see further Appendix G).

3.5.4 Knowledge exchange

Especially knowledge exchange is a key for a better integration of the subsurface into surface urban development. Since it enhances interdisciplinary cooperation, it could lead to new knowledge and knowledge management it is possible to handle uncertainties in qualitative manner. Direct and conscious knowledge exchange between surface and subsurface in early phases will promote integrated plans. In traditional planning practice, knowledge exchange is often practiced by means of documents, reports and formal meetings. Here, there are chances to improve the current practices on knowledge exchange on subsurface and surface by existing instruments.

3.5.5 Design/construct

The subsurface in plan process and design process needs:

- Better frame of reference
- Better instruments (subsurface potential map)
- Culture change from how it is done now

Taking the subsoil conditions into account in the plan and the urban design process of urban designers is a rather new concept. Especially for the plan process there should be better knowledge management of what and how data from the subsurface could be transferred into information that is relevant for the state of affairs in the process.

Even though the process of designing is ambiguous, personal and somewhat intangible, Van Dooren, Boshuizen, Van Merriënboer, Asselbergs and Van Dorst unravel it into a framework (2013), see Figure 3.8. This framework is not a step by step guide for a successful design process, but an

overview of five generic elements involved in designing, making the design process explicit in a more clear and structured way. The five elements are:

1. Experimenting
2. Guiding theme or qualities
3. A frame of reference or library
4. Sketching/modelling
5. Domains

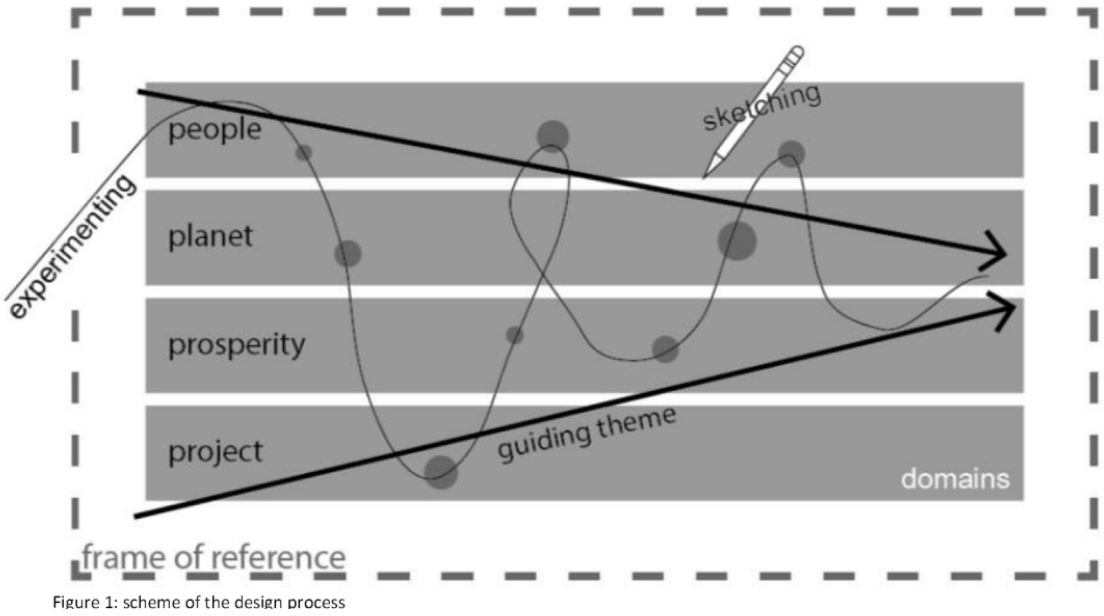


Figure 1: scheme of the design process

Figure 3.8. A conceptual framework for the design process (original Van Dooren et al., 2013; altered by P. van der Graaf 2014).

It can take some time before urban designers are used to deal with subsoil conditions, but the benefits are great. To take advantage of the potential qualities of the subsoil, its aspects should be investigated at the beginning of (1) experimenting in the design process. Although subsoil aspects derive from a wide variety of expertise, it is not to the urban designer to investigate all of them himself. By collaborating with the different experts, the urban designer can get an understanding of the context. It is to the designer to investigate the spatial effect on surface level and create a coherent design, which relates to the subsoil characteristics of a site. The urban designer can get a better understanding of subsoil condition by translating the data into his own language of (4) sketches and models. This could be a subsoil potential map in which the main characteristics of the subsoil and their spatial effect on surface level are made clear. This way, the urban designer can start experimenting and make relations between different solutions, which can strengthen each other and contribute to a coherent end result. Urban designers should start experimenting with the unknown aspects of the subsoil, so they expand their knowledge and experience. If the urban designers becomes familiar with modelling the data, know how subsoil aspects effect their spatial design on surface level and can pick generic solutions from a (3) frame of reference, then taking into

account subsoil conditions becomes as common as relating urban designs to the spatial context of the built environment. Subsoil conditions should not be seen as an obstruction in the urban design process, but needs to be dealt with as part of the (5) domains and then has the potential to enrich the final design.

3.6 Best practice

Best practice of integrating the subsurface in urban (re) development as we foresee it in this project does not exists. There is best practice on sectoral integration of different subsurface aspects, and there are examples of sustainable development that includes the subsurface in a secondary way. In the Netherlands next to the national, provincial also the municipalities Arnhem, Deventer and Maastricht have municipal visions on the subsurface. There are many municipals who have a focus on the subsurface as part of water management, or energy management. (TTE 2010) The area development of Lanxmeer (Culenburg), is a small scale, self-organized, sustainable conceptualized and internationally recognized as an example where social and urban quality is interwoven with smart development with nature. Here, permaculture as “a living environment that demonstrates the diversity, stability and resilience of natural ecosystems and creates conditions for social environments and conscious life-styles” is the steering perspective. The soil plays an self-evident part of this permaculture. Lanxmeer is a case in which collaboration (also in knowledge exchange) played a very dominant role. From the conception until the final realization, its development was a bottom-up ideological endeavour to create a permaculture village. After building a solid advocacy coalition for the vision in 1995 with an interdisciplinary group of experts an innovative consortium was formed of companies, (landscape) architects, urban designers, developers, energy companies, Water Board Rivierenland, Polder District, a waste water treatment company and the (future) residents. All came in with their own interests and skills, making it a complex process of co-creation. Specialists wanted to develop and apply their knowledge, residents wanted to live in harmony with nature, and companies wanted to develop Lanxmeer as showcase.

Figure 3.9 Lanxmeer (Copijn)

In Sweden Hammarby Sjöstad (1996) is a well-known example for sustainable development and one of the first eco-friendly areas in Europe. The core of the environmental and infrastructural planning of Hammarby Sjöstad which was jointly developed by Stockholm Water Company, Fortum and the City of Stockholm Waste Management Administration, can be summarised in an eco-cycle model known as the Hammarby Model. The model explains the interaction between sewage and refuse processing and energy provision, as well as the added benefits to society of modern sewage, energy and waste processing systems. The overall goal "twice as good as the norm" required new ideas for energy, water, waste, transport, building design and construction site logistics (City of Stockholm, 2007). Here the subsurface does not play a part of the planning process as conscious as in Lanxmeer. The approach is more coming from urban system planning and not so much a natural concept like permaculture. Another example in Sweden is Västra Hamnen in Malmö, Sweden. This site was earlier used as port, shipyard and industrial area and the new city district is built according to guidelines on sustainable energy use, green structure, waste solutions and a healthy indoor environment, with the vision that all energy should be locally self-sufficient and renewable. The project is seen as a national representative of sustainable urban development and has become an attraction for field trips and tourists to visit and learn more about smart sustainable solutions.

Although the result of the redevelopment processes in both cases are sustainable/eco-friendly housing areas, the remediation of the sites before the development started has been of traditional excavation character. Thus here, the subsurface with regard to sustainable remediation strategies was not in focus. Instead, contaminated soil has been replaced by clean new soil, in Västra Hamnen completely replacing the existing soil eco-systems with new constructed eco-systems (Strand, 2013). Few industrial items are left, instead identity is created at the sites by the eco-friendly/sustainable concept. Some critics mean that having "ecology" in focus has had the effect that other sustainability aspects have not been considered in the redevelopment process (Strand, 2013).

In Flanders the same practice is recognizable: there are some good projects on sustainability, also projects in brownfield areas but even there the focus is limited and sectoral. One of the concepts that is worked with in Flanders is the *Ecopolis* concept, where also ecology is taken as starting point. Again here water is a common part of the development and also urban heating system is popular in the projects that are on the list of sustainable projects on the websiste '*duwobo'*.[18] One of the projects is Den Draad (near Gent) on the location of a former steel cable factory. With the motto "Go Brownfield, Not Greenfield" the terrain was remediated and now rebuilt with a lot of attention to water and biodiversity.

[18] http://www.duwobo.be/index.cfm?n01=praktisch&n02=news&newsID=332

Figure 3.10 Den Draad near Gent (http://www.dendraad.be/)

4 Designing sustainable redevelopment strategies

There is a gap between having a sustainable development ambition for a project and actually executing a sustainable development. In order to assist the development process of a spatial project, various methods and tools exist that connect a sustainable approach to practice. With a ***method*** a process or supporting model is meant that guides the user towards a certain goal. By the LUDA Compendium (2005) a method is defined as a procedure followed in order to accomplish a task, sometimes in accordance with a particular theory. A ***tool*** is a program that gives the user a tangible result. The LUDA Compendium defines it as a 'concrete or abstract product used in applying a method'. The collective term ***instrument*** is used in some places in this report.

In this section the instruments for stakeholder analysis are elaborated (6.1) as well as the tools for designing sustainable redevelopment strategies (6.2).

4.1 Stakeholder analysis

For redevelopment projects or regeneration of underused sites, also called brownfields, it is crucial to map the stakeholders that are or should be involved. A stakeholder is a person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity. (ISO Guide 73:2009, 3.2.1.1) It is important to define WHY a stakeholder analysis (SA) is performed, so the result is the right information needed for the specific task. Stakeholder analyses can be used for the preparation and evaluation of projects (ODA, 1995; Grimble and Chan, 1995), for the facilitation of stakeholder involvement in participatory projects or in cooperative resource management (MacArthur, 1997; Grimble and Chan, 1995), for strategy development by project managers to assure the implementation soundness of projects or policies (Crosby, 1992; MacArthur, 1997; Varvasovszky and Brugha, 2000), for understanding the general issues related to conservation and degradation of natural resources (Grimble and Chan, 1995; Grimble and Wellard, 1997), and for a comprehensive analysis to understand better past policy making processes or to assist in formulating new policies (Varvasovszky and Brugha, 2000; Hermans, 2005).

In redevelopment projects, different kinds of SA's might be needed for different tasks. It is also important to realise that the stakeholder group, or their interests, might change during the project and the management phases. Therefore it is wise to repeat the stakeholder analysis for each management phase or when (major) changes occur in boundary conditions, involved parties etc.

The term stakeholder analysis encompasses a range of different methodologies for analyzing stakeholder interests and is not a single tool (Crosby, 1992). Different methods for performing a SA are available. For the Balance 4P project, the Crosby method (Crosby, 1992) is used. This method is also being applied in the EU FP7 project HOMBRE, in which methods for successful brownfield redevelopment are being developed. The objective of the SA for brownfield regeneration and redevelopment projects is to get support for the local managers and to help organizing the necessary means: knowledge, budgets and support for the redevelopment. A summary of the Crosby method is provided in Table 4.1.

Table 4.1. Procedure for stakeholder analysis: general steps of the Crosby method (Hermans, 2005)

STEP	Crosby method
General purpose of SA	Support for analysts or local managers in policy projects
Identify stakeholders	Draw initial ample list of stakeholders and relative importance
Collect primary input data	Use local informants to complete stakeholder table
Structure and analyse data	Fill in stakeholder tables / matrices (table 2.2, 2.3)

Stakeholders that should be taken into account are groups that can provide a benefit to the issue (such as strengthening the authority of decision maker, add resources, etc) or that can weaken the authority or position of the decision makers. Note that stakeholders do not necessarily have a positive input on decision making. Groups that influence the activities of an organisation should also be taken into account, think about local community or consumers; although not organized well in many cases, they can have a large influence towards the choices that are made.

It is not necessary to consider all potential stakeholders. Only stakeholders that have real interest in the particular issue, and that mobilize resources (the quantity and types) to affect outcomes regarding that issue should be taken into account (Crosby, 1992).

In Table 4.2the stakeholders and their position on the issue can be filled. Below, an explanation is given on the issues that are addressed in the columns.

- Group: name for the stakeholder group (or single person).
- Group's interest in Issue: those interests that will be affected by the decision to be taken (just the most important ones).
- Resources: the resources the group possesses that can be used in the decision making. (knowledge, information, leverage, money).
- Resource Mobilization Capacity: can the group mobilize these resources quickly or slowly? This is important when looking at the dynamics of the decision making. If a decision needs to be taken quickly, but the resource (eg knowledge) can only be delivered slowly, this resource is of less importance than previously thought.
- Position on issue: The position should be examined. People can be strongly negative (- -), slightly negative (-) or slightly positive (+) or completely positive (+ +). The - - take a lot of energy and will in many cases not be convinced. However, a way to handle this opposition (reduce negative impact) is necessary in the strategy for decision making. For the – a convincing argument could be enough to become +. The + and + + can be activated and sustained for the issue (Figure 4.1)

Table 4.2. Example of a blank stakeholder analysis table (Crosby, 1992).

Group	Group's interest in Issue	Resources	Resource Mobilization Capacity	Position on issue

Figure 4.1. Different stakeholders' position on issue and way to approach them.

It is important to realize that filling in Table 4.1 and Table 4.2 gives an overview. The stakeholder's behaviour and their management strategies cannot fully be predicted by these tables. It requires effort to guarantee analytical soundness and to prevent personal bias (Hermans, 2005).

In Table 4.3the participation of stakeholders can be defined: how to involve the stakeholders in the different phases of the project. This is a choice that is based on (e.g.) available means and position towards the issue (see Table 4.2). Not everybody needs to be involved in the same way. For example: if there is sufficient money, extra resources from stakeholders that provide money are not necessarily required; it can be a better choice to focus to groups that pose societal opposition.

Table 4.3. Example of a blank stakeholder participation matrix (based on ODA, 1995; Mac Arthur, 1997 and Maring et al., 2013)

Phase*	**Type of participation**			
	Inform	Consult	Partnership	Control
Planning phase				
Realisation phase				

*Phases can be adapted to the commonly used project phases. These phase names can differ per country or discipline.

The SA methodology was used to make a quick scan of important stakeholders for the cases (Section 6 and Appendix B). We identify different groups of stakeholders from the, for Balance 4P important, fields of:

- "knowledge" (knowledge institutes, universities),
- "regulators" (the different fields of regulation (environment, city planning, social and economic affairs) from municipality, region and environmental agency)
- "business" community (advisors, housing corporations, utility companies)
- "society" (social initiatives).

Interesting to see is that the stakeholders that can be involved in a project are very depending on the phase of the case. For Balance4P, the first two groups were easy to involve. The third group

(businesses) was involved in the Dutch and Swedish case, because the developers were (about) to be) involved in the phase of the project. In the Belgium case (C-site), this group was difficult to involve because of sensitivities in the potential development process of this "blackfield" and therefore their involvement was not seen advisable. The last group: society, eventually needs to be involved in all redevelopment projects. In the Swedish case there had already been some involvement of the local community in the process. In the Dutch case, there are no people living on or nearby the site and redevelopment has not started, so here this involvement was not arranged yet and therefore it was not possible to involve the local community in the B4P project. In the Belgium case this was also not possible yet.

A local community involvement process is of large importance. It should be done in the right way to manage expectations, give and get information in the right time (Chanan, 1999). Local community involvement is today often seen as an important part of sustainable development. However, it is not without challenges. How it is realised in practice and how it relates to the formal decision-making hierarchy are important aspects to consider. The Balance 4P project team does not have the role in the cases to influence this and therefore was dependent on the case holders if local community could be involved in the project. This was unfortunately in none of the cases possible.

4.2 Tools and methods

There are numerous instruments that can be used in the urban planning process: they support workshops with stakeholders, calculate the projects' effects on the natural system, increase cost-efficiency, provide a framework according to which an entire project can be executed, rate the sustainable performance of a project and more. In this study different categories are defined in which the existing instruments can be organized, based on other relevant studies. In this study the categorization is based on the primary objective of application of instruments, including several subcategories (Figure 4.2): *Information & Education, Design Development Options, Assess Project (Options) and Support Aspect of Project*. It was chosen not to base the categorization on approach (e.g. environmental, economic, etc.) because many instruments encompass multiple approaches. The instruments that fall under the category 'Support aspect of the project' are very specific, but are nevertheless incorporated because they are useful in brownfield redevelopment projects. Figure 4.3 gives an idea of the many different instruments that are available and what use they might have in a project; though an instrument can have multiple applications or approaches. For example the 'BREAAM-NL Spatial Development'-certificate can be both listed in the 'Design Development Options' category, being used as a list of actions to attend when executing a project sustainably - and in the 'Assess Project Options' category (Bouwinnovatie, 2013).

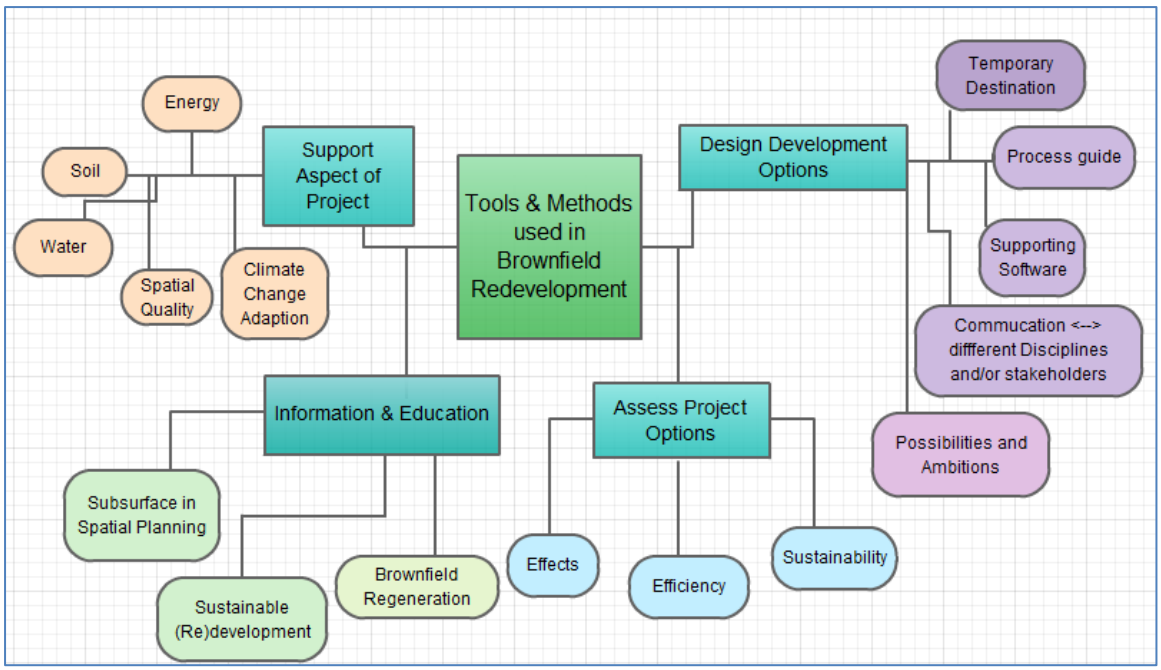


Figure 4.2. Categorization of instruments used in brownfield redevelopment. (Kok, 2014)

'*Design Development Options'* incorporates all instruments that could have a function in the development of project options: defining the general direction of the development; stimulating cooperation and communication between stakeholders or between different disciplines; supporting software; process guides or lists of concepts to attend and temporary destination.

'*Tools supporting aspect of project'* is a mixture of tools that can be used to assist in addressing one of the aspects of the project: they provide information or guidance in the fields of energy, soil, water, spatial quality and climate change adaption.

'Information & Education' includes information sources and guidelines on incorporating the subsurface in spatial planning; performing sustainable urban redevelopment; adapting to climate change and information and case study databases for brownfield redevelopment.

'Assess Project Options' contains instruments used to evaluate the effects, cost-efficiency or to rate sustainability of a project (option), see also Section 5 where assessment tools are described more in detail from a remediation perspective.

These tools can be used in different phases of the redevelopment. Figure 4.3 gives an overview of the tools available in English. Tools that are in the Dutch language are discarded in this overview, but can be found in Appendix C. The tools in red are used in the Balance4P project.

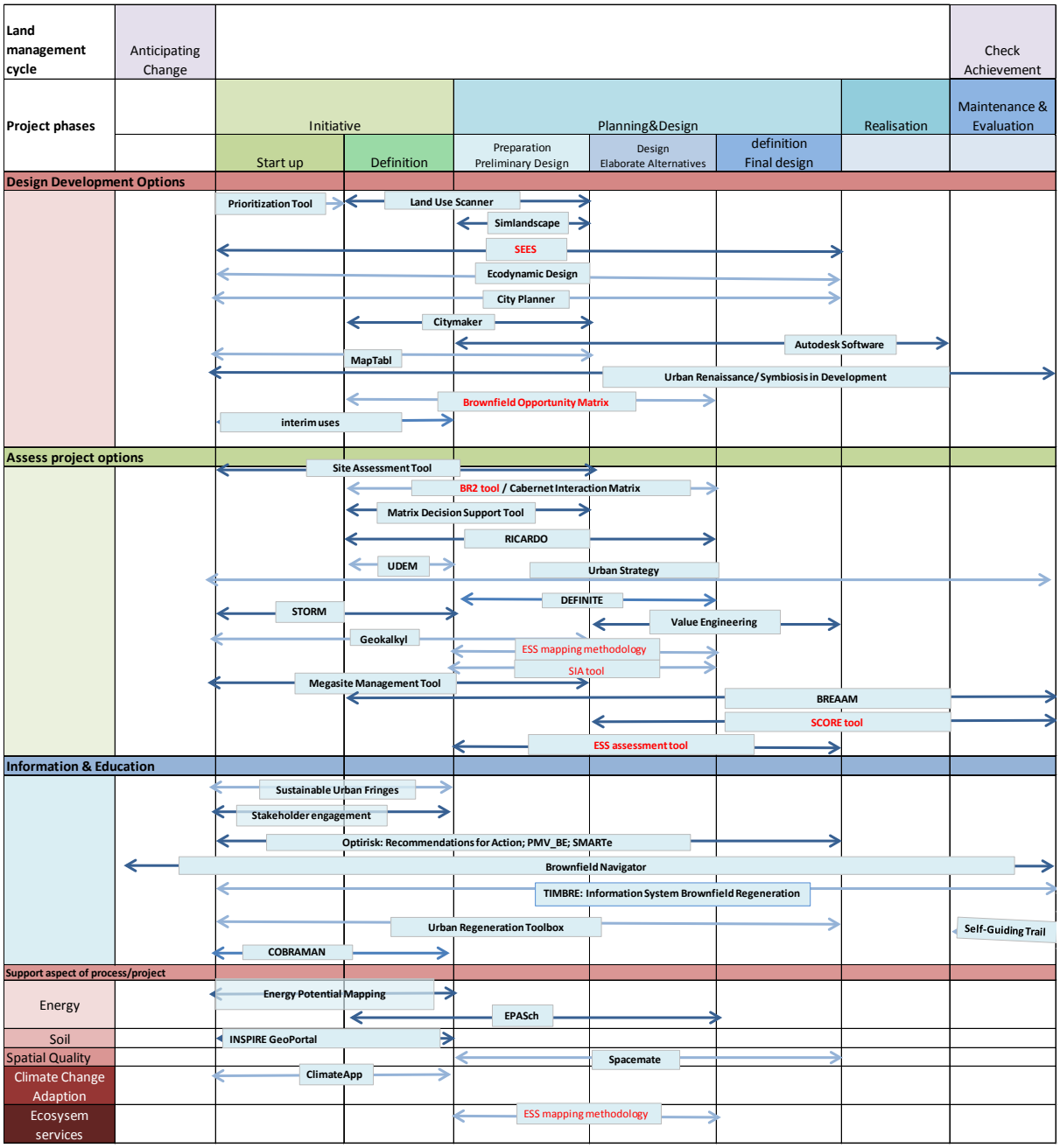


Figure 4.3. Instruments along the project phases (based on Kok, 2014)

The SEES methodology (Box 4.1) was used on the Balance 4P cases, as this methodology links directly to the aim of the B4P objective to develop a decision process framework with a strong focus on integrating urban planning and soil issues.

Description of tools in red can be found in Boxes 4.1, 4.2, 4.3, 5.1, 5.2, and 5.3. The results of the application of the tools can be found in Section 6.1 (Netherlands), 6.2 (Belgium), 6.3 (Sweden).

Box 4.1 System Exploration Environment & Subsurface

SEES

For a systematic analysis of the risks and opportunities for brownfield redevelopment related to the characteristics of the environment and specifically of the subsurface, the method System Exploration Environment & Subsurface (SEES) was used in the case studies.

SEES is a method which supports and registers the knowledge exchange between experts of different fields. The method gives an overview of the urban system: it relates the "above ground" layers of people, cycles (metabolism), buildings, public spaces and infrastructure to "subsurface qualities" divided in four themes: civil constructions, water, energy and soil. The method is related to the Japanese LEAN thinking as developed by Toyota (Womack & Jones, 2003). LEAN thinking avoids making mistakes. This is done by not focussing on impossibilities but on quality, direct communication and making and keeping clear appointments. The System Exploration Environment & Subsurface method enables smarter producing of (re)development designs if it is performed in an early stage of a (re)development process.

The SEES method is meant to be used in project teams working on urban development. It guides the dialogue between the representatives of the technical and natural boundary conditions and the aboveground specialists that represent the social-economic requirements. It offers a systematic overview that enables the consultation of all necessary specialists and fields and gives opportunity to search for clever connections. Because the subsurface is taken into account and all information is being gathered and discussed in a systematic way during the planning process, it is possible to make smarter urban designs. Smarter urban designs lead to more climate proof (think about the water issue), to energy-saving (storage and extraction of subsurface warmth and cooling water), more sustainable (the identification of cycles) and to cheaper (earlier identification of benefits, problems and costs) designs.

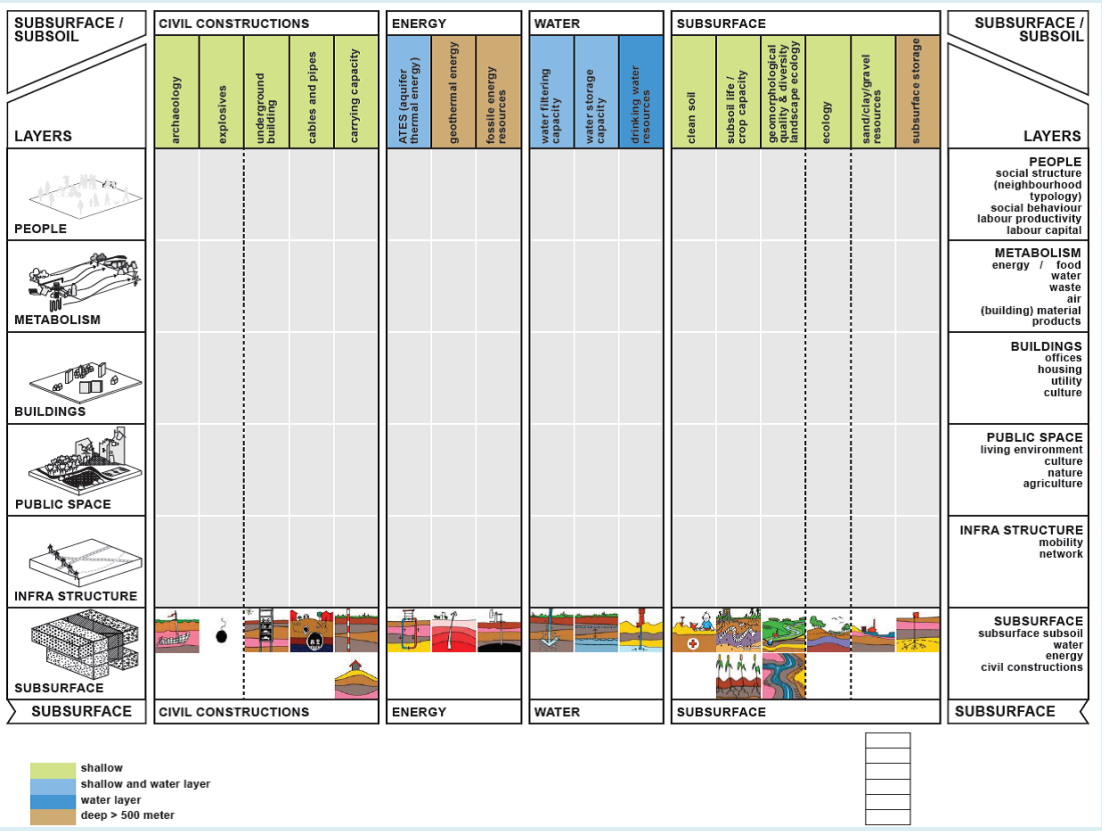


Figure 1. System Exploration Environment and Subsurface (SEES) table

What is needed?

1. Large print of the System Exploration Environment & Subsurface table (Figure 1)

2. Chairman (m/f) who keeps track of the time and asks questions
3. The stakeholders / specialists of all layers (urban designer, project leader, landscape architect, traffic expert, housing corporation, plan economist, archaeologist, cable and pipe expert, water-, energy-, soil experts etc.)
4. Information from the stakeholders / specialists for the project area.

How it works:

1 The panel chairman gives an introduction of the SEES method (10 minutes)
2 Each participant introduces him- or herself and indicates his/her domain in the system that is presented in the table (15 minutes)
3 Aboveground experts give an explanation about the characteristics of the area, the social-economic ambitions and the plans (15 minutes)
4 Go through the natural and technical boundary conditions in a systematic way with (this is presented by the subsurface experts, per theme):
   — Civil construction: Archaeologist, specialists on explosives (when expected),
   — Cables and pipes and geotechnical information in relation to subsurface building
   — Carrying capacity.
   — Energy: ATES and Geothermal energy specialists.
   — Water: Geohydrological and water management specialists.
   — Soil: soil experts and ecologist.
5 Start a conversation about the opportunities, obstacles, points of attention and boundary conditions.
6 Make connections between themes: enter the highlights in the system exploration
7 When all subsurface qualities are discussed, they can be evaluated per aboveground layer.

The SEES method is available for download and use from https://publicwiki.deltares.nl/display/SEES/HOME+English.

What is the result?

- An overview of opportunities, obstacles, points of attention and boundary conditions for development of the area.
- Possibilities for cheaper, climate proof and sustainable development options.
- Contact between all necessary stakeholders and specialists.
- A dialogue, in which the specialists from the aboveground and subsurface are involved and have the opportunity to understand each other.

When to use SEES

In all phases of the redevelopment the SEES method can be used. However, in the earlier phases of the initiative and the planning and design phases the beneficial effects of the method are greater.

Next to SEES, there are many other instruments that can be used. In the MerweVierhavens case study, two tools developed in the HOMBRE project were applied: the BR2 Brownfield Remit/Response tool (Box 4.2) and the Brownfield Opportunity Matrix (Box 4.3). The Brownfield Opportunity Matrix was also applied for Fixfabriken.

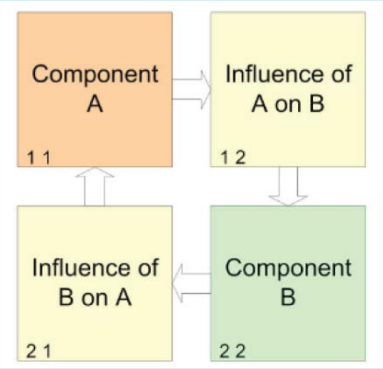
Box 4.2 Brownfield Remit/Response (BR2) tool

BR2 is a method to "provide a means for exploring the impact that brownfield redevelopment will have on the urban system within which it takes place and the exploration of the consequences that will arise as a result of these impacts. Therefore, it can provide a means for selecting redevelopment options based on site specific analysis of the impact of redevelopment rather than relying on generic theories of redevelopment (i.e. building employment generating buildings will reduce local unemployment). In this way it provides a means to select redevelopment options using a robust evidence based approach" (Leney & Nathanail, not dated).

A system is a group of elements forming a connected or complex whole (Oxford English Dictionary (OED), 1989b). Traditional approaches that assess the impact of redevelopment assume that the urban system is a simple system and that causes and effects are directly linked. These ways of approaching redevelopment impacts exclude a lot of relations and indirect causes and effects. BR2 treats the urban system as a complex and interactive system that will respond in a dynamic way to change. Within a system like this simple changes can result in unexpected, and possibly undesirable, outcomes. By applying a systems approach, the planned redevelopment options can be assessed on site specific analysis of the impact of redevelopment using a robust evidence based approach rather than relying on generic theories of redevelopment (Leney, 2008, pg. 120-121). The method is based on REMIT/RESPONSE, a procedural approach to rock engineering that applies existing knowledge about a rock mass to develop a model of a rock engineering situation which can then be used to develop procedures to deliver stated objectives (Hudson, 1992; Nathanail et al., 1992).

What is needed?
Expert knowledge of the area and the aspects that are considered.

How it works:
The BR2 tool works via a matrix - an N2 chart - that models the urban fabric of the city. The matrix is build-up out of squares representing the fabric and its functioning (see inserted simplified figure). The diagonals from the top left corner to the right bottom form the important elements e.g. housing stock, transportation, biodiversity etc. Each other square is horizontally and vertically linked to two components and describes the relation between the first and the second one. An interaction matrix can be tailor-made for every specific site. The methods used to do so are expert judgment and winnowing. With the first method a group of expert and stakeholders can determine which elements are relevant and important enough to be a leading diagonal. The second method is a more systematic process. Winnowing, in this context, means discarding the irrelevant. The theoretical process is to start with a coarse matrix with 3 or 4 very general elements, e.g. natural environment, built environment, policy and finance. Then the elements which do not seem relevant are winnowed out (unlikely in the first stage). Next each element is expanded into several sub-elements, followed by winnowing out any of these that are not relevant to the site and surrounding area. This process is continued until the user is content with the matrix. The BR2 tool is available for download and use from the Brownfield Navigator[19].



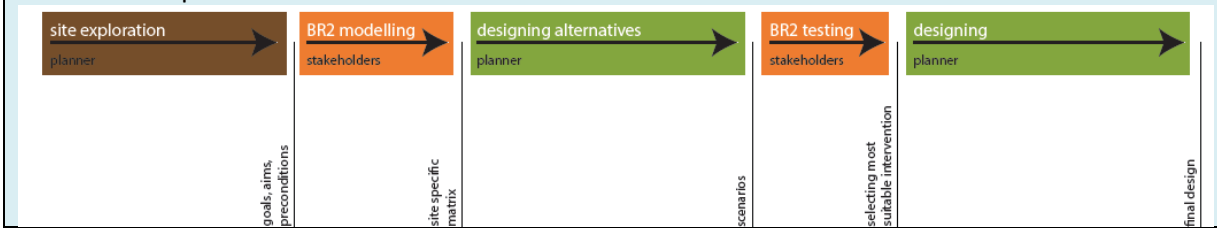
[19] bfn.deltares.nl

What is the result?

- More insight in the urban system
- An overview of interrelationships between aspects to be used in the development of the area
- An overview of dominant and subordinate aspects
- Contact between stakeholders and specialists
- A dialogue, in which the specialists are involved and have the opportunity to understand each other

When to use BR2

The BR2 tool can be used in the planning and design phase, in an early stage to explore the system and in a later phase to create scenarios.



Box 4.3. Brownfield Opportunity Matrix

Soft end uses of brownfields, such as biomass or green space, can provide services which add value to a regenerated site, both in their own right and integrated with hard uses such as for buildings. The "Brownfield Opportunity Matrix" (BOM) is a MS Excel based screening tool to help decision makers identify what services they can get from soft reuses and so add value to a regeneration project. It maps desirable services with the interventions (e.g. treatments) that can deliver these services for their site, as shown in broad terms below.

Services	Interventions
• Risk Mitigation of Contaminated Land and Groundwater • Soil Improvement • Water Resource Improvement • Provision of Green Infrastructure • Mitigation of Human Induced Climate Change (global warming) • Socio-Economic Benefits	• Soil Management • Water Management • Gentle Remediation Options • Other Remediation Options • Implementing Green Infrastructure • Renewables (energy, materials, biomass) • Sustainable Land Planning and Development

As well as mapping desirable services against the interventions that can deliver them, the BOM:

- Assists identification of the most effective combinations of available interventions
- Provides initial guidance on likelihood of success and technical feasibility
- Describes the types of value that can be generated
- Provides links to high level operating windows that describe technical suitability and sustainability drivers and to provide links to more detailed information
- Provides links to high level opportunity windows that give examples of successful deployments of interventions to provide particular services

Overall it plots the value of applying the Interventions either on their own, or in combination with other interventions. The goal of the matrix is to encourage redevelopment of Brownfield land so that it re-enters the land-use cycle. The matrix is intended for use by land owners / managers, potential investors, local authorities and government stakeholders and especially for brownfields where the market mechanism is working less well.

What is needed?

Stakeholders that are willing to look at different possibilities for BF sites, provided by soft uses
Data on site characteristics to determine required services and boundary conditions for application (operation windows).

How it works:

The matrix can be used to map the range of opportunities (and hence value) that might be achieved from a brownfield regeneration project and the project's consequent sources of value, as shown below. It also provides supporting information to describe the various services, interventions and opportunities listed in the matrix. Overall the Brownfield Opportunity Matrix is a versatile tool which can:

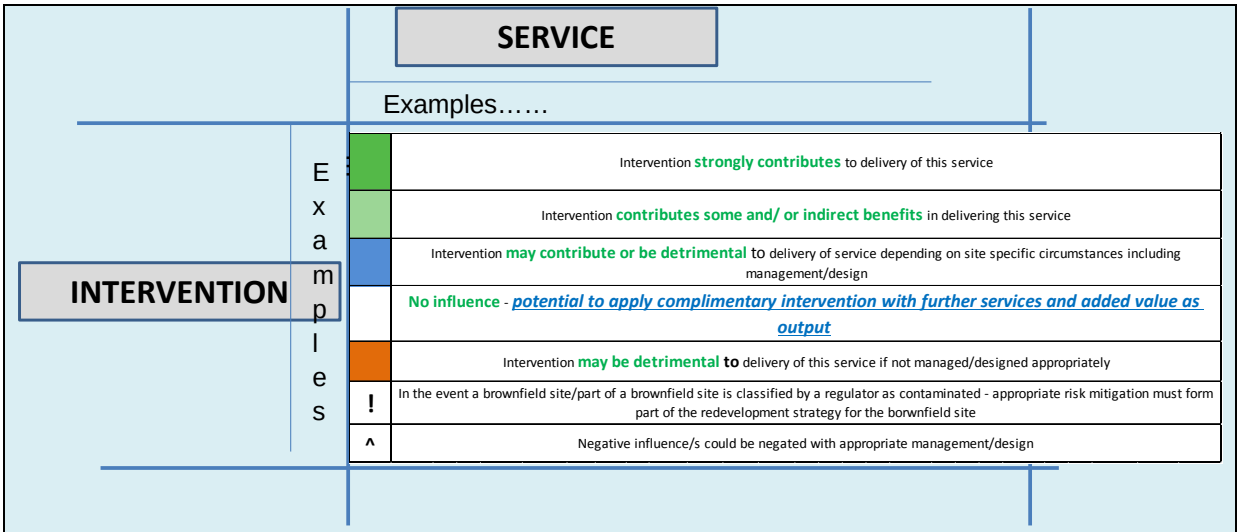
1. Support initial identification or benchmarking of soft re-use options for brownfields at an early stage, for example where a landowner is just beginning to consider options (*pre-exploratory stage*)
2. Shows the types of interaction between service and intervention (see below)
3. Support exploratory discussions of an initial concept with interested stakeholders options (*exploratory stage*)
4. Provide a framework to describe an initial design concept, in support for example of planning applications options (*exploratory stage*)
5. Provide a framework for more detailed sustainability assessment of different re-use combinations, and similarly for cost benefit comparisons

	Intervention **strongly contributes** to delivery of this service
	Intervention **contributes some and/ or indirect benefits** in delivering this service
	Intervention **may contribute or be detrimental** to delivery of service depending on site specific circumstances including management/design
	No influence - ***potential to apply complimentary intervention with further services and added value as output***
	Intervention **may be detrimental to** delivery of this service if not managed/designed appropriately
!	In the event a brownfield site/part of a brownfield site is classified by a regulator as contaminated - appropriate risk mitigation must form part of the redevelopment strategy for the borwnfield site
^	Negative influence/s could be negated with appropriate management/design

The BOM *Excel* file is a mapping matrix listing services from interventions (see schematic below)

- Showing in a table where there are strong associations, potential associations, associations that depend on site specific circumstances, potential antagonisms (see schematic below)
- Showing types of value outputs in the same table
- High level operating windows linked from interventions listed in the table
- Opportunity windows linked from the matches shown in the table
- Service descriptions to provide more information about potential services

The BOM supports a process of optimisation whereby stakeholders can discuss the integration / combination of interventions that maximise services, and hence value using interventions that are synergistic or complementary.

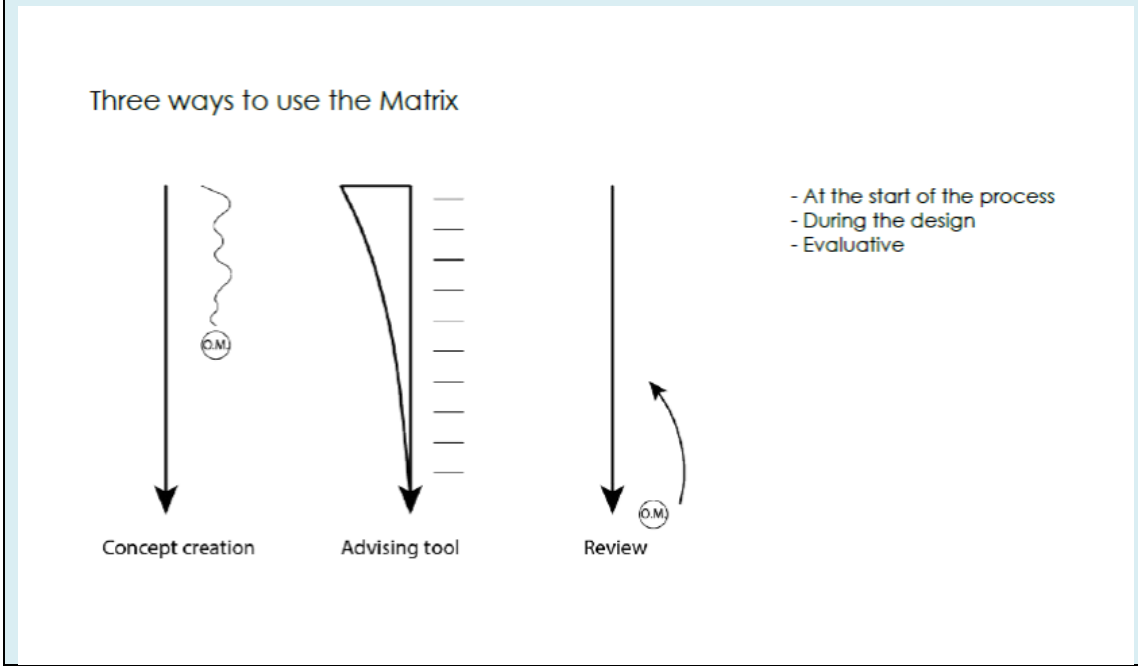


The BOM is available for download and use from the Brownfield Navigator[20], which also includes tools for describing and note taking on a geo-spatial basis the various interventions and their opportunities. It can work with the BR2 tool, by using initial BR2 assessments to identify key driving forces for service requirements. The outputs of the matrix can also be fed back into the BR2 tool to describe a post regeneration status for the site.

What is the result?

- More insight in possibilities for soft reuse and services / benefits delivered
- An overview of pursued services delivered by soft uses
- An overview of interventions needed to acquire pursued services
- Contact between stakeholders and specialists
- A dialogue, in which the specialists are involved and have the opportunity to understand each other

When to use BR2



[20] bfn.deltares.nl

5 Sustainability assessment/comparing/assessing redevelopment strategies

The concept of sustainability is important in both the execution of soil and groundwater remediation activities and brownfield redevelopment design. “Sustainability” when applied in this area, involves the balancing and consideration of factors beyond the primary objectives of managing, containing and /or removing contamination from the subsurface. The concept of sustainability or sustainable development is derived from the United Nations World Commission on Environment and Development (UNWCED), report titled “Our Common future” and refers to meeting the needs of the present generation without inhibiting future generations from doing the same (UNWCED, 1987). The intergenerational time dimension is central to the concept, requiring that the burdens associated with a course of action do not extend into the future. Mitigating present and future toxicological risks presented by contaminated land meets this requirement but may also bring about a shift in impacts from one media to another. For example, removing subsurface contamination at the expense of releasing air emissions due to fossil fuel consumption. Sustainable remediation and brownfield redevelopment therefore aims to avoid “trans-medial problem shifting” (Geldermann and Rentz, 2005) by balancing three impact categories, referred to as “the pillars of sustainability” (Figure 5.1): environmental, social and economic (SuRF-UK, 2010). Remediation and redevelopment scenario sustainability assessment approaches tend to integrate and borrow different impact assessment and aggregation methods.

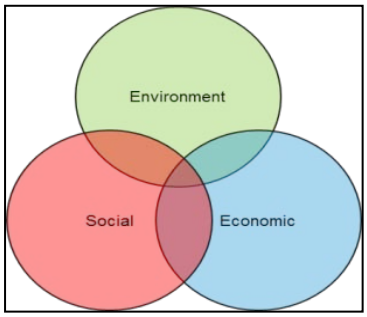


Figure 5.1. Pillars of sustainability

A consensus exists amongst professionals and expert working with contaminated land issues and remediation forums, that a discursive approach to sustainability assessment is preferred to a predefined set of criteria. Various PC-Based decision support tools that consist of a predefined set of indicators have the advantage of requiring less time and effort from the end-user and provide less experienced users with a basis from which more detailed evaluations can be performed.

Two broad or global approaches characterize the existing discursive frameworks, namely the *Green Remediation Approach* and the *Sustainable Remediation Approach*. The United States Environmental Protection Agency defines *Green Remediation* as protecting human health and the environment while ensuring that the environmental burden of the clean-up activities is kept to an absolute minimum (USEPA, 2009). The focus, therefore, is on local environmental restoration with the least harm to the global environment. Sustainable Remediation as defined by SuRF-UK, advocates choosing a course of remedial action that would bring about the greatest net benefit in terms of the environmental, economic and social impacts. SuRF-UK published a list of indicators that could be

used as a basis for performing bespoke sustainability assessments on a site by site basis. Beames et al. (2014), compared the SuRF-UK indicators to those of the PC-based DSSs.

5.1 Tools and methods

Soil and groundwater remediation is primarily intended to reduce and manage the risks to human beings and ecosystems posed by contaminated sites, therefore bringing about positive environmental changes that are beneficial to society. Determining the most appropriate course of action when faced with soil or groundwater contamination requires the consideration of technologies or approaches that can effectively remove the contamination to the required target level within project-defined time and cost constraints. An additional set of criteria based on the principle of "sustainable development" has recently given rise to the discourse on "sustainable remediation", with the intention of not only reducing the risk posed by soil and groundwater contamination but also doing so in a way which brings about a net benefit in terms of broader environmental, social and economic considerations (SuRF-UK, 2010). Decision support systems (DSSs) provide for a structured method of comparing alternative courses of action that differ in terms of impacts (Matthies et al., 2007).

The existing sustainability assessment DSSs for soil and groundwater remediation can be classified into two broad types. The first and most common type of tool, is referred to as a "sustainability appraisal" DSS (Pollard et al., 1999; Sullivan 2002) focusing on sustainability of remediation technology options. In the last decade however, there has been a shift towards the development of another kind of sustainability assessment tool that facilitates other parts of the remediation decision process. This second type of DSS considers the social and economic impacts associated with the eventual site re-use and is intended for large scale remediation and redevelopment projects or brownfield revitalization. This second type of tool will be referred to here as Scenario Appraisal DSSs. Figure 5.2 illustrates the steps in the planning process that precede the specific type of sustainability appraisal.

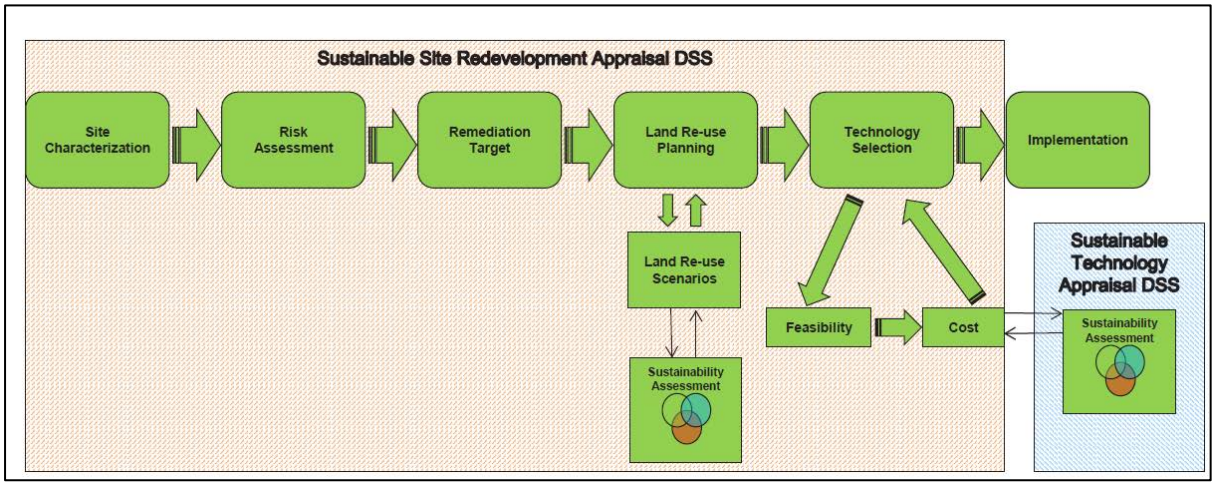


Figure 5.2. Schematic presentation of stage in remediation planning process where sustainability is assessed. Two types of tools exist: Sustainable Site Redevelopment Appraisal and Sustainable Technology Appraisal (Beames et al.,2014).

5.1.1 Technology "Sustainability Appraisal" DSSs

Sustainability appraisal DSSs are used to identify the most sustainable remediation technology options out of the possible alternatives. The sustainability appraisal is performed after determination of the intended land-use, remediation target and feasible technologies (see Figure 5.2). It only assesses the potential sustainability of the feasible technology alternatives.

There are DSSs that identify feasible technologies according to the geo-hydrological conditions and type of contamination (e.g. PRESTO, Onwubuya et al, 2009). Other DSSs also provide financial cost estimations of different technologies according to site-specific inputs, along with sustainability criteria. Examples include SRT and REC (US AFCEE, 2010; Beinat el al., 1997)

Most sustainability appraisal DSSs perform fairly extensive LCA based environmental foot-print calculations e.g. SRT, Carbon Footprint of Remediation (SGF, 2012) and the ABC-tool (Maring et al., 2004). The current state of the art of sustainability appraisals typically consider only the environmental impacts of remediation operations. The socio-economic impacts are considered either in limited detail or are not accounted for beyond on-site operations during the remediation process. This limited consideration of the social and economic elements of sustainability stands in contrast to what is prescribed in guidance material from sustainable remediation forums such as SuRF-UK (2011), NICOLE (2011) and Eurodemo (2006).

The SCORE model (Rosén et al., 2013) is a tool that accounts for a wider range of social and economic impacts, see Box 5.1. The SCORE tool builds upon previous work by Rosén et al. (2006, 2008, 2009). The evaluation of social and economic impacts depends on the chosen system boundary, thus widening the system boundaries also requires taking a different set of impacts into account. The SCORE tool builds upon previous work by Rosén et al. (2006, 2008, 2009) and widens the conventional system boundaries found in other tools.

Box 5.1. SCORE – Sustainable Choice of Remediation.

SCORE

What is needed?

How it works

What is the result

When to use SCORE

5.1.2 Scenario Appraisal DSSs

As Bardos et al. (2011) points out, at earlier stages, i.e. in a local spatial planning stage, there are wider opportunities for sustainability considerations. The second type of sustainability assessment DSS or Scenario Appraisal DSS considers the impacts of eventual site occupation and land-use in line with Bardos et al. (2011). MMT and DESYRE are two examples of this newer type of tool and were

developed to facilitate the various planning phases of large scale remediation projects. Such tools are innovative, in that they integrate different steps in the remediation planning process and because they consider social and economic impacts once the site re-occupied. These tools however, do not consider community and environmental impacts during remediation operations, which also stands in contrast to the holistic approach prescribed by remediation forums. An additional challenge for existing scenario appraisals systems is their relative complexity making them inaccessible to end users and therefore seldom applied in practice.

Once the remediation targets for a site have been determined (see Figure 5.2), the scenario appraisal DSS generates different on-site land-use scenarios. These tools (such as MMT) evaluate the different scenarios according to a selection of sustainability indicators. MMT also reflects the contaminant hotspots and groundwater plumes allowing developers to optimize their remediation strategy in accordance with the eventual land-use plans.

5.2 Sustainability indicators

As stated, the narrow focus of several Technology "Sustainability Appraisal" DSSs on on-site environmental impacts stands in contrast to what is advocated in the concept of sustainable development and leads to poor balancing of the three dimensions (environmental, economic and social) of sustainability (SuRF-UK, 2010; UNWCED, 1987). Broadening the scope of the assessment from only a few environmental indicators and financial costs to also considering social impacts and indirect economic impacts, will influence the sustainability performance of the remediation alternatives. A broader scope of evaluation comes closer to including all the impacts deemed to be important by remediation forums such as SuRF-UK and provides a more holistic account of how different courses of action impact not only the natural environment, but also the human environment.

Indicators should be based on information that can be easily obtained by remediation professionals and includes all relevant considerations on-site and off-site. On-site environmental impacts during the remediation process should be linked to their eventual social and economic impacts.

Table 5.1 includes an overview of the sustainability indicators used in the CO_2 Calculator, SRT, REC and GoldSET tool. Three are publicly available: (1) the CO_2 Calculator (request at www.ovam.be) (Praamstra, 2009), (2) the Sustainable Remediation Tool (SRT) (request at www.afcec.af.mil) (US AFCEE, 2010) and (3) the Risk Reduction, Environmental Merit and Costs tool (REC) (request at www.ivm.vu.nl) (Beinat et al., 1997). The fourth tool, (4) GoldSET (Golder Associates, 2012), is not publicly available (information about the tool can be found at www.gold-set.com).The table shows how the tools differ from one another and how the tools differ from what is prescribed by SuRF-UK. What is immediately evident form the table is that the environmental aspect or pillar of sustainability is the most detailed in terms of indicators covered in the tools. The social impact aspect is the least detailed. The reason for this is that the tools were originally developed by environmental engineers with little knowledge of metrics that are applicable to socio-economic impacts.

Table 5.1. Indicators considered in technology sustainability appraisal tools categorized according to the three pillars of sustainability and are also divided up according to whether they are related to remediation operations or site re-occupation. Quantitative (X) and qualitative (O) indicators included in each tool as well as indicators proposed by SuRF-UK (S) and those not considered in the tools (-).

		CO_2 Calculator	SRT	REC	GoldSET	SuRF UK
Environmental						
Clean-up (during operations)						
On-site	Primary energy consumed and CO_2 emissions (e.g. excavation, drilling, groundwater extraction and purification)	X	X	X	X	S
	Energy consumed and CO_2 emissions produced cleaning soil on-site	X	-	-	-	-
	Energy consumed and CO_2 emissions produced laying clean fill soil	X	X	-	-	-
	Other air emissions (SO_X, NO_X, PM_{10})	-	X	X	-	S
	Water consumption	-	-	X	X	S
	Waste generated on-site	-	-	X	X	S
	Short-term ecological impact on-site	-	-	X	O	S
Off-site	Energy consumed and CO_2 emissions produced transporting waste soil off-site	X	X	X	-	S
	Energy consumed and CO_2 emissions produced transporting workers, materials and equipment	X	X	-	-	-
	Energy consumed and CO_2 emissions produced treating dumped water off-site	-	-	X	-	-
	Energy consumed and CO_2 emissions produced cleaning soil off-site	X	-	-	-	S
	Soil consumed off-site	-	-	X	-	S
	Waste generated off-site	-	-	-	O	S
	Short-term ecological impact off-site	-	-	-	O	S
Site Re-use	Soil quality	-	-	X	O	S
	Groundwater quality	-	X	X	O	S
	Surface water quality	-	-	X	O	S
	Erosion of contaminated soil	-	-	X	O	S
	Sediment quality	-	-	-	O	S
	Free phase product removal	-	-	-	O	-
	Contaminated groundwater migration	-	-	-	O	S
	Long-term ecological impact	-	X	X	O	S
Economic						
Clean-up (during operations)	Total costs	-	X	X	X	S
	Net present value	-	-	X	X	-
	Litigation costs	-	-	X	O	S
	Additional costs due to delays and technology failure	-	-	X	O	S
	Additional costs due to logistical challenges	-	-	X	O	-
	Technological uncertainty on cost	-	X	X	O	-
	Permit and regulation related costs	-	-	-	O	S
	Use of financing opportunities	-	-	-	O	S
	Local business opportunities created	-	-	-	O	-
	Local employment opportunities created	-	-	-	O	S
Site Re-use	Increased economic value of area	-	X	-	-	S
	Reuse of property by developer	-	-	-	O	S
	Corporate reputation of developer	-	-	-	O	S
	Local business opportunities created	-	-	-	O	-
	Local employment opportunities created	-	-	-	O	S
Social						
Clean-up (during operations)	Workers' health and safety	-	X	X	O	S
	Community health and safety	-	-	-	O	S
	Duration of operations	-	-	-	X	-
	Nuisances and hindrance to community	-	-	-	O	S
	Legal requirements met	-	-	-	O	S
	Good management practices	-	-	-	O	-
	Ethical practices and local equity	-	-	-	-	S
	Site security	-	-	-	-	S
	Uncertainty and evidence	-	-	-	-	S
	Community involvement	-	-	-	-	S
Site Re-use	Soil vapour intrusion impact on human health	-	-	X	O	-
	Protection of potable water supply	-	-	-	O	S
	Preservation of historical or culturally significant buildings or space	-	-	-	O	S
	Public space created	-	-	X	O	-
	Impacts on the landscape (aesthetic)	-	-	-	O	-

Key
(X) Quantitative
(O) Qualitative
(S) Proposed by SuRF-UK
(-) Not Considered

The evaluation of the indicators and structures of the four tools highlight the differences in the scope of the tools, how indicators are calculated and how this ultimately influences the results generated by the tools. As shown in the review by Beames et al. (2014), the results of the tools differ in terms of their indicator selection and how their indicators are measured and weighted. The indicators that are common across the tools tend to focus on environmental impacts related to on-site processes and total financial costs. Off-site impacts, impacts that are felt after remediation and impacts associated with reoccupation of a remediated site are considered less thoroughly across the tools, particularly with regard to the economic and social dimensions of sustainability, i.e. a poor balancing of the three dimensions (environmental, economic and social) of sustainability.

The two sub-sections below present potential approaches to developing more holistic social and economic indicators that have yet to be adopted in sustainability assessment of remediation and redevelopment scenarios. In the Balance 4P project, these aspects are covered in the cases by applying tools that complement each other to account for a proper balancing of the three sustainability domains.

5.2.1 Social impact indicators

Social impacts are changes in the well-being of people in communities caused by a given choice of action or policy. In the context of remediation and redevelopment of contaminated sites, social impacts are experienced by those living around the site. The impacts can occur both during the operational phases of the remediation and/or redevelopment and after project completion once the site is re-occupied. In other words, social impacts occur throughout the implementation of the remediation and redevelopment project and as a result of the eventual land-use scenario. Social impacts overlap with economic impacts in terms of affecting the well-being of local community members. Economic impacts can be defined as the direct and indirect financial implications of a given choice of action for the site owner, broader community and other stakeholders. The focus of the social aspect is on the change in well-being that does not involve monetary transactions and the focus on financial impacts is on the monetary transactions that occur due to the choice of action. Some social impacts can be valued in economic terms and this valuation is sometimes also included in the economic impacts. Some argue that this may imply double-counting. However, this introduces a problem of double-counting only in the special case when economic values are considered to reflect all other types of values. Monetization through willingness to pay (WTP) is a common way of assigning economic values, and hinges on the individualistic view that well-being is determined by the degree of preference satisfaction (Hausman and McPherson, 1996). As stated in Volchko et al. (2013), whereas WTP is directly connected to, and constrained by, personal income, the same individuals taking a community well-being perspective can place another kind of value, e.g. ethical value, on the same service, not necessarily reflected in their WTP. Thus, there might be a fundamental difference between their roles as consumers and citizens (Sagoff, 2007). It is however crucial for decision making to realize that a positive economic impact is not equal to a positive financial impact for potential redevelopers.

At present there are two main approaches to evaluating social impacts (e.g. Magee et al., 2013). The first is a “top –down” approach using quantifiable metrics or indicators determined by experts. The

European Environmental Agency applies top-down approaches as measures of progress towards policy objectives designed for promoting employment, combating poverty, improving living and working conditions, combating exclusion and developing human resources (Morford 2007, EEA 20012). The second is the "bottom-up" approach by which indicators are developed in consultation with the stakeholders that stand to gain and/or loose from a project. The two approaches are often combined, where indicators are designed in collaboration between experts and stakeholders.

The top-down approach allows for the automation of decision processes but requires the initial stage of selecting indicators. Inspiration for the definition of these criteria can be found in different fields. Sustainability assessment DSSs specifically for soil and groundwater remediation include a limited set of indicators which focus on the hindrance caused to the local community by on-site operations and the changes in risk levels associated with subsurface contamination. Such tools generally do not include the consideration of post-remediation and redevelopment impacts which are also important in a holistic context. Sustainability indicator sets from other scientific disciplines such as urban renewal and building construction are also relevant to brownfield redevelopment. Such indicators have been included in the development of existing Scenario Appraisal DSSs such as the Mega site Management Tool described by Schadler et al. (2011, 2012, 2013) and the Sustainable Brownfield Redevelopment Tool (SBR) described by Wedding and Crawford-Brown (2007).

Calantonio et al. (2009) make a distinction between spatial and functional measures of social sustainability. Spatial measures refer to the difference between tangible aspects of the environment and spatial design that enhance livability and serve as a foundation for the less tangible social considerations which support the functioning of civil life, such as social cohesion and community empowerment through human capital. The sustainability assessment module MMT described in Schadler et al. (2013) focuses exclusively on physical attributes of the environment, land-use and spatial arrangement.

Another source of inspiration are Social Impact Assessments. Social Impact Assessment (SIA) is a feature of the Environmental Impact Assessment method, in which the social impacts associated with a policy change or development project can be predicted, evaluated, monitored and managed. A distinction is made between changes in the 'human environment' and changes in 'biophysical environment' (Burdge et al., 1995). The two are inextricably connected, although the scope of the SIA focuses specifically on changes that are defined as occurring in the 'human environment', i.e. changes that impact the lives of individuals and communities and their collective functioning. The goal of SIA is to go beyond simply avoiding negative consequences for communities or a given populace in question, and to maximize the desired policy and development outcomes (Vanclay, 2003). In this sense, SIA allows for both the most desirable alternative to be determined and for the chosen alternative to be optimized.

The general approach to SIA includes two fundamental steps. The first is screening the most detrimental impacts associated with the potential course of action and determining whether an SIA is indeed necessary. The second is in determining the relevant scope of the assessment (Gomez et al., 2013). The scoping step itself includes the identification of all relevant impacts. "Hard" or quantifiable impacts are identified via expert consultation and technical procedures. "Soft" impacts are determined in consultation with stakeholders. Both the approaches are essential in performing an exhaustive assessment of the potential scenarios and project outcomes (Vanclay, 2003; Gomez et

al., 2013). Both approaches are used in designing the guidelines and metrics that will be used to evaluate the impacts.

A starting point for the development of case specific guidelines and metrics are the principles laid out by the international SIA communities (Gomez et al., 2013, Vanclay, 2003 and 2013). The core values include preserving and encouraging social amenity and livability, social cohesion between individuals and between communities (also referred to as social capital) and the empowerment and capacity building of communities (referred to as human capital) (Vanclay, 2003, 2006). The principles of SIA as defined by the International Association for Impact Assessment are as follows:

- Basic amenities are provided for
- Equity and distribution of impacts
- Vulnerable segments of the community are protected
- Social support networks are not disrupted
- Consideration of collective perceptions and attitudes (Social construction of reality)

Impacts can then be defined as changes that have an influence on these principles. Impacts have the following characteristics. They range in duration and spatial scale and can occur over a long period of time or over a short period of time. Impacts range in spatial scale and can occur over and a larger area or small area. They range in terms of being beneficial on one end of the spectrum to being detrimental on the other end of the spectrum and are therefore either positive, negative or somewhere in-between. They also range in terms of intensity and severity. Different impacts can compound one another causing a cumulative effect or counterbalancing one another. Finally, impacts can cause other impacts. The knock-on effect is referred to economics as multiplier effects. Once all relevant impacts have been defined, it is necessary to determine how they will be measured or taken into consideration.

Based on the above overview, frequently applied social impact indicators can be grouped into three crucial impact categories: Social Cohesion, Human Capital and Livability.

Social Cohesion

Social cohesion refers to a healthy and functioning civil life of a community brought about by positive social interactions, strong interpersonal bonds, communal solidarity and a sense of belonging to the community amongst its members. According to Chan et al. (2006), the social interaction within a socially cohesive society are typified by shared civic values and norms that include trust and a sense of belonging, as well as a willingness to participate in civil life. Broader definitions of social cohesion also include communal attributes such as respect for diversity, reciprocity, co-operation and shared challenges (CCSD, 2000). Social cohesion can be impaired by social exclusion and social conflict arising along societal “fault lines” that are characterized by cultural differences, inequalities or economic disparity (Noll, 2002). From a policy perspective, reducing social cleavages would facilitate a more socially cohesive society (Chan, 2006). From a spatial planning perspective, these cleavages can be made less apparent by arranging diversified residential areas. Vandevyvere (2010) proposes such an indicator under the title “social integration”, however the focus of his work is construction and development as opposed the urban renewal and redevelopment of existing communities. Re-arranging existing communities would not be possible.

The social cohesion indicators in this work will focus on two specific elements of social cohesion that have already been looked at in the existing literature, namely: encouraging social interaction through the provision of public meeting places; and the preservation of structures that provide the community with a sense of place. Possible indicators that can be used as a proxy for social cohesion are provision of meeting places that facilitate and encourage positive social interactions and social network building (CCSD, 2000) and the preservation of cultural and historical structures or features of physical location that provide community members with a "sense of place" and therefore a "sense of belonging" (Phillips and Stein 2011) (Chan, 2006). These aspects are intimately connected to the actual urban design of an area, not only land-use in more general terms.

Human Capital

Human capital refers the marketable skills, employment experience and education accrued and possessed by members of society that allow them to participate in the labor market and add economic value to an activity. According to Ostrom, the improvement of an individual's human capital is achieved through the "acquisition of new capabilities", whether this is through a conscious effort of improving ones skills, education and training or unconsciously through experience (Ostrom, 2000) (Roseland, 2000). Human capital provides a community with the adaptive capacity to mitigate the negative consequences of changes in the economy and therefore sustain itself through changes in the national and regional economies (Parkins & Stedman 2003) (MacKendirk & Parkins, 2004). Human capital is therefore a factor that can help prevent future urban decay. Potential indicators that can be used as a proxy for human capital are the provision of educational facilities and/or opportunities and the creation of local employment opportunities during and after site remediation and development.

Livability

Livability and Convenience refers to a standard of human well-being facilitated by the provisioning and positioning of amenities in an urban environment. According to van Kamp et al., the term "livability" is often used in descriptions of social indicators but without a universally accepted definition and different users of the term attribute different meanings to the term (2003). Van Kamp et al. list seven definitions of "livability" taken from the work of other authors, each with slightly different meanings, although within a general theme of attaining human well-being through the arrangement of human surroundings (2003). Veenhoven is one of the authors mentioned and includes the term "habitability" in their definition (Veenhoven, 1996) (Kamp et al, 2003). Therefore "Livability" can be defined as the degree to which an environment is habitable and in which a certain standard of human quality of life or well-being is brought about by the state of that environment. Two key elements of livable environments are made reference to in literature are: 1) provisioning of amenities and; 2) positioning in spatial arrangement terms of these amenities, as to make them accessible to community members. This includes for example the provision of space for retailers and green space in locality.

Box 5.2. The Social Impact Analysis tool for urban planning developed by the City of Göteborg.

Social Impact Analysis (SIA)

What is needed?

How it works

What is the result

When to use SIA

Box 5.3. Flanders.

XXX

What is needed?

How it works

What is the result

When to use XXX

5.2.2 Ecosystem services (ESS)

Ecosystem services (ESS) are non-market products and services from the natural environment that contribute to human wellbeing both in the economy and in society. These benefits are not always taken into consideration in policy decisions, resulting in sub-optimal outcomes. Valuing ecosystem services allows for decision makers to understand the potential value of preserving and restoring natural areas and biota, as well as understanding the losses incurred to human wellbeing when these resources are over exploited or destroyed. The inclusion of ecosystems services valuation in natural resource management and spatial planning, by definition, expands the conventional system boundaries of decision making to include externalities. This broader approach to decision making has also brought new insights into the value people attribute to their interactions with the built and natural environment.

The most obvious and tangible products delivered by nature, that most people are familiar with, are food and natural materials such as fiber or wood. These products are extracted and traded in commercial markets and therefore the utility that people derive from these products are captured in

their market price. There are however products and services which are not traded that society depend on, such the conversion of CO_2 to oxygen and carbon, nutrient cycling, flood protection and climate regulation. Attributing values to these products and services allows decision makers to more broadly understand the trade-offs they are making. The goal of broadening the scope of consideration is to avoid unintended consequences of society's use of the environment is analogous with the objectives of sustainable development.

The Millennium Ecosystem Assessment (MA) (Figure 5.3) is a commonly accepted framework that allows for a structured approach to understanding the stocks and flows of the different products and services delivered by nature (Defra, 2007). Four broad categories are defined: provisioning services, regulating services, cultural services, supporting services. The existing DSS (Section 5.1.2) use a siloed approach to impact categorization and characterization which differs from the holistic systems based approach that underpins ESS valuation. The impact assessment methods in the DSSs consider impacts at a specific point in time and at a specific geographical location. The impact is therefore considered in isolation without considering the interaction with other impacts and without considering the processes and flows prior to the impact under consideration. The ESS approach on the other hand and the MA framework specifically, allows decision makers to track the causal chains of events that result in impacts as well as the auxiliary effects that may also be worthy of consideration. For example, in Figure 5.3, water purification and fresh water require nutrient cycling. Clean water contributes to the basic materials required by society. An auxiliary function of sufficient basic materials such as water is security. It is also then evident that the least tangible criteria (social cohesion, human capital, livability), discussed so far in the previous sections, are actually supported and enhanced by the natural environment.

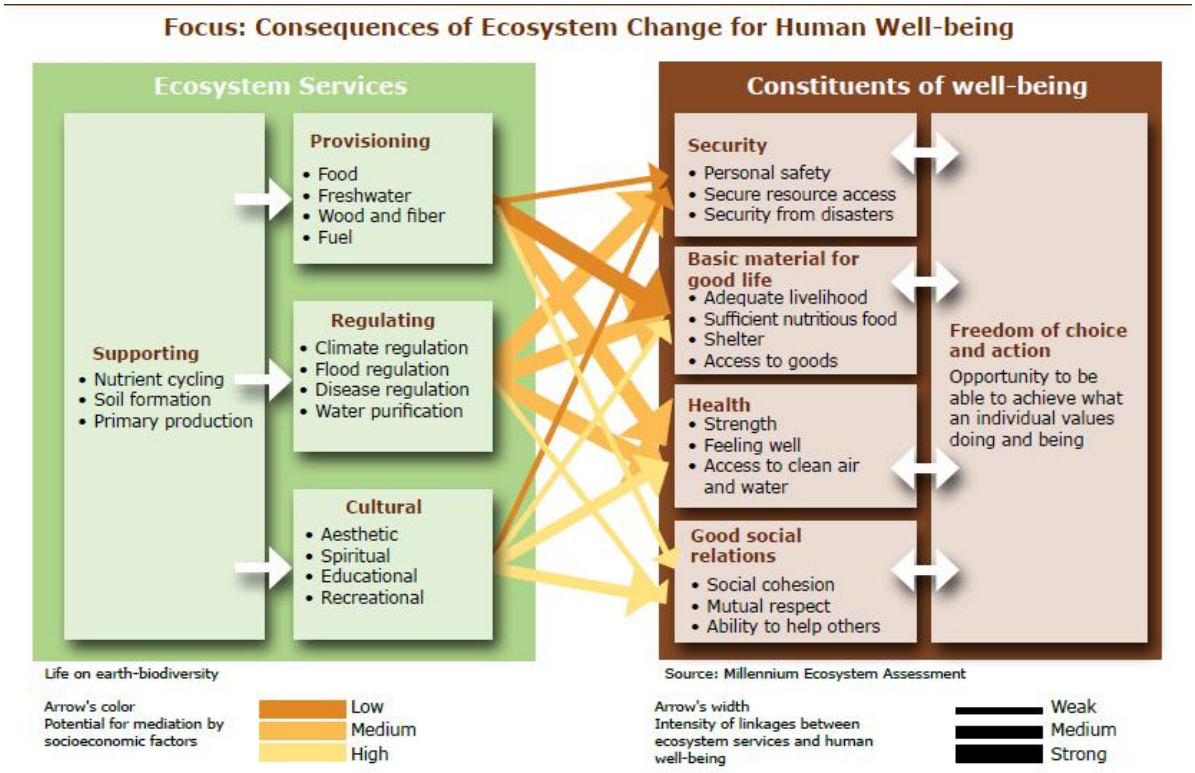


Figure 5.3: Millennium Ecosystem Assessment framework (Defra, 2007).

The existing brownfield redevelopment scenario DSSs and social impact assessment methods do not consider ecosystem services and the concept is yet to be integrated into these decision processes. Some elements of the approach have however been adopted in remediation technology evaluation and remediation technology appraisal tools. The focus in these tools is on the value of soil and groundwater restoration.

Sustainability assessment frameworks and tools and ecosystem valuation methods allow decision makers to consider a broad range of relevant factors therefore avoiding unintended consequences and externalities to the furthest extent possible. Integrating the ESS approach into the sustainability assessment frameworks and appraisal tool for brownfield redevelopment will expand the system boundaries of consideration and allow for a more holistic assessment methodology. The system boundaries of the existing approaches can be expanded in four key areas by the inclusion of an ESS approach:

1. Societal benefits of restoration: The societal value of restoring brownfields and hence preserving greenfields elsewhere can provide useful information and a further motivation why it is desirable by public authorities to intervene and provide public funds to perform brownfield restoration.
2. Scenario selection: The contribution to global ecosystem services of restoring or establishing ecosystems of different brownfield redevelopment scenarios can be accounted for in the decision making process. Small scale changes in the built environment and the use of green zones contribute to the supporting, provisioning and regulating functions of ecosystems on a regional and global scale
3. Design: Besides choosing between scenarios ecosystem service calculations typically consider potential supply of services based on the natural conditions of a specific location (what can we potentially achieve on a location?) and existing demands for services (what is desired on a location?). The concept can on the one hand be used for vision building and stakeholder discussions (which type of ecosystem services are desired the most, not desired or not wanted for a site). On the other hand it can be used to better scope design and create win-win situations for realizing different services (where on the site is the maximum potential for water infiltration or water storage, carbon sequestration, …).

Box 5.4. Nature Value Explorer (www.natuurwaardeverkenner.be)

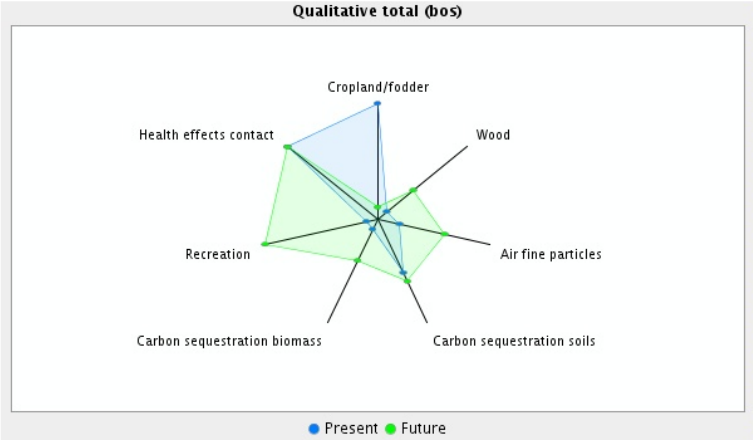
The Nature Value Explorer is an online tool, developed for the Flemish government, to explore the impact of ecosystem restoration on human welfare. Ecosystem services which can be valued are provisioning services as food production and wood production, regulating services as air quality and climate regulation and cultural services as recreation and health. Soil characteristics as texture, moisture and profile development play an important role in the calculations as these characteristics have a large impact on the potential delivery of provisioning and regulating services.
The tool is specifically suited to value the impact of land use change (nature restoration, urbanization). Users are required to deliver the location of the site, the size and the land use before and after the project. Additional information to be added depends on the individual service and includes soil characteristics, tree types, noise hindrance levels, amount of surrounding houses, etc.
Different valuation techniques can be applied:

- Qualitative scoring how important a service is in a specific area;
- Quantitative valuation of the importance of ecosystem services in physical terms (e.g.

tonnes of C sequestration, amount of visits per year, …);

– Monetary valuation of the societal value.

The tool is mainly suited for more rural areas. Ongoing research efforts are focusing on an urban version of this tool.



Box 5.4. ESS mapping

Mapping of changes in ecosystem services

What is needed?

How it works

What is the result

When to use

6 Case studies

This section presents the case study sites used in Balance 4: the work carried out, the main results and the advice for the cases. The sites differ with regard to sub-surface conditions, ownership relations, development visions, governance and with regard to which phase in the redevelopment process the cases are. Therefore, the instruments used to analyse the cases differs.

6.1 Rotterdam harbor area, the Netherlands

Because harbour activities are moving to the west part of the harbor of Rotterdam, the east part "city harbours" will be redeveloped from mainly being an industrial area into an area with mixed use, including residential use.

There is a high potential for the subsurface; a lot of data is available, but the focus lies mainly on problems and chances are not yet being explored. The main questions for the program bureau are for the redevelopment is: What are innovative possibilities for the subsurface in relation with the aboveground redevelopment? How can we use subsurface in the development strategy? These are the questions that were being investigated in the Balance4P project.

The driver for the redevelopment is urban renewal. The land is owned by municipality + several private companies. The phase of the redevelopment is mainly initiative phase: vision-building.

Within the Balance 4P project, a number of activities have been carried out in order to apply and assess different methods and tools that can provide answers to the above questions. First, there have been a number of activities to identify sustainable redevelopment strategies considering the subsurface conditions:

- Stakeholder analysis (quick-scan & for workshops)
- Stakeholder workshop 1: SEES – System Exploration Environment & Subsurface
  - Chances and challenges for the whole area
- Stakeholder workshop 2: zoom in EON, gasworks, Ferro/Eneco strategies for:
  - contamination,
  - civil structures,
  - energy
- Investigation
  - Final product: boundary condition from subsurface for redevelopments (focus on data & information, organic development, technical boundary conditions, adaptation strategy, tipping points)
- Student workshops and projects
  - SEES workshop
  - Aqua-Terra Urban Design projects
  - Tool inventory and application (Brownfield Remit/Response (BR2) tool and Brownfield Opportunity Matrix)

In the following sections, the work is further described and the main results are presented.

6.1.1 Site description

The Stadshavens of Rotterdam are located in between the Benelux tunnel and the Erasmus Bridge. It is a collection of harbour areas covering 1.600 hectares. After the completion of the western

extension of the harbour (Maasvlakte 2) in 2013, the port activities shift further and further towards the North Sea. The old harbours near the city centre of Rotterdam become available for urban renewal.

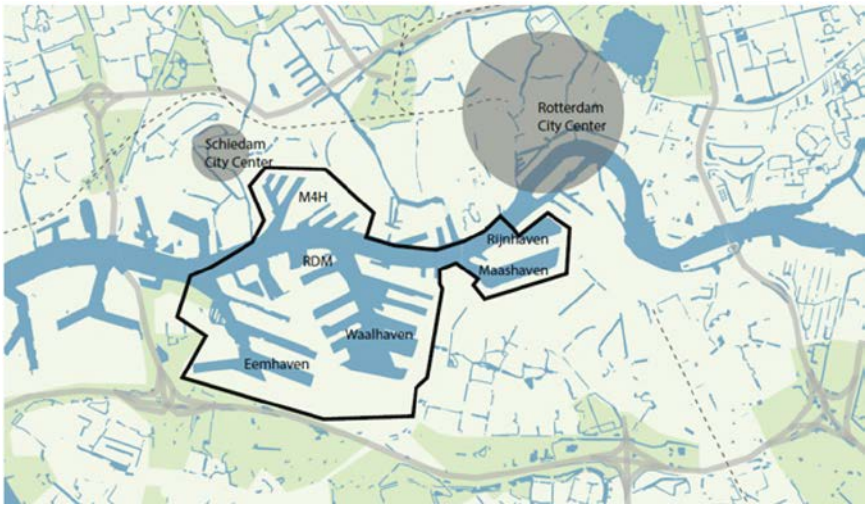


Figure 6.1. City harbours of Rotterdam (Ramkisor, 2014)

The city harbours of Rotterdam are redeveloped in a large project, on both sides of the river Meuse. The whole area is in transition and will become available for urban functions, while the harbour functions are moving or changing. The objective is to mix urban and harbour activities. At first the idea was to realise a more intensive residential area, but because of the financial crisis and the well-functioning clean tech medical and food activities, the latter is being promoted in the area.

For this area during the project a development strategy has been made (draft version oct 24th 2014). The redevelopment is being performed by the municipality and the port of Rotterdam together. In the Balance 4P project, focus was put on one part of the harbour area, Merwevierhaven (see Figure 6.2). There are three tracks from “aboveground”:

- Mapping “what is there”
- Development strategy, vision for 2035 (5 to 7 years, no regret program that contributes to the final goal for the area.)
- Acquisition and area branding (was fruit harbour). The harbour has no future for the current activities. The program bureau for the redevelopment is redeveloping the area in an ‘organic’ way, but prefers to go directly for the final planning and is searching for prominent as far as companies: pioneers, clean tech medical & food, creative industry.

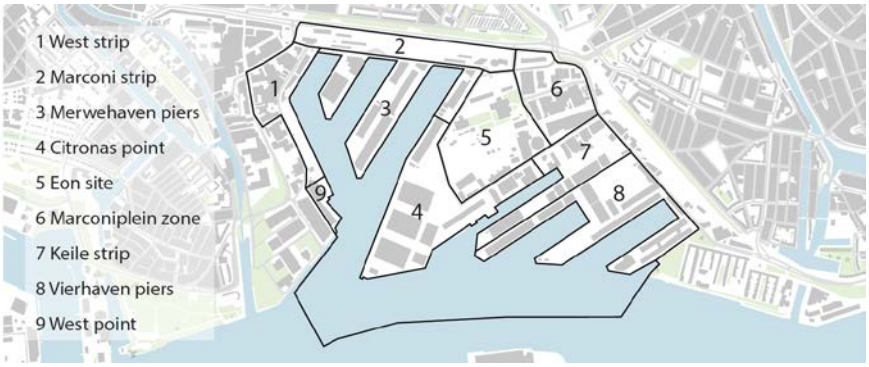


Figure 6.2. The Merwe-Vierhavens (M4H) and sub regions (Ramkisor, 2014)

One of the main objectives of the redevelopment is to give the waterfront back to the city. The area is well connected to the regional and national road system and the Marconiplein zone (zone 6 in Figure 6.2) is well connected to the rest of the city via public transport. The accessibility by both car and public transportation and the proximity to both the center of Schiedam and Rotterdam make M4H an attractive location. This can further improve if the water net is extended. The main problem is reaching the inner parts of the area from the well accessible edges. There is no designated space for slow traffic. The streets that border the area also form borders for pedestrians and cyclists from surrounding areas. Street patters and lay-out as well as transportation links need to be improved.

The location is on the border of the municipalities of Rotterdam and Schiedam. The municipality wants to transform the area into a lively living and working environment. There are some typical characteristic elements in the area which, if preserved, could aid the identity of the place. Old abandoned train tracks, cranes and warehouses can be re-used. There are already a lot of facilities located in the immediate vicinity of M4H. The development of dwellings would not require extra facilities and can be carried out from the start.

At this moment, some initiatives in the redevelopment are taking place: The Ferro terrain (3.5 ha, at site 5 in Figure 6.2) was in 2013 acquired by a real estate organisation. A concert hall will be realised in the former gasholder of the Ferro location (planned December 2014) (see Figure 6.3).

Figure 6.3. Ferro gasholder http://3voor12.vpro.nl/nieuws/2014/oktober/Rotterdam-krijgt-concertzaal-voor-6000-man---Ferro-Dome-wordt-vergelijkbaar-met-HMH-.html

6.1.2 Stakeholder analysis

For the quickscan of the stakeholder analysis for MerweVierhavens Rotterdam, most data on stakeholders was derived from an extensive analysis of the redevelopment area, the Rotterdam Stadshavens business case (2009)[21]. For the purpose of the Balance4P project, a subset of stakeholders was selected. These stakeholders were invited to the workshops of the Balance 4P project. For this stakeholder inventory, the general steps of the procedure for stakeholder analysis was followed (see Table 6.1).

Table 6.1. General steps of the procedure for stakeholder analysis of the Crosby method (Hermans, 2005)

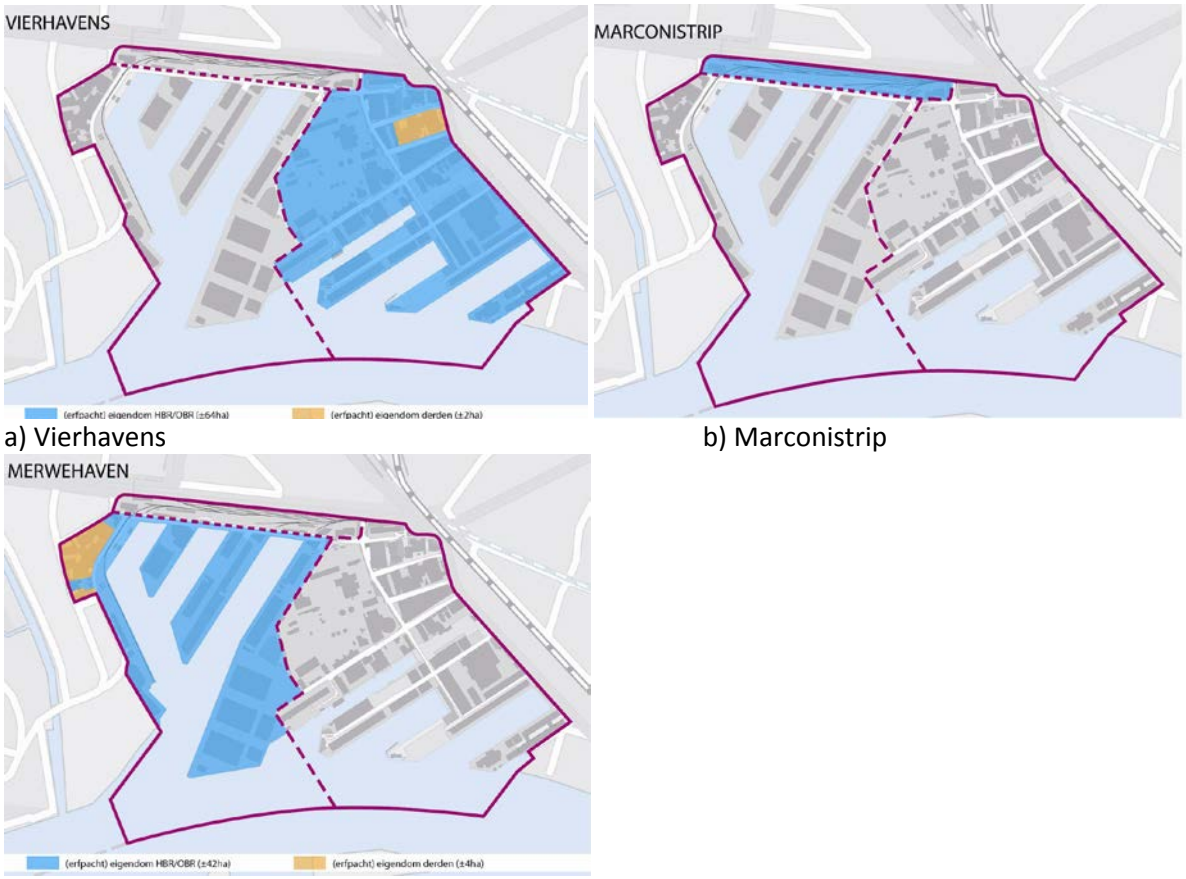
STEP	Crosby method
General purpose of SA	Involve people for the Balance4P workshops for Mewevierhavens
Identify stakeholders	Draw initial ample list of stakeholders and relative importance. Done with input of the Rotterdam Stadshavens business case (2009).
Collect primary input data	Use local informants to complete stakeholder table. based on short stakeholder inventory for the Balance4P workshops with project bureau M4H

[21] ROTTERDAM STADSHAVENS BUSINESS CASE Definitief 14 juli 2009. Chapter 5 projecten in de Merwe- en Vierhavens vierhavens

Structure and analyse data	Fill in stakeholder tables / matrices (Tables 6.1 and 6.2)

6.1.2.1 *Broad stakeholder analysis (2009) for whole area*

First we give the results of Rotterdam Stadshavens business case (2009). The area was divided in three subareas in this study: Vierhavens, Marconistrip and Merwehaven. For each of the areas an analysis of the stakeholders and their involvement were made. In the tables underneath the results are given. In red it is indicated where adaptations were made to the current situation (eg: The Dutch Ministry of Infrastructure, Spatial Planning and Environment is now the Ministry of Infrastructure and the Environment).



a) Vierhavens

b) Marconistrip

c) Merwehaven

Figure 6.4. Subareas of the broad analysis for Rotterdam Stadshavens business case (2009)

Table 6.2. Analysis of the stakeholders and their involvement Rotterdam Stadshavens business case (2009)

Group	Involvement Group's interest in Issue	resource	Involved in:		
			vierhavens	marconistrip	merwehaven
Ministry of Infrastructure and Environment	Active involvement Declaration of intent RCC (Rotterdam Climate Campus). (not realised. Not actual anymore?) tuning in and sets frameworks (manages national	Decision maker Regulator	x		

	highways)				
Ministry of Economic affairs	Support in finding possibilities for subsidies	Decision maker Regulator	x		
Province of South Holland	Regulatory frameworks for some sub areas Support in finding possibilities for subsidies	Decision maker Regulator	x	x	x
Port of Rotterdam Now in program bureau M4H	Active involved in working groups Partnership agreement	Decision maker	x	x Largest land owner	x Largest land owner
Initiators RCC(not realised. Not actual anymore?)	Declaration of intent RCC (Rotterdam Climate Campus). (not realised. Not actual anymore?) Active role in in fysical transition of the area	Decision maker	x		
Hoogheemraadschap Delfland (waterboard)	Involve in planning and regulatory frameworks for the area, especially on the subject of quays and dikes	Decision maker	x	x	x
Owners current real estate / properties	Involve in marketing research Actively involve in (re)development	Party with an interest	x	X involve or not. In case of buying up the land	
Current companies / entrepeneurs	Involve in urban debate on future Vierhavens Actively involve in (re)development Inform on progress of project Enter in transition arena (new interactive manner of area development)	Party with an interest	x	X Inform to avoid objections and opposition	X discuss premature end of ground lease contracts. Work together on moving current activities (especially fruitcluster)
Companies / entrepeneurs Waal/ Eemhaven	Draw up a administrative agreement influence area Waal-/Eemhaven	Party with an interest	x	x	
Neighbouring municipality Schiedam	Monthly consultation meeting Enter in transition arena (new interactive manner of area development)	Party involved	x	x	x
Borough Delfshaven	involve in monthly meeting Delfshaven involve in 4-yearly strategic management meeting Delfshaven involve via Platform Economy Delfshaven Enter in transition arena (new interactive manner of area development)	Party involved	x	x	x
Housing corporations	Involve via market consultation and marketing research Possible involvement in development sub-areas or sub-projects after selection	Party involved	x	x	
City region	Involve in urban debate on future Stadshavens + public transport over water Support in finding possibilities for subsidies	Party involved	x	x	x
Project developers and investors	Involve via market consultation and marketing research Possible involvement in development sub-areas or sub-projects after selection	Party involved	x	x	x
Safety area Rotterdam-Rijnmond	Involve in inititial planning initiatives	Party involved	x	x	x
Local community Rotterdam	Involve in urban debate on future Vierhavens/ RCC	interested	x	x	x

	Inform on progress of project				
Universities and schools	Offer place for trainees interns Initiate and perform pilot projects, experiments, (new) interpretations, innovation etc	interested	x	x	
Cities with same issues (Hafencity Hambug, London Thames Gateway and VS/Canada)	Organise knowledge and experience exchange meetings and excursions	interested	x	x	x
Other interested parties	Inform on progress of project	interested		x	X

6.1.2.2 Stakeholders for Balance4P workshops

For the Balance4P project, case Rotterdam three workshops have been planned.

Workshop 1

The first workshop was a broad workshop on chances and challenges from the subsurface on the aboveground development has taken place. This workshop was about the whole area with people from

- project bureau M4H ("aboveground experts")
- engineers of the municipality of Rotterdam ("subsurface experts"),
- researchers from balance4P project (the Dutch parties: Deltares, TUD and an attendee from VITO from Belgium and an attendee from Chalmers university from Sweden)
- a student doing an internship

The next two workshops aim at specific areas within MerweVierhavens and on specific themes within this area. Because the following workshops have a content based character, the stakeholders involved do not represent necessarily the broad group involved in making decisions and being affected by decisions. For the aim and character of the workshops it was decided that a specific subgroup of the parties are involved. Also note that in the workshops just representatives of the first three of the in B4P mentioned stakeholder groups are involved.

1. "knowledge" (knowledge institutes, universities),
2. "regulators" (the different fields of regulation (environment, city planning, social and economic affairs) from municipality, region and environmental agency)
3. "business" community (advisors, housing corporations, utility companies)
4. "society" (social initiatives).

In Rotterdam, involvement of social initiatives in the workshops was not found appropriate in this phase by the municipal development bureau. However, they have contacts with the local community in their ongoing projects (eg in a urban farming project in the MerweVierhavens). In the second and third workshop the companies on site are involved. Currently there are no people living on the actual site and due to the stagnating development due to the economic crisis, it is not yet clear what the future functions will be. At this moment, the local community is not a primary stakeholder for the municipal development bureau.

Workshop 2

This workshop looks at the central area with terrains of:

- EON
- Former gas plant Keilehaven
- Eneco/Ferro

The workshop will focus on themes civil constructions (incl. soil: remediation) and energy concepts

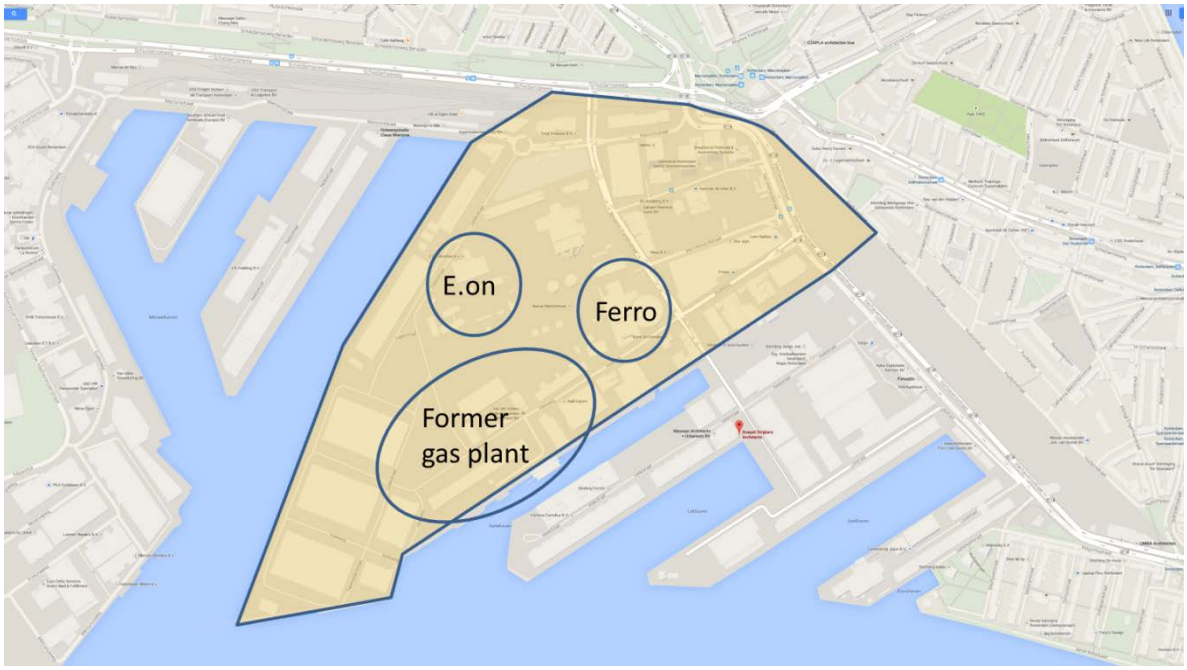


Figure 6.5. Focus area Balance4P workshop 2.

Table 6.3. The stakeholders and their position on the issue.[22]

Group	Group's interest in Issue	Resources	Resource Mobilization Capacity	Position on issue
Eneco	energy concepts	Expertise, leverage, investment	Not checked	Not checked
Warmtebedrijf	energy concepts	Expertise, leverage, investment	Not checked	Not checked

22

- Group's interest in Issue: those interests that will be affected by the decision to be taken (just the most important ones).
- Resources: the resources the group possesses that can be used in the decision making. (knowledge, information, leverage, money)
- Resource Mobilization Capacity can the group mobilize these resources quickly or slowly? This is important when looking at the dynamics of the decision making. If a decision needs to be taken quickly, but the resource (eg knowledge) can only be delivered slowly, this resource is of less importance than previously thought.
- Position on issue. The position should be examined. People can be strongly negative (- -), slightly negative (-) or slightly positive (+) or completely positive (+ +).

Ferro	Current land user	leverage	Not checked	Not checked
Stedin? (Cables and pipes)	Manager cables and pipes present in area (land user)	Expertise, leverage	Not checked	Not checked
Port of Rotterdam	Current land user	Leverage, investment	Not checked	Not checked
Municipality Rotterdam, subsurface experts: archeologie, geotechnical, geohydrology / foundations, cables and pipes	B4P project (research)	expertise	quick	++
Project leader project bureau M4H Urban planner Landscape architect	Leader of redevelopment, B4P project (research)	Decision maker, expertise, leverage, budget	quick	++
TUDelft Experts energy Urban planning	B4P project (research)	expertise	quick	++
Deltares Experts soil, remediation, geotechnical aspects	B4P project (research)	expertise	quick	++
Students TUD	B4P project (research)	expertise	quick	++

Investigation 3

The last activity in this case is to look into the information transfer between the municipality and the developers or constructors. The investigation is into tender documents in which the municipality is setting out an development or construction plan for a part of an area or infrstaructure to marjet parties. Analysing existing documents and in in consultation with subsurface experts a proposal is made onto how subsurface information can be integrated better.

Table 6.4. The stakeholders and their position on the issue

Group	Group's interest in Issue	Resources	Resource Mobilization Capacity	Position on issue
Port of Rotterdam	Current land user	Leverage, investment	Not checked	Not checked
Municipality Rotterdam, subsurface experts	B4P project (research)	expertise	quick	++
Project leader project bureau M4H Urban planner Landscape architect	Leader of redevelopment, B4P project (research)	Decision maker, expertise, leverage, budget	quick	++
Strategis	Service provider for the M4H project	Expertise,	quick	Not checked
TUDelft	B4P project	expertise	quick	++

Experts energy Urban planning	(research)			
Deltares Experts subsurface	B4P project (research)	expertise	quick	++
Students TUD	B4P project (research)	expertise	quick	++

6.1.3 Designing redevelopment strategies

For this case, two workshops and an investigation were performed within the project:

- Workshop 1: Broad workshop using SEES methodology.
- Workshop 2: Specific workshop on Ferro, Eneco area
- Investigation: focus on data & information (Dec 2014)

6.1.3.1 Workshop 1: broad exploration of subsurface chances and challenges for the whole area

The main question for this workshop was: what are innovative possibilities for the subsurface in relation to the aboveground developments. How can we integrate the subsurface in the development strategy. The objective was to identify the chances and challenges from subsurface (bot soil, subsurface and sediments) in relation to developments aboveground. The System Exploration Environment and Subsurface (SEES) was applied to this end. Different experts from the subsurface and development groups from the Municipality and Port of Rotterdam were present.

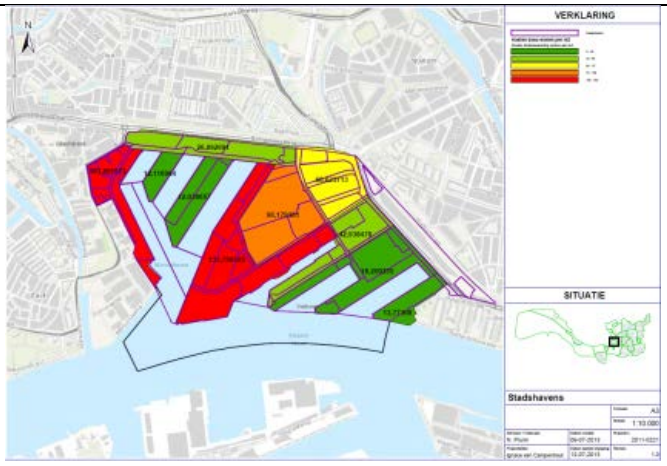
The main challenges and points of attention for the redevelopment were:

- Transformation from harbour to residential area (> 2025).
- Function as engine for new economy. Strong points of Rotterdam, (including environment and education) are Cleantech, Food, Health.
- The area team of Port and Municipality of Rotterdam has as an objective that current businesses can keep functioning and will transform in time
- Mainly ground lease contracts, ownership with municipality or port of Rotterdam
- Organic transformation of the area: change piece by piece
- How can we connect subsurface and aboveground functions?
- Specific points of attention: contamination, area outside the dikes, hard quays, limited green space.
- Do not think in problems but in possibilities when looking at the characteristics of the area. If subsurface is not considered now, it will be too late.
- For the aboveground, the (plan-economic and strategic) data is gathered in “StrateGIS”. (such as costs for buying or leases) Chance to also integrate subsurface data in 1 system (such as soil exploitation, prepare sites for building, remediation, archaeological expectation, cables and pipes, unexploded ordnance (UXO), quays etc)
- There is much information for subsurface , it needs to be translated so it becomes interesting for the redevelopment(e.g. effect on costs for developments in an area).

Subsurface aspects

The subjects civil constructions, energy, water and soil are of importance in the Merwevierhavens area and were presented in the workshop. In the workshop, the chances and challenges were identified by the attendees from above- and underground (see Table 6.5).

Table 6.5. Underground aspects of importance for M4H Rotterdam.

Civil constructions:	
• Archaeology (old dyke) • Cultural historical value (some buildings) • Structures in subsurface (cellars, fundaments, quay walls) • UXO (?) • Cables and pipes (many)	 Archaeology
Energy	
• ATES (potentially, no systems yet) • Geothermal energy (potentially, interesting) • Gas/oil (not economically interesting) • Use temperature from harbour activities	 Heat network
Water	
• Groundwater (contamination, no drinking water) • Mixed seepage / infiltration (tidal)	
Soil	
• Contamination • Elevation 5-3,5 m +NAP • Ecology (potentally interesting area, sandy soils, quay walls)	 Costs for remediation for residential use

The following aspects (bot chances and challenges) for further research were selected as result of the workshop (and used as input for the next two workshops):

Organic redevelopment

- Fast redevelopment west piers, the centre can be redeveloped as 1 large area, in the east small areas with recreation and connection to the other side of the river (Heijplaat, RDM area).
- Development higher segment (?) or mixed?, parks, residential, parks and working areas.
- Look at smaller and larger scales (use, energy, maintenance)
- Look at long and short term for companies (infra, demand for resources)
- Start with “easy” star locations, to begin the redevelopment (oil stain effect)

Soil quality

- Remediation of the gas factory can be the start of the redevelopment of the area
- Location of the environmental facilities

Groen

- Greening the area
- Green quays, as special attraction (ecological value)
- Connect the close by “Roof park” (figure 6.11) with green infrastructures to the river.

Subsurface opportunities

- Lay a spatial framework over the characteristics of the subsurface. Use the landscape as a carrier for the development of the area (contamination, infrastructure, climate) (figure 6.13)
- Investigate other ways of making fundaments, reuse quays, or old fundaments (figure 6.12)
- Which cables and pipes are still usable for other purposes at the EON area?

Water

- Options for reuse. Sewerage? Waste water? Disconnect from sewerage system?
- Recreation in surface water
- Metabolism: reuse / regain minerals / nutrients in experimental lab. Compost – sewerage water – floating crops

Energy

- Energy concepts, Smart energy grid, Energy tower
- Geothermal energy, EON as energy hub for heating the city
- Caissons /tidal energy?
- Investigate energy options (area typology, demand and supply scenarios)
- Caissons, development (osier-land, biomass)

Figure 6.6. On a former shunting-yard has in 2013 the Roof park Rotterdam opened, the larger roof park of Europe. By applying green area on the rooftop of shopping malls, 80.000 m^2 of park is added to the city (Schaeken et al, 2014).

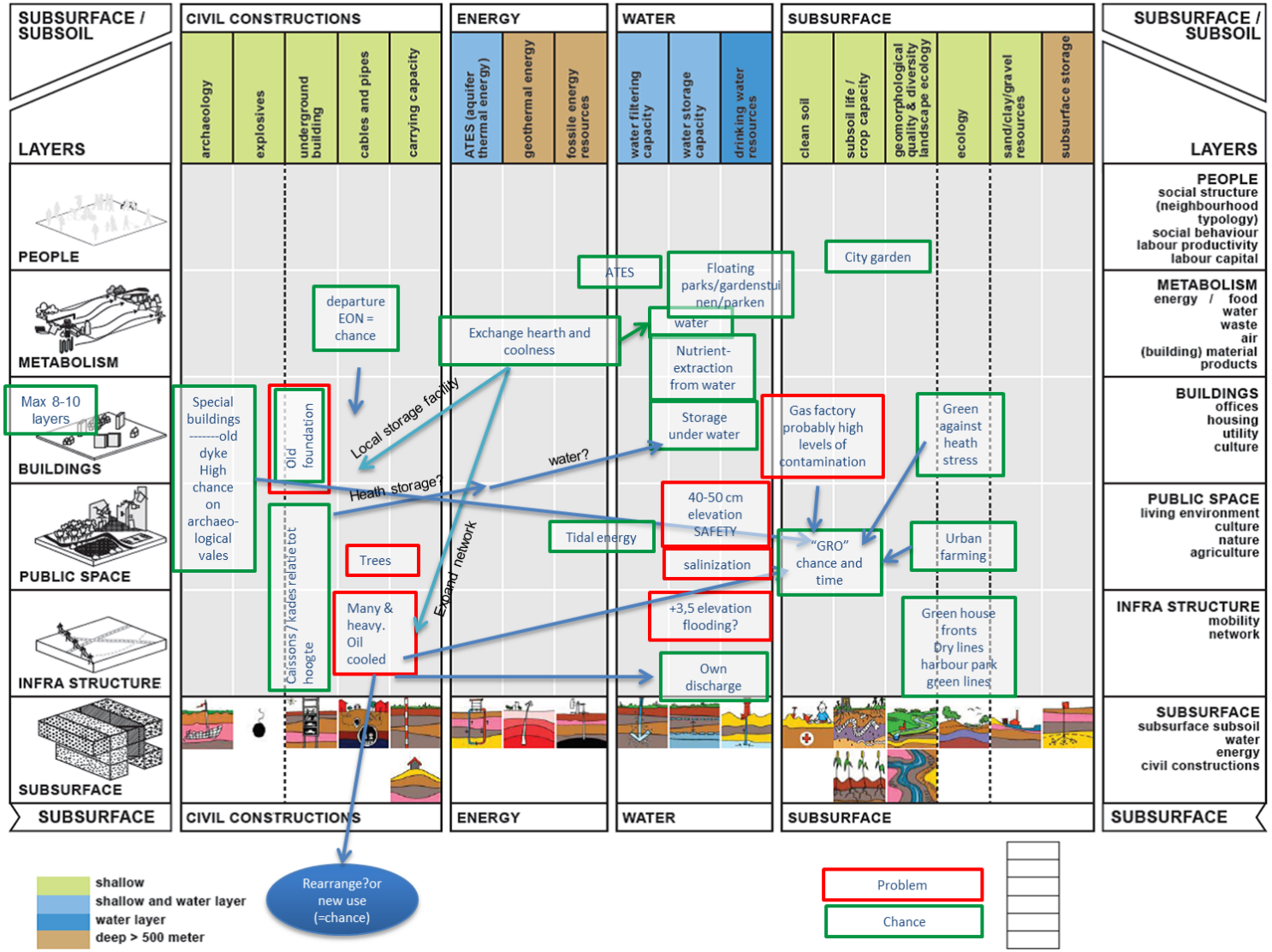


Figure 6.7. Results of workshop 1 of Merwevierhavens, Rotterdam, The Netherlands.

6.1.3.2 Workshop 2: FERRO- EON-Eneco-FerroENECO area with the focus on soil, civil constructions and energy

From the first workshop, the centre area with EON, Eneco, Ferro was chosen (see Figure 6.9). The remediation of the gas factory (for which there is budget reserved from the national government) can be the start of the redevelopment of the area. There already is some “movement” in this area. The FERRO gas holder will be transformed into a music podium in December 2014. This can be a star location, where the redevelopment begin and make the area more attractive for other investors.

Figure 6.8. The central area with the former gas factory.

The main focus for this workshop are subjects

1. Civil constructions: interferences between fundaments, archaeology, cables and pipes, related to contamination
   From workshop 1:
   - Investigate other ways of making fundaments, reuse quays, or old fundaments (figure 6.12)
   - Which cables and pipes are still usuable for other purposes at the EON area?

2. Energy concepts that can be realized when EON is seen as an energy hub for the whole city.
   From workshop 1:
   - Energieconcepts, Smart energy grid, Energy tower
   - Geothermal energy, EON as energy hub for heating the city
   - Caissons /tidal energy?
   - Investigate energy options (area typology, demand and supply scenarios)
   - Caissons, development (osier-land, biomass)

The situation and options were prepared before the workshop (Figure 6.10 and Figure 6.11).

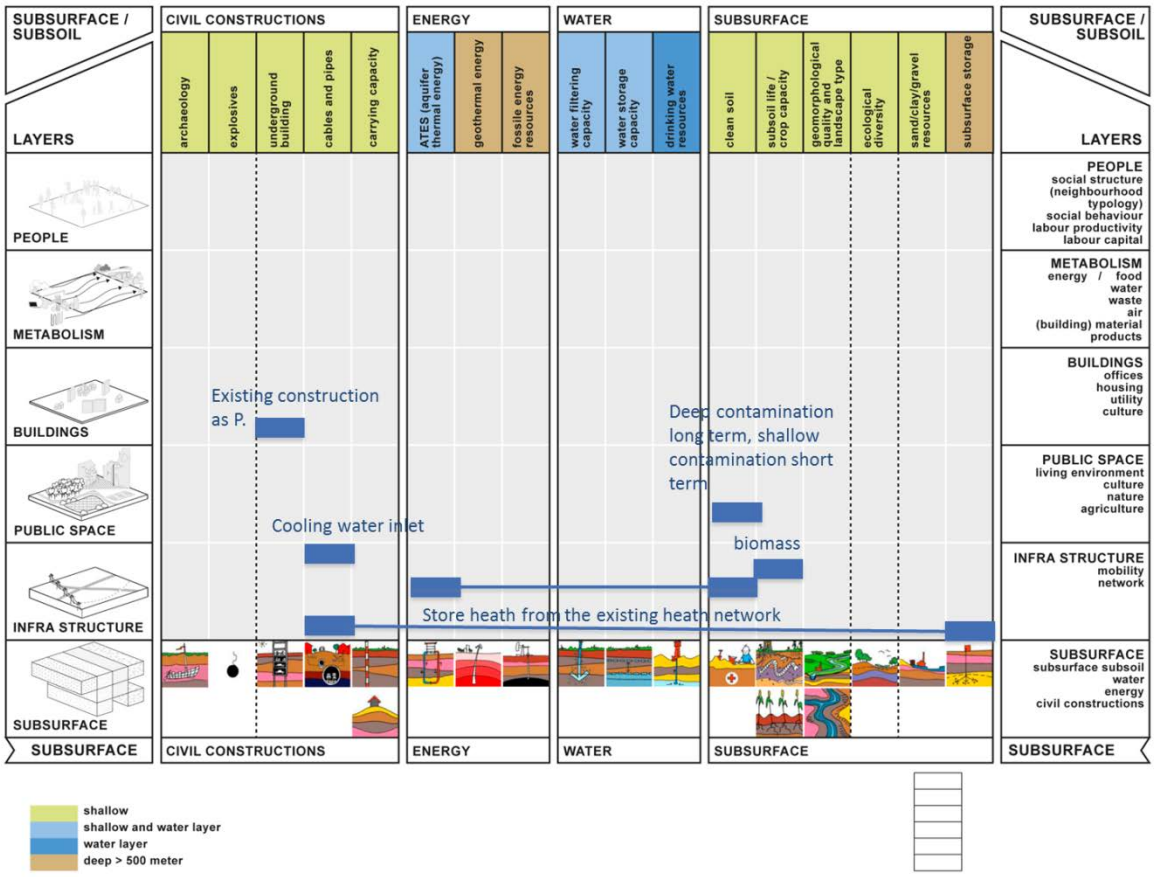


Figure 6.9. The current situation and subsurface possibilities at EON/Eneco/Ferro area

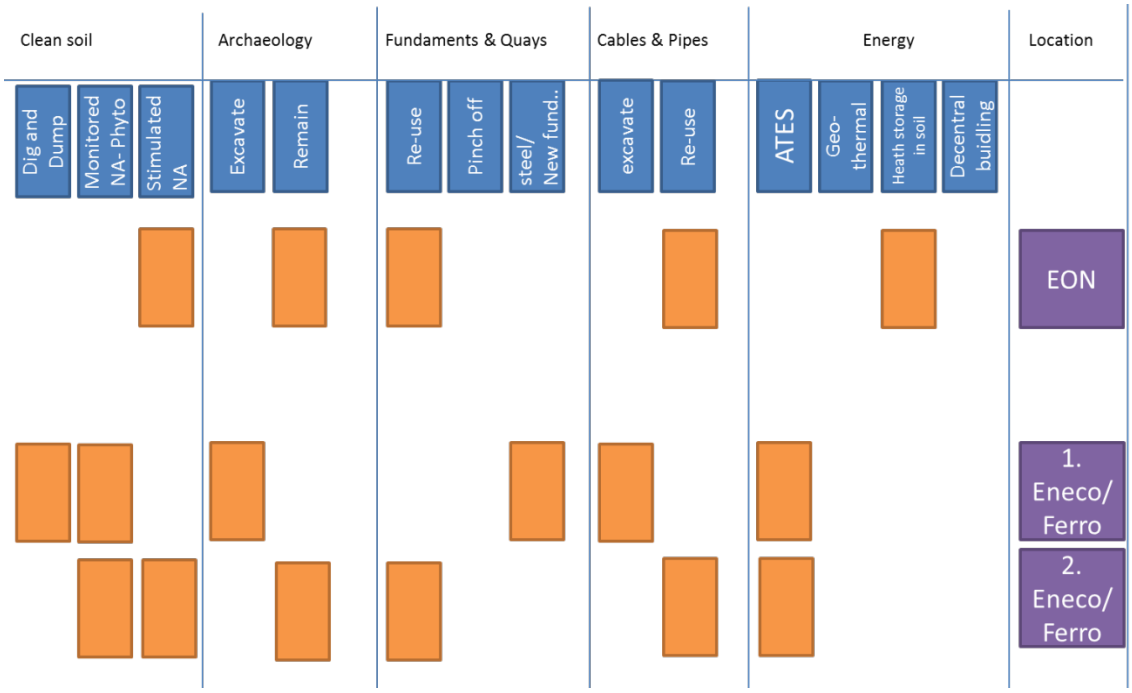


Figure 6.10. Options for the redevelopment of EON/Eneco/Ferro area, taking into account contamination, archaeology, fundaments&quays, cables& pipes, energy.

Before the workshop three scenarios were made, based on the choices that can be made for environment (mobile contamination deep, immobile contamination shallow), archaeology, cables & pipes (C&P), fundaments & quays.

1. long term. 30 year monitored natural attenuation (NA)
   In 30 year new functions / transition, when a function ceases, i twill be renewed. Clean area during temporary and cultural use of the area. Example = Emscherpark, Germany. Earn with geothermal source. Link to heath network. Gives the character of modern energy hub, future for heath supply. Green cultural function for area and city. “Brand” the location, for future use when residential area is built. Options for flexible temporal housing , container housing
2. mid-term: 7 year stimulated NA
   7 years Stimulated NA. Continue current use. Transform areas that become available and assess per site what the most suitable / feasible use is. Different forms of energy, mixed use. Use piers and reuse fundaments. Make public facilities suitable for businesses and housing (green, infrastructure)
3. short term: now remediate/ dig&dump
   clean everything up when possible. Right scale and quality for intensive residential area. Energy park

Further choices within the scenarios are:

- Archaeology: options excavate or remain
- Fundaments options quays reuse, pinch off (half remove), start over (new)
- Cable & Pipe options excavate or reuse
- Energy options ATES, geothermal energy, water surface decentralized
- remark: ATES can be combined with MNA / NA

The different scenarios were discussed. Although short term might be good to start redevelopment with a clean slate, it is not feasible in the current economic environment. There is some tension between short and long term decisions. However, there are chances for organic developments, development of an experimental area for different innovative concepts. The results of the workshop are presented in an “idea book” Appendix D. An example of the outcomes can be found in figure 6.11 (reuse fundaments).

6.1.3.3 Investigation: focus on data & information

As already discussed in the first workshop: information on the subsurface is of importance, there is a lot of information, but it needs to be translated so the information gets meaning for the (aboveground) redevelopment. Eg: effect on costs for developments in an area). For the aboveground, the (plan-economic and strategic) data is gathered in “StrateGIS”. (such as costs for buying or leases) Chance to also integrate subsurface data in 1 system (such as soil exploitation, prepare sites for building, remediation, archaeological expectation, cables and pipes, unexploded ordnance (UXO), quays etc). Instead on a third workshop, an investigation was planned on the role of data and information. The final product is to detect boundary conditions from subsurface for redevelopments. This is done together with StrateGIS, where data is gathered. Attention will also be

paid to the aspect of time: project process, the organic development and possible adaptation strategy, tipping points.

6.1.3.4 Student work

Next to that: the students of TUD have used this area in a workshop and design tasks:

- Student workshop (May 8-9)
- Two HOMBRE tools were applied by students on the area, giving redevelopment options:
  Brownfield Remit/Response tool (Ramkisor, 2014)
  Brownfield Opportunity Matrix for soft Reuse (van Gogh, 2014)

All reports are available on request.

6.1.4 Sustainability assessment

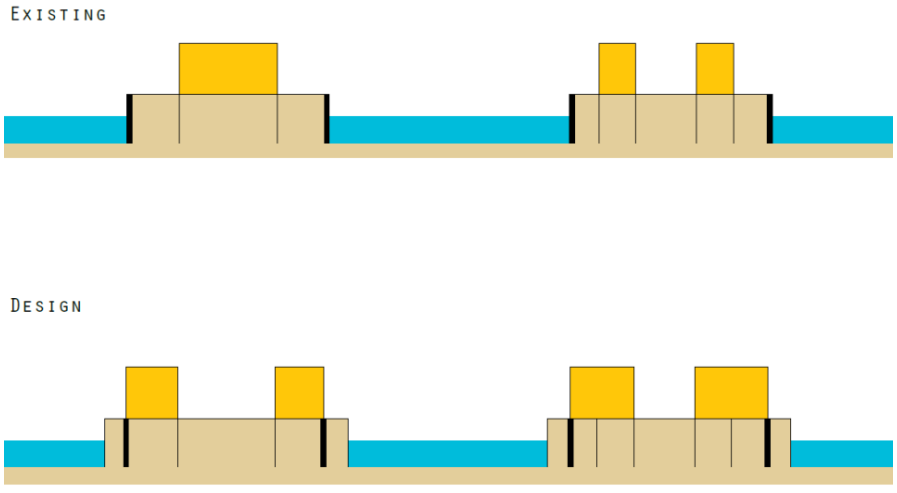
In the Rotterdam case, the emphasis is on developing sustainable urban design integrating the subsurface. In this case study, this was explored in-depth and assessments of alternatives were not performed..

6.1.5 Results

The main questions of the program bureau were: What are innovative possibilities for the subsurface in relation with the aboveground redevelopment? How can we use subsurface in the development strategy?

The workshops and student work gave many results and options for the area (figure 6.12, 6.13). It will be an organic development, over a longer time span. However, using the subsurface situation as a framework is a good starting point.

Points of attention are especially the contamination situation and possible presence of UXO and the positions outside the dykes (water safety issues) when planning new uses. Chances are the archaeological situation (make old dyke visible), re-use of fundaments, quays and cables and pipes for different options. Green should play an important role in the future use. Also in the centre part (Eon, Eneco, Ferro) there is room for energy concepts. The results are gathered in an idea book in Appendix D.



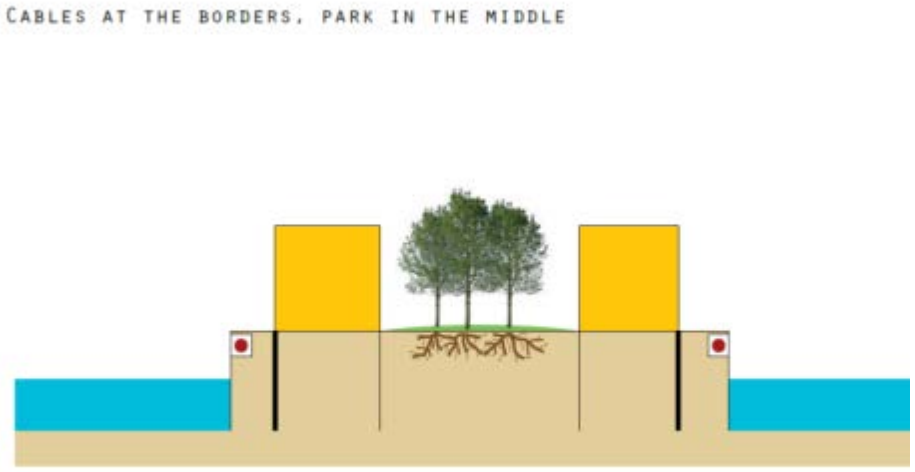


Figure 6.11. Investigate other ways of making fundaments, reuse quays, or old fundaments

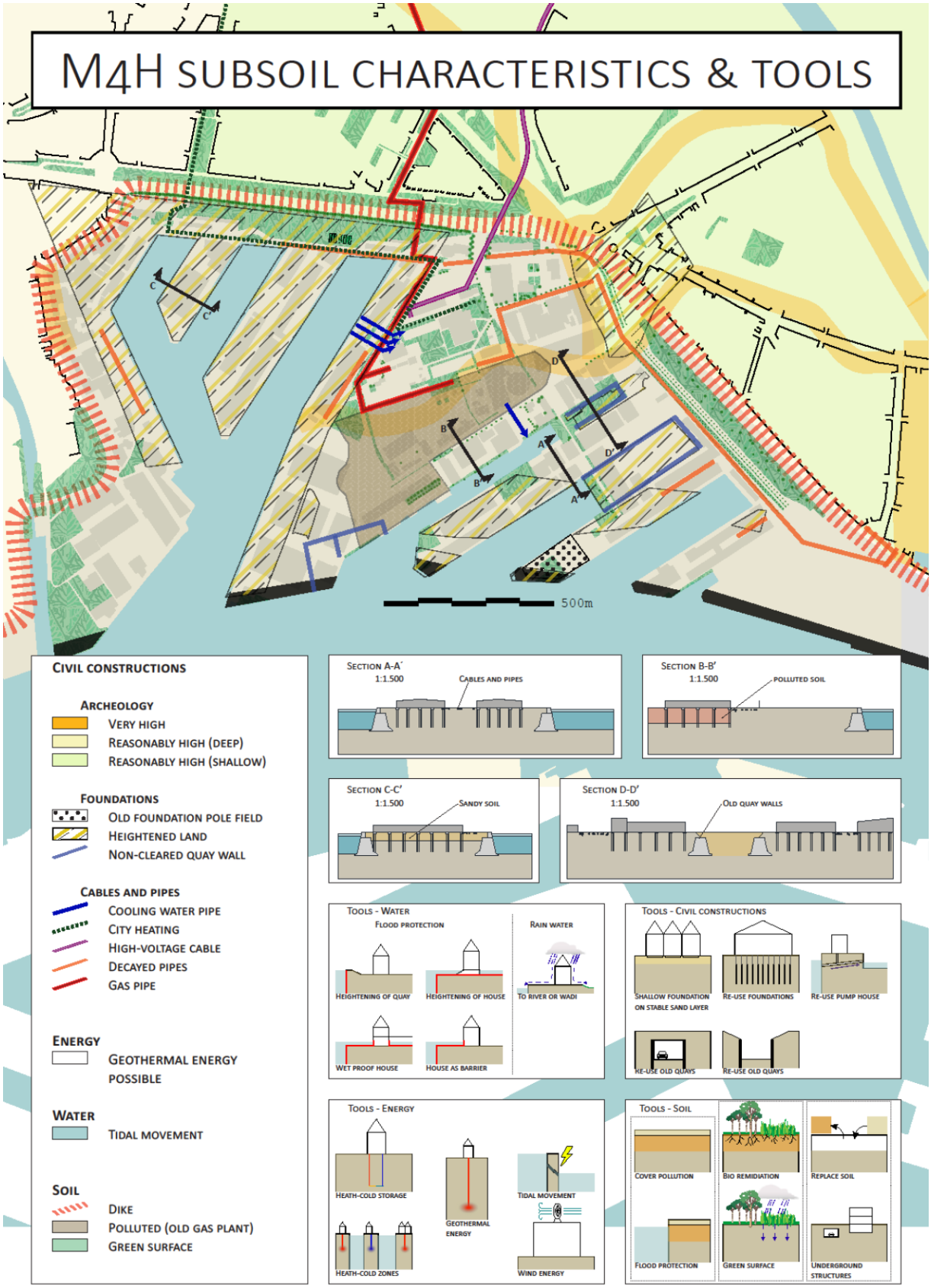


Figure 6.12. Use the subsurface as a spatial framework for redevelopments translated into a subsurface potential map with which can be designed (Mooij, 2014)

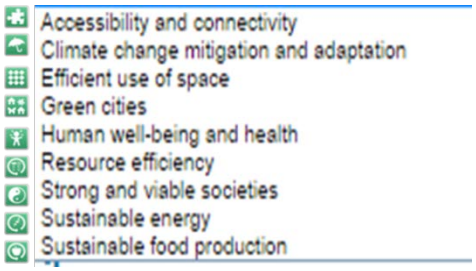
6.1.6 Discussion

For the discussion session the municipality of Rotterdam was asked to give input. The points underneath were given.

- The focus of Balance 4P is revelant!
- The focus on subsurface showed new opportunities for stakeholders
- For the first time, the subsurface information from the municipality is widespread been used in combination with redevelopment of areas in Rotterdam.and gives better plans (students)
- Complex systems, all aspects cannot be covered in one type of analysis
- Direct communication more efficient than documents, but expert knowledge must be delivered in the right form at the right moment
- It's important to have all information available. Both from municipality and private companies.

6.1.7 Advice for Merwevierhaven case

Taking the subsurface into account gives chances to the area. Especially because redevelopment can take a long time, the subsurface system and landscape can give a framework for the organic redevelopment. The advice for the case is presented in the form of an idea book: aimed at market parties showing them how to take the subsurface opportunities within the redevelopment (appendix D). For each example is indicated to which societal challenge it contributes.



6.2 Alvat, Buggenhout

6.2.1 Site description

The Alvat site is situated in Belgium and is located between Antwerp and Brussels, see Figure 6.14. The site is now an abandoned and underused industrial area of 4.6 hectares, located in the municipality of Buggenhout along the river 'Scheldt and adjacent to a living area in the North. In the Southeast there is the old railway Dendemonde-Antwerp that only serves as a touristic attraction and just across of this railway another residential area. On the East side agricultural activities take place and on the Southwest industrial activities.

Figure 6.13. The Alvat site in Buggenhout.

Until 1995 ALVAT N.V. owned the site. Due to the former activities of the company (container reconditioning services and the production of new containers) the site was highly polluted. Activities such as storage of oil products and solvents in tanks and containers, cleaning of containers using these solvents and storage of containers across large parts of the site gave rise to a contamination with BTEX, VOCs, mineral oil, heavy metals, PCB and PAHs (Figure 6.15). In addition, in February 2008 an industrial landfill was found nearby the railway that consisted of containers (filled with thinners), plastic waste, wood, concrete, paint residue, etc. At this landfill heavy metals, volatile organic hydrocarbons, phenols and cresols, phthalates, halogenated hydrocarbons, mineral oil and methylisobuthylketon were measured.

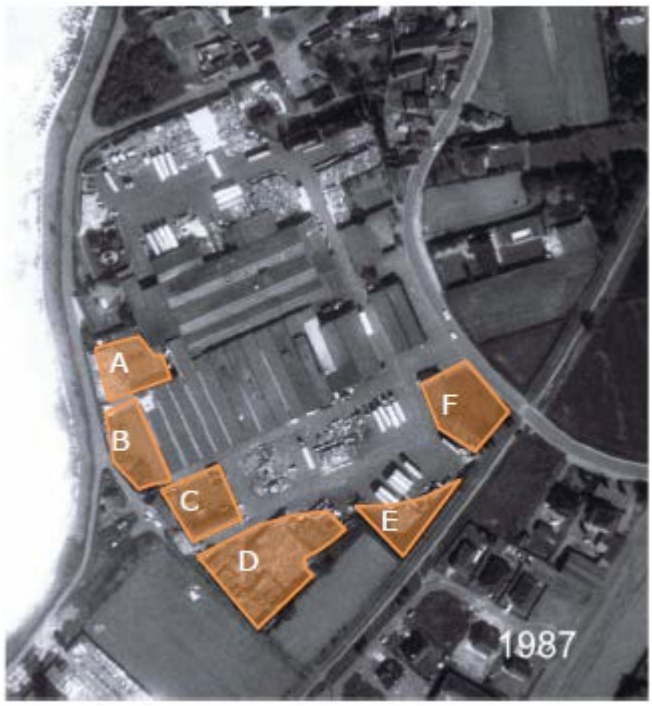


Figure 6.14. Aerial view of 1987 indicating potentially suspicious zones (A: processing liquid waste; B: processing (liquid) waste and burn-out of containers, C: processing liquid waste (above-ground and underground tanks), D: processing empty containers and burn-out of containers and E: Landfill.

Since the bankruptcy of Alvat nv in 1995 the site is under the supervision of a curator. The Alvat site is seen as a black field, a location where a market-based redevelopment is not possible by the heavy pollution. When a site is seen as a black field OVAM can acquire the site and finance the remediation so the site can be reused/redeveloped. OVAM already financed a part of the remediation (remediation of the landfill) at the Alvat site and at this moment a brownfield developer specialized in the purchase and remediation of contaminated grounds is interested in the site.

The municipal structure plan (gemeentelijk ruimtelijk structuurplan) was approved in 2005 and indicates that the Alvat site could be developed as a park and recreation area along the river Scheldt and a limited residential function. There isn't a spatial implementation plan (Ruimtelijk Uitvoeringsplan) yet, but consultation with the Flemish Region (Vlaams Gewest) is ongoing concerning the reuse.

The redevelopment of the Alvat-site is currently blocked. The major bottlenecks beside the presence of a serious soil contamination are the uncertainty about the future destination and the ownership situation. On the zoning map (gewestplan) the site is currently coloured as industrial area.

6.2.2 Stakeholder analysis

A problem that prevented the redevelopment of the site in the past are the different interests of the stakeholders. The site is situated between small residential areas and at the border of an industrial area under redevelopment. The province of East Flanders, together with the city of Dendermonde, the POM East Flanders (Development agency of the province of East-Flanders) and Waterwegen en Zeekanaal are working on the redevelopment of the industrial site "Oude Briel" adjacent to the Alvat

site (see Figure 2). This site will become a water bound business park, given its location on the waterfront, the depth of the river Scheldt (ships of 2.25 tons, upstream only 1.3 tons) and the presence of 2 quays (loskades). The Alvat site could potentially also be a part of this project. Due to its location the main ongoing discussion is related to its future destination (industry vs. residential area). This choice has important consequences for the profitability for private redevelopers to redevelop the site.

The Crosby method (Crosby, 1992) is applied to perform a stakeholder analysis for the Alvat area in Buggenhout. The initial sample list of stakeholders was completed with the help of the representative from the OVAM, see Table 6.6. For the Alvat case the four stakeholders in bold were consulted in individual interviews.

Table 6.6. List of stakeholders and their interest in the Alvat area (stakeholders in bold are consulted individually).

Group	Group's interest in Issue	Resource
Municipality of Buggenhout	A good urban development which abide to the local political objectives	Leverage
Province of East-Flanders		Leverage
Waterwegen en Zeekanaal	Incorporation of the Alvat site into a water-bound Business Park	Leverage
City of Dendermonde		Leverage
Development agency of the province of East-Flanders		Leverage
Agentschap ondernemen	Bronwfieldconvenant, support in finding possibilities for subsidies	Leverage
Santerra	Brownfield developer	Specialized in the purchase and remediation of contaminated grounds – Investment
OVAM	Responsible authority for soil contamination and remediation	Expertise Decision maker Regulator
Land owner = curator (company bankruptcy)	Selling the site	Leverage
Inhabitants	Minimal hindrance during the redevelopment and from the reuse (potential traffic issues). Potential users (in case of parks, recreational area, commercial area, …)	Leverage

From the discussion with Waterwegen en Zeekanaal (the waterway administration) it could be concluded that the administration has the potential right of first use and can enforce the different parties to use it as a waterbound industrial area. This scenario is also still preferred by this administration. However, support from the municipality and local citizens is important to get something realized. Also, the definition of "waterbound industry" does not necessarily mean the construction of heavy industry (e.g. concrete factory). There needs to be a potential for waterbound transportation of goods on the longer run. There is also a willingness to include elements to reduce

the burden for neighbouring households and increase the profitability for private redevelopers (mixed use with some residential areas or light industry as buffers).

The municipality has a strong preference to let the site be used as residential area or a mix recreational/residential area. An important objective is to maintain the existing living conditions for households surrounding the site. Hindrance from additional traffic due to activities on the site (trucks, additional cars) should be kept to a minimum. Also, noise hindrance from industrial activities on the site is a concern. Creating a good view on how transportation issues will be solved in the different scenarios is important. However, local employment can be an important motivator to also have support for more industrial redevelopment. Companies with a local historical tradition are for example more interesting for the municipality.

The private redeveloper is potentially interested in buying the site. It is however unclear which destination the site can have. A potential direction suggested by the redeveloper goes in the direction of light industry (KMO), with a potential to create waterbound transportation of goods. How to solve the soil and groundwater pollution does not seem complicated from a technical point of view. Potential remediation options are limited for this site.

After the interviews it is clear that there isn't a clear solution (land use) that satisfies all stakeholders. Because it was not possible to define one outcome, several alternatives visions (urban plans) are designed and compared in the next sections.

6.2.3 Designing redevelopment strategies

From the results of the stakeholder interviews and discussions with soil experts from VITO, Lena Niel a master student from TU Delft, applied the SEES method and designed potential redevelopment strategies.

6.2.3.1 Exploring the system (SEES)

The Alvat case is still an abandoned site due to the contamination and the different interests of the stakeholders. So the research question is 'How to develop an urban plan for the Alvat site in the near future by combining the technical characteristics of the contaminated subsurface with spatial qualities of an urban plan?'

Although it is not common that both technical engineers and urban designers work together from the beginning of the whole process, this project is trying to do so. This means that both engineers, who are investigating the subsurface from a technical perspective, and (urban) designers, who develop the surface from the perspective of people, are combined. To achieve this goal in reality the methodology used in this case is based on this dialogue between technique and spatial design is the **SEES (System Exploration Environment and Subsurface)** (Hooimeijer, 2013).

Civil constructions	
Archaeology	not relevant
Explosives	not relevant
Underground building	not relevant; buildings are broken down
Cables and pipes	not relevant
Carrying capacity	not relevant
Energy	
ATES (aquifer thermal energy)	not relevant

Geothermal energy	not relevant
Fossil energy resources	not relevant
Water	
Water filtering capacity	not relevant (% paved surface, …)
Water storage capacity	not relevant
Drinking water resources	not within a distance of 2 km
Subsurface	
Clean soil	contaminated; remediation necessary
Subsoil life/crop capacity	no agriculture or protected natural areas
Geomorphological quality & diversity landscape ecology	not relevant
Ecology	not relevant
Sand, clay, gravel resources	not relevant
Subsurface storage	not relevant

Figure 6.15. Results of the SEES method at the Alvat site.

Based the results of the SEES method, it could be derived that for most topics little opportunities are possible for this site. The redevelopment is mainly dominated by the type and the degree of the soil and groundwater pollution. The uncertainty regarding the current extent of the pollution and the future land use, makes that the plan/urban design should be flexible. Additionally, a generic urban analysis is done. The main conclusions of the analysis are:

- The site is surrounded by housing areas and by a little bit of agriculture
- Industrial area is situated along the Schelde, not far from the site
- Daily facilities like grocery stores are reachable within 7 min by car
- The other side of the Schelde is part of both Natura 2000 and the Sigmaplan. Therefore new ecological floodplains will be created in the near future.
- A bicycle path goes around the site. Nowadays it has to make a strange angle because of the contaminated site

6.2.3.2 Redevelopment strategies

The main elements in the spatial design following the technical measurements in the subsurface are:

- Main road connections & pumps (Located on between the parking garages to lead the groundwater flows as much as possible in the direction of the treatment station in one of the garages).
- (Temporary) ecological park (situated in the zone where accurate information on the contamination is lacking). Therefore an ecological park is located here using natural attenuation as a gentle remediation technique. Depending on the evolution of the pollution, this park can be replaced by built-up areas or kept more permanently.
- Contemporary buildings till soil is cleaned
- Phasing to develop a dynamic urban plan

Figure 6.16. Spatial measures as a starting point of designing alternative redevelopment strategies.

Figure 6.17. Scenario "SME-light industry" versus "residential".

These designs were transferred into land use maps as is required for the impact assessment. This requires further assumptions on the land uses surrounding the buildings. For demonstration purposes the "light industry" alternative mainly contains hardened surface around the buildings and the "household" alternative mainly contains green surface. Based on stakeholder feedback, a "heavy

industry” alternative and a “mixed use” alternative combining light industry and residential area were added.

Figure 6.18. Land use maps for 4 different redevelopment scenarios.

6.2.4 Risk assessment

6.2.4.1 Description of the contamination

The curator is unable or refuses to take any further steps to remediate the Alvat site, so OVAM conducted an ex-officio descriptive soil investigation and an ex-officio soil remediation project.

In the descriptive soil investigation (2002) 2 source zones with VOCs (chlorinated solvents and BTEX) and mineral oils were identified in soil and groundwater (see zone A and Landfill on figures 3-6). Heavy metals, PAHs and PCBs were also found in the unsaturated zone. The soil is contaminated up to 7,5 m (Figure 4). The groundwater plume moved downward into underlying aquifers (VOCs are found at the clay layer on 15 meter below ground level) and has spread to a limited extent to the surrounding (Figure 5 and Figure 6). On the side of the railway an industrial landfill was found that consists of vessels, plastic waste, wood, concrete and stone material.

While the contamination with heavy metals and VOC's in groundwater was spread over a large area of the site, the contamination with mineral oil and BTEX was mainly situated nearby the landfill. The volume of the groundwater contaminated with BTEX and VOC's nearby the landfill was estimated at 14500 m³ and at zone A (near the Scheldt) on 7850 m³. In addition to these 2 large groundwater contaminations, there were also 4 smaller present (at PP13, at PP14/PP4, at PP2 and at PP3).

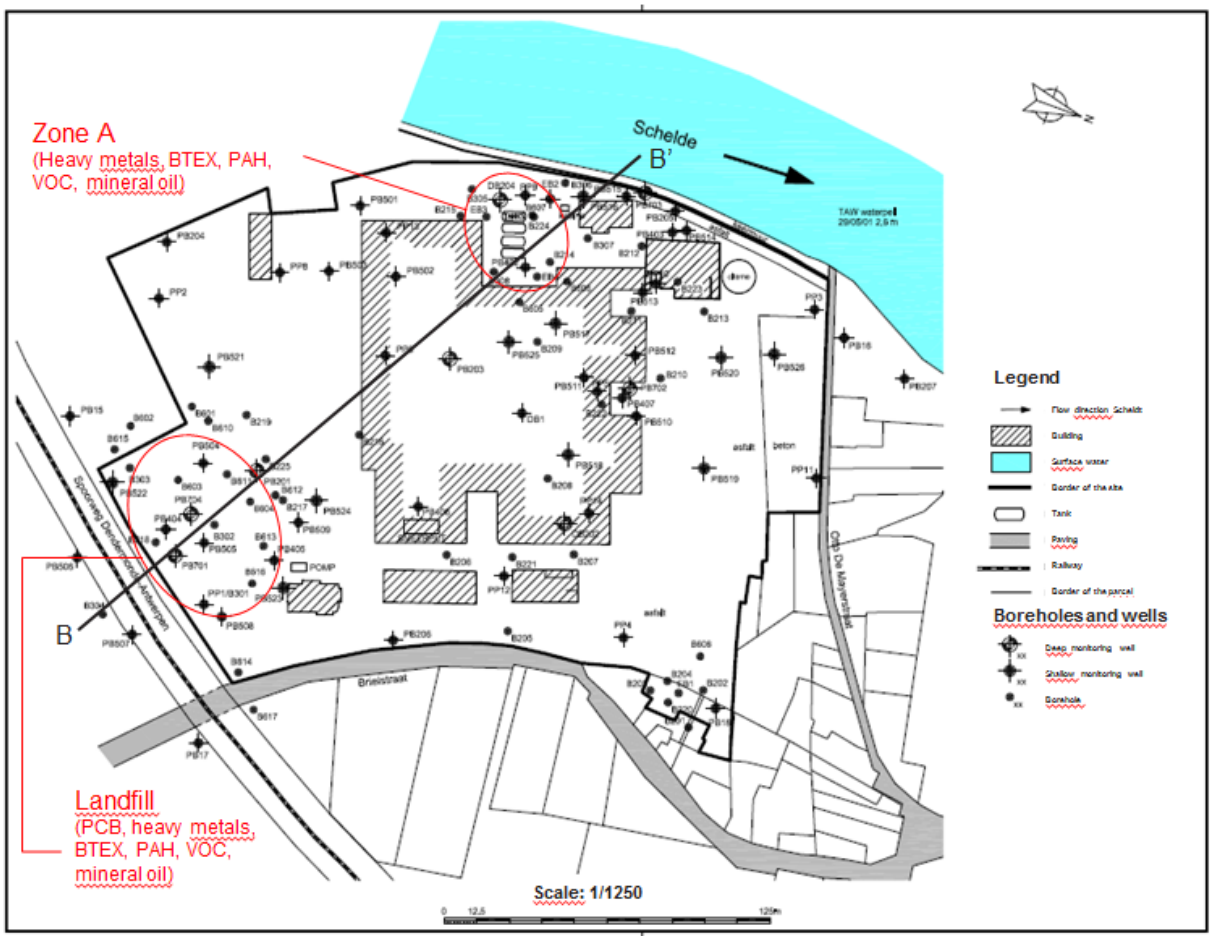


Figure 6.19 - Soil contamination (top view; based on information from ABBO Ecorem; 2002).

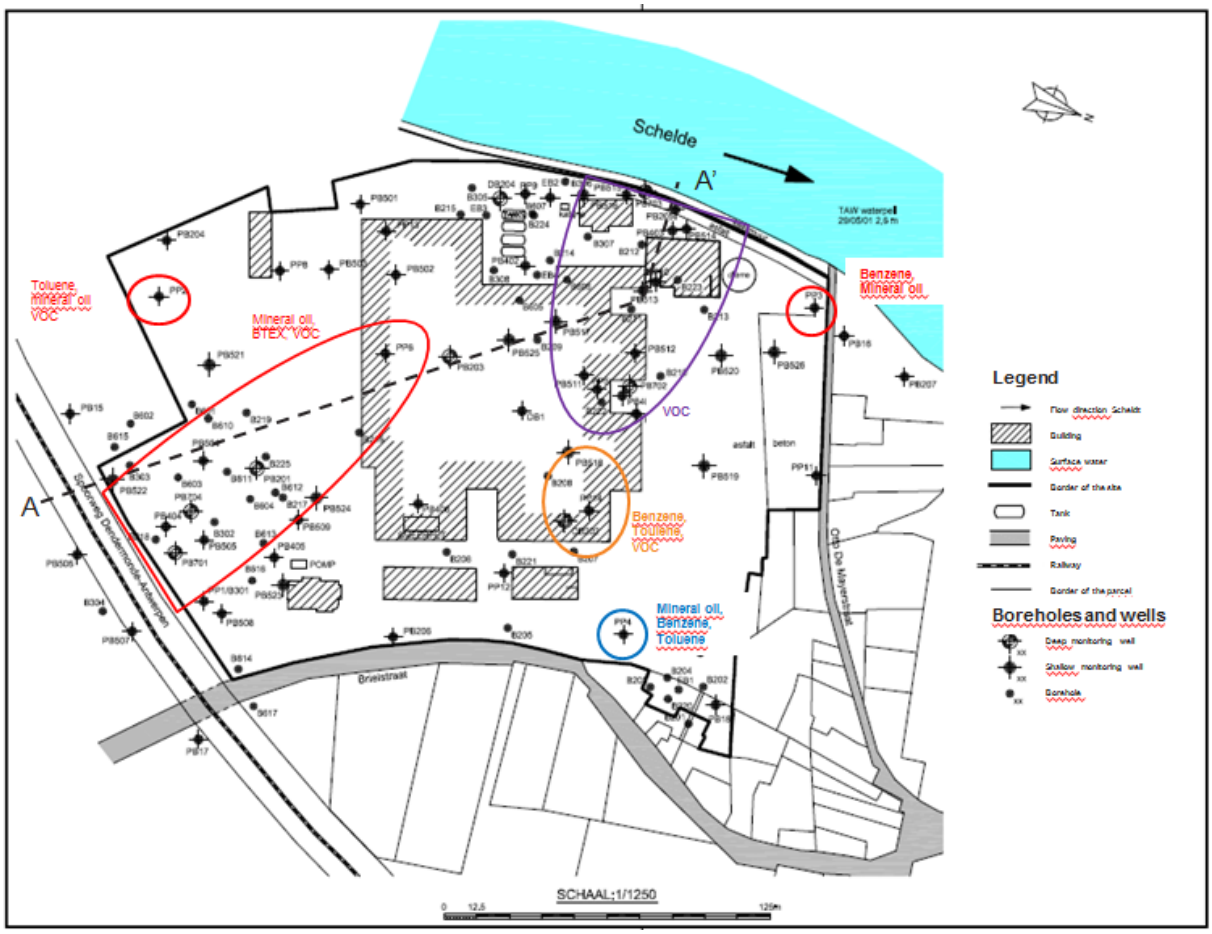


Figure 6.20 – Groundwater contamination (top view; based on information from ABBO Ecorem; 2002).

The landfill near the railway and zone A near the Scheldt were indicated as two source zones. The landfill is already remediated up to 3 metres depth (see next paragraph 'remediation') but the second contaminated zone located between the former above-ground storage tanks and the Scheldt (Zone A) is not yet cleaned up. The volume of contaminated soil with heavy metals, BTEX, PAH, VOC and mineral oil is estimated at 4100 m³ (see Table 6.71). The maximum concentrations in the unsaturated soil at zone A (measured during the descriptive soil investigation 2002) are summarized in Table 2.

Table 6.7. Contamination at zone A (near the Scheldt).

Parameter	Area (m²)	Depth (m)	Volume (m³)
Heavy metals	370	3	1110
BTEX	610	3,5	2135
PAH	470	2	940
VOC	585	4,5	2633
MO	**820**	**5**	**4100**

Table 6.8. Maximum concentration at zone A (near the Scheldt).

Parameter	Concentration (mg/kg ds)
Lead	48000
Cadmium	73

Chrome	6600
Copper	4600
Zinc	18000
Toluene	28000
Ethylbenzene	5500
Xylene	18000
Benzo(a)pyrene	47
Trichloroethene	2300
Tetrachloroethene	840

The modelling results of the risk assessment carried out during the descriptive soil investigation with the human exposure model VLIER HUMAAN (ABBO Ecorem nv, 2002) indicated that there is a **human exposure risk** based on the pollution in the unsaturated soil at Zone A and this for the future destinations industrial and residential use. So excavation of the contaminated soil at zone A (4100 m^3) is necessary.

Because of the groundwater flow in the direction of the Scheldt the identified source zones (landfill and zone A) and the associated plumes form a **threat for the surface water of the river Scheldt**. There is a receptor at risk so remediation of the source zones and the groundwater contamination is necessary. Next to the risk of spreading there is also a human risk as a result of volatilization.

6.2.4.2 Remediation strategies

A partial soil remediation project was approved in april 2007 for the remediation of the landfill. OVAM hoped that this partial clean-up would result in an increase of the profitability in the redevelopment of the site and in attracting private investors (brownfield developer) for the further remediation and redevelopment of the site.

Given the complexity of the remediation and the size of the landfill, the remediation was carried out in different phases. During the first phase (2010) the landfill next to the railway was removed. Figure 7 shows the excavated zone. Around 13500 tons of material was transported to a ground remediation center with the exception of the with PCB contaminated soil (dumping). In a second phase (2011), the remaining contaminated soil on the side of the railway was excavated. For stability reasons landfill material remained in the narrow strip between the sheet pile and the railway.

The next steps towards a full remediation of the site are currently not known in detail. Before an integrated soil remediation project for the entire site can be drawn up, an actualization of the pollution degree and the extent of the contamination is necessary since the latest results date back to 2002. This includes an update of the groundwater concentrations and an update of the source zones. It is also important to investigate if natural attenuation occurs (accumulation of cis-DCE in deeper groundwater and the formation of VC in the phreatic groundwater layer).

A rough estimation of the remaining costs of the remediation was performed for OVAM by a soil expert in 2012. The total cost was estimated on 1.550.000 euro. The soil remediation suggested by the soil expert consists of an excavation with drainage for the unsaturated source zones. The groundwater remediation will be performed using a multi-phase extraction system. The deep groundwater contamination is governed by deepwells or a barrier.

Since a human risk is associated with the soil contamination at the source zones (for example zone A) remediation of this zone is needed. For the remediation of such zones, only excavation in combination with drainage and transportation of the contaminated soil to a ground remediation center is suitable.

6.2.4.3 *Site specific risk assessment to define risk-based remediation targets for groundwater*

Targets based on human risk assessment (S-RISK[23])

The risk-based approach to the assessment and management of the contaminated site is based on S-RISK, a tool to evaluate exposure and human health risks from soil contaminants under a variety of land uses and contamination profiles. The tool calculates clean-up values based on site-specific risks and remediation objectives.

Different land use scenarios can lead to a difference in the exposure pathways and the associated risks. The model calculates concentrations in ambient and indoor air due to volatilization and soil resuspension, in drinking water from leaching or permeation, in food due to plant and animal uptake. Exposures are predicted for the inhalation route (ambient, indoor, bathroom air), oral (water, food, soil, dust) and the dermal (water, soil, dust) route. Calculations are performed for a predefined set of age intervals, ranging from children to adults. Risks are calculated by comparing exposures with toxicological reference values and concentrations with toxicological or legal reference concentrations.

Based on S-RISK the risk-based remediation targets for groundwater for several land uses are summarized in Table 3 (µg/l). The selected land uses are residential with garden (RwG), residential with garden without basement (RwG,noB), industry (offices) and park (outdoor recreation). When concentrations above the maximum solubility are calculated the maximum solubility is displayed in blue in the table.

Table 6.9 – Risk-based remediation targets for groundwater for BTEX and some VOC

Parameter	B	T	E	X
Standard[0]	**10**	**700**	**300**	**500**
RwG[1]	47-84	3292	**165000**	10610
RwG,noB[2]	100-177	6846	**165000**	21700
industry[3]	250-1250	11000-38000	**165000**	33200-1E5
park[4]	**1,78E+06**	**5,23E+05**	**1,65E+05**	**1,66E+05**

[23] S-Risk is a model for assessing exposure and human health risks at contaminated sites. Fate and distribution of chemical pollutants in soil are calculated according to steady-state conservation of mass principles. S-Risk is made available in a web application (https://www.s-risk.be). The tool is initially designed to meet the requirements of the Flemish regulatory context with regard to contaminated sites. Due to its flexibility and open structure, applications outside this regulatory context are possible.

Parameter	PCE	TCE	c-DCE	VC
Standard[0]	**40**	**70**	**50**	**5**
RwG[1]	326,7	1179	762,4	6,6-39,4
RwG,noB[2]	665	2437	1617	16-84
industry[3]	4000	13000	2500-10000	16-440
park[4]	**1,50E+05**	**1,40E+06**	**8,00E+05**	**1,12E+06**

0: soil remediation standard Flanders

In the monitoring wells at the landfill concentrations were found above the risk based remediation targets for groundwater for the land uses 'residential (with garden)' and 'light industry'. This means that for both future destinations a remediation is necessary but with different goals/remediation objectives for groundwater.

In the monitoring wells at Zone A (near the Scheldt) concentrations were found above the risk based remediation targets for groundwater for the land use 'residential (with garden)', but not for the land use 'light industry'. This means that only for the future destination 'residential' a remediation of the groundwater is necessary based on the human risk assessment. However, because of the risk of spreading towards the Scheldt remediation is still necessary.

Because of the benzene concentrations measured in the monitoring wells PP2, PP3 and PP4, there is a human risk for the future land use 'residential'. Only at monitoring well PP4 there is also a human risk for the future land use 'light industry'.

For the future land use 'outdoor recreation' there is no human risk associated with the groundwater contamination.

Risk based target setting

Because of the groundwater flow in the direction of the Scheldt, the Scheldt itself is at risk. The impact of the remediation of the landfill on the groundwater concentrations is not known, nor if natural attenuation occurred. A data update of the pollution degree and the extent of the contamination is necessary since the latest results are from 2002. Based on that information and knowledge of the groundwater velocity, retardation and degradation the risk needs to be verified. This information is lacking at the moment and will determine the risk based target.

Based on the risk assessment, it can be concluded that for some pollutants (toluene, ethyl benzene, xylene) the risk of spreading will determine the risk based targets and not the land use and the associated human risks. For other parameters like benzene and vinyl chloride the human risk assessment will determine the risk based targets. When the human risk based remediation target is more stringent than this for spreading, the land use will have a limited impact on the remediation

approach. The land use will not affect the choice of the feasible remediation techniques, but it can have an impact on the duration of the remediation. If the site will be used for residential area, the duration of the remediation may be longer than for industrial use.

6.2.5 Economic assessment (potential profit private redeveloper)

The economic value of a parcel depends heavily on the potential destination of the parcel and the building density. For this study, the relevant types of land use are residential and industrial land use. The economic value of different land uses (expressed in €/ha per land use) depends on the net income for a private redeveloper that can potentially be generated on the site. This in turn depends on the gross income from selling or renting buildings minus all the costs for preparation and development of the site, construction of buildings, administration,etc. The residual method for real estate appraisal simulates this reasoning and assesses in detail all factors that affect gross income and costs (Dugernier et al., 2014; Vos, 1996). The gross income is based on market values for renting or selling real estate, as observed in local real estate markets.

Table 5 lists the different factors that affect gross income and costs, and distinguishes between factors that are identical for all scenario's and differ between scenario's. The gross income depends on the size of the surfaces (m² living area or m² commericial or production area), the characteristics of the buildings (type, construction quality, level of completion and facilities), and the environment, wich include functional characteristics (such as proximity of tansport network, shops, schools, other firms, recreation) and physical characteristics (amenity of landscapes, nuissances,….). Whereas the size and characteristics of buildings depend on the redevelopment scenario, the characteristics of the environment are exogenous and identical for all scenario's. The costs depend more or less on the size of the buildings and their characteristics, and the development costs for the non-built up parts of the parcel. As the purpose of this study is to assess the economic value of the parcel after remediation and redevelopment, we do not include costs for purchasing the parcel. The results of the calculation (net income) can be interpreted as the amounts available to cover for expenses and risks for the investor and the costs to acquire the parcel, including taxes, administration and purchase.

Data sources to assess gross income and costs are based on a recent study to estimate the impact of land-use policy on real estate values, and for which me distinguish residential and industrial land uses (Durgenier et al., 2014). For industrial land use, we further distinguish between SME or light industry and heavy industry, as the context in terms of government involvement and real estate markets differ.

Table 6.10 – Overview of factors affecting the economic value of redevelopment scenarios.

Factors	Indicators	Gross income	Gross costs	Scenario Dependent
Buildings on site				
Size of surfaces	m² living area, m² work area	x	x	Yes
Quality of buildings	Type of building	x	x	Yes
	Construction quality	x	x	Yes
	Level of completion, facilities	x	x	Yes
Outdoors on site				
Size of surfaces	m² parking, storage, private gardens, pubic greenspace	x	x	Yes
Quality of outdoors	Level of completion, facilities	x	x	Yes
Location of the site				
Functional characteristics	Proximity transport network, work	x		No
	Schools, recreation, other firms	x		No
Physical characteristics	Amenity of landscape, nuissances	x		No
Preparation of site				
Remediation costs	Area treated / level of treatment		X	Yes
Demolition costs	m³ buildings, m² sealed surface		X [1]	Yes
Taxes and Admin. Costs			/ [2]	/ [2]
Purchase of parcel			/ [2]	/ [2]

X [1]: not further included in our study. / [2]: these costs are not accounted for in the residual method for real estate appraisal

Table 6.11 – Result of economic value of the different scenarios.

Indicator	Unit	Housing dense	Housing	SME	Industry	Mix
Land uses						
m² floor area *	m²	18.361	13.573	12.672	20.892	11.154
Grey infrastructure	m²	30.345	30.345	12.942	20.831	25.974
Green infrastructure	m²	3.633	3.633	16.109	13.992	7.875
Gross income						
Rent €/year/m²	€/m²	5,9	5,9	3,3	4,5	5,6
Total rent year	k€/year	1.288	952	507	94	663
Current Value future rents (3 - 4 %)	million €	43	32	13	2,4	24
Costs						
Building costs	million €	26	19	8	1	14
Grey infractructure	million €	0,54	0,54	2,42	-	1,18
Green infrastructure	million €	0,91	0,91	0,39	0,62	0,78
Total costs	million €	27	21	10	1,2	16
Net income	million €	**16**	**11**	**2,3**	**1,2**	**7,6**

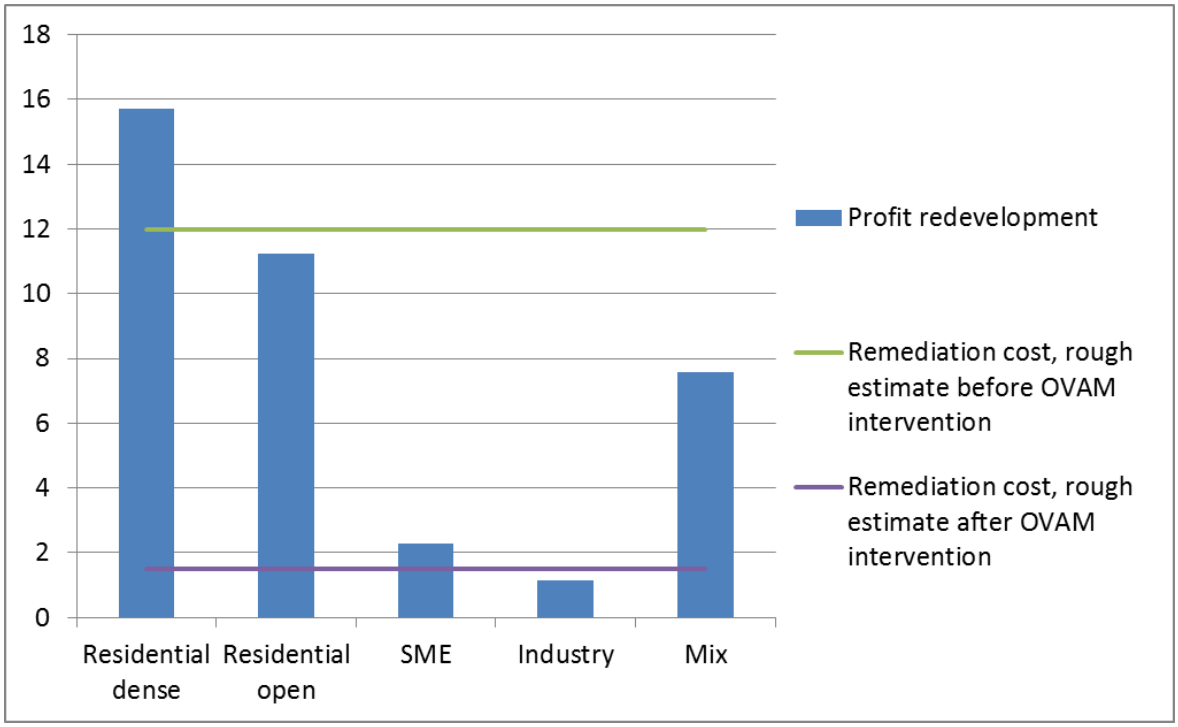


Figure 6.21. Comparison potential profits versus old estimations of the remediation costs before the OVAM intervention and more recent estimations after the OVAM intervention.

6.2.6 Sustainability assessments

6.2.6.1 OVAM MCA

The selection of the remediation techniques to achieve the remediation targets was already performed by a soil expert in the past. The most appropriate remediation strategy (combination of technologies) was selected according to the BATNEEC principle (Best Available Technology Not entailing Excessive Economical Costs). The soil remediation suggested by the soil expert consists of an excavation with drainage. The groundwater remediation will be performed using a multi-phase extraction system. The deep groundwater contamination is governed by deepwells or a barrier.

As already mentioned the multi-criteria analysis (MCA) is used to choose the most appropriate remediation strategy (combination of technologies). Two or three remediation variants can be evaluated with the MCA. The MCA is based upon 3 main aspect groups (environmental, technical and financial aspects) using several criteria. The environmental aspects are divided into 'local' and 'regional/global' environmental aspects (see Table 4). The carbon-calculator is used to evaluate one of the 'regional/global environmental effects'. Scores are given to each criterion and to each variant with a total of 15 points. Most of the scores are qualitative, some are semi-quantitative. For the Alvat case two variants will be compared for the different land uses (Variant 1 - residential and variant 2 - industry). The criteria are discussed and explained below.

Criteria	Weighing factor	Variant 1 (residential)	Variant 2 (industry)
Environmental aspects			
Local aspects	33		
Legal remediation objectives soil	6,6	5	5
Legal remediation objectives groundwater	6,6	6	4
Total reduction of contamination load	6,6	6	4
Direct emissions to environmental compartments	6,6	4	6
Duration of remediation & policy objectives	6,6	4	6
		825	**825**
Regional/global aspects	12		
Use of raw materials and recycled materials (carbon calculator)	8	4	6
Production of non-reusable waste during remediation	4	4	6
		96	**144**
Technical and social aspects	22		
Nuisance during remediation	5,5	4	6
Restrictions for land use after remediation	5,5	7	3
Damage caused by remediation works	5,5	5	5
Safety measures during remediation	5,5	5	5
		462	**418**
Financial aspects	33		
Remediation costs	22	4	6
Cost of residual contamination	11	6	4
		330	**330**
	TOTAL	**1713**	**1717**

Figure 6.22 – MCA application for the different land uses.

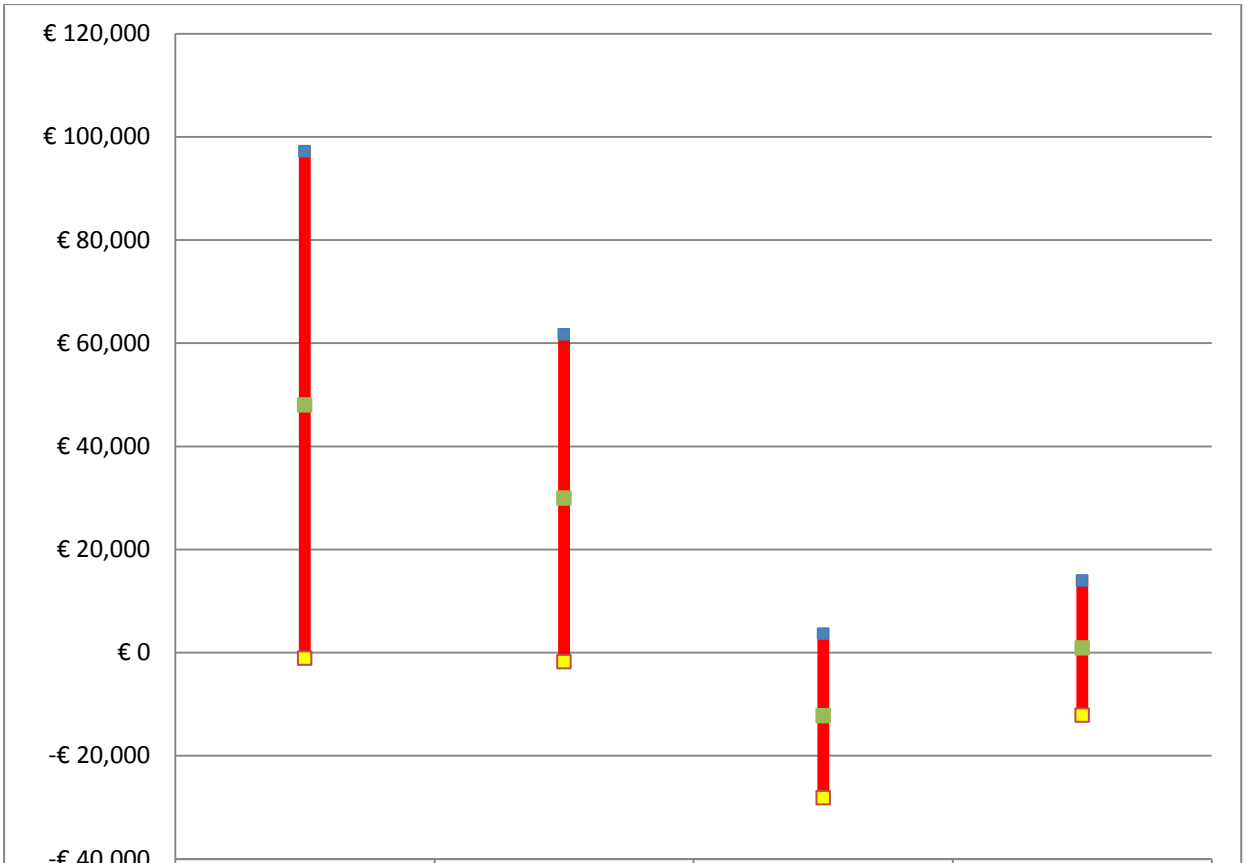
6.2.6.2 Ecosystem services

The same four possible destination scenarios were used to estimate the potential value of ecosystem services for the Alvat site in Buggenhout, with the Nature Value Explorer (www.natuurwaardeverkenner.be). More information on this tool can be found in box xx. Ecosystem services are typically used to value the impact of land use changes. To allow for a fair comparison between scenarios, a uniform reference scenario is defined. As for brownfields the reference scenario is often badly defined on land use maps, we assume as if the site was used as a maize field. This decreases the additional value on ecosystem services (e.g. loss of agricultural production) but avoids overestimation of existing services related to temporary land cover (e.g. shrubs/trees present on the existing site).

The NVE is actually used for estimating the ecosystem services provided by rural areas. Some conversions were required to estimate the ecosystem services for the Alvat case. These conversions are included in the table below.

Table 6.12. Conversion of classes used in the four designed scenarios to land uses usable in the Nature Value Explorer. Plant species are mentioned where relevant.

Class from redevelopment scenario	Land use in Nature Value Explorer	Species in Nature Value Explorer
Industrial building	Urban	
Company building	Urban	
Residential house	Urban	
Other building	Urban	
Sealing	Urban	
Road	Urban	
Flower meadow	Grasslands and tall herbs	
Herbaceous lawn	Grasslands and tall herbs	
Water	Rivers and lakes	
Hedge	Woodland and forest	
Wood row	Woodland and forest	
Big tree	Woodland and forest	Oak (*Quercus robur*)
Small tree	Woodland and forest	Beech (*Fagus sylvatica*)



	housing	mixed use	SME	Industry
High	€ 97,172	€ 61,649	€ 3,668	€ 13,945
Low	-€ 1,099	-€ 1,741	-€ 28,151	-€ 12,154
Average	€ 48,036	€ 29,954	-€ 12,242	€ 895

Figure 6.23. Monetary valuation of ecosystem services (€/year). The values depict the incremental value compared to the reference scenario (maize field). Low and high estimates are estimated with low and high unit values for each service. Average values are the average of low and high values.

6.2.6.3 Biodiversity check

The biodiversity check was developed by the non-profit organization Vrienden van Heverleebos en Meerdaalwoud (VHM) with the purpose to provide insight to project developers and urban planners into the impact of spatial developments on the value of nature and biodiversity of a certain project site.

The main use of the tool is the estimation of the biodiversity value of an urban site and how this can be impacted by a more biodiversity friendly design. The tool is qualitative. A score is calculated for the situation before implementation of a project and the situation after the implementation of a project. A dutch version of the tool can be found on www.biodiversiteitstoets.be.

Table 1 and 2 represent the selected sealing types and green shapes used for the 4 scenarios in the tool.

Table 6.13. Assumptions and results from the biodiversity check

Topic in biodiversity tool	Land use type	Scenarios			
		Housing	**Mixed use**	**SME**	**Industry**
Roof surface buildings	House	Roof without vegetation	Roof without vegetation		
	Company building		Roof without vegetation	Roof without vegetation	
	Industrial building				Roof without vegetation
	Other building	Roof without vegetation	Roof without vegetation		
Sealing types	Sealing	Concrete clinker with permeable joint filling	Concrete clinker with permeable joint filling	Concrete clinker with permeable joint filling	Non-permeable sealing with non-permeable joint filling
	Street	Non-permeable sealing with non-permeable joint filling	Non-permeable sealing with non-permeable joint filling	Non-permeable sealing with non-permeable joint filling	Non-permeable sealing with non-permeable joint filling
	Dolomite				dolomite
	Parking				Grass tile
	Open ground	Open ground	Open ground	Open ground	Open ground
Open green shapes	Open green shape 1	Lawn	Lawn		Lawn
	Open green shape 2	Flower meadow	Flower meadow	Flower meadow	
Stony soil and walls					Pace plants/wall greenery
Water	Water	Artificial open water without vegetation	Artificial open water without vegetation	Artificial open water without vegetation	
Hedges and woodrows	Hedge				Woodrow
Trees outside forest with circumference < 1 m	Small tree Big tree	Lawn under tree group/ flower meadow under tree group	Sealing under tree group/ flower meadow under tree group	Sealing under tree group/ flower meadow under tree group	Lawn under solitary tree
Trees inside forest with circumference < 1 m	Forest				Deciduous forest with well-developed herbaceous and shrub layer
	Sealing index	**74**	**64**	**35**	**50**
	Green shape index	**24**	**21**	**16**	**26**
	Biodiversity index	**49**	**43**	**26**	**38**

6.2.7 Discussion

Different tools and methods were tested for the Alvat case. A stakeholder analysis gave an overview of the different viewpoints, how this can be incorporated in different redevelopment strategies and the potential direction of compromises that could lead to a feasible redevelopment of the site. Important bottlenecks are the ownership situation (curator, who is not willing yet to sell the site) and the potential destination (industry vs. residential), which has a lot of impact on the profitability. A potential compromise is use the area for light industry/SME with a minimal pressure on surrounding residential areas.

A risk assessment indicated that little differences occur on remediation targets and strategies for the different scenarios. The duration of treatment in case of industry might reduce the duration of the treatment. The OVAM MCA also gives little differences between alternatives.

The economic assessment clearly confirms that Alvat was a blackfield, before the intervention of OVAM. After the intervention and given the fact that the site probably will not be redeveloped as a

residential area, the profitability is a borderline case and still not guaranteed. This is also reflected in the limited interests from potential redevelopers (only one interested party).

The ecosystem services assessment and biodiversity check both tend to favour the housing alternative. However, these conclusions are to a large extent driven by the assumptions made in the design of the area. Buildings in the housing alternative are mainly surrounded by grassland whereas buildings in the SME or industry alternative are mainly surrounded by hardened surface. A more "green" design of both alternatives could drastically change these results. Tools such as these are not suited to provide input for a scenario assessment on destination but are more useful in choosing between specific designs.

The usefulness of tools was also discussed with stakeholders during the stakeholder consultation. Most parties involved in the case (municipality, waterway administration, municipality) have limited interests in tools that support decision making on sustainability. The focus of information lies on legal frameworks and existing procedures (zoning plans, environmental impact assessments, location nature protected areas, maps on water sensitive areas, …) that according to the stakeholders already capture a lot of the sustainability aspects. A stakeholder analysis is however considered as crucial. Stakeholders not directly involved in the case (Agentschap Ondernemen, OVAM) indicate a need to perform more integrated planning of surface and sub-surface and across policy domains. Sustainability assessments can play an important role. The focus of research at this moment is on BREEAM-type of assessments (duurzaamheidsmeter) focusing on sustainability aspects during the entire planning process (initiative, planning & design, realization, maintenance & evaluation). An important challenge, stipulated by OVAM, still to be considered is how different types of sustainability assessments can fit into the entire planning process and how this can be better integrated in rules and regulation.

One of the identified problems in this case is that there a lot of parties involved but that there is not a single party who manages the whole redevelopment process and acts as a process owner. At this moment, it is up to the private developer to find the necessary compromises and get all procedures started. This increases the risks for the private company and potentially slows down the entire process. Government administrations such as OVAM are careful in not intervening and distorting the private redevelopment market, but might get more proactive to speed up the process of redevelopment. The brownfield convenant, current legislation for Flanders, is an example on how different public authorities can work together and assist private parties to speed up redevelopment, without intervening in the private market.

6.2.8 Advice for Alvat case

From the stakeholder analysis it can be concluded:

- Differences in opinions exist between different stakeholders on how the site should be used (residential vs. industry). However, intermediate options (SME, mix SME-residential) are possible to find compromises. Important is that the municipality and the surrounding residential areas get a good view on what will happen on the site and how potential mobility issues due to additional traffic can be solved.

- The ownership situation (curator) is a potential bottleneck for further steps in the redevelopment. More pressure and evidence on the limited profitability can be exerted to sell the site for a symbolic euro. A combined effort of OVAM and the private redeveloper might be required.

From the SEES approach and the design process of potential redevelopment strategies it can be concluded:

- The site offers little opportunities from the subsoil. The realization above ground should interact with the remediation strategy for the soil and groundwater pollution.
- A phased approach where the centre of the site is temporarily not built upon and occupied by a green area is a potential option to consider.

From the risk assessment, profitability analysis and sustainability assessments it can be concluded:

- Risk based targets and the choice in remediation technologies do not depend on the potential redevelopment strategy. The duration of treatment might reduce in a SME/industry scenario.
- The site was correctly qualified as a black field. The investments in treatment by OVAM were required to attract private redevelopers and were not exaggerated, as the potential profitability in a SME scenario is still limited.
- The sustainability assessments focusing on ecosystem services and biodiversity are not very conclusive in distinguishing between scenarios. Specific measures can be taken in all scenarios (use of materials, amount and type of hardened surface, type of vegetation, …) to make the design more eco-friendly.

6.3 Case study: the Fixfabriken site in Göteborg, Sweden

The Fixfabriken site will be redeveloped from mainly being an industrial area incorporated into attractive parts of Göteborg, into an area with mixed use, including residential use. The Fixfabriken site joined the Balance 4P project as a case study due to that the site has several activities which typically give rise to contamination problems and the Urban Planning Office at the municipality was in the phase of compiling information for suggesting a detailed plan for the area. Thus, Balance 4P was seen as having the potential to contribute to this process and the main stakeholders had an interest to participate, to contribute and to learn from the work within Balance 4P.

The driver for redeveloping the site is a foreseen land-use change, a private developer wants to turn a former industry (the Fixfabriken factory) into a residential area and the municipality in Göteborg decided to consider a larger area in the development of a new detailed plan. The land in the area is owned by the municipality, the large private developer as well as a number of smaller land owners.

Within the Balance 4P project, a number of activities have been carried out in order to apply and assess different methods and tools that can provide input to and support the decision on a detailed plan. First, there have been a number of activities to identify sustainable redevelopment strategies considering the subsurface conditions:

- A student workshop on subsurface issues in urban design and student project works;
- A stakeholder analysis (quick-scan) for identifying participants for the first workshop;
- Stakeholder workshop 1: SEES – System Exploration Environment & Subsurface;
- Identification of alternative conceptual redevelopment strategies based on subsurface conditions and stakeholders.

In addition, sustainability assessments of identified redevelopment strategies have been carried out using three methods:

- SCORE;
- Mapping of changes in ESS;
- Social impact assessment.

The results of the sustainability assessments were presented and discussed at a second stakeholder workshop (no. 2). In the following sections, the work is further described and the main results are presented.

6.3.1 Site description

The Fixfabriken area is an area located in a popular part of Western Gothenburg. At present, it is mainly an area with industrial use (a factory, buss garage, tram hall and smaller enterprises) but it is now in the planning process for redevelopment into an area with a much more mixed use, i.e. residential housing, commercial buildings and public spaces. The buss garage will move in the coming 5 years and the tram hall is also likely move to another location in the future (10 – 15 years). There are mainly two landowners: the municipality itself and a private developer consisting of two large companies (HSB and Balder). The urban planning office of the municipality is in the process of changing and developing the detailed plan of the area to make it possible to redevelop into different land-uses than the present. Already a number of workshops and meetings have been carried out to

explore what the neighbours and the existing companies prioritize and what they find valuable in the area. The potential of the area fits very well into the political objectives of the city: development of this area would not take any virgin ground into account, it is near to public transportation, it could potentially contribute with a good portion of residential housing, there is a possibility to complement the neighbouring area with now missing commercial and social services such as a food store and a sports facility, there is already a mixed use of the site and it is an attractive part of the city. Another prioritised political objective is integration, which delivers some more concern about how to achieve.

The site can be divided into four main areas: The Fixfabriken factory, the bus garage, the tram hall and the Karl Johansgatan area. Detailing on the site description is given in Garcao (2015, *in progress*)

The **Fixfabriken factory** has had industrial activities since the 1940ies. The soil at the Fixfabriken factory is contaminated to some extent by trichloroethylene, a chlorinated solvent. The present spreading conditions of the contaminants are to a large extent unknown. Archaeological remains are known in the area, although its boundaries are not defined.

The **Bus garage** property is owned by the municipality and is probably contaminated to some degree.

The **Tram hall** is operated by Göteborgs Spårvägar, which has a permit to be operating in the upcoming years. The municipality owns the property. Recently the company showed to the municipality its interest to keep operating the tram hall further after this deadline. Also

The **Karl Johansgatan area** includes the area that stands in between the road Karl Johansgatan, which is the main road serving the local neighbourhood, and the highway E45. It also includes the road Karl Johansgatan itself. Road infrastructures and traffic generate adverse effects, namely noise, air pollution and visual intrusion. Land use at the area includes two petrol stations, a residential area, parking lots, crossings and small green areas in between.

6.3.2 Stakeholder analysis

A quick-scan for a stakeholder analysis for the Fixfabriken area in Göteborg was carried out The main purpose of the stakeholder analysis is to get an overview over relevant stakeholders and to select stakeholders to invite to the first Balance 4P workshop (the SEES workshop). For this stakeholder inventory, the general steps of the procedure for stakeholder analysis according to the Crosby method (Hermans, 2005) were followed as elaborated in Section 4.1.

The initial ample list of stakeholders was completed with the help of the representative from the Urban Planning department, see Table 6.5.

Table 6.14. List of stakeholders in the Fixfabriken area and their interest in the Fixfabriken area.

Group	Specific	Group's interest in Issue
Municipality – planning functions	Urban Planning Office	A good urban development which abide to the local political objectives
	Recycling and Water Department	Planning of waste and water issues
	Property Management Department	Management of the municipality's land properties

	Parks- and Public Space Department	Planning and maintenance of green areas
	City District Administration	Development of the City District, child care, schools, inhabitants
	Traffic Planning Office	Traffic and infrastructure planning
Municipality – controlling functions	Environmental Department	Contaminated soil, noice, dangerous goods etc
County administration – controlling authority, Social planning and cultural heritage	Samhällsbyggnadenheten	National interests in the area (*Riksintressen*): Energy distribution – gas pipe, Communication – road, shipping, harbour, Cultural heritage - Klippan and Kungsladugård, Other: health and safety, environmental quality guidelines
	Kulturmiljöenheten	Archaeology and ancient monuments
Land owners	Property Management Department	Development of property
	HSB/Balder - private land owner	Development of property
	Svenska Hus – small private land owner	No planned change
	xxx – small private land owner	No planned change
Today's companies	Swedgas	Owner to the gas pipe
	Triumfglass	Ice-cream company
	Friskis & Svettis	Gym facility
	Assa (tidigare Fix)	Manufacturer of metal parts for the textile industry – looking for new location, today renting the factory from HSB/Balder who are the new owner
	Photographer	
	Tram company (Spårvägen) – activities in the bus garage and the tram hall	Possibly want to stay at site – if possible to move tram hall underground.
	Kennedygymnasterna	Gymnastics association
	Mekonomen	Seller of car parts and tools
	and others…	
Future companies	Aim for most companies to stay	
	Food store	
	Sports facility	
Inhabitants	Today's inhabitants	
	Future inhabitants	
	Sannaskolan School	
	Social housing	
Associations	BK Sandarna	Football club
	Not so many in the area but very many in the surroundings, e.g. Majorna, Sjöbergen	
	Potentially those that can use e.g. a future sports facility	
	Scooter association	
	Youth association	
Interest groups	Yimby – Yes In My BackYard	More residential housing, pro-densification
	Association for older inhabitants: Gamla majgrabbar, gamla majtöser??	

For the Balance 4P project, a workshop for applying and testing the SEES working approach was planned. This workshop covered the whole Fixfabriken area and was broad workshop on chances and challenges associated from the subsurface on the aboveground development. The aim was to include representatives from all relevant subsurface qualities and all above surface layers, as well as researchers from the B4P project. Table 6.6 shows the relevant stakeholders to invite and their position on the issue. The issue in this case is if they are willing to test the SEES working approach.

Other stakeholders not listed in Table 6.5, was invited: (1) a researcher from the University of Gothenburg (GU) who have been conducting research in urban development and interim uses of industrial areas, and (2) the architects associated with HSB/Balder whom have previously carried out studies/designs for Fixfabriken.

Table 6.15. The selected stakeholders and their position on the issue.[24] The stakeholders marked with light grey participated in the workshop. The stakeholder in bold were invited but did not participate for different reasons.

Group/stakeholder	Group's interest in Issue	Resources	Resource Mobilization Capacity	Position on issue
Urban Planning Office	A good urban development which abide to the local political objectives	Expertise, leverage (representing political decision-making)	High	++
Recycling and Water Department	Planning of waste and water issues	Expertise	High	+
Property Management Department	Management of the municipality's land properties	Expertise	High	++
Parks- and Public Space Department	Planning and maintenance of green areas	Expertise	Not checked	?
City District Administration	**Development of the City District, child care, schools, inhabitants**	**Expertise**	**Medium**	**+**
Traffic Planning Office	**Traffic and infrastructure planning**	**Expertise**	**Low**	**?**
Environmental Department	Contaminated soil, noice, dangerous goods etc	Expertise, leverage	High	-/?
"Samhällsbyggnads-enheten"	National interests in the area (*Riksintressen*): Energy distribution – gas pipe, Communication – road, shipping, harbour, Cultural heritage - Klippan and Kungsladugård, Other: health and safety, environmental quality guidelines	Expertise, leverage	Not checked	?
Kulturmiljöenheten	**Archaeology and ancient monuments**	**Expertise, leverage**	**Medium**	**++**
Property Management Department	**Development of property**	**Investment, leverage**	**High**	**++**
HSB/Balder - private	Development of property	Investment, leverage	High	++

[24]

- Group's interest in Issue: those interests that will be affected by the decision to be taken (just the most important ones).
- Resources: the resources the group possesses that can be used in the decision making. (knowledge, information, leverage, money)
- Resource Mobilization Capacity can the group mobilize these resources quickly or slowly? This is important when looking at the dynamics of the decision making. If a decision needs to be taken quickly, but the resource (eg knowledge) can only be delivered slowly, this resource is of less importance than previously thought.
- Position on issue. The position should be examined. People can be strongly negative (- -), slightly negative (-) or slightly positive (+) or completely positive (+ +).

land owner				
Swedgas	Owner to the gas pipe	Expertise	Not checked	?
Tram company (Spårvägen) – activities in the bus garage and the tram hall	Possibly want to stay at site – if possible to move tram hall underground.	Expertise, investment	Not checked	?
Yimby – Yes In My BackYard	More housing, pro-densification	Expertise	Not checked	?
Researchers B4P	Research	Expertise	High	++
What! Arkitektur – architects	Input to design	Expertise	High/medium	+
Researcher GU	Research	Expertise	High	++

Note here that representatives the first three of the mentioned stakeholder groups in the B4P proposal were invited to the workshop:

- "knowledge" (knowledge institutes, universities),
- "regulators" (the different fields of regulation (environment, city planning, social and economic affairs) from municipality, region and environmental agency)
- "business" community (advisors, housing corporations, utility companies)
- "society" (social initiatives).

The fourth group could have been covered by e.g. the organisation Yimby, but time constraints lead to that they and some of the other identified stakeholder were not invited. However, the community has been involved by different types of activities already carried out, although these activities have not been specifically considering remediation issues, rather land-use and urban design issues. The activities that have taken place are workshop with schoolchildren from the nearby school, workshop with local small enterprises, workshop with local inhabitants, and a "walk-about" around the area for local inhabitants. The people that were present at the Fixfabriken SEES workshop also took part in these activities.

6.3.3 Designing redevelopment strategies

For identifying and designing sustainable redevelopment strategies, a number of activities have been carried out.

- Urban design students from TU Delft and Engineering students Chalmers have worked in a 2-day workshop to develop urban designs with remediation issues in focus (REF!). The workshop resulted in five different proposed designs for the Fixfabriken area that were presented to the municipality and the private developer.
- Three urban design students from TU Delft carried out their project works on in-depth studies of the Fixfabriken site, and proposed urban design alternatives.
- A workshop with stakeholders was carried out to apply and assess the SEES-method (Box 4.1) for the Fixfabriken site.
- Stakeholders were asked for their preferences with regard to land-use alternatives at the Fixfabriken site at the before mentioned workshop. These preferences were, together with more in-depth information on soil contamination, future plans for the site and archaeology further concretized into five conceptual redevelopment strategies that were used to apply a number of sustainability assessments.

Summary of results from the student workshop

The student workshop was carried out on April 23-25, 2015 in Göteborg. Seventeen urban design students from TU Delft mixed with five engineering students from Chalmers. The workshop started with a site visit on Wednesday afternoon, presented by the representative from the municipality (Hanna Kaplan). Thursday morning started with presentations by the municipality (urban planning, soil contamination), the developer and a lecture on soil remediation technologies. In the afternoon, the students were working with vision making, and the first ideas were presented in the late afternoon. The last day of the workshop was hard work and in the late afternoon/evening final presentation to the clients (the municipality and the private developer).

The question posed to the students is how they view the future of the area in dealing with the soil conditions. There is contamination from the industry and garages, there is a large archaeological site and also the connection to the city along the main road was part of the assignment. The area around is a popular housing district with larger blocks of the early twentieth century with communal gardens in the courts. The students were asked to create a vision for the site with objectives and key interventions.

Five projects were presented: 1) We don't Fixfabriken[25], 2) FIXED remediation[26], 3) *balanserade* Fixfabriken[27], 4) BINDING THE PATCHES[28], and 5) GO WITH THE FLOW[29]. Some general comments of the clients about all projects were:

- Good grip on the material and the site in a very short time
- Perspective from the larger to the smaller scale, both in surface and subsurface theme's
- Good presentations, great visualization
- Attention to the feasibility of the development in providing a phasing based on revenue's is explored in two proposals, this is important for a developer
- The projects also show how to work with the subsoil from a larger order of the area towards smaller scale public space, infra-structure or even building design
- Temporary use connected to the participatory approach is considered fruitful

Students project work

The following student project works have been carried out and reported for the Fixfabriken case:

- FIXFABRIKEN – A study for future developments, by Felix van Zoest;
- Living the subsoil – A design from a subsoil perspective, by Barbara Bekhof;
- Uppleva FIXFABRIKEN!, by Janneke van der Leer.

[25] Amardeep Amavasai, Barbara Bekhof, Jelle van Gogh, Juliska Wijsman and Lena Niël
[26] Judit Gaasbeek Janzen, Nathali Cuotto, Felix van Zoest, and Sebastiaan Huls
[27] Nirul Ramkisor, Robbie Anderson, Montserrat Pantoja and Janneke van der Leer
[28] Mick van der Steeg, Willard van der Velden, Andrea Verni, Eelco de With and Ingrid Olofsson
[29] Carmen Felix Aires, Jan ten Kate, Joop Stuijt and Rita Garção

All students work uses the subsoil as point of departure in their urban designs.

Summary of results from the stakeholder workshop 1: SEES tool

The workshop was carried out on May 26, 2014, at Chalmersska huset. There were three main objectives of the workshop:

- to apply and evaluate the SEES approach on a Swedish case together with the actual stakeholders,
- to deliver input on subsurface issues to the ongoing work in the Fixfabriken area,
- to discuss strategies to analyse further in the Balance 4P research project.

The workshop was attended by different ”subsurface experts” from the Property Management Department of the City of Gothenburg[30] and ”aboveground experts” both from different functions from the City of Gothenburg[31] as well as the private developers’ project leader and architects. In total there 13 persons present, 2 facilitators, 8 stakeholders present and 3 other participants (2 from project team and 1 from Gothenburg University). Table 6.6 shows the identified stakeholders in the stakeholder analysis.

The project area was presented by the Urban Planning Department and the private developer. Afterwards, the subsurface experts presented the following subsurface themes for the project area:

- Civil Constructions: archaeology, cables and pipes[32]
- Geotechnics and water: Hydrogeology, soil subsidence
- Soil: soil contamination, landscape morphology

After each of these presentation, the yield per ”layer” (people, metabolism, building, public space, networks) was discussed and noted in the SEES matrix.

The main areas that were discussed during the workshop are the following:

- The Sandarna archaeological site: Early Stone Age settlement (6000 years B.C.) and more recent settlement from Late Stone Age (3000 years B.C.)
  There are interesting archaeological remains from the stone age in parts of the area which has a very high cultural/historical value. This was seen both as an opportunity as well as a threat. It could create an identity for the area and a full excavation could enhance knowledge about this early settlement in Sweden but at the same time, it could hinder the development of new buildings by making it expensive to build and it could also be in conflict with a number of in-situ remediation technologies.
- The old Fixfabriken (ASSA) and problems with contamination of Trichloroethylene (TRI):
  The full picture of contamination is unclear at the site although there are some data from

[30] The expert from the County Administration got ill and had to cancel his participation.
[31] The functions present from the City of Gothenburg were: the urban planning department, the environment department, the recycling and water department. The city district administration cancelled and the Traffic planning office did not respond to the invitation.
[32] Both experts cancelled – summaries by workshop facilitator + representative from the Urban Planning department instead.

different types of activities in the full area. The largest concern here is the known use of chlorinated solvents the old Fixfabriken building (now ASSA) combined with the unknown spreading and present and future risk to humans (and the environment). An issue that was raised is the possible transportation of contaminants off-site along existing pipes and cables, how the spreading situation is and if there potentially is a present problem in the existing pipes.

- Precipitation infiltration and soil subsidence, damages on old constructions:
  The site has a different geological and hydrogeological situation than what is normally found in Göteborg. Glacio-fluvial deposits and historically variable sea-level has given rise to layers of more conductive material, sand inter-bedded in the clay deposits, and parts of the area is important as an infiltration area. The need for an overview hydrogeological investigation was pointed out since exploitation that would cause a lowering of the groundwater table in this area can result in soil subsidence in the surrounding parts and thus large maintenance costs. The potential to adapt future building complexes to the hydrogeological and geotechnical conditions were discussed, but there was no time to further explore it during the workshop.
- Attractive area and high land value, gives possibilities to restructure cables and pipes:
  The Fixfabriken area is an area located in a popular part of Western Gothenburg and the land value is potentially very high. It is estimated that it will be high enough to allow for a new structure of the present pipes and cables in the ground – the cost would be outweighed by the potential benefits.

With regard to feedback on the applied SEES-method, it was concluded that the competencies that met during the workshop seldom get the chance to sit together and discuss and that the method had a high potential for use in other projects as well. Unfortunately, some experts were missing both representing the subsurface and the different layers of the built environment/city. For example, the representative from the city district administration would have been able to include the social/people perspective more clear, but the participation was cancelled last minute.

Summary of identified conceptual redevelopment strategies

After discussing the challenges and opportunities in the Fixfabriken area in the first stakeholder workshop, the participants were asked to rank what strategies they would prefer with regard to land-use and remediation strategy in the different parts of Fixfabriken. It was clearly pointed out that it was for the research project and not part of the process lead by the Urban Planning Department. Despite this, some participants were unwilling to reply due to the early stage and data unavailability, and due to the inclusion of remediation strategies that are not frequently applied in Sweden today (e.g. in-situ technologies). These opinions were then used for identifying redevelopment strategies for sustainability assessment together with more in-depth interviews with the expert from the County administration on the archaeological findings in the area, consultation of the soil remediation expert at the real estate office together with consultant reports, and also consultation with the representative from the urban planning office at the municipality. The work is presented in detail in Garcao (2015, *in progress*). Along with the reference alternative, five redevelopment strategies were identified and summarized below (see also Figure 6.7), detailed for

each of the sub-areas at the site: (1) the Fixfabriken factory; (2) the bus garage; (3) the tram hall; and (4) the road Karl Johansgatan.

REFERENCE ALTERNATIVE

The reference alternative corresponds to the present situation, keeping a relatively underused area within an attractive part of Göteborg.

ALTERNATIVE 1

The Fixfabriken factory is demolished. The existent filling material beneath the buildings and the superficial part of the underneath layer are dug out. New buildings for residential use with some commercial areas in the ground floors are then constructed, starting 5 years from now. Redevelopment occurs during 2 years. Housing heights are 4-7 floors, with a mix of rental and condominium apartments. The excavated contaminated materials are not further treated but are transported off-site to final disposal, possibly with some treatment at the disposal site.

The Bus garage is demolished and the existent filling materials beneath the buildings and the superficial part of the underneath layer are dug out. New buildings for residential use, with commerce/offices/services at the ground floor, are then constructed, starting 8 years from now. It is assumed that the development occurs in two stages. The total redevelopment period is 3 years. Housing heights are 4-7 floors, with a mix of rental and condominium apartments. The excavated contaminated materials are not further treated but are transported off-site to final disposal, possibly with some treatment at the disposal site.

The Tram hall is kept as it is. No remediation action is taken, unless any extreme hot-spots are found in the coming investigations.

The existing petrol stations at the street Karl Johansgatan are demolished, and the present residential area is kept. New buildings for industrial and office use are then constructed, starting 10 years from now. It is assumed that the redevelopment occurs in several stages, during 8 years. No action is taken in the remaining area along the street Karl Johansgatan. Regarding remediation action, the filling materials beneath the places to be reconstructed are dug out. The excavated contaminated materials are not adequate to be used on-site and are transported off-site to final disposal, possibly with some treatment at the disposal site.

ALTERNATIVE 2

The Fixfabriken factory is demolished. In the northern part the existent filling materials beneath the buildings and the superficial part of the underneath layer are dug out. New buildings for residential use are then constructed in the northern part, starting 5 years from now, and during 2 years. Housing heights are 4-7 floors, with a mix of rental and condominium apartments. The excavated contaminated materials are not adequate to be used on-site and are transported off-site to final disposal, possibly with some treatment at the disposal site. The southern part becomes a green area to preserve and emphasize the historical importance of the site. The upper soil layers are

remediated through soft techniques (e.g. phytoremediation), i.e. no excavation unless any extreme hot-spots are found in the coming investigations. This allows a lower disturbance of the underneath layers, thus lower probability of affecting the known archaeological remains from the Early stone age culture ”Sandarna settlement” (6000 B.C.) and prehistoric settlements from Neolithic age (late stone age), and eventual remains of an ancient military camp (1500s-1600s A.C.).

The Bus garage is developed in the same way as described in Alternative 1. The Tram hall is treated as described in Alternative 1. The Karl Johansgatan area is handled in the same way as described in Alternative 1.

ALTERNATIVE 3

The future land uses in this alternative are developed quite differently from alternatives 1 & 2 and also the remediation strategy is different. Whereas Alternatives 1 & 2 emphasize excavation, this alternative focuses on no excavation, but instead using surface cover, hot-spot *in-situ* remediation and active ventilation of new constructions to prevent vapors in-door to manage contamination.

Consequently, when the Fixfabriken factory is demolished, foundations and sub-surface structures are left untouched to disturb the sub-soil as little as possible. These structures are instead ventilated to manage contamination. Around buildings, *in-situ* and soft techniques (e.g. phytoremediation) are potentially applied in combination with surface cover. New buildings are constructed on top of existing sub-soil structures. Ground floor is ventilated to manage contamination and used as commercial space. 2 floors of apartments are built on top of these for residential use, with a mix of rental and condominium apartments. In addition, 20% of the apartments are subsidized for low-income families. Development starts 5 years from now, and is carried out during 2 years.

The Bus garage is demolished without digging out the existent filling materials beneath the buildings. New buildings are constructed on top of the surface with piling where needed, to disturb the sub-soil as little as possible. New buildings are constructed on top of existing sub-soil structures. Ground floor is ventilated to manage contamination and used as commercial space. 3-4 floors of apartments are built on top of these for residential use, with a mix of rental and condominium apartments. In addition, 20% of the apartments are subsidized for low-income families. Around buildings, in-situ and soft techniques (e.g. phytoremediation) are potentially applied in combination with surface cover. Development starts 4 years from now, and is carried out during 2 years.

The Tram hall is kept as it is. No remediation action is taken, unless any extreme hot-spots are found in the coming investigations.

The Karl Johansgatan area is developed in the same way as described in Alternative 1.

ALTERNATIVE 4

Fixfabriken factory is handled in the same way as described in Alternative 1.

The Bus garage is demolished and the existent filling materials beneath the buildings and the superficial part of the underneath layer are dug out. A new tram hall is constructed, starting 8 years

from now, and during 2 years. The excavated soil is handled in the same way as described in Alternative 1. Different future land uses is thus the main difference between Alternative 1 and 4.

The Tram hall is demolished and the existent filling materials beneath and eventually the superficial part of the underneath layer is dug out. New buildings for residential use (a mix of rental and condominium apartments), with commerce/offices/services at the ground floor, are then constructed, starting 10 years from now. It is assumed that the redevelopment occurs in 2 different stages, in a total of 3 years. The excavated contaminated materials are not adequate to be used on-site and are transported off-site to final disposal, possibly with some treatment at the disposal site.

The Karl Johansgatan area is handled in the same way as described in Alternative A1.

ALTERNATIVE 5

This alternative keeps the existing constructions at the area to a highest extent, namely Fixfabriken and the tram hall.

Buildings and uses (industrial and offices) at Fixfabriken factory are kept as they are. Buildings are renovated to assure an adequate indoor air quality, namely through active ventilation. The space is used as incubator for new businesses and social entrepreneurs. Depending on further investigation of the soil contamination in the area, in-situ remediation might be carried out if there are any hot-spots / left source areas. This is assumed to occur 2 years from now.

The Bus garage is developed in the same way as described in Alternative 1, but with housing heights of 7-15 floors, with a mix of rental and condominium apartments. In addition, 20% of the apartments are subsidized for low-income families.

The Tram hall is treated as described in Alternative 1. The Karl Johansgatan area is handled in the same way as described in Alternative 1.

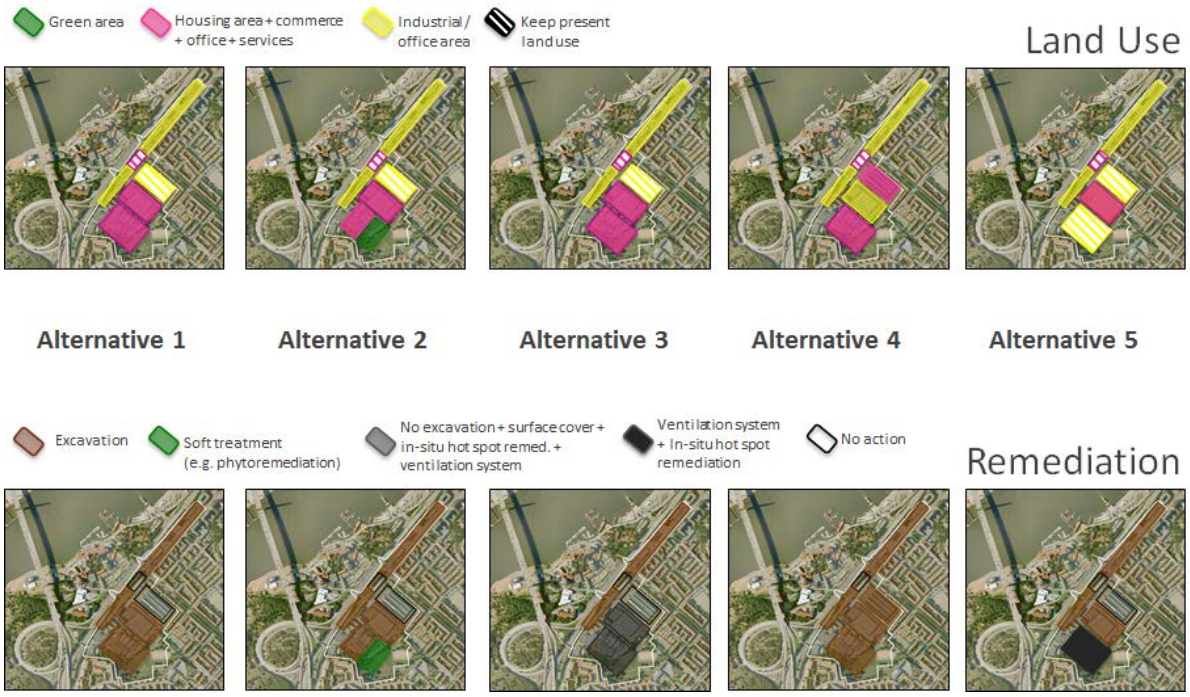


Figure 6.24. Overview of redevelopment strategies at the Fixfabriken site. From Garcao (2015, in progress).

6.3.4 Sustainability assessments

Three different approaches were selected for sustainability assessment of the identified alternatives: the SCORE tool, mapping of Ecosystem services (ESS), and social impact analysis (SIA). All methods are evaluation relative to the reference alternative, i.e. the assessments try to say something about how a change from the present situation to one of the identified redevelopment strategies will affect different aspects. The results were presented at the second stakeholder workshop on 13th of October, 2014.

SCORE tool – Sustainable Choice of Remediation

The SCORE framework (Rosén et al., 2013) aims to assess the sustainability of *remediation strategies* with regard to criteria in the environmental, the socio-cultural and the economic domains of sustainability (see Table 6.7). It has been developed to support decisions on remedial strategy and not to support decisions on land-use and urban planning. Primarily the social domain lacks aspect of sustainable urban development.

In the economic domain, costs and benefits are measured quantitatively in monetary terms using Cost-Benefit Analysis (CBA) addressing the *Social profitability* criterion (Rosén et al., 2008, de Rus, 2010). In the environmental and socio-cultural domains, qualitative scores are assigned to a number of key criteria. The effect of a remediation alternative on each criterion is scored between -10 representing “very negative effect” and +10 representing “very positive effect”. A score of 0 represents “no effect”. All effects of the analysed remediation alternatives are measured relative to the effects of a reference alternative, e.g. when no remedial action is taken.

Table 6.16. Key criteria of the SCORE framework by Rosén et al. (2013).

Environmental domain	Socio-cultural domain	Economic domain
• Soil • Flora and fauna • Groundwater • Surface water • Sediment • Air • Non-renewable natural resources • Non-recyclable waste	• Local environmental quality and amenity • Cultural heritage • Equity • Health and safety • Local participation • Local acceptance	• Social profitability

The SCORE framework is based on multi-criteria decision analysis (MCDA) and uses a linear additive model to rank the remediation alternatives, in combination with a non-compensatory method to identify those alternatives which are regarded as not leading towards sustainability. The score of each criterion are added and integrated, together with the results of the CBA, into a normalized sustainability index. The most sustainable alternative is the one which generates the highest sustainability index. The uncertainties in the MCDA model are analysed using Monte Carlo simulation (Rosén et al. 2013). The details of the SCORE analysis for the Fixfabriken site are presented in Garcao (2015, *in progress*). The results of the analysis are given in Appendix E.

Mapping of Ecosystem services (ESS)

A qualitative mapping of changes in Ecosystem services with regard to the five alternatives was carried out, based on the following principles: An inventory of existing ecosystem services with regard to two typologies: i) Urban Ecosystem Services (Baggethun et al., 2013) and ii) Soil Ecosystem Services (Finvers, 2008) and a qualitative valuation of changes (assessment ex-ante and assessment ex-post) using the following scale:

-1: Land use has a negative impact on supply of ESS
0: Land use implies no supply of ESS
+1: Land use has a significantly negative effect but allows for some supply of ESS
+2: Land use has a somewhat negative effect on the supply of ESS
+3: Land use is not affecting the supply of ESS

The total change of each alternative is summarized by looking at the change on each type of ESS. Further detailing on the analysis and the results of the analysis is given in Appendix F.

Social impact analysis (SIA)

The City of Göteborg offers different tools that can be used in urban planning and design, and one of the aspects lifted forward in urban planning and design is social sustainability. Two tools have been

developed for the City of Gothenburg to aid in urban planning: a social impact analysis (SIA)[33] and a child impact analysis[34]. For the Fixfabriken site, the SIA tool was used in order to analyse the redevelopment alternatives from a social sustainability perspective that would include aspects of urban planning and design. In practice, this tool is used to map the current situation, the needs and to analyse the impacts of the suggested detailed plan. In the balance 4P project, we choose to use the tool to map the impacts of the alternative against the current situation (i.e. the reference alternative). The results of the analysis are presented in Appendix G.

Stakeholder workshop 2: presentation and discussion of results

The second stakeholder workshop was carried out on October 13th, 2014, at Chalmersska huset. The same stakeholders as for the first workshop were invited and in addition there was an expert invited who had long experience of remediation issues in connection to planning. The overall aim was to present the conceptual redevelopment strategies together with the results of the sustainability assessments described above, as well as to discuss the advantages and the difficulties in applying those methods.

As the redevelopment strategies were developed within the research project, the main interest in this workshop was on a conceptual level, not the detailed results of the different analyses. One of the reflections from the workshop was that qualitative and semi-quantitative methods are more relevant in this stage (development of detailed plan). Especially with regard to the CBA-part in the SCORE analysis, putting monetary valuations on items was of some regarded as risking giving to much weight to issues that are able to be monetized. On the other hand, the structured comparison of alternatives was seen as potentially very useful, as this was not a common way of analyzing different aspects.

6.3.5 Results

Data availability very low, all calculations in SCORE have a relatively high degree of uncertainty. Alternatives 1 and 3 equal from a plan point of view, but remediation strategy differs, assessment results very different. Hypothesis: that cheaper remediation allows for cheaper housing, and thus a larger mix of housing price levels – not necessarily true, depends on developer and if municipality demands a proportion cheaper housing. In Alts 3 and 5 costs for the remediation also affects the uncertainty of the SCORE results, especially for Alt 3. All remediation strategies must be acceptable from a risk point of view, but some options are not accepted in Sweden today. Alternative 5 assumes the highest degree of preserving old buildings and archaeological remains, but the exact location of remains are still uncertain.

[33] http://goteborg.se/wps/wcm/connect/8439c0bc-9996-44a8-88ca-cbf89a197b1a/OPA_R_sartryck_SKA_WUF.pdf?MOD=AJPERES, access date: 2014-11-19

[34] http://goteborg.se/wps/wcm/connect/171d705a-cfa7-48fe-b788-c0b18eac593e/OPA_R_BKAenglish.pdf?MOD=AJPERES, access date: 2014-11-29

Table 6.17. Ranking of alternatives according to the different sustainability analyses.

Alternative	Rank according to SCORE	Rank according to mapping of ESS	Rank according to SIA
Alternative 1	4		4
Alternative 2	3		3
Alternative 3	1		2
Alternative 4	5		5
Alternative 5	2		1

Overlapping between SIA and SCORE. Overlapping between SCORE and ESS.

6.3.6 Discussion

- The focus of Balance 4P is relevant (!) - procedures differs greatly
- Challenge of bringing in detailed analyses into early phases: communication and use of results, data availability
- Qualitative (or semi-quantitative) analyses seems very applicable in early stages
- Complex systems, all aspects cannot be covered in one type of analysis
- Direct communication more efficient than documents, but expert knowledge must be delivered in the right form at the right moment.

Other reflections

- Challenge to transfer achieved knowledge from one phase to the following when the regulatory systems (and actors) changes

SCORE was perceived as too detailed, too complicated, if to be used, necessary to improve communication to stakeholders. Advantage to show that the same plan can have very different effects due to how the remediation is carried out – important to open up for possibilities in early phase. Remediation strategy is not regulated in plan.

SIA used in this way was effective. Potentially a way to explore the connection between subsurface issues to surface social impacts.

Potential damages on surrounding buildings due to soil settlements were not considered in CBA.

6.3.7 Advice for Fixfabriken case

The advices that can be offered to the Fixfabriken area are summarized below.

From the SEES workshop:

- Investigate the archaeological remains prior to deciding on the plan to map how valuable the remains are and if there will be a conflict with remediation and construction.

- Consider groundwater levels and infiltration of water. A hydrogeological investigation of the site is recommended. Permeable sidewalks etc to allow for locally infiltrating precipitation can be important elements in the urban design.
- The contamination situation should be mapped, preferably prior to decision on plan, to potentially locate residential areas in parts less contaminated.

From the sustainability assessments:

- Minimise excavation and transports from the site and explore alternative remediation strategies together with controlling authorities to gain acceptance.
- ESS:
- Identifying models for mixing cheaper housing with more expensive will have positive social effects.
- Explore possibilities to preserve the Fixfabriken factory.

7 Discussion and concluding remarks

Obvious from this report is that there is a multitude of instruments to guide sustainable development both in urban planning as well as in remediation projects. The tools have been developed in different regulatory contexts and with different concepts/ideas of sustainability and for different tasks in the phases of redevelopment. The tools can focus on one or multiple aspects of sustainability. They can be focused on different phases of redevelopment: eg to support the planning and design (eg SEES) or assessment of scenarios (eg SCORE). Because of the multitude of angles and purposes of tools, it is difficult to rank them: this would be comparing apples and oranges. For application of the tool the following boundary conditions are necessary. The user needs to:

- be allowed to (managerial approval, eg for the time to spent)
- be able to (necessary resources: data, information, knowledge, stakeholders, organisational power)
- want to (to add something extra / special to a project, the right questions need to be asked and the people need to be enthusiastic about it)

Always, when using tools one needs to look carefully at the objective of the tool and asses if the application has multiple value for the task to perform.

From an urban planning perspective, remediation is just one subsurface aspect which needs to be considered along with others and along with other considerations not connected to the subsurface at all. Typically, focus is on the end-result and not on the pathway leading there. From a remediation perspective, sustainability is not only associated with remediation technology but also with the foreseen land-use (remediation targets) and the time frame available for remediation. Smarter planning considering remediation aspects in early phases is believed to lead to more sustainable redevelopment. However, smarter planning in early phases should also include broader subsurface aspects than soil contamination. Archaeology and civil constructions, geotechnical issues and (ground)water are as important to consider in early phases of planning to reach sustainable redevelopments. It is clear from the three case studies that the soil contamination issue has different importance at the different sites. In an urban setting, where land values normally are high (so-called A-sites), the soil contamination issue becomes one of many pieces in the jigsaw puzzle of urban planning. In a setting where value is harder to generate by a redevelopment (B- and C-sites), soil contamination can be a stagnating factor and public intervention is needed to start redevelopment.

The Balance 4P project aims to integrate perspectives on brownfield redevelopment, urban design and planning, and remediation by engaging in an interdisciplinary project. We show that the sustainable remediation perspective can bring some important instruments into the planning and design sector, and vice versa: the planning and design sector brings with it the complexity of urban planning to include in the redevelopment process. To reach sustainable redevelopment strategies, the triple bottom line (PPP) should be in focus, but the uniqueness of the project itself (the project-specific conditions) and the process (WHO and HOW) becomes important additions. Reaching the holistic approach, where the subsurface is explicitly accounted for in law & regulation, policy & vision, knowledge exchange and design/construct calls for changes on all levels in the planning system.

In Balance 4P, we suggest instruments to improve knowledge exchange related to the outlined decision process framework, as a way of guiding project teams who aim to engage in enhancing the subsurface in the planning process of brownfield redevelopment. Focus is on early phases, because here the highest gain can be realized when the different disciplines can still take each other along in their envisaged plans. These benefits will be collected when making plans: unpleasant surprises are prevented and opportunities are identified in an early stage. But the better planning will also influence the realisation and maintenance phase of redevelopments, for exactly the same reasons. There may also be a true challenge in transferring the knowledge and experience from one phase to the next when the regulations, laws and actors are different. Including the subsurface in early phases should aim at open up for sustainable solutions in the later phases, and not create plans that limit sustainable solutions in later phases.

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Appendices

Appendix A. Comparison of planning system using COMMIN

Table A.1. Comparison of the spatial planning systems in the Netherlands, Sweden and Flanders.

			NETHERLANDS	SWEDEN	FLANDERS
			Spatial Planning	Spatial Planning	Spatial Planning
CONSTITUTIONAL	1 Planning legislation	Which types of by-laws exist outside the central legislative council(s) of the state and by whom are they adopted?	Municipalities have the right to enhance the national building law with local regulations (gemeenteverordening)	As laws, by-laws can only be decided by the parliament in the field of planning.	Land and building Decree(to regulate social housing); rDecree for renewal (to prevent empty stock); Housing Act
	2 State-municipal division	Which constitutional principle(s) regulating state-municipal relations exist and what is it called?	Planning Act (Wet Ruimtelijke Ordening)	State-municipal relations are regulated by municipal self-government.	Before 1970s, the Belgian Federal Government was the planning authority; this are now the regional governments. Brussels, Flanders and Walloon
	3 what are main responsibilities of:	state	Main responsabilities of the state are: legilative; Structure vision infrastructure & space	Main responsibilities of the state: national interests, sectoral planning.	Flanders planning system operates on a subsidiarity principle. Competences are regulated in 1996 Spatial Planning Decree
		regional and	Main responsabilities of the Provinces are: regional vision (Streekplan); check land-use plans against Streekplan; management of infrastructure; assist municipalities. Grant permits considering the middle deep layers. Water Boards are there for organising and maintaing the water system.	Main responsibilities of regional authorities (the County Administration Board): Guiding and scrutinizing Municipal comprehensive plans concerning national interests and adressing appeals for detailed plans.	Provincial plans are checked by the regional department; Provinces checks the municipal plans.
		municipal planning agencies	Municipal planning departments make development plans and land-use plans (bestemmingsplan; issue local ordinances and grant building	Main responsibilities of the municipal planning agencies: Comprehensive planning, legally binding detailed planning.	Main responsibilities of the municipal planning agencies is making Spatial Structure Plans and Implementations plans.

			permission. also involved by subsurface user functions related to land use planning (bestemmingsplan)		
	4 Access to public authority matters	The people's right to be informed and their right to give their voice: Are they defined as constitutional rights and what is the name for that principle?	Yes, Wet Openbaarheid Bestuur New plans need to be published online.	Yes. The constitutional rights are the Principle of free access to official documents (offentlighetsprincipen) and the Principle of citizens participation in planning.	Yes, Flanders has a Decree Publicity of Governance. Plans need to be published.
	5 Property rights	Does the constitution protect property rights against public intervention and what is the constitutional principle in case of public taking?	Yes, the constitution protects property rights against public intervention. In case of public taking the principle of expropriation for public needs against compensation is applied.	Yes, the constitution protects property rights against public intervention. In case of public taking the principle of expropriation for public needs against compensation is applied.	Yes, the constitution protects property rights against public intervention. In case of public taking the principle of expropriation for public needs against compensation is applied.
	6 Public rights to the use of land	Is there a general access to land and water and is there a specific right for it?	general access to land and water is not regulated. so-called 'recht van overpad' is private and historically present or not in contracts	According to "everyman's right" (allemansrätt) everyone has the right to cross and stay temporarily on another's land and water areas provided his behaviour is not disruptive and he does not cause any damage. The right is guaranteed in the Constitution (Chapter 2, article 18, [Sveriges grundlagar]). It is allowed to pick mushrooms, wild berries, pinecones, wild flowers and suchlike on another person's land (regulated in Chapter 12, Section 2, Penal Code [brottsbalk 1962:700]).	The freedom to roam, or everyman's right is the general public's right to access certain public or privately owned land for recreation and exercise. The right is sometimes called the right of public access to the wilderness or the right to roam.

	8 Groups to be prioritized in planning	Is planning meant to give favour to particular groups of the population and if so, which groups are favoured?	Planning is meant to balance acces to urban resources for all citizens	Planning is not meant to give favour to particular groups of the population.	Planning is meant to balance acces to urban resources for all citizens
NATIONAL	1 Planning organization	A) Are the legal responsibilities for planning and management at national level within one ministry?	legal responsibilities for planning and management at national level lie with the Ministry of Infrastructure and Environment (housing = Min. Internal Affairs). and Minsitry of Economic Affairs	No, different ministries have different legal responsibilities for planning and management at national level. E.g. the Swedish National Board of Housing, Building and Planning [Boverket] is a central government authority administered by the Ministry of Health and Social Affairs responsible for planning legestation. The Environmental Protection Agency [Naturvårdsverket], the Ministry of the Environment, responsible for legislation with regard to natural resource management in planning projects.	legal responsibilities for planning and management at national level lie with the Ministry of the Environment, Nature and Energy
		B) What is the name of the planning law at national level?	Wet Ruimtelijke Ordening (Territorial Planning Act). Soon Environmental Act	The name of the law at national level is Planning and Building Act.	The name of the law at Flanders level is Planning Decree
	2 Laws of particular importance in planning	Which laws have a particular importance in planning at national level?	A number of Laws have impact on planning such as: Environmental Code, Noise pollution Act; Roads & dangerous transport Act, Railway Act (etc), Mining Law, WBB?	Laws having a particular importance in planning at national level are: Environmental Code, Roads Act, Railways Act.	Structural plans give guidelines. Decreeing power lies in implementation plans

	3 Regulations and instruments in central government policies and planning	A) Which policy guidelines exist in central government policies and planning?	The National Territorial Structure Vison (SVIR) is informed by international competitiveness, flood protection and	The central government policy that governs a planning process includes environmental quality objectives summarized e.g. in The Swedish environmental objectives system 2013 (http://www.miljomal.se/Global/24_las_mer/broschyrer/the-swedish-environmental-objectives-system-M201301.pdf).	SVIR 2012: Productive landscape; long term uncertainty & governance; welfare & wellbeing
		B) Which legally binding regulations exist in central government policies and planning?	A legally binding regulation in central government policies and planning is the Territorial Planning Act.	A legally binding regulation in central government policies and planning is the Planning and Building Act and Environmental Code.	A legally binding regulation in central government policies and planning is the Planning Decree and a number of ordinances.
	4 EU regulations	Which EU regulations are adopted/ applied?	Natura 2000, Soil Protection Act; Malta Treaty, Water Framwork Directive, Environmental Impact Assesment	Natura 2000, Water Framework Directive, Waste Directive, Environmental Impact Assessment	Natura 2000, Soil Protection Act; Malta Treaty, Water Framwork Directive, Environmental Impact Assesment
	5 Subsoil management	Which instruments / regulations considering soil management are applied?	There is a Nation Structure Vision Subsoil (STRONG) in preparation; soil convenant and SV shalegas (both in preparation), Basis registration subsoil (EU INSPIRE) National rspronsibility is >500m mostly considering oil and gas winning. For Cables and Pipes there is KLIK info-system and also archaeology is steered on national level.	Legislation related to the subsurface can be divided into four groups: (i) “soil and groundwater quality” regulated by the Environmental Code; (ii) “archeology” regulated by the Heritage Conservation Act (kulturmiljölagen) of 1988; (iii) “use of natural resources” regulated by the Water Act (vettenlag) of 1983, the Mineral Act (minerallagen) of 1991, the Peat Deposits Act (lagen om vissa torvfyndigheter) of 1985, and the	

				Continental Shelf Act (lagen om kontinentalsockeln) of 1966; and (iv) “underground installations” regulated by The Pipelines Act (rörlrdningslagen) of 1978, the Water and Sewerage Act (lagen om allmänna vatten- och avlopsanlägningar) of 1970, the Public Heating System Act (lagen om allmänna värmesystem) of 1981, the Electrical Installations Act (ellagen) of 1985, and the Telecommunication Ordinance (teleförordningen) of 1985.	
	6 Nature conservation and cultural heritage	Which nature conservation instruments, and which instruments relating to cultural heritage are applied?	Nature conservation instruments applied are: Flora & Fauna Act Heritage is protected by Monuments Act.	Nature conservation instruments being applied are: Environmental Code and Nature conservation Act (naturvårdslag 1964:822). An instrument being applied relating to cultural heritage is Heritage Conservation Act.	Nature, Forrest, Bird, Protecten Flora & Fauna and Habitat Decrees; Protection of Monuments and Town and City Scapes (1976), Decree Protection of Landscape (2010) and Decree Protection of Archaeology (1993)
	7 Integration of sectoral aspects	A) Are there certain bodies/ instruments for integration of sectoral aspects?	Structuurvisies, Streekplannen & bestemmingsplannen integrate sectoral aspects	Legally binding land and water use restrictions through special area regulations (områdesbestämmelser) in comprehensive plans, e.g. recreational amenities, communication routes, restricted areas and safety zones.	The Spatial Structure Plans are the integration of sectoral aspects.

		B) Which formal duty for integration of sectoral aspects exists?	Every province has a planning commission for the coördination of provincial spatial policies	The County administrative board has the formal duty for integration of sectoral aspects.	
	8 Environmental Protection	Is there an independent Environmental Impact Assesment Committee	yes, it requires structure plans and zoning plans to consider all relevant data of environmental assesment in order to make a sound decision, advice is not binding but in case of a law suit it's advice is ussually adopted by the court	no, EIA is done on the municipal level only for (not legally binding) comprehensive plans in consultation with the County Administration Board and sometimes neighbouring municipalities. EIA for the legally binding detailed plans is performed only if the municipality judges (behovsbedömning) that the proposed development may cause "substantial environmental impact" (betydande miljöpåverkan).	The project needs to hire an certified EIA expert to lead the team of experts that make the report. This certification is to ensure quality of the report and takes a procedure leaded by th Environmental Licences department and supported by different other departments. The report is assesed by the Department of EIA.
REGIONAL	1 Territorial organization	1) Are decentralized state agencies, regional and municipal entities acting authorities in planning?	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning.	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning. However, the municipality has a planning monopoly. Regional bodies only consult to ensure national and public interests in a planning process.	Yes, decentralized state agencies, regional and municipal entities are acting authorities in planning.

		B) What is the territorial unit of the regional level, what is the decentralized state authority and what is the regional planning authority?	The territorial unit at regional level is the Province, for regional planning and inter-municipal coordination. The decentralized state authority is the Province administrative board. The regional planning authority is the Regional planning body.	Regional planning is only undertaken for the Stockholm and the Gothenburg regions. The Stockholm County Council (Stockholms län landsting) and the Gothenburg Regional Association of Local Authorities (Göteborgsregionens komunalförbund) are governmental bodies responsible for regional planning in the respective region. Regional plan is adopted only for the Stockholm County. In the Gothenburg Region, regional planning is carried out without formal regional plans. In orther cases the County Administration Boards are regional bodies which does not have planning competence but consult and coordinate the municipalities in the planning process to secure national and public interests in the plans.	The territorial unit at regional level is the Province, for regional planning and inter-municipal coordination. The decentralized state authority is the Province administrative board. There are also Arrondissements.
	2 Forms of planning at regional levels (planning process)	Which forms of planning/ planning processes exist at regional level?	superimposed or self-organized regional (planning) associations	The forms of planning/ planning processes at regional level are regional development programming, regional planning for Stockholm and Gothenburg regions.	The Provences and Arrondissements are part of the three step planning system of Flanders, regional and municipal scale.
	3 Statutory categories of plans (planning products)	Which statutory categories of plans/ planning products exist at regional level?	Statutory categories of plans ar regional level are development program and structure vision by the Provencies, the	The regional development programme and the regional plan (voluntary) are plans/ planning products at regional level.	The Provincial Development Agency makes a Spatial Structure Plan. This is translated to a Spatial Implementation Plan.

			water Boards make Water Plans		
	4 Body mandated for initiating and approval of plans	Which body is mandated for the initiation and the approval of plans at regional level?	The Provincial council are mandated for the initiation and approval of regional development programmes	The County Administrative Boards and the Regional Council are mandated for the initiation and approval of regional development programmes; the National government and the regional planning body are mandated for the initiation and approval of regional plans.	The Flanders government.
	5 Binding force of regional plan	A) Is the regional plan binding on subordinate planning?	Yes, municipalities must check building applications to provincial stuctural plans. The water boards do the water assesment of plans.	No, the regional plan is not binding on subordinate planning.	Yes, municipalities much check building applications to structure and implementation plans
	6 subsoil management		A numer of provinces made a Soil Vision that is aiming at integrating the subsoil in planning. Methods to integrate subsoil in spatial planning like the Soil Ladder Provinces and water boards are responsible for watermanagement, the province for layer inbetween (aquifers) in relation to extraction permits, they also deal with contamination. The water boards maintain the regional water system, dikes, pumps and open water. The Province is also framing archaeology.	The concession from the Government is needed for extraction of minerals, The permits for mineral extraction are granted on the national level. The archeological and soil remediation procedures are coordinated on the regional level by the County Administration Boards. The County Administration Boards also oversee hazardous activities, such as energy facilities, quarries and mines.E46	Waterboards and *wateringen* for water management. For contaminated soil there are Brownfield decrees and convernants.

LOCAL	1 Territorial organization	a) Which local territorial unit(s) exist(s)?	rural *buitengebied,* village *dorpskern,* town *stad, area* wijk	The territorial unit at municipal/ local level is the Municipality.	Municipality
		b) Is the local planning authority also the local building authority?	Planning and Building are 2 departments of the same authority	No, by law, the local planning authority is not the local building authority.	*Planning and Building are 2 departments of the same authority?*
	2 Local planning authority bodies	A) Which are the local committees and/ or the local supreme authority for initialization and adoption/ endorsement of plans?	The local committee for initialization and adoption/ endorsement of plans is the Standing committee for planning matters (various names, depends on the municipality) and the local supreme authority for initialization and adoption of plans is the Municipal council.	The local committee for initialization and adoption/ endorsement of plans is the Standing committee for planning matters (various names, Specific name depends on the organisation of the municipality) and the local supreme authority for initialization and adoption of plans is the Municipal council.	*The local committee for initialization and adoption/ endorsement of plans is the Standing committee for planning matters (various names, depends on the municipality) and the local supreme authority for initialization and adoption of plans is the Municipal council.?*
		B) Do legally notified instruments exist to cooperate between municipalities and which are the instruments?	Legally regional collaboration may be superimposed by national government, sometimes it is a voluntary initiative of municipalities (non legally notified)	Yes, there is a legally notified instrument to cooperate between municipalities: the Regional Plan (used only for Stockholm region). Otherwise, despite the planning monopoly of municipalities, the State has right to interfere in municipal planning in order to protect structures of national interests, national resources and inter-municipal issues.	Yes, on the provincial lever the Structure Vision and the Implementation Plan are putting links between smaller units.
	3 Forms of planning	A) Which forms of planning for the territorial unit exist at local level?	Vison for municpal level, Masterplan for distict level (both no binding status) and then on the lowest level the Land use plans (bestemmingsplan) are the legal	The form of planning for the territorial unit at local level is the Municipal comprehensive plan.	Spatial Implementation Plans are the legal instrument for planning at local level

			instrument for planning at local level. These are under development towards and Environmental Plan		
		B) Are there plans for various levels and how are they called?	City Vision, Master Plan, Urban Design Plan (Zoning Plan), Public Space Plan	Yes, there are plans for various levels: Municipal comprehensive plan, detailed municipal comprehensive plan, detailed development plan.	Yes, there are plans on two levels the Municpal Structure Plan and the Municipal Implementation Plan
	4 Regulation instruments of local plans	*A) Are land use zoning categories required in local plans?*	*Yes, land use zoning categories are required in 'bestemmingsplan'*	*Yes, land use zoning categories are required in local plans.*	Yes, land use zoning categories are required in Municipal Structure and Impementation Plan
		B) Which formulations are applied for giving future directions in local plans?	Master plans contain guidelines; Zoning plans provide legally binding regulations concerning land-use and building envelope.	Comprehensive plans contain guidelines; detailed development plans provide legally binding regulations concerning building and land-use.	Structure Plans (sometimes called Master Plans) contain guidelines; Implementation Plans provide legally binding regulations concerning land-use and building envelope but also maintenance.
	5 Overall local plan	A) What is the name of the overall local plan(s), and is it legally binding?	The overall local plan is usually the Municipal Development Vision. It is not legally binding	The overall local plan is the Municipal comprehensive plan. It is not legally binding.	The overall local plan is the Municipal Structure Plan. It is legally binding
		B) What are the main components of the overall local plan(s)?	The main components of the overall local plan are diagnoses, vision, maps and indicative timetable	The main components of the overall local plan are a plan map and an explanatory report.	The main components of the RUP are diagnoses (situation physical, jurisdictional, spatial option), urban guidelines in maps, drawings and texts.
		C) Which statutory zoning and land use categories are shown on the plan map?	Identification of districts and their future development, thematic in housing area or centre district.	The following should be clear from the plan: the intended use of land and water areas, how the built environment should be developed and be preserved and how the municipality intends to provide for areas of national	The following should be clear from the plan: the vision of and intended use of land in the area,

				interest and environmental quality standards.	
		D) Is the time horizon of the overall plan(s) positively limited and for how long?	It differs per city but it usually is about 30-50 years.	There are no horizon limits of the overall local plan but the plan shall be revised at least every 5-6th year.	There are no horizon limits.
	6 detailed plans	A) Is there a free right to initiate a detailed development plan, what categories of these plan(s) exist and are they legally binding?	Yes, there is a free right to initiate a detailed development plan, the municipality need to check the plan before implementation against formal existing plans & regulations	Yes, there is a free right to initiate a detailed development plan but the municipality can without appeals refuse the initiative (Municipal Planning monopoly). The category of plan is Detailed development plan. It is legally binding.	The municipality makes the Municipal Spatial Implementation Plans.
		B) Are time limits set for the public handling of detailed development plans and is the time horizon/ validity of these plan(s) positively limited?	Zoning Plan needs to be updated within max 10 years	There are no time limits set for the public handling of detailed development plans. The time horizon of the plan is positively limited: the protection of not used development rights is limited to 5 - 15 years.	There is no time limit.
		C) Which statutory land use zoning categories exist in detailed development plans?	Type of plan, type of usage (housing, water, traffic, garden, sports, recreation, nature, societal, trade, green, mixed, service, industry, trade, culture, centre, forrest, agriculture and office), double zoning, type of hindrance contour, type of plan, type of juristicial level.	Main categories in the detailed plan are blocks for building purposes, streets, parks and special areas (railways, waste managemant). Blocks then can be given different uses as residential, industry, commerce and so on.	Boarder, Usage: housing four types), centre (two types), shops, leisure, industry, green, public space, trade and right of sale.

	7 Development control	A) Which statutory density measures are implemented in addition to land use zoning categories?	In addition to land use zoning categories different means are used to regulate building within blocks, height of structures, number of storeys, floor space etc.	In addition to land use zoning categories different means are used to regulate building within blocks, height of structures, number of storeys, floor space etc.	In addition to land use zoning categories different means are used to regulate building within blocks, height of structures, number of storeys, floor space etc.
		B) What are the statutory categories of building permit matters?	Statutory categories of building permit matters are: Building permit, Demolition permit, *woonruimteontrekking* permit.	Statutory categories of building permit matters are: Building permit, Demolition permit, Site improvement permit.	
		C) What are the categories of permits for projects requiring building application and are there time limits for the permit`s validity?	Buildingactivities may require a 'light' of 'full' building permit and need to start within a year.	There is a time limit for the permit´s validity for projects requiring building application (2 years).	
		D) what relation has the Zoning plan to the building permits?	The zoning plan is checked to see if the building application is meeting the requirements in that zone. There is a very strong connection.	There is a very strong connection between building permits and the leaglly binding detailed plan. The latter is checked to see if the building application meets the requirements in the detailed plan.	

	8 subsoil management		Through the Zoning Plan some categories of the subsoil are touched on a munipal level. But next to water, remediation, archaeology and cables and pipes there is no active management or vision. Some municipalities are working on a Master Plan for the subsoil.	Only archeological procedures integrated into a detailed planning process (early stage). The soil remediation procedures are usually carried out in the late stage of detailed planning or after approval of the detailed plan. Contaminated soil related issues are handled on both municipal and regional levels, but since the division of responsibilities is not clear in the legislation the Swedish Environmental Protection Agency is currently inquiring into this issue. There are special regulations in the detailed plan defining land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter).	
PARTICIPATION	1 The entitlement to inform and the right to get access to information (answers sorted by levels)	Are there statutory requirements for informing the public and public access to information?	Zoning Plans need to be available online	Yes, at regional level, the statutory requirement for public access to information is firstly the constitution principle of free access to official documents (offentlighetsprincipen), secondly the rules for regional planning in the Planning and building Act.	All RUP's are availeble online.

	2 Particular participatory instruments beyond information in the planning process	Are there statutory instruments for public participation during the preparation of plans like number of hearings, meetings, etc.?	Yes, plans need to be made public and a period of time that citizens can appeal to the plans.	At regional level, there are no statutory instruments for public participation during the preparation of regional development programmes but regional plans require public reviews, public exhibition and comments on public opinions.	
	3 The public opportunity to challenge the plan after the plan is formally adopted	Is there an option for an appeal in order to challenge the plan after it is formally adopted?	No	At regional level, nobody can appeal in order to challenge the comprehensive plan after it is formally adopted, because it is not legally binding. But the residents can express dissatisfaction with the planning process initiating the local appeal procedure (kommunalbesvär) under the Local Government Act (kommunallag) of 1991. The content of the adopted legally binding detailed plan can be contested by appeal to the County Administrative Board, whose decisions in turn can be contested to the Land and Environmental Higher Court (Mark- och miljööverdomstolen), and ultimately to the Supreme Court (Högsta domstolen).	

BUILDING PRACTICE	1. Who initiates urban development?	Municipalities used to get a assignement for building a certain amount of houses in their region form the national state. Provences support these numers in their structure plan, municipalities would inititate the developement. Today development takes formost place in existing urban tissue, the initiative is with the project developer, housing cooperation or self organized citizens.	There are several models of the development process depending on the ownership conditions within the development area and the role of the developer in the process. Initiative may come from the municipality because of need for housing, non-residential development or the enlagement and improvement of infrastructure provision. The initiative in changing the land use may also be taken by owners of a prospective development area.	
	2. what type of process is used?	There is an initiation phase that looks into the feasability and formulates a vision, then there will be a masterplan, a urban design plan and design for public space.	The process consists of vision formulation and detailed planning of the development area. When developer owns land, he playes an active role in a planning process. Municipality and developer may agree that land for streets and green areas is to be conveyed to municipality and that developer reserves space for services and communal facilities.	
	3. what role does the government play?	The government changes from initiator and producer to facilitator. They bring parties together and set out tenders for cooperations to propose a development.	The Government through its representative at the regional level (County Administration Board) ensures protection of structures of national interests, national resources and inter-municipal issues in the planning process. Planning of high-, rail-, tram- and	

			subways is in responsibility of Government under the Road Act (väglagen) of 1971 and the Railway Act (järnvägslagen) of 2004.	
	4. How is knowledge integrated in the plan and design process?	Technical support always came from the municipality. In the new organic development it is unclear what the role of the municipality is in supporting knoledge integration.	Technical support comes from responsible divisions at the County Administration Boards and the municipality, as well as consulting agencies.	
	5. how is subsoil inserted in the development process?	There is now no common practice concerning introducing subsoil into the developent, this works through experts who enter late in the process.	Archeological procedures integrated into a planning process. Planning of subsurface electrical installations and municipal facilities (pipelines) are integrated into the planning process. The soil remediation procedures are usually carried out in the late stage of detailed planning or after approval of the detailed plan.	

Table A.2. Expanded COMMIN system – the Netherlands.

	institutions	**laws**	**policy/instruments**	**regulation**
EU	Board of European Ministers of Spatial Planning	Waste Directives Natura 2000	European Spatial Planning Charter (1983); European Spatial Development Perspective (2003) INSPIRE Directive (2007): information gathering	EU Guidelines energy performance for buildings (EPBD)
National	Ministry of Infrastructure and Environment (Institute for Social Research, Environmental Assesment Agency) Ministery of Internal Affairs	Spatial Planning Act (2008) > Environmental Act Nature Protection Act	Structure Vision Infrastructure and environment 2040 (2012); Ministerial guidelines (no law) for gas and inflamable liquid	

	Environmental Impact Assesment Commission Ministry of Education, Culture and Science (Cultural Heritage Agency) Forestry (staatsbosbeheer)	Noise Polution Act Transport Dangerous Substances Act Building Act (2012) Environmental Protection Management Act Public Health Act Monuments and Historic Buildings Act	transport: distance around networks. External Safety ordonance: obligation to register risk with dangerous material. National Waste Magement Plan (LAP) National Environment and Health Plan 2008-2012 Noise and Fine dust zoning	 Building Codes Environmental Impact Assesment (for structure and zoning plans)
Regional	Regions Provences		Regional Plan Structure Plan Area Profiles Spatial Qualities Provincial Environmental Ordonnance	
Local	VNG Municipalites		 Vision, Master Plan Architectural Quality Assesment	Model Ordonannces (modelverordeningen) Zoning Plan Building Permits
Water	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Water Framework Directive Urban Wastewater Directive Ground Water Directive		
National	Ministry of Infrastructure and Environment (Deltares) National Water State Department	Water Act Environmental Management Act	National Water Plan Safety Qualification Primary Defence (veiligheids kwalificatie keringen)	
Regional	Provence Water Authority	Water Level Decree	Regional Water Plan Water Plan waterschapslegger	Province regulates infiltration and extraction of water (new Waterwet/Water Act in preparation) Water Assesment Test

Local	Municpality		Water Plan local waste-water plan	
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Directive on Waste Directive on Landfill of Waste	European Soil Strategy	
National	Ministry of Economic Affairs Ministry of Infrastructure and the Environment (TNO)	Mines Act Soil Protection Act (1987) Excavation Act Evironmental Management Act Nature Protection Act	STRONG (National Spatial Planning Strategy for the subsurface) (expected 2015) Information System Soil Soil Polici Letter (2003) Soil Convent	
Regional	Provences		Soil Vision/Soil Ladder	soil remediation
Local				soil remediation
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	
National	Ministry of Economic Affairs (Municipal Platform of Cables and Pipes, Cultural Heritage Agency, Centre of Underground Building) Ministry of Education, Culture and Science (Cultural Heritage Agency)	Information Exchange on Underground Infrastructure Act (WION) Excavation Act Archaeological Heritage Management Act Monuments and Historic Buildings Act	KLIC External Safety ordonance: obligation to register risk with dangerous material.	
Regional	Provences		Structure scheme pipelines (SBUI): national main network for provinces to incorporate in structure plans. Provincial Research Agenda Archaeoly Policy Culturel Heritage; Programme	

			Heritage	
Local	Municipality	Environmental Management Act		sewer regulations Local regulations considering cables and pipes in general.
Energy	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National	Ministry of Economic Affairs, Ministry of Infrastructure and the Environment and Ministry of Social Affairs and Employment	Nuclear Energy Law: regulates ministerial competences for storage of radio-active waste; Strategy on Shale Gas (expected 2015)	SER energy agreement (2013)	Energy Prestation Certificate
Regional	Provinces		IPO agreement geothermal	license issued under the General Provisions Environmental Law (Wabo) (open systems) reporting closed bottom energy ATES (recorded in amending soil energ , no separate Amvb)
Local				

Table A.3. Expanded COMMIN system – Sweden.

	institutions	**laws**	**policy/instruments**	**regulation**
EU	Board of European Ministers of Spatial Planning	Waste Directives Natura 2000	European Spatial Planning Charter (1983); European Spatial Development Perspective (2003) INSPIRE Directive (2007): information gathering	EU Guidelines energy performance for buildings (EPBD)
National	Ministry of Health and Social Affairs (National Board of Housing, Building and Planning [*Boverket*], Swedish Environmental Protection Agency, National Board of Health [*Socialstyrelsen*])	*riksintresse has 13 laws*		

		Planning and Building Act (*Plan- och Bygglagen - PBL (2010:900*)		Planning and Building Ordinace (plan- och byggförordningen 2011:338) Houskeeping Ordinance [Hushållningsförordningen 1998:896]
		Environmental Code (Miljöbalken (1998:808)		Regulation on implementation of the Environmental Code (Lag om införande av miljöbalken 1998:811) Environmental Impact Assessment Ordinance (Förordningen om miljökonsekvensbeskrivningar 998:905)
	Ministry of Health and Social Affairs (National Property Board of Sweden [*Statensfastighetsverk*]) Ministry of Culture (Swedish National Heritage Board [*Riksantikvarieämbetet*])	Cultural Heritage Act (kulturminneslagen 1988:950)		
	Ministry of Health and Social Affairs (National Land Survey *Lantmäteriet*)	Property Subdivision Act (fastighetsbildninglagen 1970:988) Utility Easement Act (ledningsrättslagen 1973:1144) Joint Installation Act (anläggningslagen 1973:1149)		Registration of jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter) in Land Registration System (fastighetsregister)
	Ministry of Environment - Miljödepartamentet (*Swedish Environmental Protection Agency - Naturvårdsverket)*	Environmental Code (Miljöbalken 1998:808) Lag om införande av miljöbalken (SFS 1998:811) Förordningen om avgifter för prövning och tillsyn enligt miljöbalken (SFS 1998:940)		Förordningen om miljökonsekvensbeskrivningar (SFS 1998:905)
		Expropriation Act (expropriationslagen 1972:719) Pre-emption Act (förköpslagen 1967:868) Joint Land Development Act	These property rights-related laws serve as important instruments for plan implementation and land development	

	Ministry of Enterprise, Energy and Communications (Transport Administration [*Trafikverket*])	(lagen om exploateringssamverkan 1987:11) Road Act (väglagen1971:948) Railway Act (järnvägslagen 2004:526)		
Regional	County Counsil *(Landstinget)* is the link between national and municipality (County Administrative Board [Länsstyrelsen])		Environmental quality standards, shorelines and human health, safety, risks, flooding, erosion. Regional Plans (*Regionplan)* and Regional Development Strategies (*Regionala utvecklingsstrategier)*	
Local	Municipality (Urban Planning Departments *(Stadsbyggnadskontoret),* Urban Planning Committees *(Stadsbyggnadsnämnden)*		Municipal Comprehensive Plan (*Översiktsplan) and Parts of a Comprehensive Plan (*Fördjupad översiktsplan*)* building permit (bygglov) demolition permit (rivningslov) site improvement permit (marklov)	Detail Plan *(detaljplan)* Area Regulations (*Områdesbestämmelser)*
Water	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Water Framework Directive Urban Wastewater Directive Ground Water Directive		
National	Ministry of Health and Social Affairs (National Board of Housing, Building and Planning *(Boverket))* Ministry of Environment - Miljödepartamentet (Swedish Environmental Protection Agency - Naturvårdsverket)	Planning and Building Act (*Plan- och Bygglagen - PBL (2010:900*) Environmental Code (Miljöbalken (1998:808) Water Act Public Water and Waste Water Plant Act (lag om anmälla		

		vattentjänser) 2006		
Regional				
Local				Area Regulations (*Områdesbestämmelser)*
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Directive on Waste Directive on Landfill of Waste		
National	Ministry of Health and Social Affairs (*Swedish Environmental Protection Agency, Swedish Geotechnical Institute)* Ministry of Enterprise, Energy and Communications (Geotechnical Survey of Sweden)	Environmental Code (Miljöbalken 1998:808) Peat Deposits Act (lagen om vissa torvfyndigheter 1985) Mineral Act (minerallagen 1991) Continental Shelf Act (lagen om kontinentalsockeln 1966)		
Regional				
Local				*Special regulations in the Detail Plan (detaljplanebestämmelser), i.e. land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar), easements (servitut), utility easements (ledningsrätter)*
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	
National	Ministry of Culture (Swedish National Heritage Board [*Riksantikvarieämbetet*]) Ministry of Enterprise, Energy and Communications (Swedish Energy Agency [*Energimyndigheten*])	Heritage Conservation Act (kulturmiljölagen 1988) Electrical Installations Act (ellagen 1985) Public Heating System Act (lagen om allmänna värmesystem 1981) Pipelines Act (rörledningslagen1978)		Telecommunication Ordinance (teleförordningen 1985)

	Ministry of Health and Social Affairs (National Land Survey Lantmäteriet)	Water and Sewerage Act (lagen om allmänna vatten- och avlopsanläggningar 1970) Joint Installation Act (anläggninglagen 1973:1149) applies to facilities common to two or more properties e.g. parking C12 play C14 water and sewarege facilities constructed and maintained by property owners Utility Easements Act (ledningsrättslagen 1973:1144) applies to e.g. water and sewrege facilities constructed and managed by municipalities (legal bodies), telephone lines		Registration of jointly owned facilities (gemensamhetsanläggningar), easements (servitut), and utility easements (ledningsrätter) in Land Registration System (fastighetsregister) by National Land Survey (lantmäteriet)
Regional				
Local				
Energy	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National	Ministry of Enterprise, Energy and Communications (Swedish Energy Agency [*Energimyndigheten*]) Ministry of Health and Social Affairs (Lantmäteriet)	Municipal Energy Planning Act (lagen om kommunal energiplanering 1977:439) Utility Easements Act (ledningsrättslagen 1973:1144) applies to heating main, high- and low-voltage power lines		
Regional				
Local			Energy plan (energiplan)	Special regulations in the detailed plan, i.e. land reserves (markreservat) for jointly owned facilities (gemensamhetsanläggningar) and utility easements (ledningsrätter)

Table A.4. Expanded COMMIN system – Flanders.

	institutions	laws	policy/instruments	regulation
EU	Board of European Ministers of Spatial Planning	Waste Directives Natura 2000	European Spatial Planning Charter (1983); European Spatial Development Perspective (2003) INSPIRE Directive (2007): information gathering	EU Guidelines energy performance for buildings (EPBD)
National		Planning Act (1962)		
national/ Flanders	Flanders Department for the Environment, Nature and Energy (Department Space and Monuments) Flanders Department for the Environment, Nature and Energy (Flanders Environment Administration) Flanders Department of Mobility and Public Works		Regional Zoning Plan *(gewestplan);* gradually replaced by Spatial Structure Plans (RUP) Spatial Structure Plan Flanders SVIR 2012	Planning Planning Decree 1996 Decree Protection of Monuments and Town and City Scapes (1976) Decree Protection of Landscape (2010) Nature, Forrest, Bird, Protecten Flora & Fauna and Habitat Decrees EIA decree (Milieueffectenrapport) Spatial Safety Report (ruimtelijke veiligheidsrapport; RVR) Mobility Impact Assessment (mobiliteitseffectenrapport; MOBER)
Regional	Provences and Arrondissements (Provincial Development Agency)		Regional Spatial Structure Plan Provincial Spatial Structure Plan Strategic Plan Tourism and Recreation and Scheldeland	Regional Spatial Implementation Plan Provincial Spatial Implementation Plan
Local	Municipality	Local Government Act 1991	Municipal Spatial Structure Plan	Municipal Spatial Implementation Plans
Water	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		Water Framework Directive Urban Wastewater		

		Directive Ground Water Directive		
National	Flanders Environment Agency	Surface Water Act	Sigmaplan (flood protection)	
Regional	Provinces Water Boards			Decreet Integraal Waterbeleid
Local	*Watering*			Water Assesment Test
Subsoil	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Strategy & Soil directive: protection and remediation. Covering, pollution, erosion, loss organic material, saltification, densification, biodiversity, landslides); Directive on Waste Directive on Landfill of Waste	European Soil Strategy	
National	Ministry of Economic Affairs (Belgium Geological Department)	Mining of Minerals Act		
National /Flanders	Flanders Department for the Environment, Nature and Energy (Public Waste Compagny) Brownfield Cel		Subsoil Information System Brownfield Decree	Soil Protection and Contamination Decree (2006) > Brownfield decree Brownfield Covernant
Regional				
Local				
Civil constructions	**institutions**	**laws**	**policy/instruments**	**regulation**
EU			European Convention on the Protection of the Archaeological Heritage (1992)	
National /Flemish	Flanders Department for the Environment, Nature and Energy (Department Space and Monuments, Flemisch Insitute for Heritage) Platform of Cables and Pipes			Decree Protection of Archaeology (1993) KLIP information system cables-pipes
Regional				

Local				
Energy	**institutions**	**laws**	**policy/instruments**	**regulation**
EU		European Energy Strategy Plan (2013)	Energy Technologies and Innovtion (2013)	
National				Energy Prestation Certificate
Regional				
Local				

Appendix B – Example Inventory of stakeholders

Table B.1 shows an example of an inventory of stakeholders.

Table B.1. Example of stakeholder inventory (After: DPNH - Handreiking Ruimtelijke Adaptatie, Van de Ven 2014).

Party	**Specific**
municipality	College mayor and alderman
	public works
	sewerage / urban water
	roads
	spatial planning & design
	Landscape architecture
	maintenance public buildings
	maintenance public green
	police / fire fighters
	economics
	social affairs
	Engineering office
	other
water board	administration
Province (region)	counsil
	spatial planning
	road maintenance authority
	other...
national government	ministry of Infrastructure and environment
	other …
knowledge providers	service providers /advisors
	research institutes
waterworks	Winning
	Distribution
housing corporation	Name
network operator	Electricity
	Gas
	Telecom/internet
	Water (see also waterworks

Party	**specific**
real estate sector	shopping centres
	theatres / cinema
	hospital
	nursing home// home for the elderly
	amusement park
	zoo
	Other ...
green / garden companies	Name
Building companies	Name
Local industry	Type 1
	Type 2
	Other ...
Banks	Name
Insurance companies	Name
NGOs	Association
	interest group
	Other ...

Appendix C – Overview of instruments

The content in this appendix is derived from Kok, Sien (2014): A Guide Through the Forest of Sustainable Urban Redevelopment Instruments. Internship at Vrije Universiteit Amsterdam, The Netherlands.

The original aim of this study was to inform actors in the field of sustainable brownfield - and urban redevelopment on available methods and tools and provide directions to their use. To this end, an overview was made of 91 relevant instruments recently applied in Europe, and they are described in a short text and by using the following parameters: original aim, character, approach, tool/ method, project phase, target group, effort, costs, application history, launch date, international applicability, sustainability and incorporation of the subsurface. These parameters address some of the criteria important for users in applying these instruments: universality, simplicity, multidimensionality, transparency, adaptability/ flexibility, (legal) status and approach. Choosing the right instruments for a specific project and applying them in the right way is not a straightforward process, especially in a brownfield redevelopment: every brownfield has a different set of characteristics defining it (e.g. history, environmental circumstances, location in the urban system, economic potential) and there are often many different stakeholders and other aspects complicating the process. Ideally, instruments applied in the redevelopment process are chosen after the priorities and characteristics of the site are established and the problem is characterized carefully. Where (if at all) the focus in sustainability lies and which role the subsurface can play in the redevelopment project, depends on this assessment: several instruments are available addressing these topics. The need for adapting indicators, weighting and topics addressed in these instruments to local circumstances, is increasingly recognized in the field. Choosing the optimal instruments for a project becomes more difficult if there is lacking know-how and knowledge in an organization on available instruments: the overview in this study provides the potential user with ideas on available instruments.

Which type of instrument is applied, and which purposes they serve, differs over the project phases. In the Anticipating Change phase (pre-initiative), instruments are available to prepare organizations for change, predict future land use or assess climate risks. In the Initiative phase instruments are used to support communication (e.g. familiarize with the area and stakeholders and determine ambitions), the decision making process, and for gathering information. In the Design/ Planning phase instruments are used in developing and choosing project scenarios and optimizing the final design. In the Realization phase they are used in optimizing the construction process and communication of the projects' progress and in the Maintenance & Evaluation phase for evaluating the efficiency or sustainability of the project.

The role of the subsurface in the instruments assessed in this study ranges from very generic to quite specific. Especially in more recently developed instruments the subsurface gets more attention, often as part of a holistic approach. Several instruments are included in the overview that have the primary purpose of addressing the subsurface in spatial planning or urban (re)development: informing the spatial planner on important factors, familiarizing stakeholders or spatial planners with the possibilities and enabling them to create a collective vision and finding synergies between the subsurface and other project targets. Compared to other instruments, subsurface-related instruments have an even stronger need for adaption to local conditions: subsurface related factors are very site-specific (e.g. soil type, hydrological situation, contamination). It is recommended to address the subsurface early in the project by specifying a subsurface agenda for the area, including

local subsurface qualities, issues and urgency. Another advice for the early phases in the project (Initiative) is to include stakeholders as early as possible. This facilitates gathering local information and challenges, and enables engagement and goodwill under local stakeholders: not only during the process but afterwards as well. Instruments facilitating workshops and stakeholder sessions are available to support this. Participation can be improved by clearly defining and communicating - before application of the instrument- what will be done with the results, and making sure financial means and time to deal with them are reserved. When digital instruments are used in the project without complementing them with traditional, non-digital ones, it is good to note that they might decrease meaningful interaction between stakeholders and with the data; also they have an internal credibility which might not be justified. In general, it is best not to attach too much value to the outcome of one single instrument, especially when it concerns software tools calculating or assessing effects of a project or project scenario (remembering the old rule: the output is only as good as the input). A good understanding of the instrument before application and a clear definition of the desired outcome increases the result of applying a tool; especially when it concerns a workshop with various participants. In this case, an independent facilitator might be also advisable. Lastly, there is much development and change in the field of instruments and information available for brownfield and urban redevelopment. Therefore the set-up of a general, EU-wide database is recommended – as well as more local, national-scale databases of available instruments. This will enable users to find the best instruments for their projects and increase exchange of available knowledge.

Table C.1. List of instruments per category.

List of instruments per category **Category**	**Instruments**
Design development options	
General direction: possibilities and ambitions	Ambitieweb, Natuurlijke Alliantie, Matrix Ruimtelijke Kwaliteit, Prioritization tool, Land Use scanner, ABC Model
Communication & cooperation stakeholders/ Different disciplines	SEES, Ontwerpend Onderzoek, Meerwaardescan, Triple O, Ecodynamic Design, Schetsschuit, Ondergrond Stratego, Serious Game Ondergrond, Simlandscape
Supporting Software	Citymaker, Cityplanner, Gebiedsontwikkelaar, Autodesk software, MapTables
Process guide/ Concepts to attend	Cabernet Opportunity Matrix, Urban Renaissance
Temporary Destination	Tijdelijk Anders Bestemmen (TAB)
Assess Project options	
Effects	SAT, Cabernet Interaction Matrix, Matrix Decision Support Tool, UDEM, DEFINITE, Urban Strategy, Bodemtool, RICARDO
Cost-efficiency	GPR Onderhoud, STORM, Value Engineering, Geokalkyl
Sustainability	Megasite Management Toolsuite, GPR Stedenbouw, BREAAM-NL Gebiedsontwikkeling, Omgevingswijzer, DPL, Duurzaamheidsmeter, SCORE tool
Tools supporting aspect of process	

Energy	Quickscan gebiedskenmerken, WKO-tool, ThermoGIS, EPL, CO2 Prestatieladder, EPASch, Energieatlas, EPM
Soil	Bodemloket.nl, BRO, INSPIRE Geoportal, Risicotoolbox bodem
Water	Kansrijke Gebieden Gebiedsgericht Grondwaterbeheer, Watertoets, Functiefaciliteringskaarten
Spatial quality	Spacemate
Climate change adaption	Ruimtelijke klimaatscan, Adaptatiescan
Other	www.Cultureelerfgoed.nl, www.aardkunde.nl, Klic: www.infracad.nl, etc
Information: Guides, toolboxes, websites, databases	
Incorporate subsurface in spatial planning	www.bodemvizier.nl, soilpedia.nl, Routeplanner Bodemambities , Handreiking Ordening Ondergrond: Financieel-Juridisch afwegingskader, Gebruik van de ondergrond: Ingrediënten voor een afweging, Redeneerlijn voor de ondergrond, Zeven sleutels voor gebruik van de ondergrond , Ontwikkelingsmodel Ondergrond, Afwegingskader Ondergronds/Bovengronds: Kwaliteit van de Leefomgeving, Duurzaam Gebruik Ondergrond: Gereedschap Structuur en Visie, Afwegingen bij Gebruik Grondwater en Ondergrond, De Bodem: een Stevige Basis
Executing a sustainable (re)development	www.ruimtexmilieu.nl, Sustainable Urban Fringes, Duurzame Gebiedsontwikkeling: Doe de Tienkamp, Information System TIMBRE, Brownfield navigator, SMARTe, Aanpak duurzaam GWW, Stakeholder Engagement Toolkit, Self-Guiding Trail, www.werkpartners.net, www.handreikingdro.nl, Leidraad Brownfield Ontwikkeling PMV_BE, Optirisk: Recommendations for Action
Adaption to climate change	Klimaatwijzer
Brownfield regeneration case-studies & examples	Urban Regeneration Toolbox, COBRAMAN database

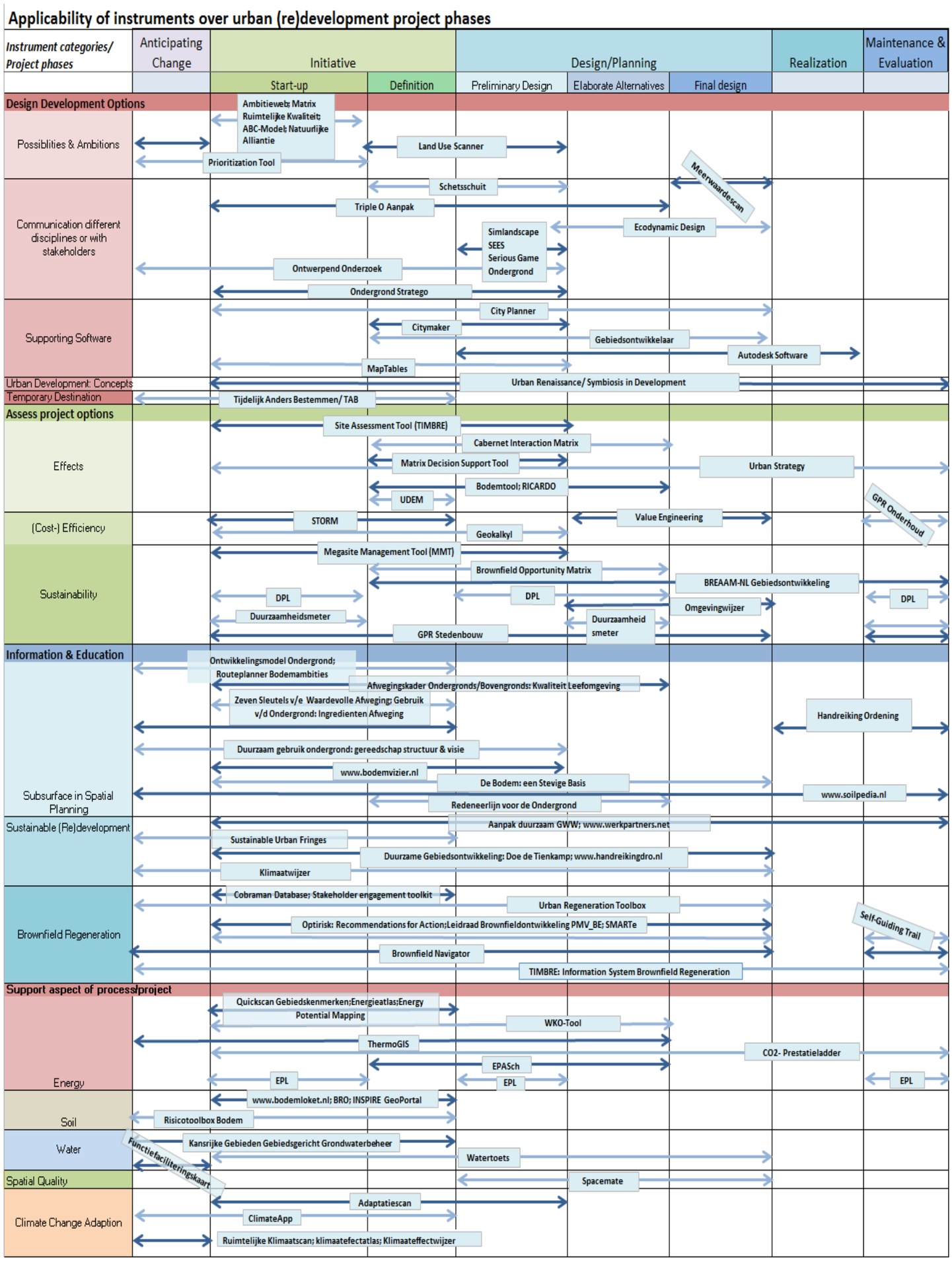


Figure C1. Overview of instruments along the project phases.

Appendix D – Rotterdam Merwevierhaven idea book

Appendix E – Fixfabriken: SCORE analysis

In this appendix, the results of the SCORE analysis are presented. For details, the reader is referred to Garcao (2015) where all methods, assumptions and uncertainties of the analysis are presented. The analysis is carried out on a Swedish case and Swedish crowns (SEK) was used as monetary unit. Ten SEK is approximately 1 €.

Figures E.1 to E.3 presents the resulting mean score in each sustainability domain. Figure E.4 presents the mean sustainability score of each alternative, where it can be seen that Alternative 3 has the highest total sustainability score. The score is normalized and a relative measure, i.e. it is related to the reference alternative, and the figure shows the mean value.

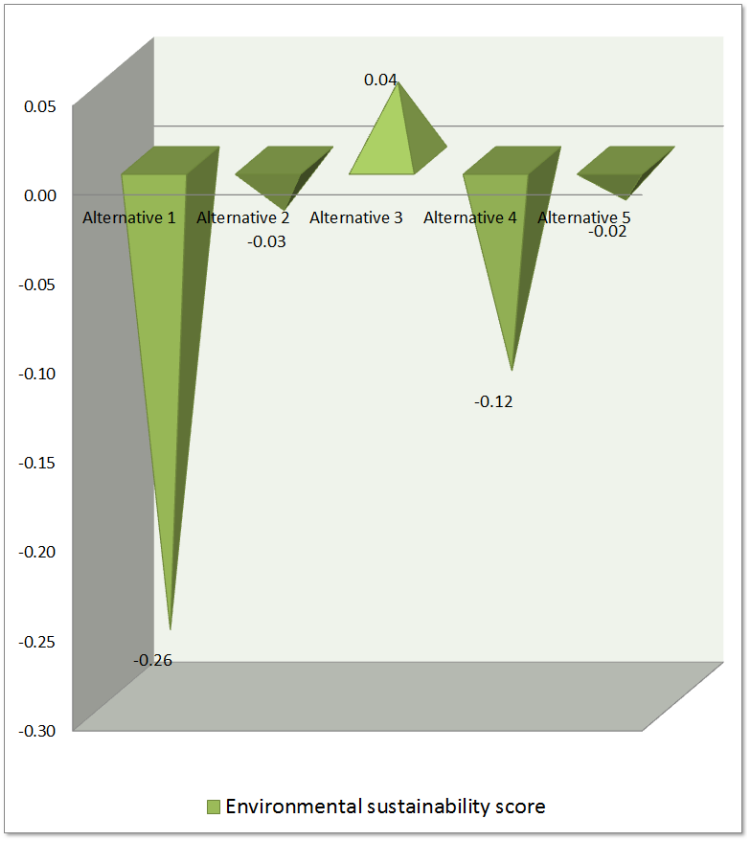


Figure E.1. Resulting score in the environmental domain.

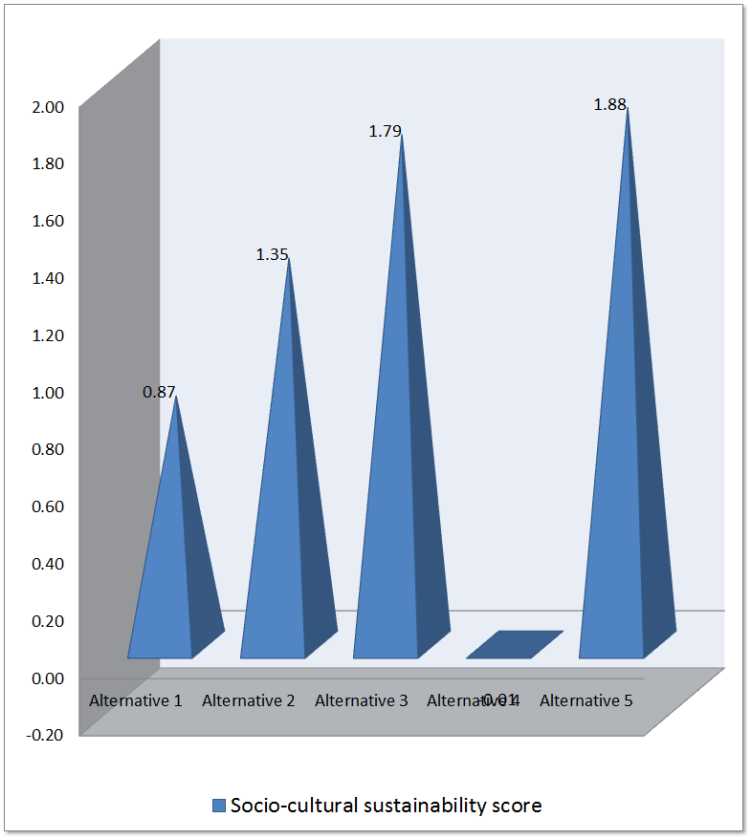


Figure E.2. Resulting score in the socio-cultural domain.

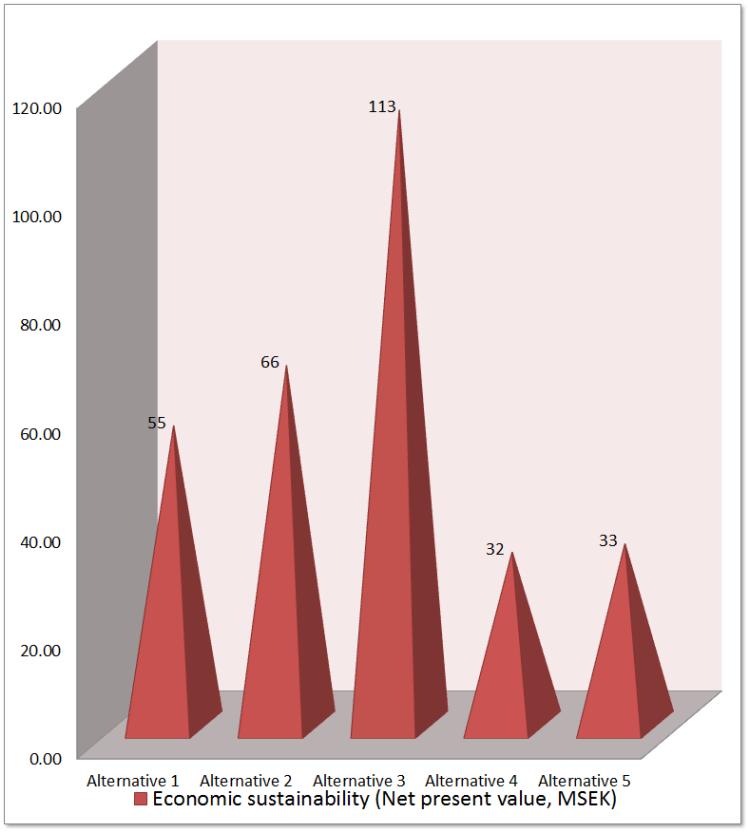


Figure E.3. Resulting score in the economic domain.

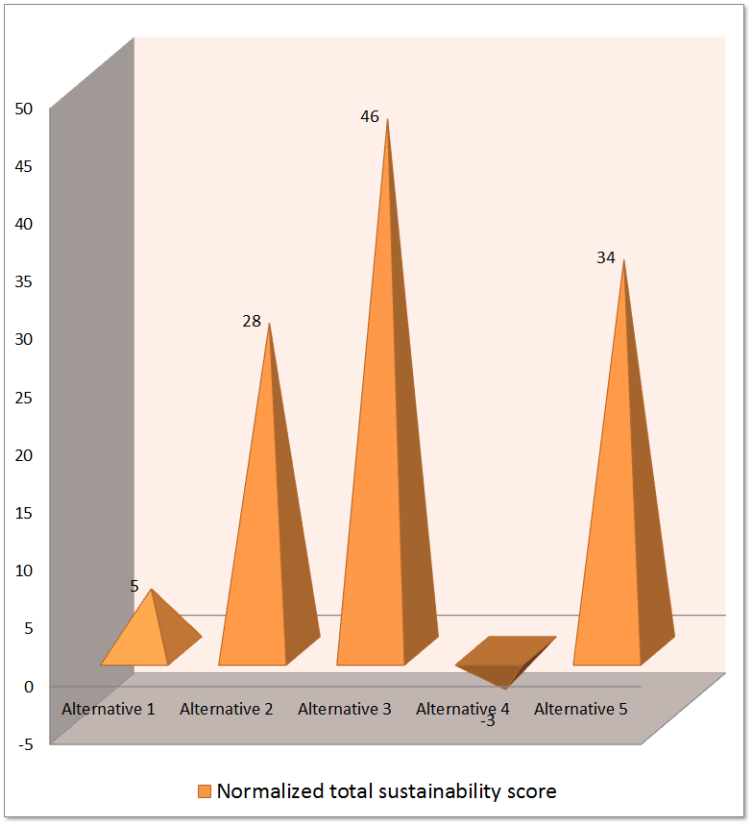
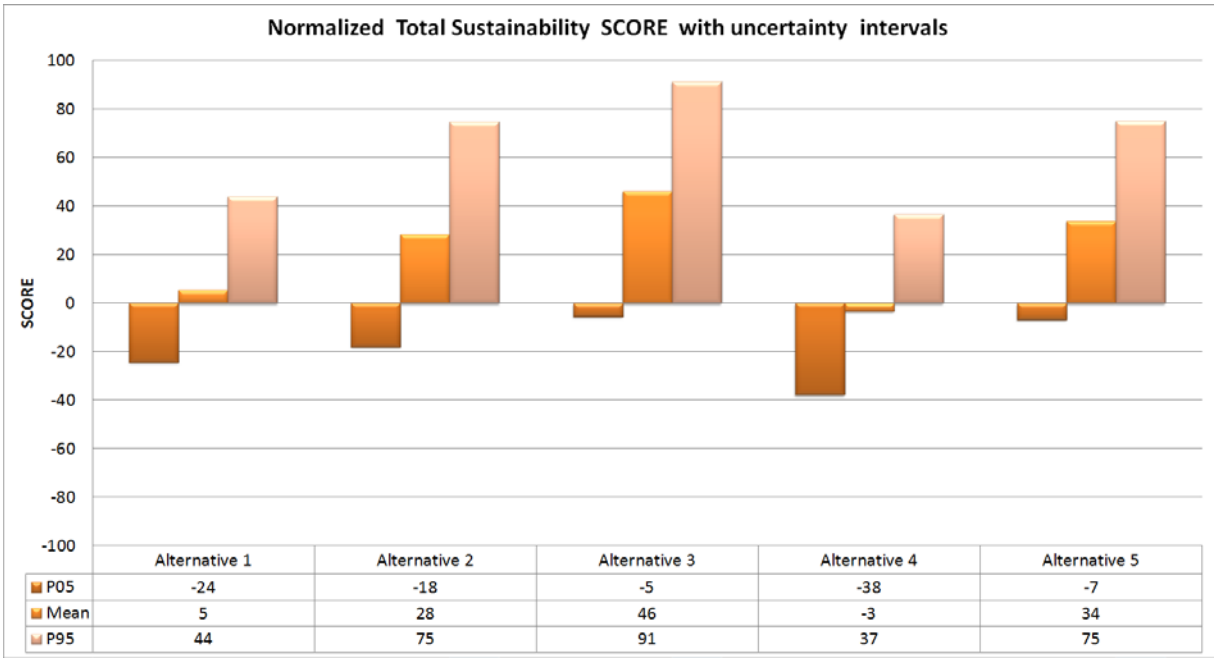


Figure E.4. The resulting sustainability score of the alternatives.

The uncertainty intervals of the sustainability scores are shown in Figure E.5. The uncertainty intervals are very wide, informing that the uncertainties are high in the analysis. Figure E.6 shows the probability for each alternative of having the highest sustainability score as a way of translating what the large uncertainty intervals means. For example, Alternative 3 has the highest score with a probability of approximately 48%, whereas Alternative 4 only has 2% probability of having the highest score. Alternative 1 has 0%, but Alternative 2 and 5, have 21% and 24% respectively.



	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
P05	-24	-18	-5	-38	-7
Mean	5	28	46	-3	34
P95	44	75	91	37	75

Figure E.5. The uncertainty intervals of the sustainability scores.

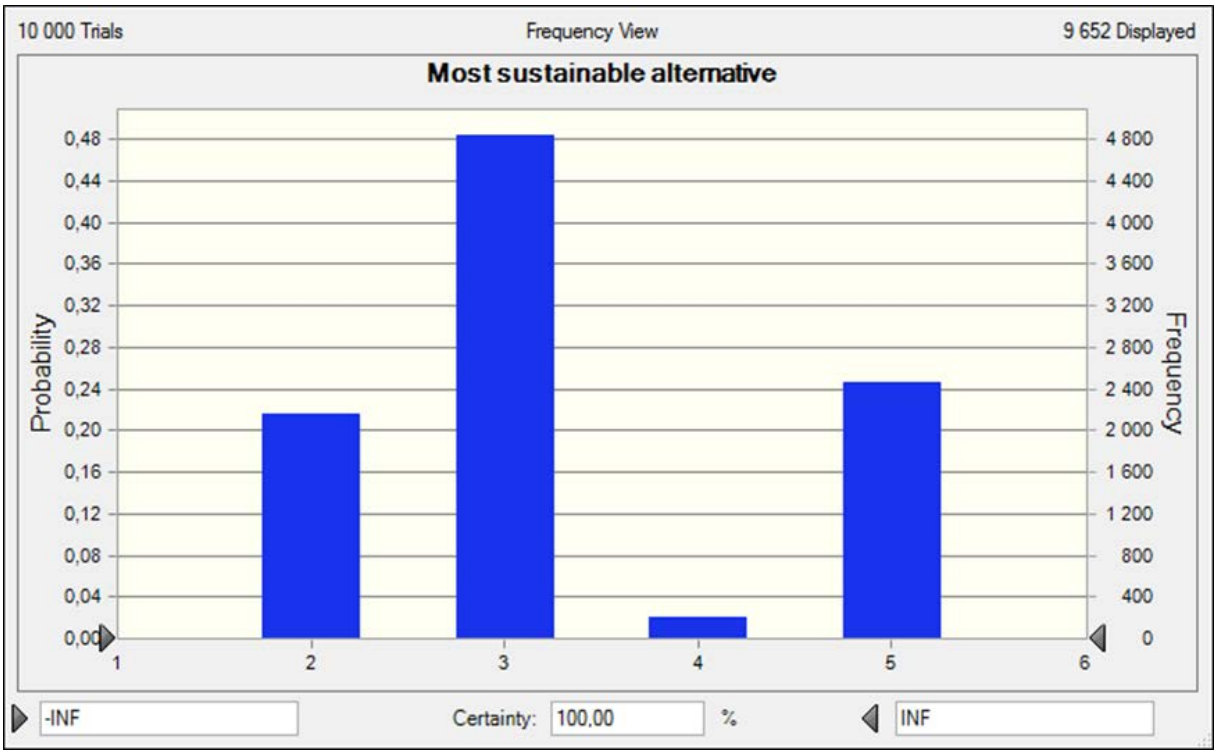


Figure E.6. The probabilities for each alternative of having the highest sustainability score.

The uncertainty analysis in SCORE allows the user to investigate which criteria have the highest impact on the uncertainty of the result. Figure E.7 shows an example for Alternative 1, where the increased property value has the largest contribution to the uncertainty of the sustainability score of

Alternative 1. For all alternatives the increased property value is the item contributing most to the uncertainty in the sustainability score, indicating that the uncertainty is very high in this item.

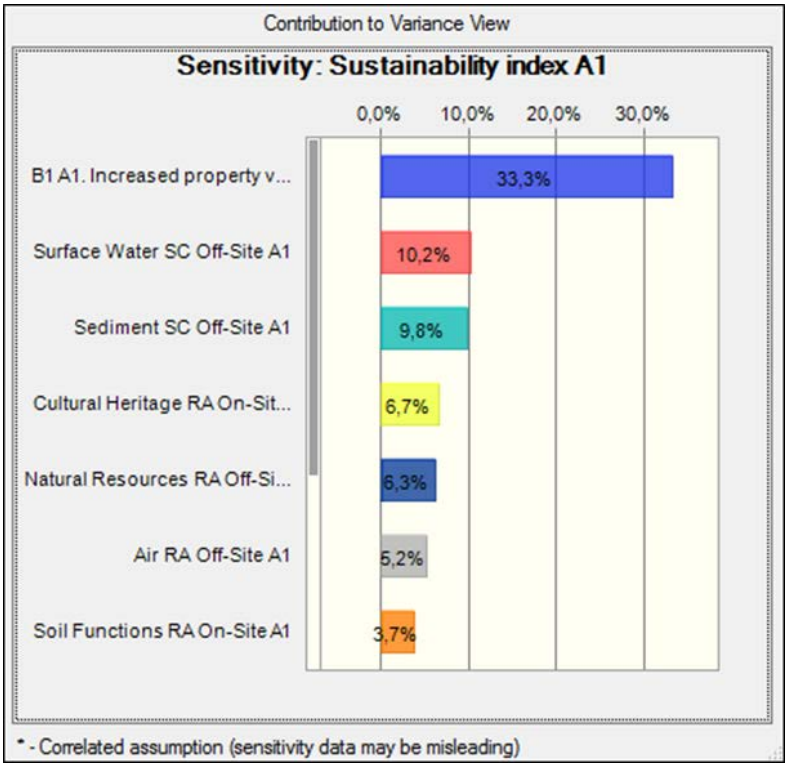
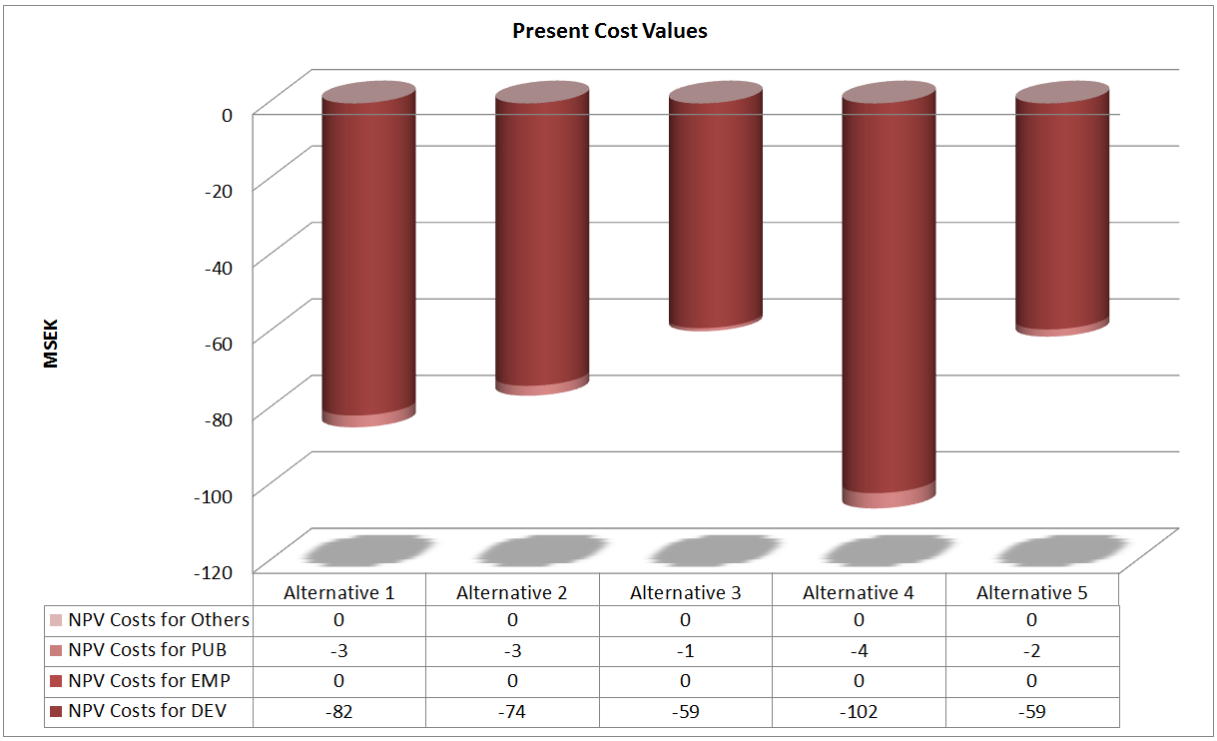


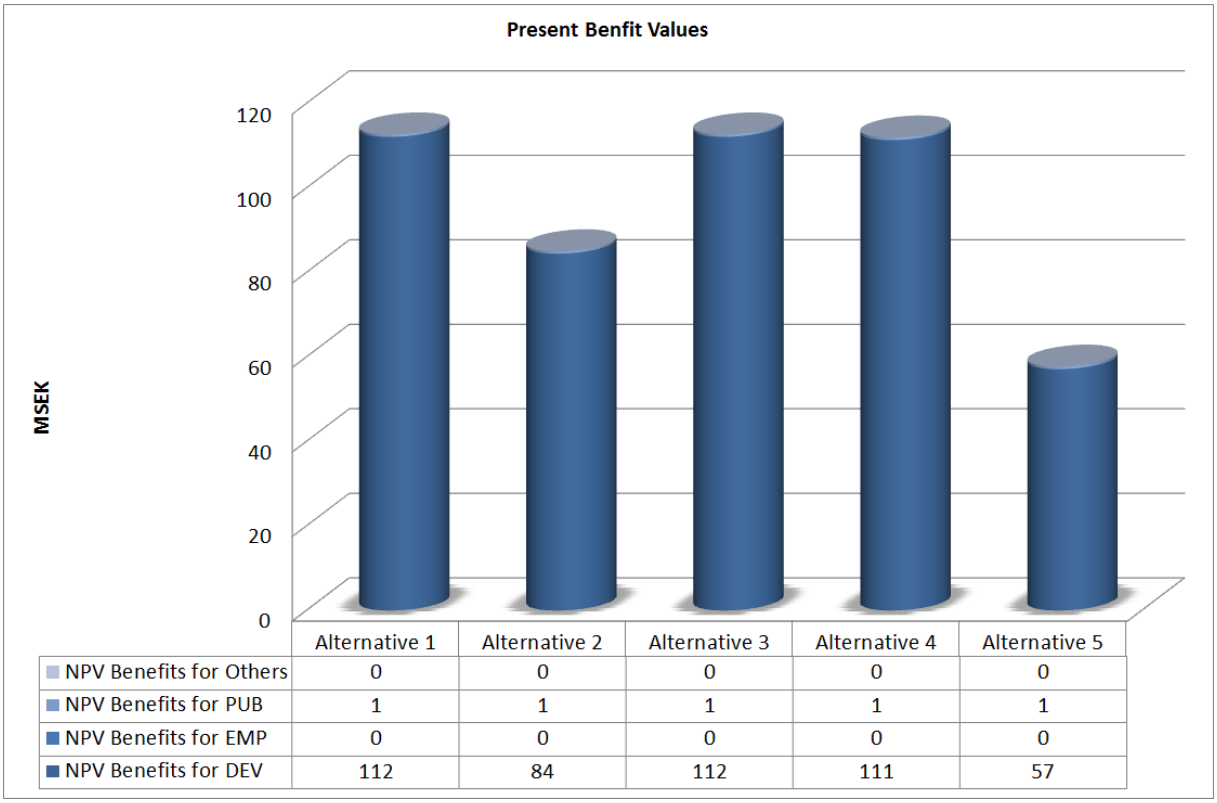
Figure E.7. Sensitivity analysis for Alternative 1. The uncertainty of the increased property value is the item contributing most to the uncertainty of the sustainability score in Alternative 1.

The economic analysis in SCORE is a cost-benefit analysis (CBA), and it is also necessary to check distributional effects of the costs and benefits in the CBA. Figure X.8 shows the costs and Figure E.9 shows the benefits, and how they are distributed with regard to different groups: the public (PUB), employees (EMP), developer (DEV) and others. Here it can be seen that Alternative 3 is the only alternative which does not incur higher costs than benefits for the public with regard to the monetized items in the CBA.



	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
NPV Costs for Others	0	0	0	0	0
NPV Costs for PUB	-3	-3	-1	-4	-2
NPV Costs for EMP	0	0	0	0	0
NPV Costs for DEV	-82	-74	-59	-102	-59

Figure E.8. The present costs of the CBA and how they are distributed with regard to different groups: the public (PUB), employees (EMP), developer (DEV) and others.



	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
NPV Benefits for Others	0	0	0	0	0
NPV Benefits for PUB	1	1	1	1	1
NPV Benefits for EMP	0	0	0	0	0
NPV Benefits for DEV	112	84	112	111	57

Figure E.9. The present benefits of the CBA and how they are distributed with regard to different groups: the public (PUB), employees (EMP), developer (DEV) and others.

Figure E.10 shows the complete table of the CBA, indicating which items were monetized and which were not. An X indicates that the item is important but not monetized, and an (X) indicates a somewhat important item which is not monetized. As can be seen in Figure E.10, several items are not monetized and could potentially affect the outcome of the CBA and thus also the full SCORE analysis. Several of these items are costs and benefits for the public, thus also affecting the distributional analysis.

Benefit item	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
B1. Increased property value on site	112	84	112	111	57
B2a. Reduced acute health risks	nr	nr	nr	nr	nr
B2b. Reduced non-acute health risks	0	0	0	0	0
B2c. Other types of improved health, e.g. reduced anxiety	0	0	0	0	0
B3a. Increased recreational opportunities on site	(X)	(X)	(X)	(X)	(X)
B3b. Increased recreational opportunities in the surroundings	(X)	(X)	(X)	(X)	(X)
B3c. Increased provision of other ecosystem services	(X)	(X)	(X)	(X)	(X)
B4. Other positive externalities	(X)	(X)	(X)	(X)	(X)
Cost item					
C1a. Costs for investigations and design of remedial actions	0	0	0	0	0
C1b. Costs for contracting	0	0	0	0	0
C1c. Capital costs due to allocation of funds to the remedial action	2	2	2	3	2
C1d. Costs for the remedial action, including transport and disposal of contaminated soil minus possible revenues of reuse of contaminants and/or soil	66	58	43	84	47
C1e. Costs for design and implementation of monitoring programs including sampling, analysis and data processing	13	13	13	15	10
C1fa. Project risks	X	X	X	X	X
C2a. Increased health risks due to the remedial action on site	0	0	0	0	0
C2b. Increased health risks due to transports to and from the remediation site, e.g. transports of contaminated soil	1	1	0	2	1
C2c. Increased health risks at disposal sites	(X)	(X)	(X)	(X)	(X)
C2d. Other types of impaired health due to the remedial action, e.g. increased anxiety	(X)	(X)	(X)	(X)	(X)
C3a. Decreased provision of ecosystem services on site due to remedial action, e.g. reduced recreational opportunities	0	0	0	0	0
C3b. Decreased provision of ecosystem services outside the site due to the remedial action, e.g. environmental effects due to transports of contaminated soil	2	1	1	2	1
C3c. Decreased provision of ecosystem services due to environmental effects at the disposal site	X	X	(X)	X	(X)
C4. Other negative externalities	X	(X)	(X)	X	(X)

Figure E.10. Complete list of items in the CBA. An X indicates that the item is important but not monetized, and an (X) indicates a somewhat important item which is not monetized. The numbers indicates the expected present value (not the mean present value).

Finally, the user specifies weights of the domains and the criteria in SCORE, and the results sheet produces graphs of these weights, see Figures E.11 – E.13. The economic domain does not use weights, as all items are measured in the same unit (SEK).

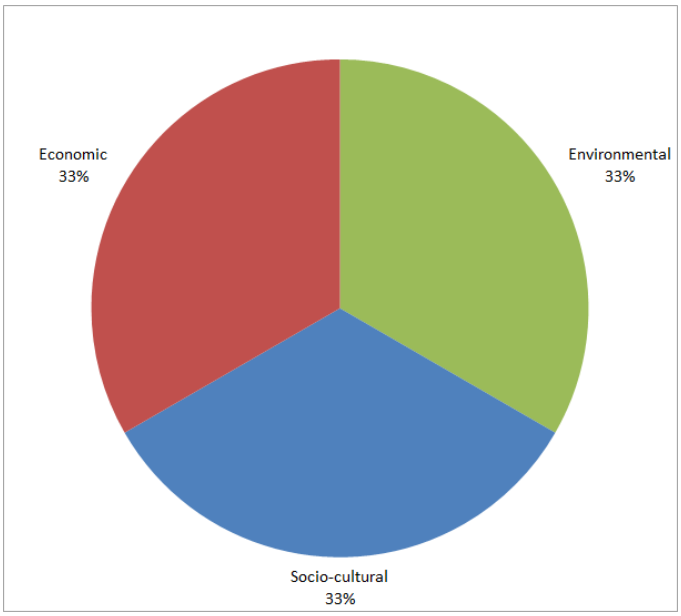


Figure E.11. Chosen weights for the different domains: equal weights to all three domains.

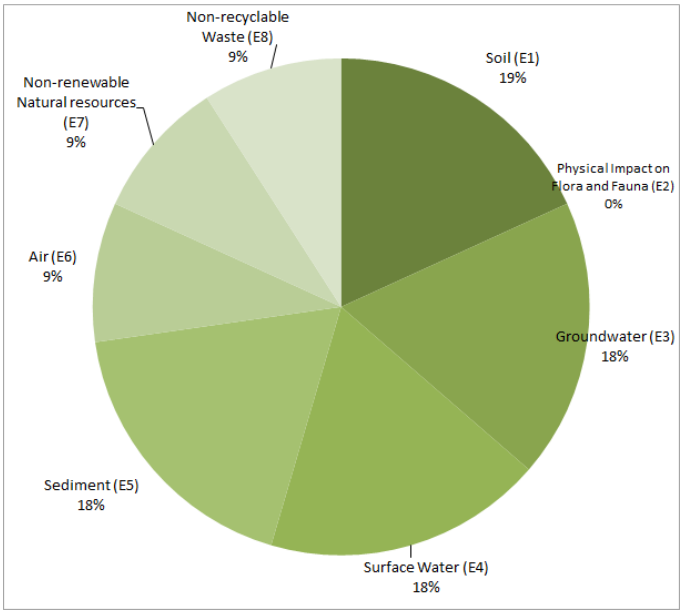


Figure E.12. Chosen weights for the environmental domain.

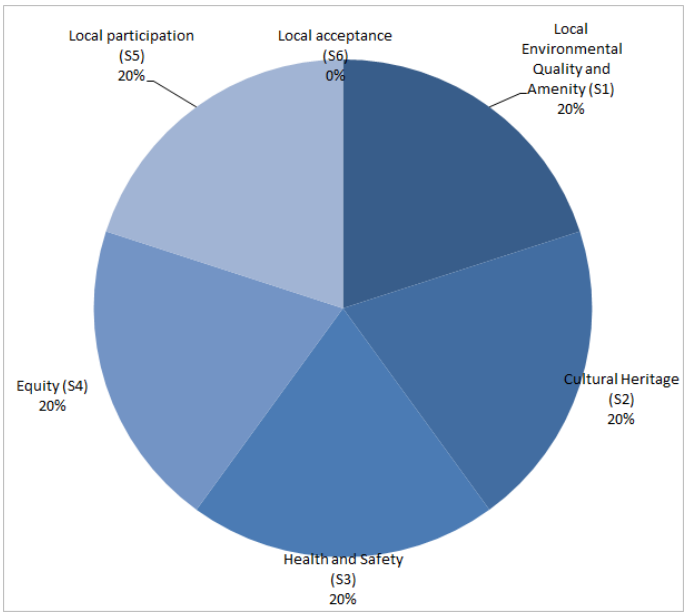


Figure E.13. Chosen weights for the socio-cultural domain.

Appendix F – Fixfabriken: Mapping of Ecosystem services

Mapping of ecosystem services, or ecosystem services analysis, has been applied on the Fixfabriken case study in Gothenburg as one of three methods for evaluating sustainability in remediation projects. The objective of the analysis has been to investigate the potential of this method in adding useful information to the sustainability appraisal of identified remediation alternatives and future land use.

Method

The method applied follows the principles outlined in a guidance for implementation of the Water Framework Directive (200060/EC) and the Floods Directive (2007/60/EC); *Development for Integration of Ecosystem Service Assessment into WFD and FD Implementation. (COWI 2014),* the first three steps are as follows:

1. Identification of relevant ecosystem services (baseline)
2. Quantification of changes in quality and quantity of ecosystem services affected in the identified remediation alternatives.
3. Valuation of the welfare effects from the identified changes.

The third step of the methodology, Valuation, has not been applied in the Fixfabriken application. The analysis was delimited to a semi quantitative comparison between the baseline situation and the resulting changes in the provision of ecosystem services in one of the identified remediation/future land use scenarios.

The steps described above is also in accordance with the 6-step approach to ecosystem services analysis put forward in a World Resource Institute guidance document; *Weaving Ecosystem Services into Impact Assessment (WRI 2013).*

Identification

The process starts with identification of relevant ecosystem services. The Fixfabriken application takes its point of departure in an inventory of existing ecosystem services with regard to two typologies: i) Urban Ecosystem Services (Baggethun et al., 2013) and ii) Soil Ecosystem Services (Finvers, 2008), see tables of identified ESS below in the results section.

Table F.1. Urban ecosystem services

Ecosystem service		Urban context
Provisioning	Food	Vegetables produced by urban allotments and peri-urban areas.
	Fresh water	Ecosystems provide cities with fresh water for drinking and other human uses and by securing storage and controlled release of water flows. Vegetation cover and forests in the city catchment influences the quantity of available water.
Regulation & Maintenace	Air quality regulation	Vegetation in urban systems can improve air quality by removing pollutants from the atmosphere, including ozone (O 3), sulfur dioxide (SO 2), nitrogen dioxide (NO 2), carbon monoxide (CO) and particulate matter less than 10 μm (PM10).
	Climate regulation global	Carbon sequestration and storage by biomass of urban shrubs and threes.
	Climate regulation local (urban climate)	Water areas buffer temperature extremes by absorbing heat in summertime and by releasing it in wintertime trees. Urban vegetation provide shade, create humidity and block wind, water from the plants absorbs heat as it evaporates, thus cooling the air in the process.
	Water regulation	Soil and vegetation percolate water during heavy and/or prolonged precipitation events. Vegetation reduces surface runoff following precipitation events by intercepting water through the leaves and stems. The underlying soil also reduces infiltration rates by acting as a sponge by storing water in the pore spaces until it percolates as through-flow and base-flow.
	Noise reduction	Urban soil and plants can attenuate noise pollution through absorption, deviation, reflection, and refraction of sound. In row plantings of trees, sound waves are reflected and refracted, dispersing the sound energy through the branches and trees.
	Water purification and waste treatment	Wetlands and other aquatic systems, for example, filter wastes from human activities; this process reduces the level of nutrients and pollution in urban wastewater. Likewise, plant communities in urban soils can play an important role in the decomposition of many labile and recalcitrant litter types.
	Pollination and seed dispersal	Urban ecosystems provide habitat for birds, insect and pollinators. Pollination, pest regulation and seed dispersal are important processes in the functional diversity of urban ecosystems and can play a critical role in their long term durability.
	Maintaining nursery populations and habitats	Urban systems can play a significant role as refuge for many species of birds, amphibians, bees, and butterflies
	Natural hazard regulation	Storm, flood and wave buffering by vegetation buffers, wetland areas; heat absorption during heat waves.
Cultural	Knowledge systems	Allotment gardening as preservation of socio-ecological knowledge.
	Aesthetic values	Urban parks, sea view, urban scenic view in sight from houses.
	Cultural heritage values	
	Recreation and ecotourism	Urban green areas provide opportunities for recreation, mediation and relaxation.

Table F.2. Soil ecosystem services

Ecosystem service		Soil context	Functional process
Provisioning	Food	Nutrient cycling to support plant growth (primary production) including food and fibre production	Soil biota recycle dead organic matter into mineralized for usable by plants and required for vegetative cell information and growth.
	Biomass	Basis of all terrestrial ecosystems –life support	Soil (horizon) development and disturbance regime controls ecosystem development
Regulation & Maintenace	Fresh water	Water purification and soil contaminant reduction	Atmospheric deposits, applied fertilizers, pesticides or other contaminants are adsorbed into soil aggregates, by clay particles and organic matter, and degraded (chemically altered) by soil biota
	Climate regulation global	Carbon Sequestration	Carbon in short-lived to more stabile forms of soil organic matter are (SOM) is stored (and recycled). SOM is approximately 58% organic carbon.
		Regulation of greenhouse gasses	Soil biota affect fluxes of CO2, CH4 and N2O.
	Water regulation	Flood regulation	Rainfall infiltration and storage in soil reduces the rates of surface runoff, reducing and delaying peak flows, and re4ducing flood risk. Decreased surface runoff also result in lower rates of erosion, reducing sediment load in flood water (reducing their volume).
	Erosion regulation		
	Water purification and waste treatment	Water purification and soil contaminant reduction.	Atmospheric deposits, applied fertilizers, pesticides or other contaminants are adsorbed into soil aggregates, by clay particles or organic matter, and degraded (chemically altered) by soil biota.
		Remediation of soil contaminated by diffuse airborne pollution.	Soil biota metabolize contaminants through oxidative or reductive processes

In the identification of relevant ecosystem services at the Fixfabriken site, the present land use as presented in maps of the site is utilized to make qualitative/quantitative assessments of the supply of relevant ESS (baseline). The changes in provision of ESS resulting from remediation/land use alternatives is assessed qualitatively/quantitatively by use of information on excavation of soil, on site/off site remediation actions, transports etc.

Score	Explanation
-1	Present land use has a negative impact on supply of ESS
0	Present land use implies no supply of ESS
1	Present land use has a significantly negative effect but allows for some supply
2	Present land has a somewhat negative effect on the supply of ESS
3	Present land use is not affecting the supply of ESS

The score -1 is used in situations where the present land use not only inhibits the supply of the ESS but also have an active counteracting effect. One example could be the Bus garage; the hardened

surface prevents the supply of *Air purification* from soil and vegetation in addition to a significant contribution to air pollution from the daily activities on the site.

The score 0 is used in situation when the supply of the ESS is of no significance due to present land use or other natural conditions. For example the ESS Food; for obvious reasons there are no vegetables produced by urban allotments in the Bus garage area due to the ongoing land use.

The score 1 is used in situations where the supply of the ESS exists but is significantly impaired by the present land use. For example; there is some vegetation along the Karl Johansgatan Boulevard in terms of trees and bushes with a positive noise reducing effect in relation to the road passing just north of the area. This effect could be enhanced if the present land use in terms of buildings and roads allowed for more vegetation.

The score 2 is used in situations where the supply of the ESS is significant but also negatively affected by the present land use. For example; fields of lawn and vegetation are found in the areas surrounding the future remediation sites. These areas have positive effect on the ESS *Air purification* and *Local climate*. The supply of these ESS is however impaired by buildings and roads which implies that the full potential is not achieved.

The score 3 is used in situations when the ESS can be considered to be unaffected by the present land use. An example is given by the high cultural values represented by the Neolithic remainings south of the Fixfabriken factory area.

Quantification

The quantification step implies continued analysis of the identified ESS by,

4. identification of suitable indicators to describe changes in relation to the baseline, and
5. identification of sources of information and/or data with regards to the indicators.

The indicators that have been identified for the urban and soil ESS are presented in table E3 and E4 below. The indicators have been collected from literature or from ongoing projects. In cases where no information have been found, indicators have been suggested based on the features of the ecosystem services they are designed to describe, e.g. the indicator for the ESS *Pollination and seed dispersal* was chosen to be *Area of vegetation (ha)* which is motivated by its function as habitat for birds and insects providing the mechanism for the service.

Table F.3. Indicators for quantifying changes in provision of urban ecosystem services

Ecosystem service		**Indicator**
Provisioning	Food	Production/Harvest (ton/year), Areas available suitable for production (m^2)
	Fresh water	Groundwater generated (m^3/ha/year;m^3/year)
Regulation & Maintenace	Air quality regulation	Area of vegetation (ha)
	Climate regulation global	Carbon bound in ecosystems = C sequestration (ton C/year; ton C/ha/year) O2-CO2 balance (+/- kg C /year) Production or reduction of other GHG (kg/yr;kg/ha/year)
	Climate regulation local (urban climate)	Area of vegetation (ha)
	Water regulation	Area of vegetation (ha), water storage capacity (m^3/ha/year)
	Noise reduction	Area of vegetation (ha)
	Water purification and waste treatment	
	Pollination and seed dispersal	Area of vegetation (ha)
	Maintaining nursery populations and habitats	Area of vegetation (ha)
	Natural hazard regulation	Area of vegetation (ha)
Cultural	Knowledge systems	Area of vegetation (ha)
	Aesthetic values	Scenic landscape (ha)
	Cultural heritage values	Number of visitors/tourists
	Recreation and ecotourism	Number of visitors/tourists

Table F.4. Indicators for quantifying changes in the provision of soil ecosystem services

Ecosystem service		**Indicator**
Provisioning	Nutrient cycling to support plant growth (primary production) including food and fibre production	Area of vegetation (ha)
	Basis of all terrestrial ecosystems –life support	Soil (horizon) development and disturbance regime controls ecosystem development
Regulation & Maintenace	Water purification and soil contaminant reduction	Volumes of soil available for filtration (m^3/ha)
	Carbon Sequestration	Area of vegetation (ha)
	Regulation of greenhouse gasses	Area of vegetation (ha)
	Flood regulation	Natural water retention capacity (m^3)
	Remediation of soil contaminated by diffuse airborne pollution.	Area of vegetation (ha)

Results

Appendix G – Fixfabriken: Social impact analysis

The social impact analysis tool (SIA) was developed as a tool to be used in urban planning in Göteborg. It is typically used as an inventory tool to check what there is, what is needed and the anticipated impacts of the detailed plan. In the Balance 4P project, the SIA was used as a tool to investigate the social impacts with regard to each alternative. The SIA tool is displayed in the form of a matrix, which takes four different social aspects into consideration: Cohesive city, Interactions, Everyday life and Identity, see y-axis in Figure G.1. Those aspects are in line with the political objectives of the City of Göteborg and are analysed with regard to five different scales: Buildings and places, Neighbourhood, District, City, and Region, see x-axis in Figure G.1.

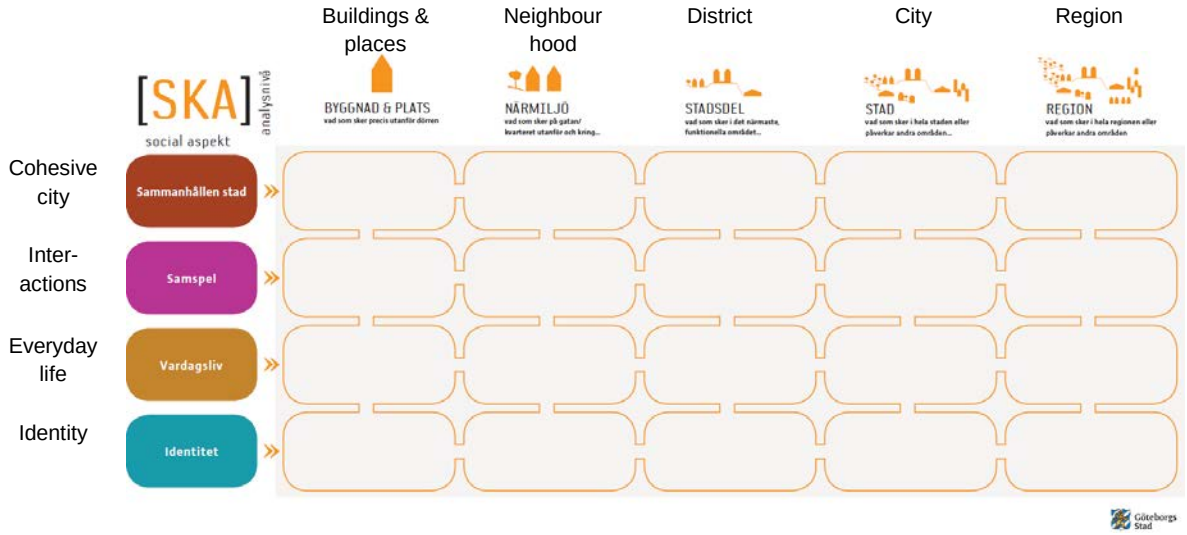


Figure G.1. The SIA tool matrix.

Focus in Balance 4P has been on Neighbourhood and District, since the conceptual redevelopment strategies are not detailed enough to provide information for an analysis on the scale of Buildings and places. The matrix was used to: 1) map the reference alternative, 2) map preferred changes, and 3) map the impacts on Alternatives 1 to 5. Figures G.2 – G.8 shows all matrices. The impacts are qualitatively valued on the following scale: very negative impacts: (--), negative impacts (-), no impacts (0), positive impacts (+), very positive impacts (++).

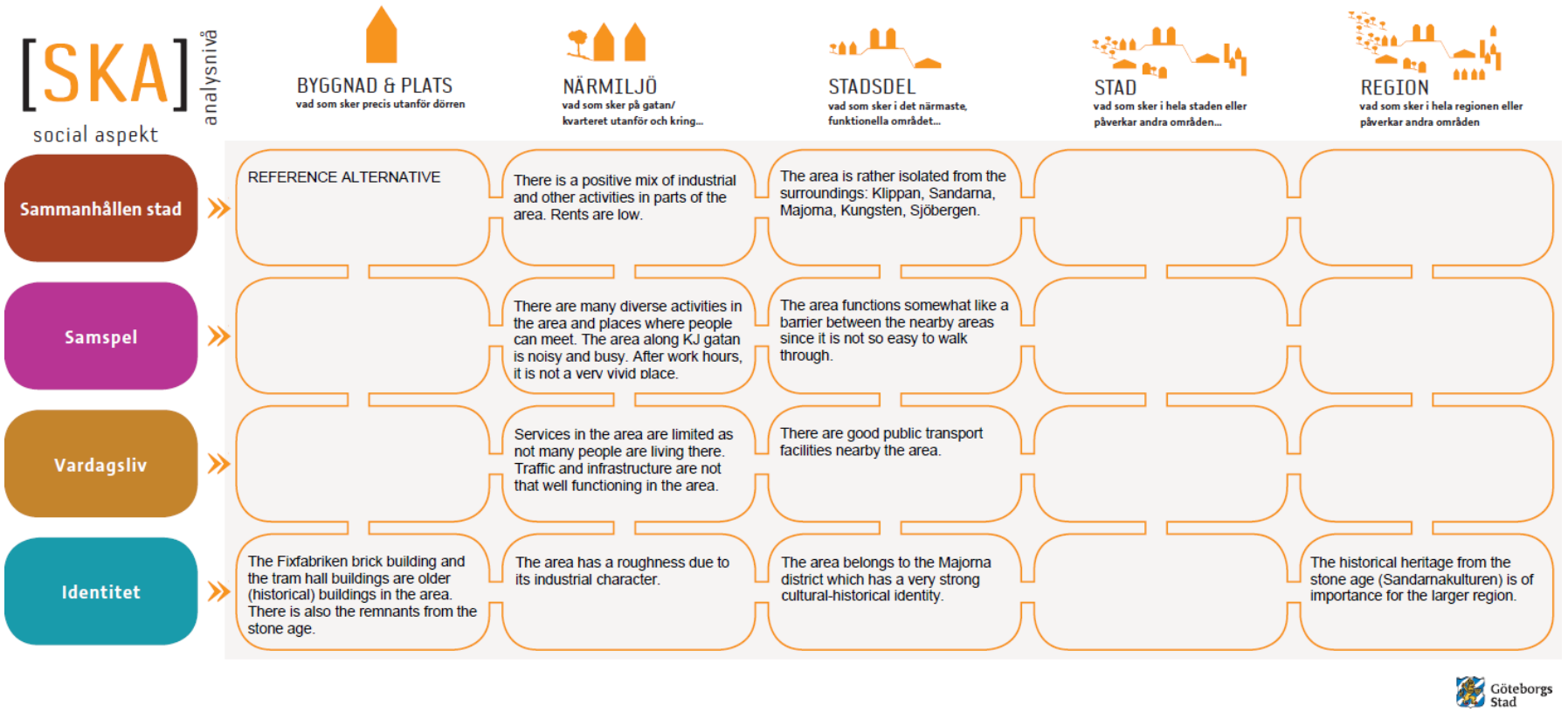


Figure G.2. The reference alternative.

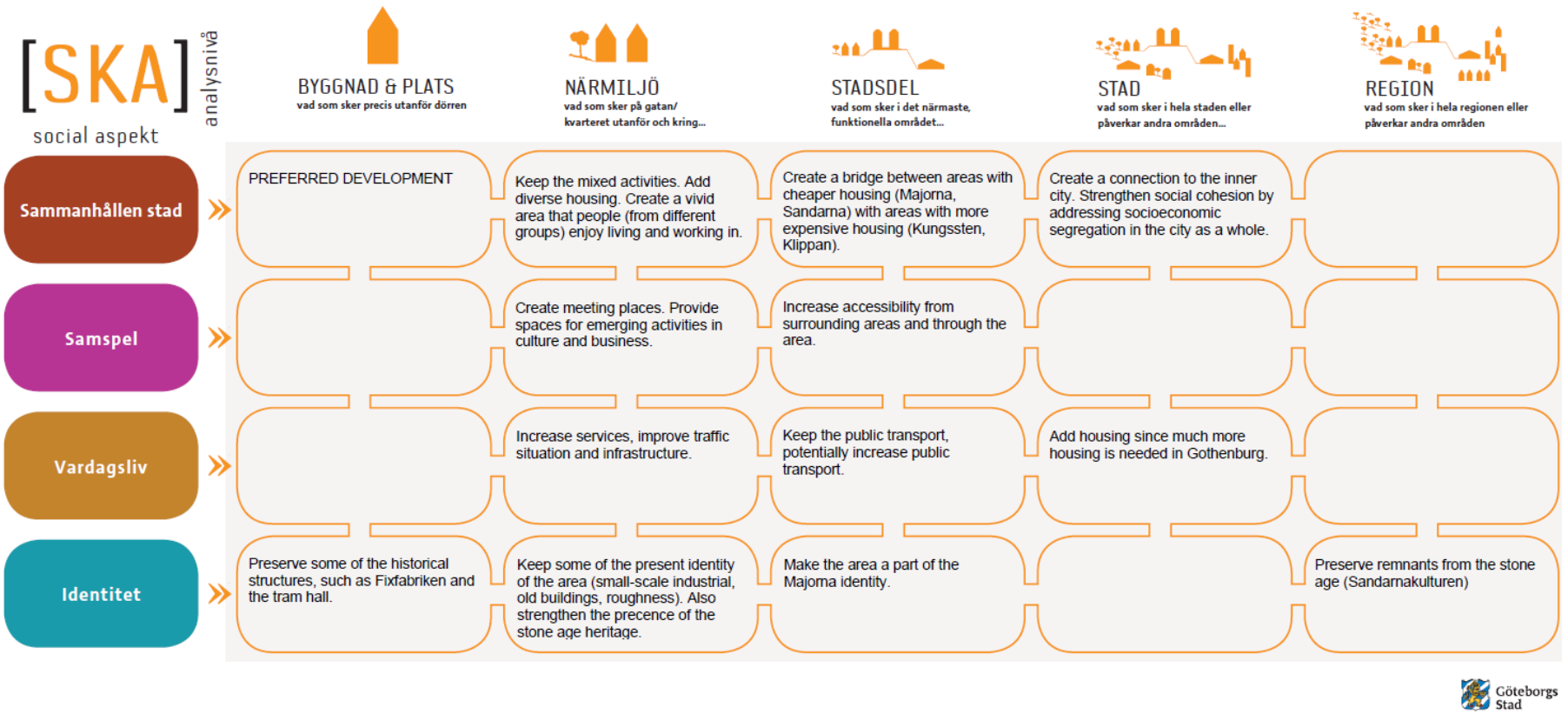


Figure G.3. Preferred changes.

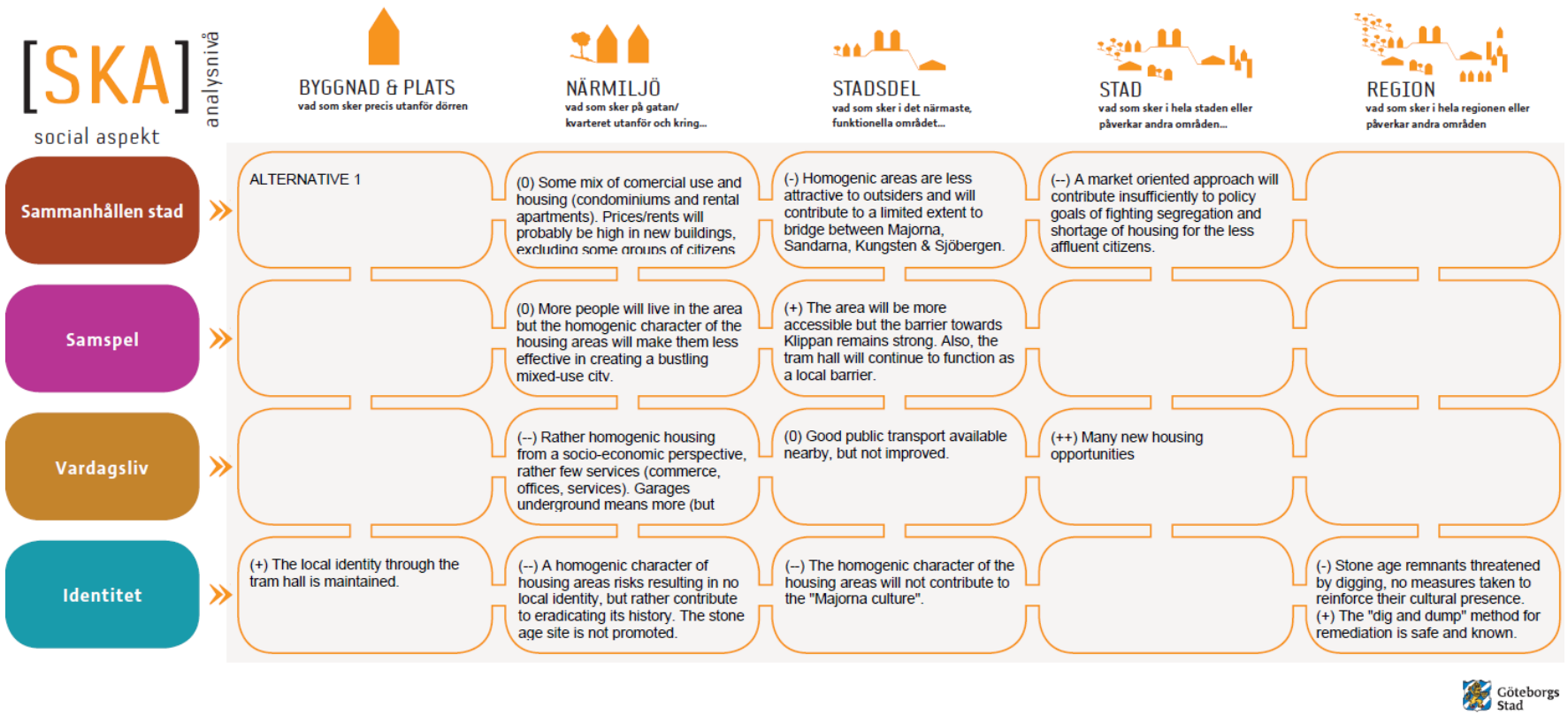


Figure G.4. Social impacts due to Alternative 1.

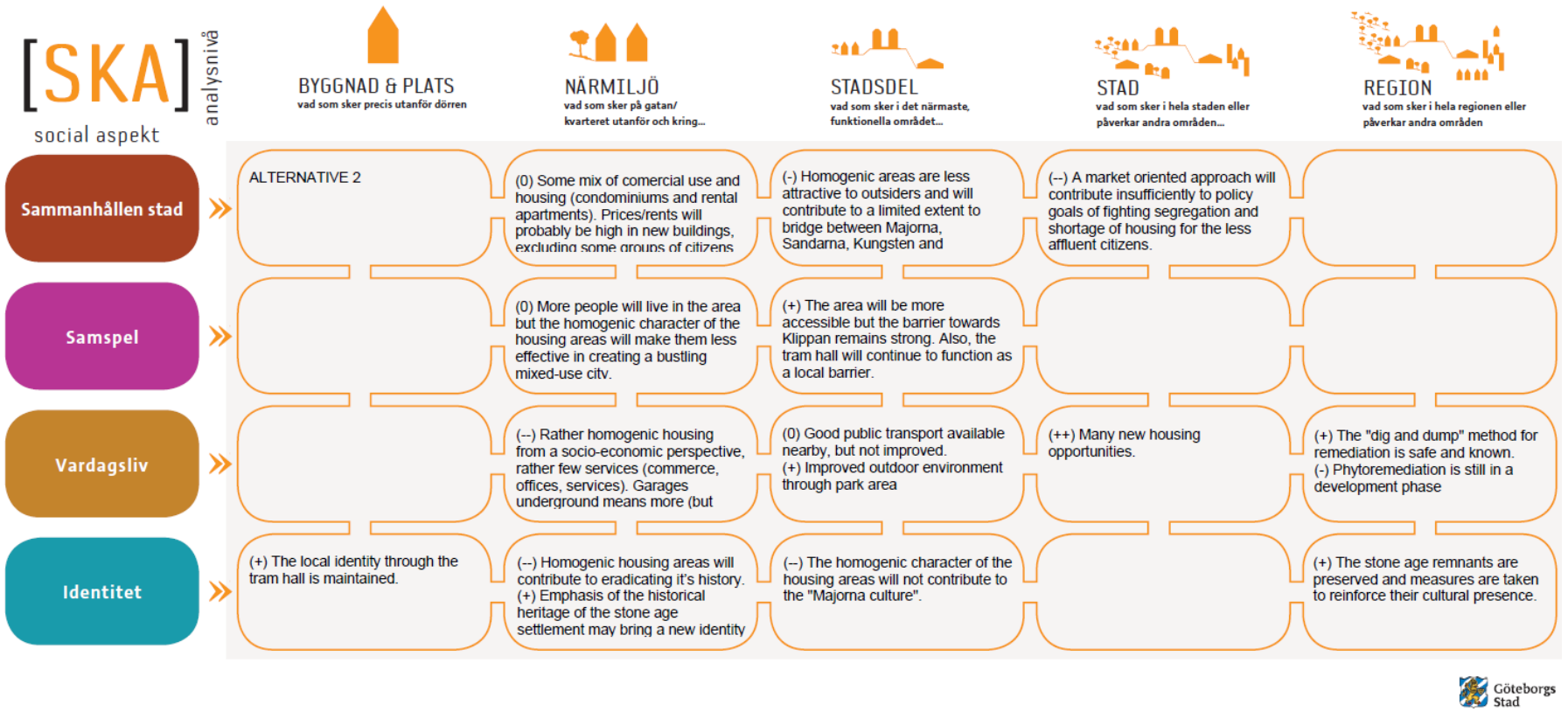


Figure G.5. Social impacts due to Alternative 2.

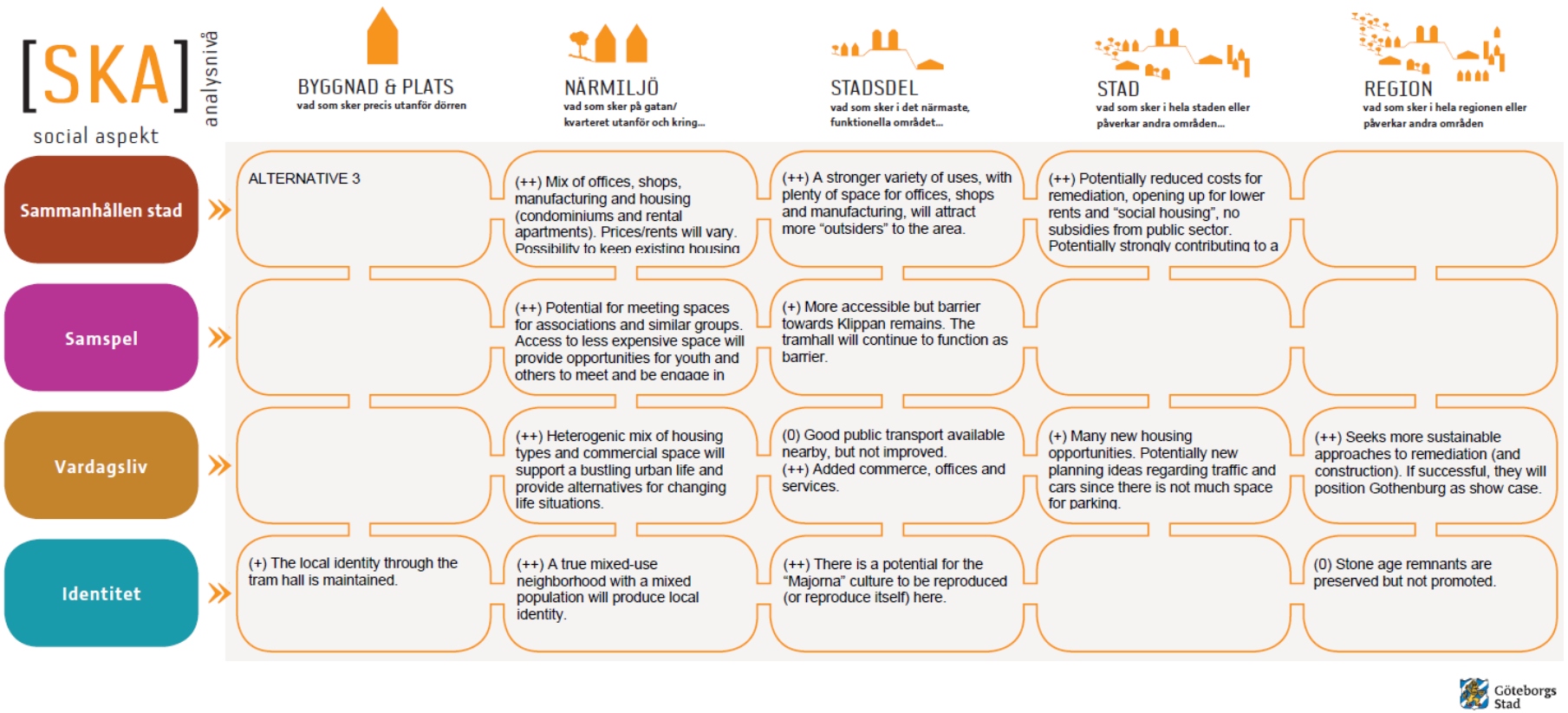


Figure G.6. Social impacts due to Alternative 3.

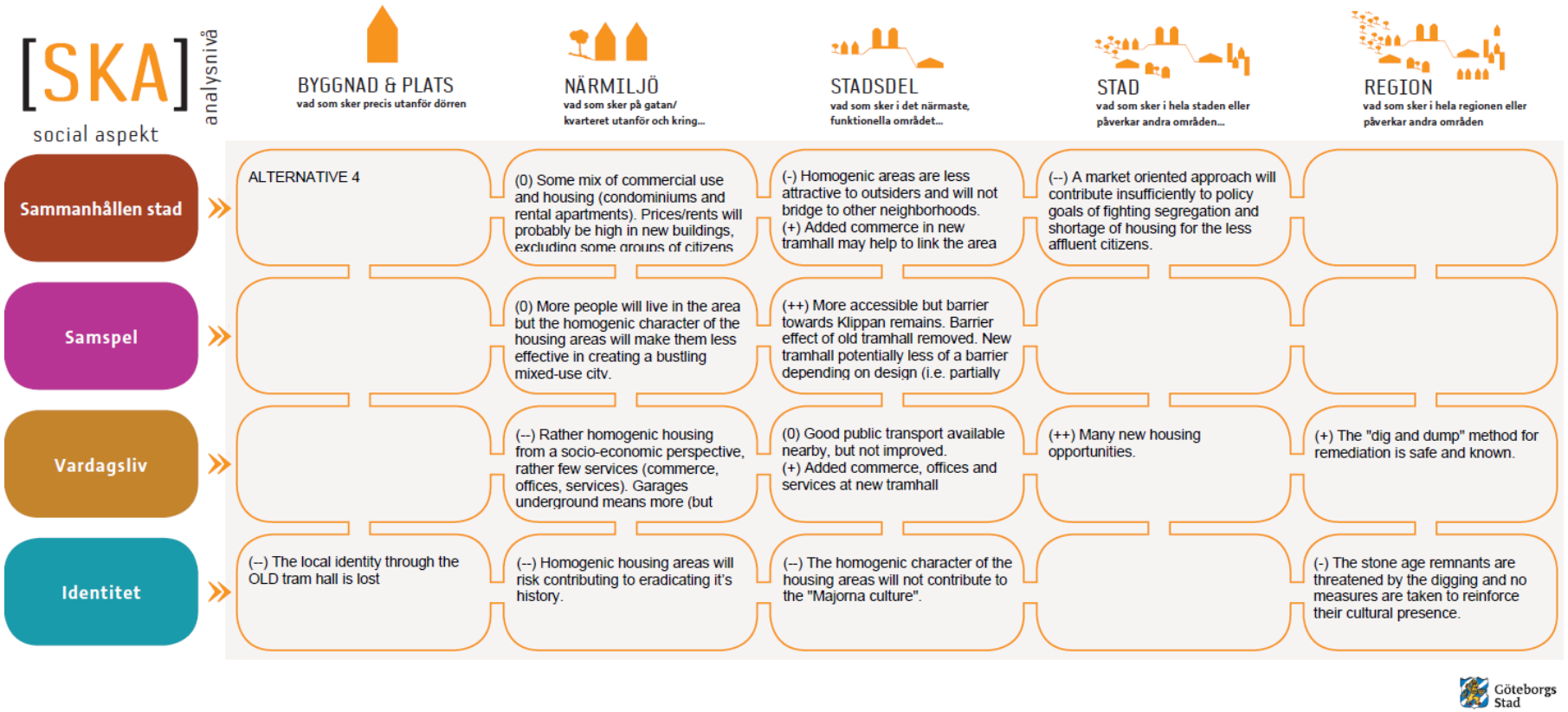


Figure G.7. Social impacts due to Alternative 4.

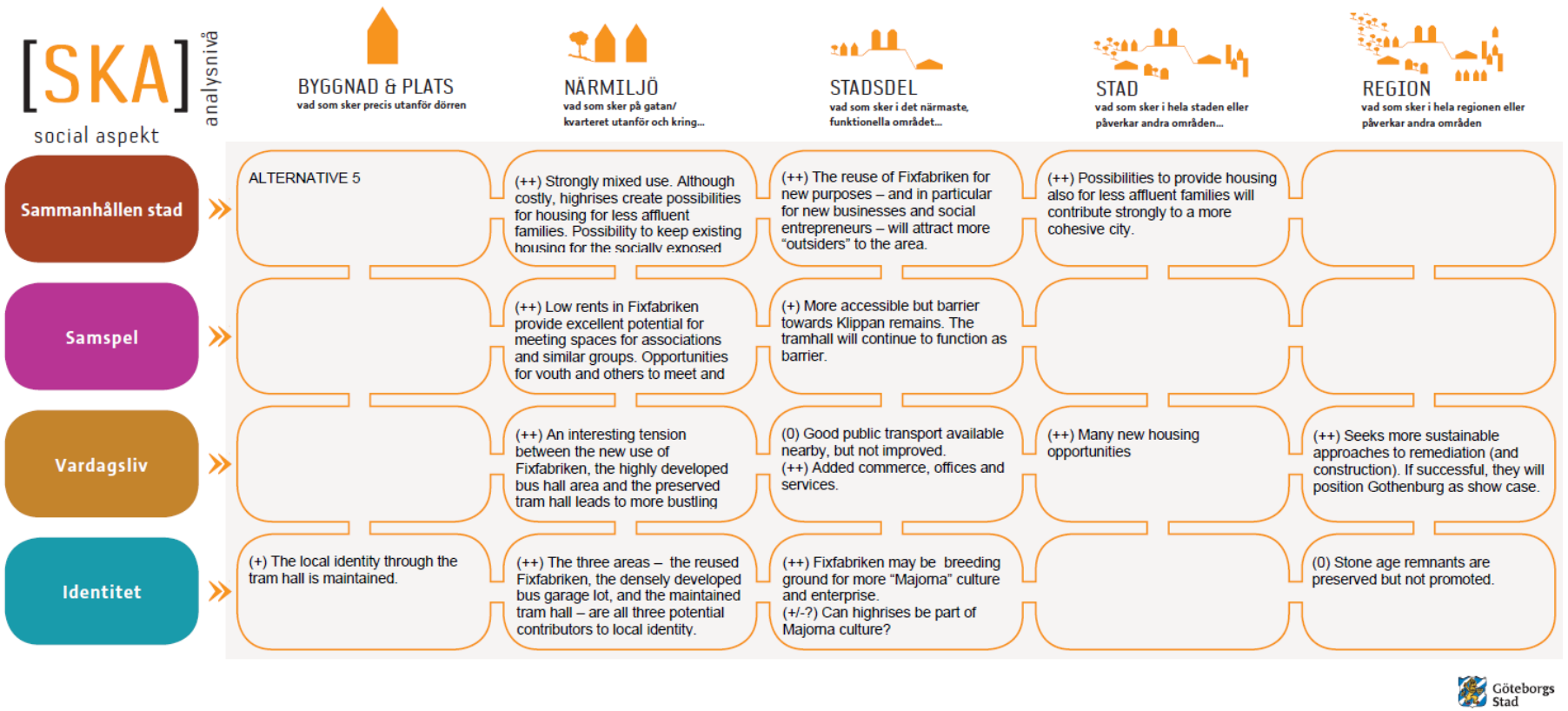


Figure G.8. Social impacts due to Alternative 5.

The impacts with regard to the different alternatives relative the reference alternative are summarized in Table G.1. For details, the matrices must be used.

Table G.1. Summary of impacts of the alternatives.

Alternative	Total negative impacts	Total positive impacts	Total	Rank
Alternative 1	-10	+5	-5	4
Alternative 2	-9	+8	-1	3
Alternative 3	0	+21	+21	2
Alternative 4	-12	+7	-5	5
Alternative 5	0	+22	+22	1