Commissie voor de
milieueffectrapportage

Structure vision Shale Gas

Advice Terms of Reference for EIA

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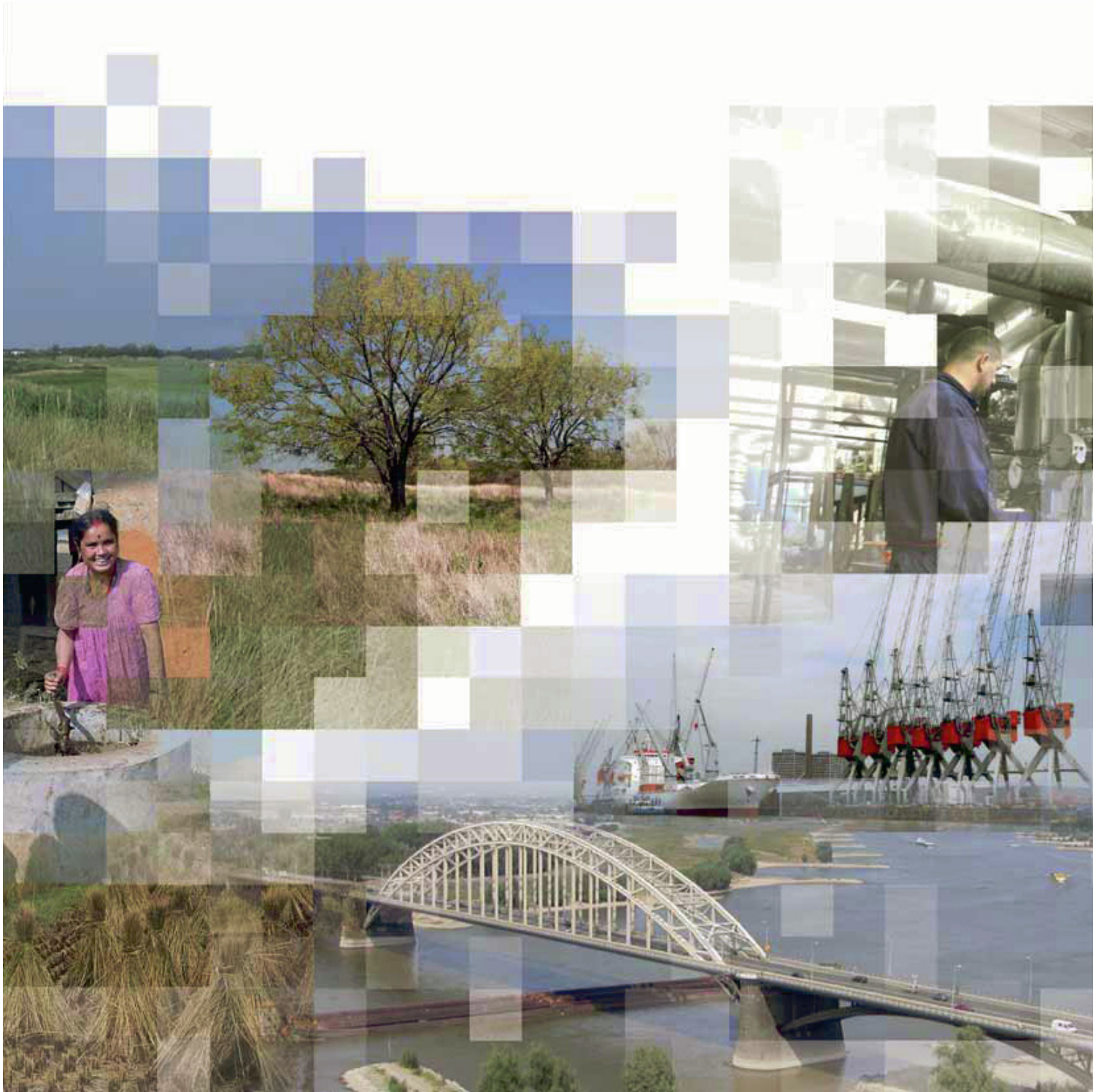

1. Introduction

The Minister of Economic Affairs and the Minster of Infrastructure and the Environment are planning to develop a joint 'structure vision' for shale gas. This structure vision will outline whether shale gas exploration and extraction may be pursued in the Netherlands, and if so, where. This relates to areas where the potential impact on nature, people and environment can be safeguarded. It will also examine how *beneficial* and *essential* shale gas extraction would actually be for the Netherlands.
The effects of shale gas extraction on nature, people and environment will be investigated as part of a Strategic Environmental Assessment (SEA). This SEA will form the basis for decision-making with regard to the structure vision.

The Minister of Economic Affairs requested the Netherlands Commission for Environmental Assessment (NCEA)[1] to advise on the *Terms of Reference (ToR)* for the SEA. In its advice, the NCEA will build on the *draft ToR for the SEA: Structure Vision for Shale Gas* (May 2014) (hereinafter referred to as the draft ToR). The NCEA also took note of 1,175 unique views and recommendations which it had received from the the competent authorities. It incorporated these into its advisory report wherever they were relevant to the pending ToR for SEA[2].

Chapter 2 summarises the NCEA's recommendations and lists the most important issues that should be addressed in the SEA. Chapter 3 *et seq.* address in greater detail which issues should be covered and investigated in detail, and what information should be contained in the SEA.

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[1] The NCEA's working group composition, its procedures and other project details are listed in Appendix 1 of this advisory report. Project details and associated documents (if available electronically) can also be found on the www.commissiemer.nl/english/ website under the 'Advice' tab or by searching on project number '2888'.

[2] Many detailed views were submitted by Dutch and foreign government authorities and other authorities as well as the general public. In light of these submissions, the NCEA advises that the SEA should be sufficiently detailed and broad. Many submissions referred to recently published studies and reports, both Dutch and foreign. While drafting the SEA report, it is vital that the sources upon which these studies and reports have been based be checked for their scientific quality and reliability. Current knowledge and information should be updated on a continuous basis, given the large volume of (scientific) literature currently being published on shale gas exploration.

2. Summary of advisory report & SEA framework

The Minister of Economic Affairs has to make a decision on the matter of shale gas extraction. Initially, he needs to determine *whether* to permit shale gas extraction in the Netherlands and if so, *where* and under *what* conditions. Information is required in order to facilitate social and political debate about *whether* and *where* this should be pursued. Information for both is partly the same. For instance, both questions require an insight into the potential effects of shale gas exploration and extraction on nature, people and the environment. Although these debates will be held consecutively, the NCEA is of the opinion that incorporating the underlying data into the SEA would be practicle, as this would help create a completer picture.

The NCEA believes the following information to be vital to answering the question as to *whether* shale gas extraction should be allowed in the Netherlands, i.e. its *benefit* and/or *necessity*:

- Insight into the balance between economic and environmental concerns at a regional, national and international level (where relevant).
- Reliable baseline scenarios *without* shale gas for comparison with *minimum* and *maximum* levels of shale gas extraction.

The NCEA provides the following framework for answering the question as to *where* shale gas extraction should be allowed:

- Justify and detail the criteria that automatically preclude certain areas, e.g. urban, *Natura 2000*, water catchment and groundwater protection areas, as well as the generic 1,000-m depth limit.
- Detail the foremost criteria that do not automatically preclude certain areas, but play an important role in decision-making, e.g. drill-free zones, other protected nature conservation areas and proximity to fault systems.
- Define pre-conditions for further decision-making, including the necessity and scope of buffer zones around shale gas activities or distances to be maintained from susceptible areas/properties.
- Examine any potential cross-border impact and any requirement for buffer zones to be imposed along borders and/or minimum distances to be maintained from certain activities in neighbouring countries from a perspective of international law.
- Create a representative model for shale gas extraction (quantitative and qualitative) and provide insight into the full range of relevant parameters, e.g. land use, intensity of operations, traffic, etc.
- Extrapolate this shale gas extraction model (and its impact) to alternative land use/extraction scenarios (and their impact).
- Clarify the types of area covered by the structure vision, e.g. exclusion zones, *no-unless* zones, *yes-but* zones and buffer zones.
- The probability exists that other hydrocarbons may also be found, e.g. *shale oil*. Consider this scenario in the account of the shale gas extraction model and its impact if the structure vision intends to cover this eventuality.
- Clarify subsequent decision-making (spatial planning or otherwise) and the SEA report's role therein.

Pay particular attention to the presentation of the information for both these elements. It is important that tables, figures, graphs, charts and other illustrations be easy to read and interpret, and have clear explanatory notes consistent with the body text. Documents will contain a lot of geographical information. Make sure that maps are clear, current and accompanied by an intelligible legend.

The relationship with the STRONG *Structure Vision for the Subsurface* (Dutch: Structuurvisie Ondergrond) is also important. Examine issues such as time-frame progress and the extent to which the SEA report under consideration addresses how surface/subsurface shale gas activity interferes with other subsurface processes or the extent to which the SEA report views these as issues to be addressed by STRONG.

Lastly, the NCEA would like to emphasise the importance of a good summary, as decision makers and speakers will generally read this first of all. Make the summary understandable for a wide audience without resorting to excessive simplification.

3. Study for 'Benefit & Necessity' debate

3.1 Scope of Study

The answer to the question as to how beneficial or essential shale gas extraction would be is not a rational one. It cannot be described or analysed in purely non-subjective, scientific terms. Objective information about its benefit and necessity is however required for purposes of social and political debate. The NCEA views the SEA report's study into shale gas' benefit and necessity to be a study in support of this debate.

It is important to clearly define the scope of this study and to adhere to this scope. The NCEA has identified two layers to this study. Firstly, how beneficial and/or essential is shale gas in the context of Dutch demand for gas? In other words, shale gas as an alternative/supplement to Groningen gas, gas from other smaller Dutch gas fields or gas imports. Secondly, how beneficial and/or essential is gas (shale or natural) in the context of the Dutch energy mix (*system choices*) and its positioning with respect to the main elements of the Social and Economic Council's (SER) *Energy Agreement* (*sustainable energy* and *energy savings*)?

The *draft ToR* states that the 'benefit & necessity' debate is being held at two levels - *regional* and *national*. However, international relations also play a role in the energy debate. A large portion of Dutch natural gas is currently being *exported*. Conversely, a large portion of our other energy carriers and electricity is currently being *imported*. This reciprocity not only adds to this issue's complexity, but also plays an important role in terms of environmental impact. The scope of the 'benefit & necessity' debate extends much further therefore than the Netherlands' own borders. It ought to be addressed at an EU level, if not at a global level.

Energy source extraction and power generation in other countries also have local social and environmental implications. It would be going too far to consider these knock-on effects within a domestic structure vision for shale gas. However, the NCEA recommends that these issues be included in broad terms in the 'benefit & necessity' debate/assessment.

3.2 Alternatives/Scenarios

The question arises, therefore, as to how broad the study should be. Various submissions specifically address this issue. Theoretically, every conceivable scenario/alternative for a mix of energy supplies could be investigated, with or without shale gas. However, this could potentially result in an overly detailed and unmanageable overview. This is not necessary in order to be able to debate the issue of 'benefit & necessity' properly. Nonetheless, submissions revealed that many people believe it necessary to present viable alternatives, i.e. not only *minimum* v. *maximum* levels of shale gas extraction, but also *shale gas* v. *other energy options*, e.g. renewable energy sources, fossil fuel imports (coal, oil, etc.) and electricity import (generated at coal-fired and/or nuclear power stations, hydroelectric plants, etc.).

The NCEA proposes mapping out the scope of various potential scenarios. Examples might include alternative sources of natural gas from intensified exploitation of the smaller Dutch gas fields or imports of natural gas by pipeline (Nord Stream, South Stream or Ukraine) or

imports of liquefied natural gas (LNG) by ship from farther afield. Other options include alternative fossil fuel and renewable energy sources such as coal, nuclear power, geothermal power, etc.
Incorporate at least one representative and realistic fossil fuel-based alternative/scenario and one renewable energy-based (as requested in numerous submissions) for the two *draft ToR* scenarios.

SER Energy Agreement
The NCEA believes it sensible to base the development of all scenarios/alternatives on the SER's Energy Agreement forecast that states that by 2023 it should be feasible to generate 16% of the Netherlands' power requirement by deploying all available renewable energy sources, e.g. wind, solar, hydro, etc. Shale gas could therefore form part of the remaining 84%.

Baseline scenario uncertainties
Future energy supplies are subject to considerable uncertainty, especially in the longer term from 2030 to 2050. The benefit and necessity of shale gas extraction depends partly on these uncertainties. The NCEA recommends investigating the robustness of baseline scenarios, thereby identifying their foremost uncertainties. Examples might include far-reaching electrification of energy demand, sharp energy price fluctuations (gas prices), major improvements to power system sustainability, etc.

3.3 Assessment framework for 'Benefit & Necessity' study

The NCEA agrees in general terms with the assessment framework presented. The NCEA recommends adding an extra theme to the framework – partially in response to submissions – that allows for a comparative assessment of shale gas extraction versus other forms of economic exploitation, including subsurface and surface usage (recreation, agriculture, flora & fauna, industry, etc.).

Environmental Impact
The SEA report describes the environmental impact of the shale gas extraction model. The 'benefit & necessity' study should extrapolate this impact to the *maximum* and *minimum* exploitation level scenarios. This means that the effects are not merely limited to the effects of a single extraction model. For each scenario, outline how many extraction sites would be required over time and in terms of geographic location, and in doing so, pay particular attention to surface-level differences between each scenario.

Ultimately, the information provided should provide an insight into the balance between the economic and environmental issues involved, which can then be incorporated into the comparative assessment.

4. Investigation into suitable areas

4.1 The structure vision's objective

Potential areas & exclusion zones

The *draft ToR* states that the aim of the structure vision is to identify areas at a national level that could be potentially suitable for shale gas exploration and extraction. The NCEA has interpreted this to mean that the minister envisages using the SEA report to create a map indicating areas that would not automatically be precluded, i.e. where extraction might be possible. The memorandum also states that these areas be '...areas where the potential impact on nature, people and environment can be safeguarded...'. The NCEA has interpreted this to mean that the SEA report should also provide an insight into potential pre-conditions and/or mitigating measures.

The NCEA foresees that areas might need to be differentiated in more detail.
For instance, areas may exist that are immediately and unconditionally precluded, as well as areas that are in theory precluded unless certain circumstances exist, e.g. the existence of impermeable subsurface strata, i.e. *no-unless* areas.
A distinction can also be made between potentially suitable areas and areas where extraction is not automatically precluded, as long as certain mitigating measures are taken, i.e. *yes-but* areas.

The NCEA assumes that no drilling or test drilling or extraction will be permitted within exclusion zones. The SEA should clarify the buffer zones around these areas, as well as options for horizontal drilling and production under these areas.

The NCEA has deduced from the *draft ToR* that the SEA results – decided upon in the structure vision[3] – should include a terrain map depicting exclusion zones, buffer zones and potential extraction zones (subject to certain conditions). It should also include a geologic or stratigraphic map of a wider area within which shale gas extraction is possible. In this respect, it may be necessary to create a three-dimensional map or model to illustrate the options available and at what depth.

Shale gas or hydrocarbons

The NCEA questions whether the structure vision should address only shale gas. It believes that potential test drilling may reveal that not only *shale gas* is present, but also *shale oil*. Up until now, Dutch *Mining Act* licences have not differentiated between *oil* and *gas*. They only refer to *hydrocarbons* in general.

Although *Geverik* strata consist mainly of shale formations, they also form part of Carboniferous rock formations. Carboniferous rock formations also contain coal seams with a potential for coal-bed methane gas (CBM) exploitation. In the past, Dutch Carboniferous formations have often been designated as potential CBM resources.

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[3] This assumes that the answer to the question as to *whether* shale gas exploration and extraction is permitted is a positive one.

The SEA should make clear which extractable substances the structure vision applies to. If it also covers other hydrocarbons, then it also needs to consider these in its account of the extraction model and impact. The NCEA believes that *shale oil* extraction can have other potential effects than *shale gas* extraction, e.g. different transportation requirements and a different risk profile in the event of an incident.
It points out that this difference is crucial to the 'benefit & necessity' debate.

4.2 Exclusion criteria

The *draft ToR* lists several criteria that automatically preclude certain areas. These criteria define the areas to be investigated further in the SEA report. The NCEA examines these exclusion criteria in more detail below.

4.2.1 Surface exclusion criteria

Sea (Dutch Continental Shelf), large & smaller bodies of water
According to the *draft ToR* , the North Sea, virtually the entire Dutch coastline and larger bodies of water form parts of exclusion zones. The NCEA was informed in an oral hearing that it is assumed that for economic reasons shale gas extraction would only take place *onshore*. Moreover, offshore shale gas extraction would be prohibited because most larger bodies of water are protected *Natura 2000* areas. Explicitly explain these issues in the SEA report. Clearly state how offshore extraction (beneath the sea or larger bodies of water) will be addressed.

State in the SEA report how smaller bodies of water will be addressed. The NCEA foresees that deeper-water extraction would be infeasible on economic grounds, but that this may not apply to shallow-water extraction.

Water catchment / groundwater protection areas & strategic reserves
Water collection and groundwater conservation areas are automatically precluded. Clearly define these areas in the SEA report. Justify in detail why drill-free zones should not be automatically precluded and how any *no-unless* or *yes-but* areas will be addressed with regard to impermeable layers.

Numerous submissions raised the issue of strategic drinking water reserves and their protection. The *draft ToR's* approach was based on current groundwater abstraction activity. However, a large portion of the Netherlands' groundwater, that is potentially suitable for drinking water extraction, is managed as a strategic groundwater reserve. Address this issue in the SEA report and establish a link with the *Structure Vision for the Subsurface* (STRONG).

Flood containment areas & water control structures
Numerous submissions stated that critical water control structures would require special protection with regard to shale gas extraction and/or that extraction should be prohibited beneath said water control structures. Reference was also made to the recommendations

adopted by the European Commission on these matters[4]. Clarify in the SEA what potential risks exist and whether sufficient grounds exist to preclude extraction beneath critical water control structures.

Flora & fauna

The *draft ToR* states that authorisation for shale gas extraction in *Natura 2000* areas is thought to be unrealistic. This is why *Natura 2000* areas, as opposed to national ecological network (EHS) and protected national monument areas, are automatically precluded. The NCEA recommends explaining clearly why *Natura 2000* areas are automatically precluded and other protected nature conservation areas are not. Merely referring to assessment frameworks, however stringent, is not sufficient in this respect.

Urban areas & industrial estates

The *draft ToR* proposes using Statistics Netherlands' (CBS) *surrounding address density* (SAD) as the definition of an 'urban area'. Areas falling into the CBS *strongly* or *extremely urbanised* categories (>1,500 addresses per km²) are automatically precluded in the *draft ToR* .

The NCEA believes that roughly setting an exclusion limit based on an SAD of 1,500 addresses per square kilometre or more provides insufficient insight, as is the case in d*raft ToR* illustrations. Additionally, numerous submissions revealed that local authorities and local residents had little faith that residential areas would be excluded.

Other conceivable methods exist for excluding residential areas, e.g. built-up areas or 'red contours' demarcating the ten-year limit for urban expansion. However, the NCEA foresees that SAD is a manageable enough system for most analytical purposes. This is why it endorses the decision to use SAD.

Scale

It is important that SAD be applied at a sufficiently fine scale. The NCEA believes that SAD zoning at a neighbourhood level[5] (rather than at a local authority level) would provide the desired level of insight into the *degree of urbanisation*. This makes it possible to readily differentiate between residential areas and industrial estates, transitional zones. etc.

Density Level

CBS zoning deviates slightly from that used in the *draft ToR* , adopting 1,000 addresses per km² rather than 1,500. Expressed in *draft ToR* terms, *urban* and *urbanised* areas are precluded, and in CBS terms, *moderately*, *strongly* and *extremely urbanised* areas are precluded. The NCEA proposes setting the cut-off at a neighbourhood level with an SAD of 1,000 addresses per square kilometre, as this provides a workable system for excluding residential areas.

Planned residential sites

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[4] *Commission recommendation of 22 January 2014 on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing* C(2014) 267 final)

[5] www2.cbsinuwbuurt.nl → Theme → Population Density → Neighbourhood Level

Various submissions requested that attention be paid to planned, i.e. as yet unbuilt, residential sites. Clarify in the SEA how such sites will be addressed. For example, will planned designated residential sites count as exclusion zones?

Business parks & industrial estates
The NCEA recommends stating explicitly how transition zones, business parks and industrial estates will be addressed (including a differentiation by environmental category). The NCEA foresees that surface activities associated with shale gas extraction could be integrated into certain existing industrial estates. It recommends assessing explicitly the pros and cons of integrating test-drilling rigs, extraction sites and gas processing stations with business parks and industrial estates.

Buffer zones & integration measures
The *draft ToR* does not discuss buffer zones around property, land usage or activities at surface level. The NCEA recommends investigating whether to consider buffer zones and integration measures for property, land usage and activities, and if so, how – in terms safety and environmental impact.

Belgian & German borders
Many Belgian and German government bodies, agencies and members of the public submitted opinions that voiced concerns about the impact of Dutch shale gas extraction on land usage and activities within their own borders. Clarify in the SEA how any potential environmental impact in Belgium and Germany would be handled. State to what extent international laws, regulations and other arguments exist that would require buffer zones to be imposed along borders and/or minimum distances to be maintained from certain activities in neighbouring countries.

4.2.2 Subsurface exclusion criteria

1,000-m depth limit
The *draft ToR* imposes a 1,000-m depth limit beneath exclusion zones. This means that *horizontal* drilling into an exclusion zone at a depth of less than 1,000 m below the surface is automatically precluded. The 1,000-m limit is arbitrary however. The reasoning behind this is that no economically extractable shale gas will be found above this depth, and that imposing this limit maintains an adequate distance from susceptible subsurface zones such as aquifers. Various submissions reveal that this limit is not clearly understood. The NCEA recommends justifying why this limit has been imposed.

Economically viable shale gas extraction between 1,000 and 5,000 m
The *draft ToR* states that shale gas formations exist at depths between 1 and 5 km below the surface. The NCEA recommends being more specific about this information in terms of shale gas reservoirs' upper and lower boundaries, and depicting their depths in a geologic cross-section (Posidonia and Geverik shale formations). Clearly indicate how far the Posidonia and Geverik formations extend beyond the Belgian and German borders, insofar as this is relevant to their areas of influence.

Sufficient distance from susceptible subsurface zones

The NCEA recommends justifying the assumption that the 1,000-m limit constitutes an adequate buffer. Is this assumption based on the fact that the top 1,000 m of the Netherlands' subsurface comprises thick impermeable or low-permeability clay beds, and that these effectively isolate shallow freshwater resources from shale layers?

One option is to abandon this arbitrary depth limit and to implement a variable depth limit, e.g. based on the presence/absence of impermeable layers. The question arises as to whether a 1,000-m depth limit is necessary under every type of exclusion zone. Conversely, below certain exclusion zones such as water catchment areas, an even deeper limit may be required. Explain in detail what pre-conditions apply.

The NCEA recommends addressing the maximum extent to which vertical effects can occur above horizontal well sections during drilling, fracking and extraction operations in order to gain a better insight into the issue of subsurface buffer zones. Use the Witteveen+Bos study as a basis[6].

Drinking water supply

The *draft ToR* states that water catchment and groundwater protection areas are automatically precluded. The SEA report will investigate drill-free zones in more detail.

The *draft ToR* explicitly considers issues including the 'fifty-year zones' around drinking water abstraction sites. Address this time span in relation to shale gas extraction. Fifty-year zones were implemented based on the assumption that these would provide sufficient time and space to carry out any remediation required to sustainably protect abstraction in the event of a surface-level incident. This may not be the case, however, for incidents occurring at depths of 100 m or more.

The timescale on which natural processes (chemical or biological) can neutralise the effect of subsurface leaks cannot be estimated. Combined with dispersion rates, a greater insight can be gained into the buffer zones required to protect ground water supplies. To estimate this, it will be necessary to fill certain gaps in our understanding about subsurface reactivity. Technical intervention measures are also conceivable, e.g. *isolation*. Address monitoring options for early detection of any contamination in shallower layers.

The SEA should therefore address the following questions:

- What substances could infiltrate the subsurface ecosystem and what is the probability of this occurring?
- How or to what extent could the problem be resolved by natural processes?
- What buffer zones should be maintained around wells for this reason?
- How should monitoring be carried out and what measures should be relied upon to mitigate any adverse effects?

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[6] Witteveen+Bos, GV1106-1/kleb2/234 final version, *Aanvullend onderzoek naar mogelijke risico's en gevolgen van de opsporing en winning van schalie- en steenkoolgas in Nederland Eindrapport onderzoeksvragen A en B* ['Supplemental study into the potential risks and implications of shale & coal gas exploration and extraction in the Netherlands – Final report on research topics A & B'] (16 August 2013).

Various submissions correctly stated that well caps installed after a well is abandoned can ultimately fail. Address the timescale over which this could occur, the probability that any substances still present could contaminate the subsurface ecosystem, whether and how they could disperse and what the implications of this would be.

Lastly, the NCEA recommends addressing long-term supply basins, e.g. infiltration zones, deep-seepage plateaus, etc. Where are these located and what buffer zones should be imposed?

Subsurface exclusions zones?

The *draft ToR* appears to assume that it is unnecessary to create any other type of subsurface exclusion zone, other than the 1,000-m depth limit beneath surface-level exclusion zones. Justify this in the SEA. In doing so, address any possible interference with other deep subsurface activities such as geothermal power, conventional gas extraction, radioactive waste storage, etc. Clarify these issues, but also address their relation to the STRONG *Structure Vision for the Subsurface*.

Fault systems

Proximity to a fault is currently no longer considered an exclusion criterion, even though the Witteveen+Bos study states that fracking could potentially trigger earthquakes caused by movement along existing tectonic faults[7] subject to shear stress. This is because not all the faults in potential shale gas formations have been equally well identified.

The NCEA emphasises the fact that little or no information is available for certain areas of the *draft ToR's* search area. Hence, very little is known about certain deep subsurface regions and their composition. It is important therefore to gather detailed subsurface information for any future project-specific SEAs in order to map out existing fault systems more reliably than is currently possible, e.g. by drilling or conducting seismic surveys.

However, several large fault systems are well mapped. For example, it is known that Peelhorst in East Brabant is bordered by faults. However, more detailed seismic surveys need to be conducted to determine the exact location of faults and fault zones. Explain in the SEA whether areas with known faults should be automatically precluded or whether a buffer zone should be imposed.

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[7] Three types of earthquake or tremor exist that are also discussed in the Witteveen+Bos report: (1) *Natural earthquakes* triggered by fracking are the most relevant to shale gas extraction. If fracking is carried out in, or very close to, a natural tectonic fault subject to naturally occurring shear stress, then this can cause the fault to shear. This stress would then be dissipated by the release of strain triggered by fracking. (2) *Tremors* can be caused as a direct result of fracking activity. These are minor and probably only relevant to very sensitive systems and installations. (3) The third type of earthquake/tremor relates to movements of the reservoir rock formation along new or existing faults, caused by reservoir compaction in situations where no naturally occurring critical shear stress was previously acting on the fault – *Groningen earthquakes*. This type of earthquake or tremor is unlikely in the case of shale gas extraction because little or no reservoir compaction occurs during extraction.

4.3 Extraction model

The environmental impact assessment is performed using an extraction model. This model for shale gas extraction is based on the *base case* used in the *National Field Development Final Report* (Halliburton, 2011) and on the *Shale Gas Production in a Dutch Perspective* (Royal Haskoning, 2012) report published by Energiebeheer Nederland (EBN), hereinafter referred to as the 'EBN Study'.

The NCEA recommends defining all the elements relevant to each phase of the exploration and extraction process. What is meant exactly by 'an extraction zone', 'a drilling site' or 'a well'? Give an idea of the number of extraction models (min./max.) possibly required to exploit a single concession. What is the procedure for this in terms of time and space?

Supplement the account of the extraction model with quantitative data and clear illustrations of surface and subsurface issues.

Clearly define the extraction model's *base case*. The *draft ToR* refers to thirteen drilling sites, each with ten wells. However, Haskoning (2012) refers to thirty-eight *well pads* with six to ten wells (p. 59). Submissions also revealed that greater clarity is required concerning the scope of operations.

Before shale gas can be commercially exploited, exploration drilling, confirmation drilling, test fracking and production tests all need to be carried out. The NCEA assumes that all these activities will be described in detail in the SEA.

The extraction model should be used to determine the risks, probabilities and impact associate with shale gas extraction. The NCEA considers the *EBN Study* to be useful in this respect, but notes that its information is already several years out of date. It recommends using up-to-date knowledge, including information about international experience and innovation.[8]
For instance, studies are being performed that examine options for minimising the use of additives, e.g. by fracking with liquid propane.
The Minister has announced that research will be conducted into alternative fracking methods as part of the structure vision. Also incorporate these results into the SEA, if possible.

4.3.1 Extraction model characteristics & activities

All the extraction model's characteristics should be defined to an appropriate level so that it can be superimposed onto various landscapes/sub-regions for assessment purposes as part of the framework. Accounts should provide insight into scope, variables and uncertainties. Provide insight into the following issues:

- *Land usage*: Determine the extraction zone's size based on the extraction requirements imposed. Base the SEA on the extraction zone's most probable size (type/surface area), considering minimum viable daily production levels, gas processing station presence, mains gas network connection, water supply, etc.

[8] Expertise and experience from the UK, and not only from the USA, is highly relevant in this respect due to specific SEA information that has already been gathered.

- *No. of drilling sites*:
  Number of sites within the extraction model's area and any leeway technically available for determining site location.
- *Scope*:
  Economic minimum and maximum values for extraction model characteristics (type, size, no. of drilling sites, no. of wells per site, timeline, etc.).
- *Infrastructure*:
  Essential infrastructure, e.g. roads, surface and underground pipelines, central storage capacity, waste processing, etc.
- *Timeline*:
  The timeline for each phase of the exploration and extraction process, and whether sites will be operated simultaneously or consecutively.
- *Cumulative Figures*:
  Cumulative figures for the extraction zone's foremost quantitative characteristics, e.g. vehicle movements[9], water requirements, raw materials, waste, etc., in relation to the environmental impact being assessed for each phase – exploration, implementation, drilling, fracking, extraction (inc. repeat fracking), decommissioning.
- *Directional Drilling*:
  Options available for directional drilling. The *draft ToR* assumes that drilling operations would be vertical to a depth just above the layer being extracted and then horizontal. If directional drilling is an option at an early stage in drilling operations, then this gives greater leeway in terms of drilling site locations.
- *Integration & mitigation measures*;
  A summary of such measures.

The assessment of some of the surface effects is based on landscape types and sub-regions (see § 5.1). Superimpose a model onto the landscape and/or sub-region to illustrate how the area's specific characteristics are taken into account when determining extraction site locations, and how mitigation measures could be taken.

4.3.2 Model drilling site characteristics & activities

Provide insight into the following issues:

- spatial characteristics of a drilling site, e.g. space requirement, visual characteristics, etc.
- anticipated no. of wells per drilling site (min./max.)
- no. of simultaneous drilling operations during drilling phase
- duration at each site for each phase of the drilling and extraction process
- activities and environmental characteristics associated with a drilling site throughout each phase (drilling, fracking and extraction), e.g. traffic, noise, water, waste water, ancillary materials, air quality, light, external safety, etc.
- water requirement, source and transportation options

[9] Foreign submissions specifically requested information about traffic management, namely cross-border traffic to and from shale gas extraction sites close to borders.

- materials used for fracking / produced during extraction[10] and their impact on health, safety and the environment in the event of a leak Include substance characteristics in the impact assessment in the event of subsurface contamination. The availability of information about these substances' characteristics in the event of contamination of shallower formations is fairly limited for the Dutch subsurface. State these gaps in understanding and explain how to deal with them.
- activities and measures for decommissioning a well after extraction

4.4 Alternatives

Objective

The *draft ToR* states the following about the objective of the structure vision: 'In its structure vision, the government will establish a spatial planning framework for possible shale gas exploration and extraction in the Netherlands. The structure vision will state whether shale gas exploration and extraction should be pursued, and if so, where.' It states the SEA report's objective to be '...assessing the environmental impact of shale gas extraction on potentially suitable areas. The SEA report will present the risks and probabilities associated with potential shale gas extraction (above and below ground) and will provide points for attention and parameters for further planning purposes.'

Alternatives

The *draft ToR* does not discuss what potential alternatives exist in terms of these objectives, whereas this would be a mandatory requirement for an SEA. The NCEA recommends discussing this in the SEA.

In Section 3.2, the NCEA stated what it believes to be viable alternatives in the context of the 'benefit & necessity' debate.

Based on these alternatives, the NCEA recommends providing an insight into the possible implications of *large-scale* shale gas extraction when considering possible locations. Alternatives should therefore illustrate the full range of activities and environmental implications from a spatial planning perspective. Cumulative effects are important in terms of distinguishing clearly between alternatives. Whether one or ten sites make a difference in terms of environmental impact depends on their potential *cumulative* effect.

The NCEA envisages a *minimum alternative* whereby a single extraction model is located at a promising potential site, e.g. in one or two landscape types within a single region, and a realistic *maximum alternative*, e.g. in all landscape types across multiple. potentially suitable regions (assuming multiple nationwide initiatives). Both *minimum* and *maximum* alternatives should be economically realistic and reasonably attainable, e.g. in light of the quantities of drilling equipment available.

[10] Various submissions referred to NORM (naturally occurring radioactive materials). Both the Posidonia and Geverik are relatively rich in uranium. It is conceivable that uranium and decay series daughter elements, as well as any other heavy metals present in the shale, could be brought to the surface with produced water.

5. Impact account & assessment

Reference
Clarify what the effects are being compared with. Discuss how the SEA deals with the current situation and autonomous development of the areas under investigation.

Impact description for extraction model & alternatives
Clearly consider in the SEA the extraction model's impact on its own merits and express this in terms of actual extraction scenarios for *minimum* and *maximum* alternatives.

5.1 Extraction model & assessment framework usage

The extraction model's characteristics should be assessed in light of the environmental concerns listed in the assessment framework. This will result in a refinement of the map depicting exclusion zones, potential extraction zones and zones not automatically precluded from potential extraction operations. Area boundaries should be as specific as possible, i.e. delineated to scale with a recognisable topographical subsurface. Address the level of detail required in the SEA for its impact description in order to assist with structure vision policy-making. The NCEA assumes that a sub-regional level of detail is sufficient for the purposes of extrapolating environmental scores to a map image.

Landscape type description
The *draft ToR* requires that surface-level impact descriptions be based on seven factors, e.g. landscape, flora, fauna, etc., with reference to eight landscape types. Initially, effects should be illustrated based on the landscape type's characteristics. Next, these should be extrapolated to sub-regions.

The NCEA believes this approach to be useful, as long as the method and associated uncertainties/limitations[11] are properly justified in the SEA. When extrapolating effects to a sub-regional level, regional differences may exist that affect their assessment. For example, the impact of shale gas extraction on cover sand areas in North-East Friesland would be different from its impact in the Achterhoek or East Brabant. Indicate how this will be addressed in the SEA. Use an intermediate stage if necessary, e.g. northern, central and southern cover sand areas, to make this extrapolation more intelligible[12].

5.2 Surface/shallow subsurface impact

5.2.1 Soil

The *draft ToR's* assessment framework lists criteria for the impact on soil quality and soil balance. Specify in more detail the depths at which this will be assessed. The 'landscape type'

[11] For most of the Netherlands, no particular landscape type will be dominant, for example the overlap with urban areas.
[12] Various submissions also stated that a refinement should made in order to distinguish landscape types.

approach is relevant to the surface and perhaps even down to depths of several tens of metres below the surface. However, subsurface geology usually bears little or no relation to that at surface level.

Soil and/or water contamination will have a varying impact on the ecosystem depending on depth. The Dutch National Institute for Public Health and the Environment (RIVM) and the Netherlands Environmental Assessment Agency (PBL) are currently mapping the Netherlands' *natural capital* as part of the DANK project ('Digital Atlas of Natural Capital'). DANK could form a basis for visualising the ecological impact of any contamination arising from shale gas operations.

Drilling operations produce large volumes of cuttings in the form of solid materials and rock. Describe how this material should be processed.

5.2.2 Water

The *draft ToR's* assessment framework mentions both groundwater and surface water. The NCEA recommends listing drinking water separately as a separate category in light of numerous submissions on this subject. Also describe any impact on the water system and its management.

As voiced in various submissions, the *draft ToR* fails to explicitly mention the quality and quantity of water used and produced during shale gas extraction.

Changes in water quality and its purification may have an environmental impact. Distinguish between water used for fracking, water produced during the first phase and formation water that comes to the surface for an extended period during the extraction phase. Address the waste treatment processes that would be required as a result.

The quantities of water required to produce drilling fluid and for hydraulic fracking are also important. Address the source of this water. Is it sourced locally? Is it shipped in? Is it grey water? Or does it come from a water purification plant? This can have any one of many environmental impacts. Discuss the most recent insights regarding fracking water requirements. It is often assumed that large quantities of water are required. Is this still the case? How do the quantities used compare to other activities, e.g. industry, agriculture, households, etc.?

5.2.3 Flora & fauna

The *draft ToR* states that the impact on *protected areas* should be defined with reference to five criteria and the impact on *protected species* with reference to six criteria. The NCEA endorses the criteria listed. In light of the submissions received, it proposes that the 'dehydration' criterion be extended to include *dehydration* and *groundwater/water quality* under the header 'hydraulic issues'. Pay particular attention to the relationship with PAN (Programmatic Approach to Nitrogen) when addressing nitrogen deposition issues.

Protected areas

The *draft ToR* states that the impact on *Natura 2000* areas will be detailed in an *appropriate assessment* document[13]. This document should form a clearly defined component of the SEA. Incorporate its main conclusions into the SEA. Also include relevant Belgian and German *Natura 2000* sites in the assessment.

The *appropriate assessment* document should draw conclusions for each individual *Natura 2000* area, i.e. landscape type → sub-region → *Natura 2000* area, appropriate for the SEA's level of detail. Indicate whether any harm to natural characteristics may be precluded for the various *Natura 2000* areas.

Also explicitly address the implications for protected national monument areas that fall under the auspices of the Dutch *Nature Conservation Act 1998*. This is important due to the potential susceptibility of these areas to shale gas operations. Generally, they occupy a minimal area of land, even though a complex hydrological system is involved.

Detail whether any harm to national ecological network (EHS) areas may be precluded in terms of these areas' *essential characteristics* and *values*. Do so at a level of detail commensurate with the SEA, e.g. by extrapolating landscape-type effects to types of nature management (as a measure of their essential characteristics and values) and in turn, by illustrating these effects on EHS areas (or clusters of EHS areas) for each sub-region. Also describe how other protected areas[14] (and if relevant, similar areas in Belgium and Germany[15]) will be addressed.

Protected species

Indicate for each family or genus (or group of relevant species with equivalent habitat requirements, i.e. by applying a habitat-based approach)[16] whether shale gas extraction would be detrimental to their conservation status and which cause-and-effect relationships are involved.

5.2.4 Landscape & cultural heritage

Issues described under the headers *spatial planning quality*, *landscape* and *cultural heritage* (inc. archaeology) should be assessed with reference to specific landscape-type and sub-regional characteristics. In doing so, use as many maps and illustrations as possible.

As stated in various submissions, several types of Dutch landscape exist with a protected status, ranging from 'world heritage site', such as (provisionally) the New Dutch Waterline, through 'national landscape' to 'regionally protected landscape'. These areas will generally not coincide with regional or national landscape types. Describe in the SEA how this issue will be addressed.

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[13] *Natura 2000* sites constitute exclusion zones, but *external effects* should still be assessed.

[14] Provincial spatial planning by-laws sometimes protect other areas of natural value outside the auspices of the EHS.

[15] Various submissions from government bodies in other countries requested that attention be paid to these issues.

[16] This approach may be combined with the impact assessment for protected/vulnerable areas, e.g. meadow bird areas.

5.2.5 Living environment

Noise

The *draft ToR's* assessment framework states that noise levels will be assessed for housing and other susceptible properties. This suggests that calculations will be performed for all non-precluded areas. The NCEA believes that this is unnecessary at this stage.

It recommends mapping the extraction model's noise contours. Differentiate between the noise levels generated during each phase, including the duration for each specific activity. Distinguish between average noise levels (day/evening/night-time mean long-term assessment levels) and peak levels (maximum), especially in relation to pipe handling, fracking and flaring operations. It is important to adopt an assessment framework that prevents or minimises serious nuisance or disruption to sleep[17]. Noise contours may add an additional dimension to exclusion zones, or even result in buffer zones.

Air quality

NO_2 and particulate matter ($PM_{2.5}$ and PM_{10}) levels can be mapped as contours in a similar way to noise levels. New exclusion zones or buffer zones may arise where critical situations still exist and concentration levels are higher than 'insignificant'. Any potential emissions/immissions of other substances in addition to NO_2 and fine particulate matter should also be analysed, e.g. CH_4 and H_2S.

External safety

In this context, external safety is understood to mean the risks arising from the storage, trans-shipment and use of hazardous substances. Site-specific risk contours can be determined, indicating where potential exclusion or buffer zones should be imposed in a similar way as noise contours.

Table 5.2 in the *draft ToR* states that the *collective risk* (CR) will be calculated. The NCEA believes that this is also unnecessary. Every potential site would then have to be investigated because a CR is site-specific. Assume therefore a pre-determined value for absolute CR and a rise in CR. The pre-determined CR value can then be specified in more detail as part of follow-up procedures relating directly to the options available at the site in question.

Health

The *draft ToR* states on p. 3 that the SEA report should address potential adverse effects of shale gas extraction on health, safety and the environment, and how to mitigate or prevent these as far as possible. Health was not addressed as part of the assessment framework. The

[17] In effect, this means that more stringent noise level limits will generally be imposed than imposed under the Dutch *General Environmental Regulations for the Mining Industry Decree* (BARMM).

NCEA recommends clarifying in the SEA report what effects shale gas extraction can have on health, how these can be assessed and what measures can be taken to mitigate these effects.

5.3 Subsurface risks & effects

The Witteveen+Bos report concluded that the probability of adverse subsurface effects occurring, e.g. groundwater contamination, are readily manageable using common technical measures for well installations and well capping. The NCEA endorses this in its recommendations on this study[18], with the proviso that technical procedures be properly and adequately performed and supervision of these matter be properly implemented. Incorporate the foremost conclusions from the Witteveen+Bos report on potential risks and associated countermeasures, and update these wherever necessary.

Risk = Probability × Impact. The intensity of shale gas operations will result in an increased probability of an incident, as compared to conventional gas operations. As previously mentioned, two issues are of major importance in the event of an incident in which hazardous substances escape from the well at depth – natural restoration and monitoring/technical remediation.

Estimate the time required for natural restoration to occur and the subsurface volume adversely affected by the incident. It is important to distinguish between substances added during fracking, e.g. organic substances such as biocides, and naturally occurring substances in the brine found in shale formations, e.g. radioactive isotopes.

Provide an insight into possible monitoring systems designed to act as an early-warning system and explain what technical measures could then be taken.

5.4 STRONG (Structure vision for the subsurface)

One question that arose frequently in submissions was how the *Structure Vision for Shale Gas* related to the *Structure Vision for the Subsurface* (STRONG). The *draft ToR* states that the *Structure Vision for Shale Gas* forms an integral part of STRONG. The *Structure Vision for Shale Gas* focuses primarily on where shale gas could be extracted, whereas shale gas is just one of many issues addressed in STRONG. In this light, the question then arises as to whether shale gas extraction could be permitted given other subsurface activities addressed by STRONG.

Clarify STRONG's timeline in the SEA report. The NCEA foresees that the investigation into shale gas (outlined in the SEA report) would be conducted first and that, time permitting, its findings would then be incorporated into STRONG.

Whatever the case may be, state in the SEA report which subsurface activities might be affected by shale gas extraction and extraction. State the extent to which activities are located in the same strata and whether strata above or below could be disrupted in any way.

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[18] 023-114 *Beoordeling effectstudie Schaliegaswinning* ['Evaluation of impact study into Shale Gas Extraction'] (19 September 2013)

6. Uncertainties & gaps in understanding

Much is still unknown about the Netherlands' deep subsurface. However, this should not stand in the way of an analysis into the pros and cons of shale gas. Consider these uncertainties in terms of bandwidths, probability distributions, etc. and appropriate countermeasures.

List the uncertainties and state how each uncertainty will be addressed in the decision-making process. Which uncertainties may be left for follow-up investigations and subsequent decision-making? Which uncertainties could result in a 'no go'? Address the significance attributed to the precautionary principle.

7. Follow-up steps & subsequent decision-making

7.1 Other studies

Address other studies conducted within the context of the structure vision, e.g. the study into alternative drilling techniques and amendments to the Dutch *Mining Act*. The NCEA assumes that any findings will be incorporated into the SEA's account.

7.2 Follow-up decisions

Section 1.1 of the *draft ToR* states that the *Structure Vision for Shale Gas* should provide a spatial planning framework for potential shale gas exploration and extraction in the Netherlands, assuming the question as to *whether* this is permissible has been answered. The structure vision should state whether shale gas exploration and extraction may proceed and if so, where. The structure vision does not address specific sites in a given region. This will only happen once a concrete initiative is in place.

In order to avoid unnecessary discussions, the NCEA believes that it is important to provide as much clarity as possible regarding the subsequent decision-making process and the mandatory requirement to draft/establish an SEA report or project. Various submissions pointed to an omission in the Dutch *Environmental Impact Assessment Decree* concerning a mandatory requirement to set up an SEA project or draft an SEA report in the follow-up phase.

7.2.1 Subsequent decision-making on spatial planning at municipal, inter-municipal, provincial and/or national level(s)

Section 1.1. of the *draft ToR* states that a site-specific SEA project should be initiated at a licensing level. However, subsequent decision-making on spatial planning is not discussed. Nonetheless, this will often be the case because zoning plans would be insufficient for allowing shale gas operations to proceed. Amendments to local authority zoning plans would then be required. It is probable that the government would implement some form of concrete planning framework for shale gas exploration and exploitation by means of a government-imposed zoning plan amendment given that shale gas activities could cross municipal

boundaries and regional interests would be at stake in shale gas operations. It is also possible that the provinces could initiate subsequent decision-making on spatial planning by means of provincial zoning plans that allow shale gas exploration and exploitation.

State in the SEA at which decision-making level subsequent spatial planning policy is expected to be made.

7.2.2 Mandatory SEA requirement for subsequent decision-making

Section 1.1. of the *draft ToR* states that a SEA project be established for concrete initiatives in the context of the required licences. Several remarks can be made about this section and Figure 1 included therein.

Firstly, the question as to what is meant by a 'concrete initiative'. Given that the structure vision also deals with shale gas exploration, it would seem to include initiatives aimed at shale gas exploration. This was explicitly confirmed in the Minister of Economic Affairs' letter to the House of Representatives dated 26 August 2013. This should be clearly stated in the SEA, so that no doubts exist about this matter.
Secondly, the Dutch *Environmental Impact Assessment Decree* does not provide for a mandatory requirement to initiate/draft an SEA project or SEA report for granting the required licences (subsequent decision-making)

The NCEA addresses this issue in more detail below: The NCEA recommends presenting a clear schedule in the SEA report for possible subsequent decision-making processes and associated mandatory SEA requirements.

Mandatory SEA requirements per phase

Exploration phase

Of all the potentially applicable activity categories in Sections C and D of the annex to the *Environmental Impact Assessment Decree*, only Category D17.2 applies to shale gas exploration. This category addresses deep drilling. Deep drilling will not generally be permitted within the context of the current zoning plan. This is why either a zoning plan or a provincial/national government-imposed zoning plan amendment or a project deviation decision (integrated environmental permit for those activities deviating from the zoning plan) would be needed to allow deep drilling operations to proceed. When opting for a zoning plan or government-imposed zoning plan amendment, a mandatory SEA report requirement would exist if the plan aims to provide the framework for Column 4 decision-making purposes under D-17.2. It is not certain whether the plan will always provide this framework however.

During the exploration phase (onshore), it is probable that only mobile systems will be used that fall under the auspices of the *General Environmental Regulations for the Mining Industry Decree* (BARMM). This would not constitute any need for a framework plan. There may be a need to establish a framework plan if a plan requires an integrated environmental permit for an installation during exploration. The plan is then subject to an SEA report. An integrated environmental permit for an installation used at a later stage in operations is subject to an SEA assessment, but not directly subject to a requirement for an SEA project. If opting for a project deviation decision instead of a zoning plan amendment, then an SEA would become a mandatory requirement.
The exploration licence issued under Section 6 of the Dutch *Mining Act* is not a 'decision' as referred to in D-17.2, Column 4. This decision is not subject to an SEA, therefore.

Extraction phase

Other *Environmental Impact Assessment Decree* categories may be relevant to the extraction phase[19]. It could be argued that if extraction is permitted under planning rules using a zoning plan or a provincial/national government-imposed zoning plan amendment, then it would already be subject to an SEA report requirement by virtue of D-17.2. The environmental permit (regular or integrated) would then be subject to an SEA report requirement. If extraction is permitted using a project deviation decision under planning rules, then an SEA report would not be necessary.

Section 1.1 and Figure 1 of the *draft ToR* do not explain what the legal obligation to establish an SEA project is based on. This obligation does not automatically exist. For example, an SEA project only needs to be established if the production threshold of 500,000 m^3 of shale gas per day is exceeded (C-17.2) or if the water infiltration threshold of 10 million m^3 of water per year is exceeded (C-15.1).

[19] C-8.1, C-17.2, C-15.1, D-8.2, D-17.2, D-17.3, D-25.2.

Appropriate assessment

If an *appropriate assessment* needs to be drafted for a zoning plan or a provincial/national government-imposed zoning plan amendment, then a mandatory requirement for an SEA report would – for this reason – still exist for the plan.

SEA project for permit

The SEA decision (if required) concerning the environmental permit may focus wholly on issues relating to the shale gas extraction site and may refer back to the SEA report if necessary, insofar as it actually contains the relevant information.

Advice Terms of Reference for EIA Structure vision Shale Gas

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