6 Sound

6.1 Delimitation of the study area

The study area for the discipline of Sound is limited to the zone within which relevant effects may occur.

In accordance with the provisions of VLAREM II, the zone is considered to be 200 m from the edge of the project area, supplemented by the noise-sensitive zones 200 m from the industrial area in which the project area is located. This concerns the nearest nature reserve, Galgenschoor, which extends less than 200 m west of the project area, and the Opstalvallei nature reserve on the other side of canal dock B2, more than 400 m northeast of the project area. The residential area of Lillo is located approximately 1.3 km south/southwest of the project area and 200 m from the industrial area. In addition, one additional discreet reference point is considered at the level of the houses in Berendrecht, which is located approximately 890 m northeast of the project area.

For the acoustic assessment with regard to the disciplines of Human Health and Biodiversity, the study area is further extended to a zone of approximately 2 km around the project area, with the calculated noise contour of 40 dB(A) as the lower limit. See Chapter 13 Human Health and Chapter 11 Biodiversity for the specific acoustic assessment of these disciplines.

6.2 Methodology

6.2.1 Description of the reference situation

The description of the reference situation in the Noise discipline is based on noise measurements in the vicinity of the project area on the one hand and the strategic noise maps for the Antwerp agglomeration for road traffic and industry (reference year 2016) on the other.

As part of this EIA, continuous immission measurements were carried out at four measuring points for four weeks in June 2019, three weeks in February 2021 and 4.5 weeks in December 2023 – January 2024:

4. Scheldelaan (west) bordering the Galgenschoor north nature reserve;
5. Scheldelaan (west) bordering the Galgenschoor South nature reserve;
6. residential area in Lillo (south/south-west) and
7. residential area in Berendrecht (northeast) of

the project area.

6.2.2 Description and assessment of environmental impacts

In the description and assessment of the impacts, a distinction will be made between the construction phase on the one hand and the operational phase of Project One on the other.

To determine the noise impact of the work during the **construction phase** of the project, the noise effect of the various construction stages on the surrounding area is calculated using an acoustic transmission model.

Project One has estimated the activities that will take place and the machinery that will be used for this purpose. This estimate takes into account the type, number and operating time of the construction machinery in the northern and southern parts of the project area respectively. This is an estimate of the machines that can be used simultaneously and therefore represents the maximum but representative noise emission per construction stage.

The noise emission or sound power (Lw) per type of machine is estimated on the basis of the Royal Decree of 6 March 2002 on the sound power of equipment for outdoor use (2000/14/EC), on the basis of technical manufacturer specifications applicable to categorised construction machinery and on the basis of available data from the literature relating to the noise emission of machinery during construction work and on open work sites.

Based on the calculated noise emissions from the various site activities for the entire duration (approximately 44 months) of the construction phase, a distinction can be made between three site phases within the Noise discipline. For the Noise discipline, it is important to divide the construction phase into different stages, as the type, number and operating time of the machines can vary significantly between the different construction stages and the calculated noise emissions from the site. We distinguish between the following stages/activities:

- Construction phase A: removal of vegetation, excavation of topsoil and limited levelling of the site, construction of access roads, construction of a contractor village.
- Site phase B: site profiling (cut and fill), foundation works, etc.
- Site phase C: construction of the project's buildings and installations, etc.

The sound effect for the three construction phases will be quantified using the acoustic model for both the day and evening/night periods. The calculated noise emissions for the three construction phases will be spatially distributed across the entire project area.

For the impact description and assessment for the **operational phase**, the noise power levels of the relevant installation zones of Project One and their respective locations were provided by the client. The specified sound power levels per zone are the result of the noise emissions for the individual installations based on the supplier data obtained and, in the absence of data, based on assumptions from similar installations. For the estimation of the future situation during the operation of Project One, a distinction will be made between the following elements:

- The effect of operation during representative, yet maximum, operation of the production installations of the future company, evaluated as a continuous noise emission;
- The effect of operation during start-up or planned shutdown of the ECR, during which one ground flare may be in operation in addition to the production installations (a normal start-up takes 24 to 72 hours, a planned shutdown takes several hours), evaluated as a continuous noise emission;
- The effect of operations during an emergency, in which one or more of the company's flares may be in operation for a short period of time in addition to the continuous sources, is evaluated as an incidental noise emission.

For both the construction phase and the operational phase, the transfer calculations are performed in accordance with the ISO 9613-2 standard using the 'IMMI' computer programme, version 2020, for the standardised 1/3 octave bands between 25 Hz and 10,000 Hz. This takes into account geometric expansion, air absorption, potentially relevant screen effects and the influence of the ground.

The calculated specific noise is determined using the acoustic transmission model on a fixed grid of 20x20m to determine the noise contours of the specific noise over the entire surface of the study area as well as at discrete reference points, including the four reference points 'IP1', 'IP2', ‘IP3’ and ‘IP4’, where immission measurements were also carried out.

A qualitative analysis will be carried out to assess the impact of the project on traffic flows on the relevant roads and waterways, which in turn may result in a change in noise emissions from the road or waterway. To assess the change in noise emissions from the road, mobility data (see Chapter 10 Mobility) will be used to predict traffic flows on the roads before and during the construction and operational phases of the project. To assess the change in noise emissions from shipping traffic on canal dock B1/B2, data from the Antwerp Port Authority reflecting current shipping traffic will be used, as well as data from the Mobility and Soil disciplines providing an estimate of the expected shipping traffic during the construction and operational phases of the project.

In order to assess the planned situation, the calculated specific noise level of the planned situation will be compared with the reference situation and tested against the applicable conditions in accordance with VLAREM II.

If relevant effects are identified, mitigating measures will be proposed.

6.2.3 Effect expression

The effects for the Noise discipline are expressed in a specific noise level in dB(A).

For the construction phase, the specific noise levels of the relevant activities/machinery used are determined for discrete locations near residential areas and nature reserves (the most noise-sensitive areas) and in the form of contours across the entire study area.

The effect of the facility's operation will also be assessed at discrete reference points near residential areas and nature reserves, supplemented by discrete reference points 200 metres from the site boundary and in the form of contours across the entire study area.

As prescribed in the guidelines, the effects will be calculated at a standard height of 4 m above ground level. The change in noise level (ambient noise) for these representative points will be expressed as an effect.

The calculated noise contour maps will also serve as input for the disciplines of Human Health and Biodiversity in determining the potential nuisance.

6.2.4 Assessment framework

The legal assessment framework for nuisance-causing establishments is Title II of the VLAREM (Belgian Official Gazette 31/7/1995, amended and replaced in part by Belgian Official Gazette 31/3/1999) including all amendments made in subsequent years by means of decisions of the Flemish Government.

According to the provisions of **VLAREM II**, Annex 2.2.1. "**Environmental quality standards** for noise in the open air", the following standards apply to the LA95,1h of the original ambient noise, depending on the regional plan designation or equivalent BPA (special development plan) or RUP (spatial implementation plan) designation or the location in relation to another designation.

Table 6-1: Environmental quality standards for noise in open air

Area	Environmental quality standards in dB(A)		
	during the day	evening	At night
1. Rural areas and areas for recreational stays	40	35	30
2. Areas or parts of areas less than 500 m from industrial areas not mentioned in point 3 or from areas for community facilities and public utilities	50	45	45
3. Areas or parts of areas located less than 500 m from areas for craft industries and small and medium-sized enterprises, service areas or areas under development during development.	50	45	40
4. Residential areas	45	40	35
5. Industrial areas, service areas, areas for community facilities and public utilities, and development facilities during development	60	*55*	5
6. Recreational areas, excluding areas for residential recreation	50	45	40
7. All other areas, except: buffer zones, military domains and those for which guideline values are set in special decisions	45	40	35
8. Buffer zones	55	50	50
9. Areas or parts of areas located less than 500 m from extraction areas designated for gravel extraction during extraction	55	50	45
10. Agricultural areas	45	40	35
Note: If an area falls under two or more points in the table, the highest guideline value applies in that area. Day: from 7 a.m. to 7 p.m. Evening: from 7 p.m. to 10 p.m. Night: from 10 p.m. to 7 a.m.			

The guideline values (RW) for specific noise in open air from establishments classified as nuisance-causing as described in Annex 4.5.4 of VLAREM II correspond to the above values (same areas and guideline values as Annex 2.2.1).

These guideline values impose restrictions on the noise caused by the facility in question in the surrounding area. The facility's own contribution to the total noise level in the surrounding area is referred to as the 'specific noise Lsp'. The restriction depends on the period (day-evening-night), the location according to the regional plan of both the installation itself and the reference point, and finally on the date of authorisation, existing or new installation.

The conditions for a **new** Class 1 and 2 **facility** are set out in Chapter 4.5.3 of VLAREM II, Article 4.5.3.1, and can be summarised as follows:

- If the original ambient noise (LOOG) is lower than the guideline value (applicable to the areas considered as described in § 2.2.1), the specific noise must be lower than the guideline value reduced by 5 dB(A).

Lsp < guideline value (RW) - 5 dB(A)

Lsp < original ambient noise (LOOG) - 5 dB(A) and

Lsp < guideline value (RW)

- If the original ambient noise (LOOG) exceeds the reference value (RW), the specific noise of the new installation (Lsp) must comply with the most stringent of the following two conditions:

The above conditions apply to the continuous noise emitted by an establishment.

For incidental noise, i.e. noise whose level increases infrequently as a result of events lasting longer than 2 seconds and in total no longer than 10% of the duration of the relevant assessment period, the following conditions apply:

Table 6-2: Guideline values for incidental noise

Guideline value expressed as LAeq,1s in dB(A)		
during the day	**evening**	**at night**
Applicable value +15	Applicable value +10	Applicable value +10
The applicable value for new establishments is the guideline value in Appendix 4.5.4 of VLAREM II reduced by 5 dB(A).		

The activities that will take place in preparation for the site and the construction itself are not classified as an establishment, so the conditions for specific noise do not apply.

For the evaluation of the construction phase, the extent to which the existing noise climate is affected by the planned construction activities will be assessed using the assessment framework described in section 6.2.5 below. For the assessment of vibrations during the construction phase, reference can be made to the comfort criteria as described in DIN 4150 (German standard).

6.2.5 Assessment framework

To assess the impact of the project (construction phase and operational phase) on environmental noise, the significance framework applicable to new facilities with regard to noise will be applied (significance framework as described in the guidelines manual for noise and vibrations of February 2011). As with the VLAREM II legislation, the point at which this assessment is carried out will be chosen at discrete points 200 m from or near the nearest homes and nature reserves. Table 6-3 below provides an overview of the significance framework.

Table 6-3: Significance framework for noise

Impact on the environment		Final score after correction for new developments	
L_{na}-L_{before}	Interim score		
$\Delta L_{AX,T}$	(effect score)	Lsp≤GW	Lsp>GW
$\Delta L_{AX,T}>+6$	-3	-1	-3
$+3<\Delta L_{AX,T}\leq+6$	-2	-1	-3
$+1<\Delta L_{AX,T}\leq+3$	-1	-1	-3
$-1\leq\Delta L_{AX,T}\leq+1$	0	0	-1 / -2 *
$-3\leq\Delta L_{AX,T}<-1$	+1	+1	-
$-6\leq\Delta L_{AX,T}<-3$	+2	+2	-
$\Delta L_{AX,T}<-6$	+3	+3	-
$\Delta L_{AX,T}$: difference in ambient noise in dB(A) before and after a project is implemented, with X and T to be determined and justified by the expert With T = duration in seconds With X = "N" parameter of statistical analysis ($L_{AN,T}$), in VLAREM II N = 95 is used for testing against the environmental quality standard or "eq" for the equivalent sound pressure level ($L_{Aeq,T}$) of the ambient noise			
GW: limit value (= value between the guideline value and guideline value – 5, depending on the original ambient noise level) Lsp: specific noise * the choice of -1 or -2 depends on the extent to which the GW is exceeded (whether or not within the confidence interval of the calculated specific immission)			

For those exceptional situations where the noise climate improves (significantly) but the limit values are still exceeded (box with '-'), the expert will indicate a score accompanied by a sound justification.

The final negative scores are linked to mitigating measures as follows:

Significance level	Mitigating measures
Limited negative (-1)	Research into mitigating measures is less compelling, but if the legal and policy preconditions indicate that a problem may arise, the expert must proceed to propose mitigating measures. If these are not available, this must be justified.
Negative (-2)	It is essential to seek mitigating measures linked to the longer term. If these are not available, reasons must be given.
Significantly negative (-3)	Mitigating measures linked to the short term must be sought. If these are not available, this must be justified.

The scores 0, +1, +2 and +3 are assessed as negligible/none, limited positive, positive and significantly positive, respectively. See § 5.3 for a description of the 7-point scale used in the significance frameworks and the negative scores linked to the mitigating measures.

For noise sources that are not covered by VLAREM legislation – including activities during the construction phase – the corrected final score is strictly speaking not applicable, as there are no legally imposed limit values, and the so-called interim score, i.e. the extent to which the existing noise climate is affected by the planned activities, is taken into account in the first instance.

6.3 Reference situation

6.3.1 Description of the existing situation

The project area is located in the port of Antwerp and, according to the Antwerp Regional Plan, is situated in a zone designated as an industrial area. The project area is also located within the boundaries of the regional spatial implementation plan (GRUP) Demarcation of the Antwerp Seaport Area and, more specifically, within the area for seaport and water-related businesses in the 'Industry' zoning category. This means that the zoning of the area is confirmed in accordance with the provisions of VLAREM II, Annex 2.2.1, as area 5 (see Table 6-1). See Chapter 3 Project Description for a spatial description of the project area. An aerial photograph of the existing situation with the boundaries of the project area indicated is shown in Figure 6-5.

To the east, the project area borders canal dock B1/B2. On the other side of the canal are the nearest homes in Berendrecht, approximately 890 metres northeast of the project area. South of the Berendrecht residential area and more than 400 metres northeast of the future boundary of Project One lies the Opstalvallei nature reserve.

Less than 200 metres west of the project area is the Galgenschoor nature reserve, which stretches between the industrial area and the right bank of the Scheldt. Further south, approximately 1.3 kilometres from the project area and adjacent to the Galgenschoor nature reserve, is the residential area of Lillo.

In the current situation, the noise climate of the project area and its immediate surroundings is determined by industrial activities in the industrial area and, to a limited extent, by traffic noise.

The strategic noise maps for the Antwerp agglomeration (reference year 2016) for the project area zone relating to industry and road traffic are shown in the following four figures. These noise maps for Lden[10] and Lnight[11] can be found on the website of the Environment Department (source: https://omgeving.vlaanderen.be/geluidsbelastingkaarten).

When preparing this EIA (the research data was updated in December 2023/January 2024), the most recently published strategic noise maps for the Antwerp agglomeration for the reference year 2021 were not yet available (publication date 22/03/2024 https://www.portofantwerpbruges.com/geluidsbelasting-antwerpen). Furthermore, the new maps generally show higher noise levels in the area from road traffic and industrial noise than those from the reference year 2016, which is a consequence of the newly applied CNOSSOS calculation method (lower soil absorption factors and modified transmission calculations) and modified basic data. In this EIA, it has therefore been decided to continue to use the noise pollution maps from the reference year 2016 for the impact assessment, in order to provide the most critical evaluation of the project. Taking into account the fact that the new noise pollution maps (reference year 2021) generally show higher ambient noise levels – and will therefore probably imply a 'louder' reference situation – the negative noise effects of the project on ambient noise will remain unchanged or may be more limited than described in this EIA.

10 Lden: day-evening-night noise exposure indicator - the A-weighted long-term average over 1 year during the 24-hour period.
11 Lnight: night-time noise exposure indicator - the A-weighted long-term average over 1 year during the night-time period.

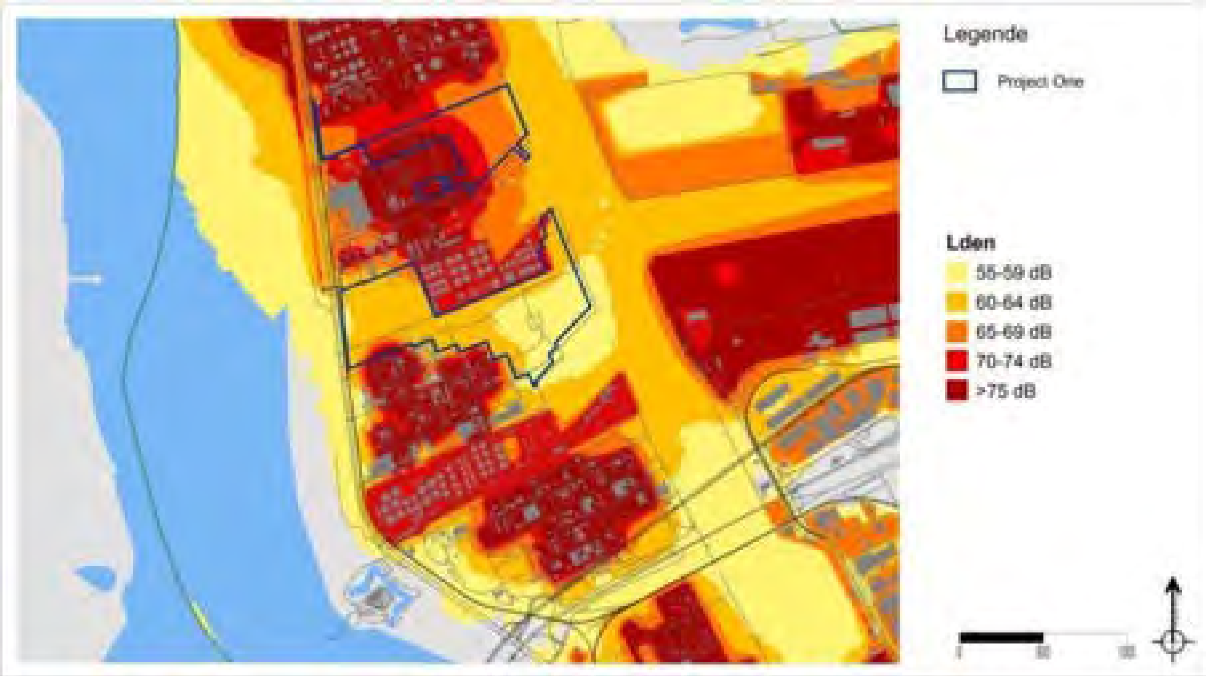


Figure 6-1: Strategic noise map for the Antwerp agglomeration - industry Lden (source: Environment Department)

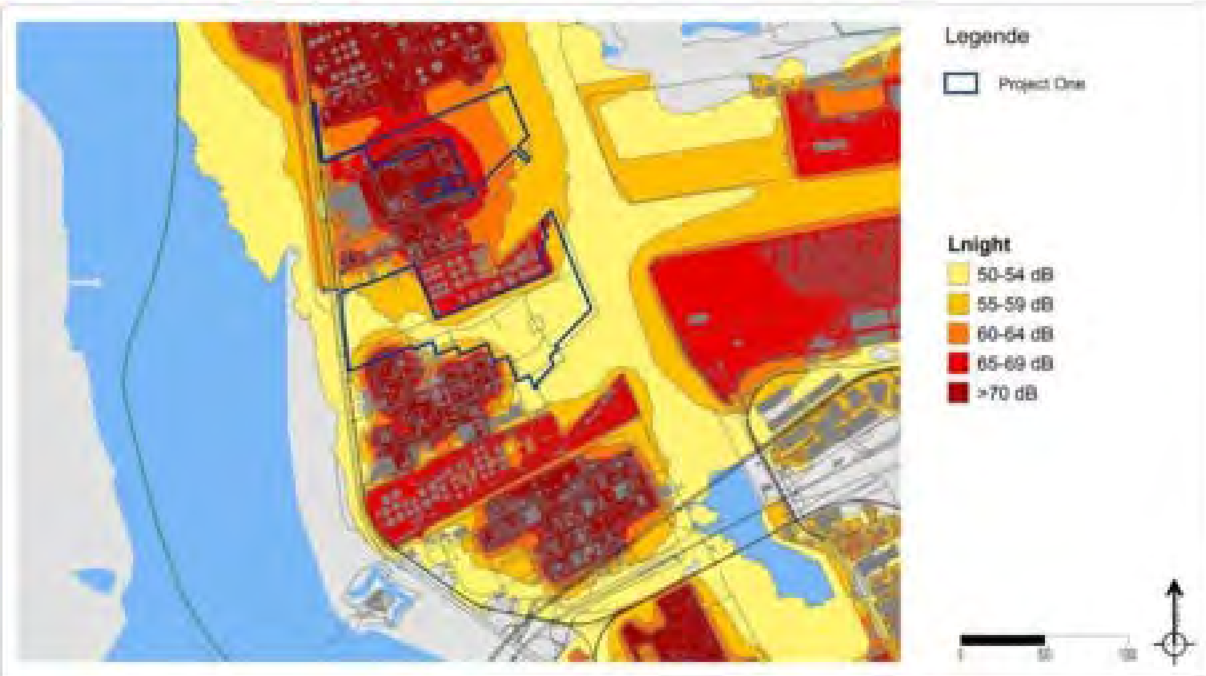


Figure 6-2: Strategic noise map for the Antwerp agglomeration - industry Lnight (source: Environment Department)

Figure 6-3: Strategic noise map for the Antwerp agglomeration - road traffic Lden (source: Environment Department)

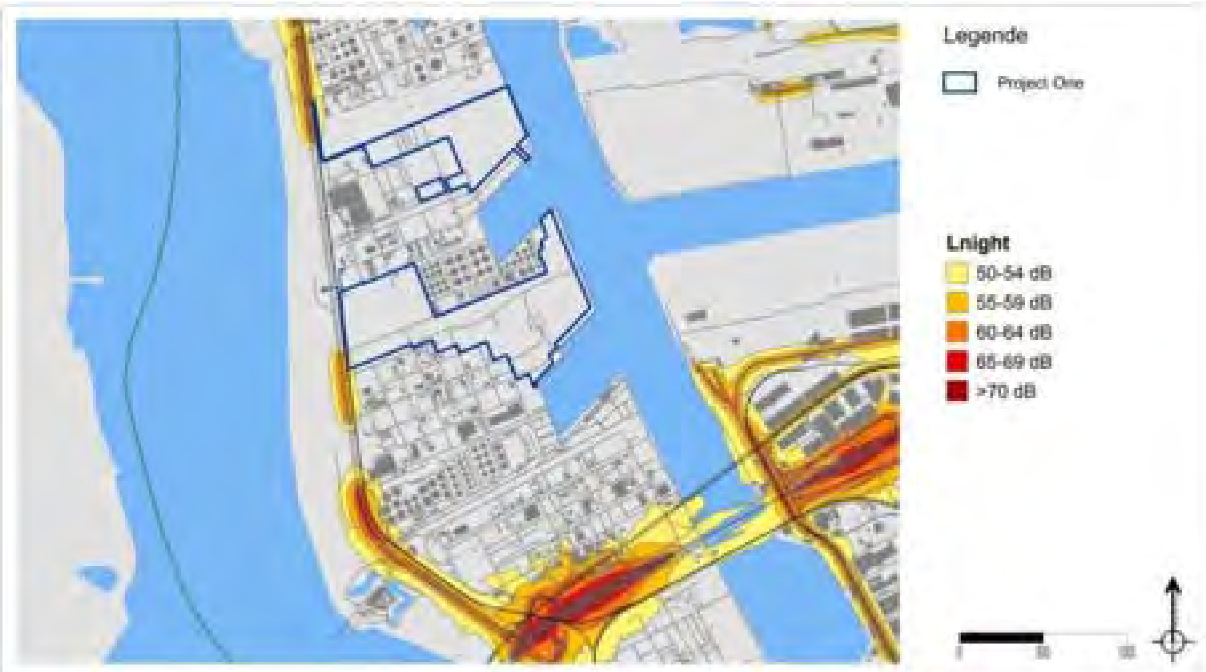


Figure 6-4: Strategic noise map for the Antwerp agglomeration – road traffic Lnight (source: Environment Department)

Based on the above strategic noise maps, the dominant influence of industrial activities on the project area is clearly noticeable. The influence of road traffic on Scheldelaan has hardly any impact on the project area. However, the maps show that the noise emissions from road traffic near the homes in Lillo and the southern half of the Galgenschoor nature reserve cannot be considered entirely negligible compared to the noise emissions from industry. It should be noted that in 2017, and therefore after the above maps were drawn up, the entire road infrastructure of Scheldelaan from the Berendrechtsluis to the R2 slip road complex in Lillo was renewed. The new asphalt road surface may result in lower noise emissions from road traffic on Scheldelaan than shown on the above maps.

The contours of the more distant motorways R2 (approx. 1.3 km away) and A12 (approx. 3 km away) from the project area, as well as those of air and rail traffic, have no impact on the project area.

6.3.2 Immission measurements of ambient noise

In preparation for Project One, the existing ambient noise in the vicinity of the project area was measured in June 2019. Continuous immission measurements were carried out at four measuring points over a period of four weeks. The measuring points were determined in accordance with the technical provisions of VLAREM II, at the Galgenschoor nature reserve to the west (measuring points 1 and 2), the houses in Lillo to the south-west (measuring point 3) and the houses in Berendrecht to the north-east of the project area (measuring point 4).

Since mid-2020, the production facilities of Gunvor (now Vopak), located north of the project area, have been shut down. Due to this change in the immediate vicinity, an additional noise measurement campaign was carried out in February 2021 to determine the ambient noise. This noise measurement campaign included continuous immission measurements at the same four locations as in June 2019 over a period of three weeks. During this measurement campaign, there was snowfall, which meant that no representative values could be obtained for one week.

As part of the update of the EIA in 2024, a third measurement campaign was organised in December 2023 – January 2024, during which continuous immission measurements were carried out at identical locations as in 2019 and 2021 over a period of 4.5 weeks.

These measurements make it possible to determine the average total ambient noise for the different periods of the day, taking into account wind direction and wind speed.

An overview of the reference points with their Lambert coordinates is shown in Table 6-4 below. The location of the measuring points is also indicated in Figure 6-5 below.

Table 6-4: Location of the measuring points

Point	Location	Lambert coordinate X	Lambert coordinate Y	Distance to plot boundary	Area according to regional plan
IP1	Scheldelaan 490 – border with Galgenschoor north nature reserve (at west of project area)	144 005	224 523	Approx. 140 m west	Nature reserve<500mfrom industrial area
IP2	Scheldelaan 460 – near nature reserve Galgenschoor south (west of project area) (1)	144 223	223,044	Approximately 115 metres west	industrial area Nature reserve < 500 m from
IP3	Homes in Lillo – Kazerneplein Lillo	144 571	221640	Approx. 1,400 m south of /southwest	Residential area < 500 m from industrial area
IP4	Homes in Berendrecht – Dorpbeekstraat 129.	145 586	225,609	Approx. 950 m northeast	Residential area<500mfrom industrial area

(1) The reference point is located in the nature reserve 'Schorren en Polders van de Beneden-Schelde' (Salt marshes and polders of the Lower Scheldt), designated as a Bird Directive area near the Galgenschoor nature reserve (+/- 35 m from the border with Galgenschoor). It was not possible to take a measurement at the border of Galgenschoor due to the presence of a railway line.

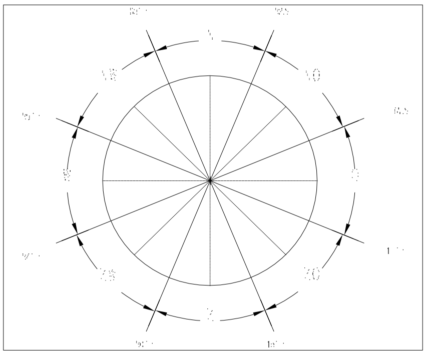
Figure 6-5: Orthophoto showing the project area and the measuring points

For the immission measurements, the following statistical parameters are calculated for each measurement period of 1 hour: Leq, L01, L10, L50, L90 and L95.

- Leq = the equivalent sound pressure level, i.e. the energy-weighted average level;
- LN = the sound pressure level that was exceeded during N% of the measurement period.

All sound pressure levels are expressed in dB(A) re $^{2x10-5}$ Pa with the fast dynamic characteristic. The hourly percentiles are analysed in relation to the prevailing wind direction. A distinction is made between the eight different wind sectors as defined in VLAREM II, namely:

North:	from 337.5° to 22.5°
North-east:	from 22.5° to 67.5° East:
	from 67.5° to 112.5°
Southeast:	from 112.5° to 157.5°
South:	from 157.5° to 202.5°
Southwest:	from 202.5° to 247.5°
West:	from 247.5° to 292.5°
Northwest:	from 292.5° to 337.5°



The calculation of the averages per wind direction is based solely on the values measured at an average wind speed of less than 5 m/s. For the $L_{Aeq,1h}$, $L_{A50,1h}$ and $L_{A95,1h}$ percentiles, an average for the three periods of the day is calculated in accordance with the technical provisions of VLAREM II, i.e.

- Daytime period: arithmetic mean of all hourly averages between 7 a.m. and 7 p.m.;
- Evening period: arithmetic mean of all hourly averages between 19:00 and 22:00;
- Night period: arithmetic mean of the lowest four hourly averages between 22:00 and 07:00.

The results of the measurement campaigns in June 2019, February 2021 and December 2023 – January 2024 are summarised in Table 6-5, with a breakdown per emission point considered. The situation with tailwinds from the company to the measurement point considered was indicated by underlining the relevant noise level in the table. For the measurement campaign in February 2021, only snow-free days were considered (+/- 2 weeks).

The results obtained were compared with the environmental quality standards (MKN) set out in Annex 2.2.1 of VLAREM II. The four measuring points are all located near a nature reserve or residential area less than 500 m from an industrial area. According to the zoning of VLAREM II, this corresponds to an area 2 (see Table
6-1), where an environmental quality standard of 50 dB(A), 45 dB(A) and 45 dB(A) applies during the day, evening and night periods respectively.

Table 6-5: Results of continuous immission measurements per day, evening and night period.

IP	Statistical analysis per assessment and wind direction										MKN VLAREM II in dB(A)
			June 2019								
		Wind direction	N	NE	E	SE	S	SW	W	NW	
IP 1 - Scheldelaan 490 – border with **Galgenschoor North** nature reserve	Day	Gem LAeq	56.1	54.0	56.2	57.2	53.7	54.1	54.0	55.7	50
		Average LA50	52.9	52.4	54.3	54.6	52.0	51.3	51.1	52.8	
		Average LA95	**48.7**	**49.7**	**50.9**	**49.9**	**48.1**	**47.0**	**47.0**	**48.8**	
		Number of hours	22	19	41	25	21	52	26	17	
	Evening	Gem LAeq	55.5	52.9	53.7	55.6	54.9	53.2	51.3	53.8	45
		Average LA50	52.2	51.9	51.9	53.5	51.3	50.4	49.6	51.2	
		Average LA95	**49.1**	**50.2**	**49.5**	**50.5**	**47.6**	**46.3**	**46.4**	**48.0**	
		Number of hours	16	4	8	5	6	7	4	11	
	Night	Gem LAeq	52.6	53.6	53.6	51.6	53.0	49.9	50.3	55.3	45
		Average LA50	51.9	52.9	52.0	50.5	50.4	48.6	47.8	50.6	
		Average LA95	**50.4**	**51.4**	**50.7**	**49.1**	**48.7**	**46.7**	**45.5**	**48.5**	
		Number of hours	15	11	14	7	6	8	7	6	
			February 2021								
	Day	Gem LAeq	59.3	57.0	58.1	58.7	59.5	56.5	57.5	61.2	50
		Average LA50	56.8	54.0	54.9	55.7	56.8	54.5	54.5	55.6	
		Average LA95	**51.7**	**52.0**	**52.0**	**52.7**	**53.0**	**49.7**	**50.4**	**50.9**	
		Number of hours	1	7	2	25	41	3	3	7	
	Evening	Gem LAeq	-	-	55.9	57.2	58.2	54.3	-	55.7	45
		Average LA50	-	-	54.5	55.1	55.5	53.1	-	52.2	
		Gem LA95	**-**	**-**	**52.4**	**52.8**	**53.2**	**50.1**	**-**	**48.8**	
		Number of hours	0	0	6	7	7	1	0	3	
	Night	Gem LAeq	51.4	54.7	56.3	56.0	57.9	57.6	-	55.2	45
		Average LA50	51.0	54.2	53.2	54.0	53.7	52.8	-	51.0	
		Average LA95	**49.5**	**53.0**	**51.5**	**52.6**	**52.2**	**50.6**	**-**	**48.8**	
		Number of hours	1	1	6	15	9	4	0	3	

IP			Statistical analysis per assessment and wind direction								MKN VLAREM II in dB(A)
			June 2019								
		Wind direction	N	NE	W	SE	S	SW	W	NW	
			December 2023 – January 2024								
	Day	Gem LAeq	55.3	58.0	60.4	59.4	55.6	52.8	54.7	57.4	50
		Average LA50	53.3	55.3	56.2	56.8	53.8	51.3	51.8	53.8	
		Gem LA95	**49.7**	**51.7**	**53.3**	**53.3**	**50.7**	**48.5**	**48.6**	**49.3**	
		Number of hours	27	46	2	9	28	28	20	5	
	Evening	Gem LAeq	55.8	54.9	58.5	55.4	55.4	53.9	52.6	54.3	45
		Gem LA50	52.9	53.2	53.9	53.6	52.1	50.6	51.1	49.8	
		Gem LA95	**49.2**	**50.7**	**52.2**	**51.9**	**49.9**	**48.4**	**48.8**	**47.4**	
		Number of hours	3	12	1	4	7	8	9	5	
	Night	Gem LAeq	50.9	53.6	53.9	54.1	52.2	49.6	51.5	51.1	45
		Gem LA50	49.6	51.8	53.1	53.3	51.1	48.7	49.6	49.8	
		Gem LA95	**47.5**	**50.0**	**51.8**	**52.0**	**49.3**	**46.7**	**47.4**	**47.2**	
		Number of hours	14	13	2	4	9	15	4	4	
IP 2 - Scheldelaan 460 – near **Galgenschoor South** nature reserve	Day	Gem LAeq	58.5	56.2	58.1	60.1	58.3	56.4	57.8	58.7	50
		Average LA50	56.6	54.6	56.6	58.1	56.7	54.3	55.0	56.0	
		Average LA95	**50.7**	**51.2**	**52.3**	**52.5**	**50.8**	**48.7**	**48.0**	**49.6**	
		Number of hours	22	19	41	25	21	52	26	17	
	Evening	Gem LAeq	56.6	54.1	55.8	57.2	57.8	56.8	55.1	56.6	45
		Average LA50	53.8	52.9	53.5	54.7	54.9	53.9	51.8	52.7	
		Average LA95	**50.4**	**51.2**	**50.9**	**51.2**	**50.7**	**48.8**	**46.6**	**48.4**	
		Number of hours	16	4	8	5	6	7	4	11	
	Night	Gem LAeq	53.6	54.1	54.2	53.6	53.1	51.4	51.5	53.4	45
		Average LA50	52.8	53.2	52.6	52.2	51.9	50.3	49.9	52.2	
		LA95 average	**51.1**	**51.8**	**51.2**	**50.6**	**50.1**	**47.7**	**47.7**	**50.1**	
		Number of hours	15	11	14	7	6	8	7	6	
			February 2021								
	Day	Gem LAeq	59.7	57.9	58.1	58.1	59.3	59.5	60.3	59.6	50
		Average LA50	58.7	57.0	56.6	56.9	57.8	58.3	58.7	58.3	
		Average LA95	**54.1**	**53.7**	**53.5**	**52.9**	**53.0**	**52.0**	**53.3**	**53.1**	
		Number of hours	5	27	12	25	25	1	6	21	
	Evening	Gem LAeq	57.2	59.0	55.6	56.8	58.1	-	-	57.6	45
		Average LA50	55.6	57.9	54.8	55.3	55.9	-	-	55.2	
		Gem LA95	**52.6**	**55.1**	**53.0**	**53.0**	**52.2**	**-**	**-**	**51.7**	
		Number of hours	7	6	2	5	7	0	0	7	

IP	Period	Statistical analysis per assessment and wind direction	N	NE	W	SE	W	SW	W	NW	MKN VLAREM II in dB(A)
		June 2019									
		Wind direction	N	NE	W	SE	W	SW	W	NW	
	Night	Gem LAeq	54.3	55.7	58.0	55.0	54.4	55.0	-	54.0	45
		Gem LA50	53.1	54.6	57.0	54.2	53.2	53.4	-	52.9	
		LA95 average	**51.2**	**52.9**	**55.3**	**52.6**	**51.1**	**50.8**	**-**	**50.8**	
		Number of hours	6	10	6	13	7	3	0	3	
		December 2023 – January 2024									
	Day	Gem LAeq	55.1	56.9	58.1	58.5	55.0	53.0	56.1	56.6	50
		Average LA50	53.8	55.4	57.5	56.7	53.6	51.5	53.7	55.2	
		Average LA95	**50.8**	**52.2**	**53.4**	**52.1**	**49.6**	**48.0**	**49.2**	**50.7**	
		Number of hours	27	46	2	8	28	28	23	5	
	Evening	Gem LAeq	55.6	54.6	53.9	54.1	53.3	53.4	53.5	51.6	45
		Gem LA50	53.2	53.4	52.3	52.1	50.5	50.3	51.3	50.2	
		Gem LA95	**50.5**	**51.1**	**50.7**	**50.1**	**47.8**	**47.7**	**48.8**	**48.3**	
		Number of hours	3	12	1	4	7	8	9	5	
	Night	Gem LAeq	51.4	54.1	52.1	52.1	51.0	49.8	51.3	51.6	45
		Gem LA50	50.3	52.1	50.1	50.7	48.8	47.9	47.9	49.6	
		Gem LA95	**48.7**	**50.5**	**49.2**	**49.2**	**47.2**	**46.3**	**46.5**	**47.6**	
		Number of hours	12	13	1	6	10	15	4	6	
IP 3 - Homes in Lillo – Kazerneplein Lillo	Day	Gem LAeq	48.6	49.1	49.3	49.9	49.3	48.7	51.2	50.6	50
		Gem LA50	47.1	47.2	47.6	47.9	45.0	45.7	48.0	47.6	
		Average LA95	**44.0**	**44.3**	**44.8**	**44.3**	**41.8**	**42.6**	**43.4**	**44.4**	
		Number of hours	22	19	41	25	21	52	24	17	
	Evening	Gem LAeq	49.2	47.2	47.4	47.9	47.7	48.1	47.7	48.5	45
		Average LA50	46.9	45.9	46.0	46.3	46.1	45.8	45.8	47.1	
		Average LA95	**44.2**	**43.5**	**43.6**	**43.8**	**43.6**	**42.9**	**42.7**	**44.4**	
		Number of hours	16	4	8	5	6	7	4	11	
	Night	Gem LAeq	48.5	47.0	45.3	45.0	46.5	44.9	45.2	47.7	45
		Gem LA50	47.9	46.7	44.8	44.6	45.4	44.4	44.7	47.0	
		Average LA95	**46.0**	**45.1**	**43.1**	**43.0**	**43.9**	**42.5**	**43.1**	**45.5**	
		Number of hours	18	11	14	6	5	8	7	4	
		February 2021									
	Day	Gem LAeq	50.1	48.9	48.7	49.6	50.0	49.8	49.1	49.8	50
		Average LA50	48.6	47.0	47.0	47.5	47.8	45.5	48.4	48.6	
		Average LA95	**45.7**	**44.9**	**44.9**	**45.4**	**45.6**	**43.2**	**46.1**	**45.8**	
		Number of hours	7	34	14	34	41	3	7	22	

IP	Statistical analysis per assessment and wind direction										MKN VLAREM II in dB(A)
			June 2019								
		Wind direction	N	NE	W	SE	S	SW	W	NW	
	Evening	Gem LAeq	48.9	49.5	46.7	47.7	49.2	47.3	-	47.3	45
		Average LA50	48.0	49.2	46.3	47.4	48.0	47.0	-	46.8	
		Gem LA95	**45.5**	**47.6**	**44.5**	**45.7**	**46.4**	**45.3**	**-**	**44.3**	
		Number of hours	7	6	6	7	7	1	0	7	
	Night	Gem LAeq	45.7	46.5	47.7	47.1	46.9	48.2	-	45.1	45
		Average LA50	45.1	46.0	47.3	46.8	46.6	47.9	-	43.9	
		Gem LA95	**43.3**	**44.4**	**45.9**	**45.4**	**45.0**	**46.1**	**-**	**41.9**	
		Number of hours	6	13	10	17	10	3	0	3	
			December 2023 – January 2024								
	Day	Gem LAeq	49.4	49.6	47.8	49.5	47.9	48.3	48.9	49.4	50
		Average LA50	47.4	48.7	47.5	48.5	46.8	46.9	46.9	46.1	
		Gem LA95	**45.7**	**47.0**	**46.3**	**47.0**	**45.1**	**45.1**	**45.0**	**43.6**	
		Number of hours	27	46	2	9	28	28	23	5	
	Evening	Gem LAeq	47.7	47.6	46.6	47.5	47.6	45.9	47.1	46.1	45
		Gem LA50	47.3	47.3	46.4	47.1	46.4	45.3	46.8	45.7	
		Gem LA95	**45.7**	**45.9**	**44.2**	**45.7**	**44.4**	**43.5**	**45.1**	**44.1**	
		Number of hours	3	12	1	4	7	8	9	5	
	Night	Gem LAeq	45.7	46.1	43.6	45.1	46.1	45.8	46.5	45.9	45
		Gem LA50	45.2	45.7	43.1	44.7	45.8	45.5	45.9	45.2	
		Average LA95	**43.7**	**44.3**	**41.0**	**43.4**	**44.1**	**43.7**	**43.9**	**43.6**	
		Number of hours	14	13	1	6	7	16	3	4	
IP 4 - Houses in Berendrecht – Dorpbeekstraat 129	Day	Gem LAeq	54.0	53.7	54.3	54.9	54.3	55.3	55.4	55.8	50
		Average LA50	49.0	47.3	47.9	49.3	50.3	52.1	51.7	51.1	
		Gem LA95	**44.2**	**42.3**	**43.7**	**45.0**	**47.1**	**49.2**	**48.5**	**47.3**	
		Number of hours	22	19	41	26	21	52	23	17	
	Evening	Gem LAeq	51.5	51.2	51.4	52.7	54.3	54.1	53.2	52.9	45
		Gem LA50	46.6	44.0	46.0	46.7	50.9	51.8	50.7	48.6	
		Average LA95	**43.4**	**40.2**	**41.8**	**43.5**	**48.1**	**49.1**	**48.2**	**45.1**	
		Number of hours	16	4	8	5	6	7	4	11	
	Night	Gem LAeq	48.7	45.6	49.1	51.2	51.6	51.9	53.3	48.6	45
		Average LA50	45.8	42.3	46.2	49.6	50.9	51.2	51.3	47.5	
		Average LA95	**43.4**	**40.2**	**43.8**	**47.0**	**49.0**	**49.3**	**48.7**	**45.1**	
		Number of hours	18	12	10	7	5	9	5	4	
			February 2021								

IP	Statistical analysis per assessment and wind direction										MKN VLAREM II in dB(A)
			June 2019								
		Wind direction	N	NE	W	SE	W	SW	W	NW	
	Day	Gem LAeq	53.9	51.8	53.2	54.2	54.7	54.0	53.5	54.3	50
		Average LA50	48.2	45.6	45.2	49.3	50.0	47.9	50.3	49.2	
		Average LA95	**45.0**	**41.6**	**42.3**	**46.5**	**47.1**	**45.0**	**46.7**	**45.8**	
		Number of hours	3	7	2	25	41	3	3	6	
	Evening	Gem LAeq	-	-	50.2	50.7	51.9	50.7	-	48.3	45
		Gem LA50	-	-	47.5	48.0	50.0	49.4	-	45.7	
		Gem LA95	**-**	**-**	**45.9**	**46.1**	**48.5**	**48.1**	**-**	**43.6**	
		Number of hours	0	0	6	7	7	1	0	3	
	Night	Gem LAeq	43.7	48.7	48.8	50.8	49.8	52.1	-	47.2	45
		Average LA50	43.1	48.4	48.0	48.8	49.3	50.8	-	44.4	
		Gem LA95	**41.3**	**46.9**	**45.9**	**47.3**	**47.9**	**48.9**	**-**	**41.5**	
		Number of hours	1	1	4	20	8	2	0	3	
			December 2023 – January 2024								
	Day	Gem LAeq	52.7	52.1	-	53.8	52.9	54.1	55.3	52.5	50
		Gem LA50	47.2	45.1	-	49.7	49.4	50.4	50.7	46.8	
		Gem LA95	**44.2**	**42.5**	**-**	**47.2**	**47.3**	**48.3**	**48.4**	**43.7**	
		Number of hours	25	45	0	8	27	28	20	5	
	Evening	Gem LAeq	50.8	49.0	53.5	50.9	50.9	50.9	52.3	50.4	45
		Average LA50	45.7	43.5	46.9	47.4	48.3	48.3	49.7	47.0	
		Gem LA95	**43.6**	**41.3**	**45.5**	**45.8**	**46.1**	**46.7**	**47.7**	**44.8**	
		Number of hours	3	12	1	3	7	8	7	5	
	Night	Gem LAeq	45.6	43.1	47.3	49.0	48.3	49.1	52.4	47.9	45
		Gem LA50	44.3	41.8	47.0	48.2	47.4	48.2	51.5	45.3	
		Gem LA95	**42.1**	**39.9**	**45.7**	**46.6**	**45.9**	**46.8**	**49.6**	**43.0**	
		Number of hours	12	13	1	5	7	16	2	3	

The situation with tailwind from the company to the measurement point in question was indicated by underlining the relevant noise level in the table.

The immission measurements show that:

- At **measuring point 1,** located in the northern half of the Galgenschoor nature reserve to the west of the project area, the average $_{LA95.}$1h level at critical wind directions varies little from 53 dB(A) during the day to 52 dB(A) during the evening and night, based on immission measurements in December 2023 – January 2024. This means that the environmental quality standard is exceeded by a maximum of 3 dB(A) during the day and a maximum of 7 dB(A) in the evening and at night. The measurements show that the ambient noise can vary by 5 dB(A) during the most critical night-time period when there is a tailwind or headwind. The average $_{LA95.}$1h level at critical wind directions over the day-evening-night period in 2023–2024 is 52 dB(A), which is in the same order of magnitude as during the immission measurements in February 2021 and rounded 2 dB(A) higher than during the immission measurements in June 2019.

- At **measuring point 2,** located near the southern half of the Galgenschoor nature reserve to the west of the project area, the average $L_{A95.1h}$ level at critical wind directions varies slightly from 52 dB(A) during the day, 51 dB(A) in the evening and 50 dB(A) at night, based on the immission measurements in December 2023 – January 2024. The environmental quality standard is therefore exceeded by a maximum of 2 dB(A) during the day, 6 dB(A) in the evening and 5 dB(A) at night. Based on the noise measurements during the most recent measurement campaign, the ambient noise varies by 4 dB(A) during the most critical night-time period when the wind is blowing in the same direction or against the wind. The average $L_{A95.1h}$ level at critical wind directions over the day-evening-night period in 2019, 2021 and 2023–2024 is 51, 54 and 51 dB(A) respectively. The average current $L_{A95.1h}$ level is therefore back in the same order of magnitude as in 2019.
- At **measuring point 3,** located near the residential area in Lillo, the average $L_{A95.1h}$ level at critical wind directions varies slightly from 46 dB(A) during the day and evening to 44 dB(A) during the night period, based on immission measurements in 2023-2024. However, the average $L_{A95.1h}$ level over the day-evening-night period is of the same order of magnitude as in 2019 and 2021 and amounts to 45 dB(A). The most recent immission measurements in 2023–2024 show that the environmental quality standard is exceeded by a maximum of 1 dB(A) during the evening period, but is respected on average over the day-evening-night period. The ambient noise in tailwind or headwind conditions varies hardly at all during the most critical night-time period.
- At **measuring point 4**, located near the residential area in Berendrecht, the average $L_{A95.1h}$ level at critical wind directions varies slightly between 48 dB(A) during the day and 46 dB(A) during the evening and night, based on immission measurements in December 2023 – January 2024. The average $L_{A95.1h}$ level at critical wind directions over the day-evening-night period is 47 dB(A), which is slightly lower than the average $L_{A95.1h}$ level of 48 dB(A) according to measurements in 2021 and 49 dB(A) according to measurements in 2019. This indicates a decrease in ambient noise, possibly as a result of changes in activity at the former Gunvor site (now VOPAK) since mid-2020. The environmental quality standard is met during the day and exceeded by a maximum of 1 dB(A) in the evening and at night. Furthermore, measurements taken in 2023–2024 show that ambient noise varies by 7 to 9 dB(A) during the most critical night-time period, depending on whether the wind is blowing in the same direction or against the wind.

The most recent measurement results from December 2023 – January 2024 will be used to determine the impact in this EIA.

Based on the results of the continuous immission measurements and the reported strategic noise pollution maps for the Antwerp agglomeration for the reference year 2016 (see above), the original ambient noise (LA95 level) in the vicinity of the project area can be determined. The environmental measurements taken in December 2023 – January 2024 show that the current $L_{A95.1h}$ level at critical wind directions averages 52 dB(A) and 51 dB(A) over the day-evening-night period at IP1 and IP2 respectively. During the most critical night-time period, this is 52 dB(A) and 50 dB(A) respectively. IP1 and IP2 are located approximately 140 m and 115 m west of the project area respectively. At 200 m west of the site boundary, in the **Galgenschoor nature reserve**, the original ambient noise level is **at least 50 dB(A)**. At the **homes in Lillo**, located 200 m west of the industrial area, an ambient noise level of **44 dB(A)** was measured during the most critical night-time period. Based on the measured ambient noise **in Berendrecht** of an average of **46 dB(A)** during the most critical night-time period and the strategic noise pollution maps, an original ambient noise level of approximately **47 dB(A)** can be assumed in the **Opstalvallei** nature reserve, located south of the residential area of Berendrecht. Furthermore, for the reference points located near the installation parts of the **neighbouring companies (industrial area),** it can be stated that the noise level is **higher than 60 dB(A)**. At the reference points **200 m east of the boundary** of the project area (in the Kanaaldok)**,** the original ambient noise is unknown. Based on continuous immission measurements carried out earlier (2018) on the vacant land 200 m east of the IMB site and based on the strategic noise pollution maps, the ambient noise can be estimated **at between 50 and 55 dB(A)**.

6.4 Construction phase

6.4.1 Description of the construction phase

The construction of Project One will involve work spread across the project area over a period of approximately 3 years and 8 months (roughly from August 2022 to March 2026, or 44 months).

The noise emissions during the construction phase on site depend on the type of machinery used, the number of machines, the operating time, the age of the machines, etc. These factors depend on how the site is organised and planned, as well as on the choices made by the contractors on site. For the various activities, a well-founded assumption was made by the client regarding the number, type, electrical power and operating time of the construction machinery.

The noise emission or sound power (Lw) per type of machine (both global and spectral data) has been estimated on the basis of the Royal Decree of 6 March 2002 on the sound power of equipment for outdoor use (2000/14/EC), based on technical manufacturer specifications applicable to the categorised construction machinery and based on available data from the literature regarding the noise emission of machinery during construction works and open work sites. The estimated electrical power and/or type of machinery was taken into account. The following sources were consulted for this purpose: *NOMEVAL (Noise of Machinery - Evaluation of Directive 2000/14/EC – Study on the experience in the implementation and administration of Directive 2000/14/EC relating to the noise emission in the environment of equipment for use outdoors), Europe, 2008; Database for noise during construction works and open work sites, DEFRA (Department for Environment, Food and Rural Affairs), United Kingdom, 2005/2006; TNO (Study on the suitability of the current scope and limit values of Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors), Netherlands, 2015 and the article 'Noise power of lorries at low speeds', Tijdschrift Geluid (Sound Magazine), no. 1 / March 2013.*

Based on the total number and estimated maximum operating time during a representative working day per type of machine, a time-weighted calculation was made of the machines that can be used simultaneously on the site. Taking into account the specified noise emission level per type of machine, the noise emission level of the entire site during a maximum but representative working day was determined in this way. A calculation of such a representative working day for the approximately 44 months that the construction phase will take results in three distinct site stages, within which the noise emission level of the site remains fairly stable. For each site stage, the most critical month has been retained. The impact assessment of the construction phase has therefore been carried out for a maximum but realistic working day during the peak period for each construction phase (the three most critical months of the approximately 44 months).

The results of the calculated overall sound power level (Lw) in dB(A) re. 1 pW per construction stage are shown for the daytime period and evening/night-time period in Table 6-6 and Table 6-7 respectively. These tables also provide a description of the construction site machinery considered (with estimated electrical power and/or type) and the number of machines that can be deployed simultaneously during a maximum but representative working day.

The main activities in the three distinct construction stages are as follows:

- Construction phase A (approx. 9 months): vegetation removal, topsoil excavation and limited levelling of the site, construction of access roads, construction of a contractor village;
- Construction phase B (approx. 15 months): site profiling (cut and fill), foundation work, etc.;
- Construction phase C (approx. 20 months): construction of the project's buildings and installations.

Construction phase A comprises similar activities in the northern and southern parts of the project area in preparation for the sites. During construction phases B and C, the majority of construction activities will shift to the southern part of the project area, for the construction of the ECR and supporting infrastructure on the one hand, and the construction of the administrative zone, including an administrative building, warehouse, workshop, etc., on the other (see § 3.4.12). The northern part of the project area will then serve as a contractor village with a more limited number of construction machines (see Table 6-6). The specified duration per construction stage should be considered indicative, as some construction activities from two different construction stages may be carried out simultaneously across the entire project area.

The following tables show that the overall sound power level across the entire project area during construction phase A is 127.6 dB(A) during the day and 109.1 dB(A) during the evening and night. During construction phase B, this is 128.1 dB(A) during the day and 118.3 dB(A) in the evening and at night, and finally during construction phase C, 126.2 dB(A) and 114.7 dB(A) respectively.

As described above, the choice of the three construction phases, which will be used for the impact assessment of the construction phase (see §6.4.2), is based on a calculation of the overall noise emission level of the site during a maximum but representative working day for the approximately 44 months that the construction phase will last. A comparison of the calculated overall noise emissions from the construction site during the approximately 44 months shows that the variations within the described construction stages are approximately constant (variations of up to +/- 2 dB(A)), with the exception of the first two months of the construction process. During the first two months, the sound power level during the daytime period is on average 6 dB(A) lower than the calculated sound power according to construction stage A. During the evening and night-time periods, the variation is limited to less than 2 dB(A). During construction stage B, construction activities will be interrupted between August 2023 and December 2023, and therefore there will be no relevant noise emissions from Project One.

Table 6-6: Overview of construction machinery and their sound power levels, with an estimate of maximum operating conditions per construction stage during the daytime period

	Construction machine	Electrical power - type	Sound power (Lw)	Construction stage A Number of machines		Construction stage B Number of machines		Construction stage C number of machines	
			In dB(A)	*Project area north*	*project area south*	*project area north*	*project area south*	*project area north*	*project area south*
Day period	Bulldozer	325 kW - Cat D9	112	4	4	-	-	-	-
	Roller compactor or compactor	75 kW - Cat CS44B	108	5	5	-	7	-	4
	Tractor	129 kW - Manitou MHT 10130	107	3	3	-	7	-	5
	Mobile crane	Liebherr LTM 1100	106	2	1	-	18	-	17
	Screw foundation machine	400 kW	107	-	-	-	10	-	2
	Wheel loader	168 kW - Cat 950GC	106	4	5	-	9	-	4
	Dumper	Mercedes-Benz Arocs 3240	110	10	8	-	10	-	5
	Levelling machine	133 kW - Motor Graders 140 / 140 AWD	107	4	4	-	-	-	-
	Plate compactor	5 kW - Hand plate compactor	105	2	-	-	11	-	5
	Concrete truck mixer	300 kW - Mercedes 8m3	108	1	-	-	10	-	6
	Backhoe loaders	128 kW - Cat 320	101	5	5	-	16	-	5
	Vacuum tanker	300 kW - Guess	107	2	-	3	3	2	2
	Generators	500kW - Kohler 350-500 REOZJ with acoustic enclosure	100	1	4	1	4	1	4
	Forklift	129 kW - Manitou MHT 10130	107	2	-	4	9	4	11
	SPMT "automated modular carriers"	340 kW - PPU Z340	105	-	-	-	-	-	6
	Asphalt machine	199 kW - Cat AP600F + SE60 VT	105	1	1	-	-	-	-
	Wheel loader with rear excavator arm	70 kW - Cat 444F2	102	4	4	5	11	-	5

	Construction site machine	Electrical power - type	Noise power (Lw)	Construction stage A Number of machines		Yard stage B number of machines		Yard stage C number of machines	
			In dB(A)	*project area north*	*project area south*	*project area north*	*project area south*	*project area north*	*project area south*
	Platform truck	338 kW - Volvo D13K460	102	1	1	3	8	3	8
	Welding post	20 kW	93	-	-	1	14	1	14
	Tower crane	100 kW	100	-	-	-	4	-	4
	Drainage pump	104 kW - Godwin CD225M	99	2	5	7	35	-	8
	Air compressor	10 kW	97	1	3	1	6	1	4
	Sheet piling	Hydraulic pressing	102	-	-	-	1	-	-
Total sound power level per construction stage - in dB(A)				**124.9**	**124.2**	**117.4**	**127.7**	**115.6**	**125.8**
				127.6		**128.1**		**126.2**	

Table 6-7: Overview of construction site machinery and their sound power levels, with an estimate of maximum operating conditions per construction stage during the evening/night period

	Construction machine	Electrical power - type	Sound power (Lw)	Construction stage A		Construction stage B		Construction stage C	
			In dB(A)	*Project area north*	*project area south*	*project area north*	*project area south*	*project area north*	*project area south*
Evening/night period	Mobile crane	Liebherr LTM 1100	106	-	-	-	4	-	2
	Forklift	129 kW - Manitou MHT 10130	107	-	-	-	2	-	2
	Generators	500 kW - Kohler 350-500 REOZJ with acoustic enclosure	100	1	-	1	3	-	2
	Platform truck	338 kW - Volvo D13K460	102	1		1	1	1	1
	Drainage pump	104 kW - Godwin CD225M	99	2	5	7	35	-	8
Total sound power level per construction stage - in dB(A)				**106.2**	**106.0**	**109.1**	**117.7**	**102.0**	**114.5**
				109.1		**118.3**		**114.7**	

6.4.2 Impact assessment and impact evaluation – construction phase

6.4.2.1 Dispersion calculations using the acoustic transmission model

The noise impact of the various construction phases on the surrounding area was calculated using an acoustic transmission model.

The sound transmission calculations were performed in accordance with ISO 9613-2 using the IMMI 2020 calculation model. In these calculations, the noise emission from the construction site activities was considered to be a flat source at a height of 2.5 m above ground level, which is representative of the majority of construction site machinery. The construction zone during construction phase A concerns the project area, including the temporary project area that will serve as a laydown zone for, among other things, the construction of the installations. The construction zone for the pipelines to the north-west of the southern part of the project area has not been taken into account, due to the expected low noise emission level and very limited duration of these construction activities in comparison with the construction phase as a whole. For construction phases B and C, the noise-relevant activities and therefore also the construction zone considered are limited to the final site boundaries of Project One. Furthermore, the southern part of the project area has been divided into three parts in the acoustic transmission model, namely the administrative zone (construction of, among other things, an administrative building, warehouse, workshop, etc.), the western installation zone (construction of, among other things, a transformer station, water treatment facilities, general facilities, etc.) and the eastern installation zone (construction of, among other things, boilers and steam turbine generator, ECR, ethane tank, etc.). The total number of construction machines for the southern part of the project area, as shown in Table 6-6, is divided over the three zones in question, taking into account the number of construction machines required in each zone per construction stage. The calculations take into account the distance between the source zone and the immission point, air absorption, reflections, screen effects and the influence of the soil. In order to take reflections and screen effects into account, all relevant buildings, silos and other obstacles in the vicinity of the future industrial site are included in the calculation model. The calculations were performed for the most critical wind direction, i.e. the wind direction from each noise source to each immission point. Humidity and temperature were set at 70% and 10°C respectively. The calculations were performed for the normalised 1/3 octave bands between 25Hz and 10kHz. The height of the immission points is 4 m (1st floor level) in accordance with the guidelines.

The resulting noise contours that represent the specific noise levels of construction phases A, B and C during the daytime and evening/night-time periods respectively are shown in Appendices 2.1 to 2.6.

In addition to the noise contours shown, the noise level has also been calculated at a number of discrete points at relevant locations near residential areas and nature reserves (the most noise-sensitive areas), including the four reference points where immission measurements were carried out. The location of these points is described in the table below, indicating the zoning according to the regional plan or the GRUP Demarcation of the Antwerp Seaport Area and the applicable environmental quality standards. Figure 6-6 also visually represents the discrete reference points in relation to the zoning according to the regional plan/GRUP, with the relevant nature, residential and industrial areas indicated in green, red and purple respectively.

The discrete points are all located 200 m from the project area where noise-related construction activities may occur (as described above, this concerns the entire project area, including the temporary project area, with the exception of the pipelines to the north-west of the southern part of the project).

In the Galgenschoor nature reserve, which is characterised from east to west by a sloping dyke approximately 30 metres wide followed by an embankment down to the Scheldt (>100 m depending on the tides of the Scheldt), the discrete points – all located 200 m from the project area – were chosen on the dike as well as on the embankment towards the Scheldt, in order to be able to quantify an impact assessment for the entire nature reserve.

Table 6-8: Location of discrete points for the evaluation of the construction phase

Point	Location	Lambert coordinate X	Lambert coordinate Y	Distance to plot boundary	Area according to regional plan / GRUP	Environmental quality standard
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve	144 005 the west	224 523	Approximately 140 m to	Nature reserve < 500 m from industrial area	Day: 50 dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP2	Scheldelaan 460 – near nature reserveGalgenschoor	144	223,044	Approx. 115 m to the west		
IP3	Houses in Lillo – Kazerneplein Lillo	144571	221640	Approx. 1,400 m south-/southwest	Residential area < 500 m from industrial area	Day:50dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP4	Homes in Berendrecht – Dorpbeekstraat 129	145586	225609	Approximately 950 metres northeast		
IP10	200 m W "Project area N" (Galgenschoor - on dyke)	144023	224 127	200 m west	Nature reserve < 500 m from industrial area	Day: 50 dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP11	200 m W "Project area N" (Gallows rope)	143984	224	200 m west		
IP12	200 m NW "Project area N" (Galgenschoor – on the dyke)	143956	224 694	200 m west		
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	144202	222,857	200 m west		
IP28	200 m W "Project area Z" (Galgenschoor)	144118	223 224	200 m west		
IP29b	200 m NW "Project area Z" (Galgenschoor – on dyke)	144104	223 535	200 m west		
IP31	200 m NE Industrial area (Opstalvallei)	145,767	225,057	approx.580mten northeast		

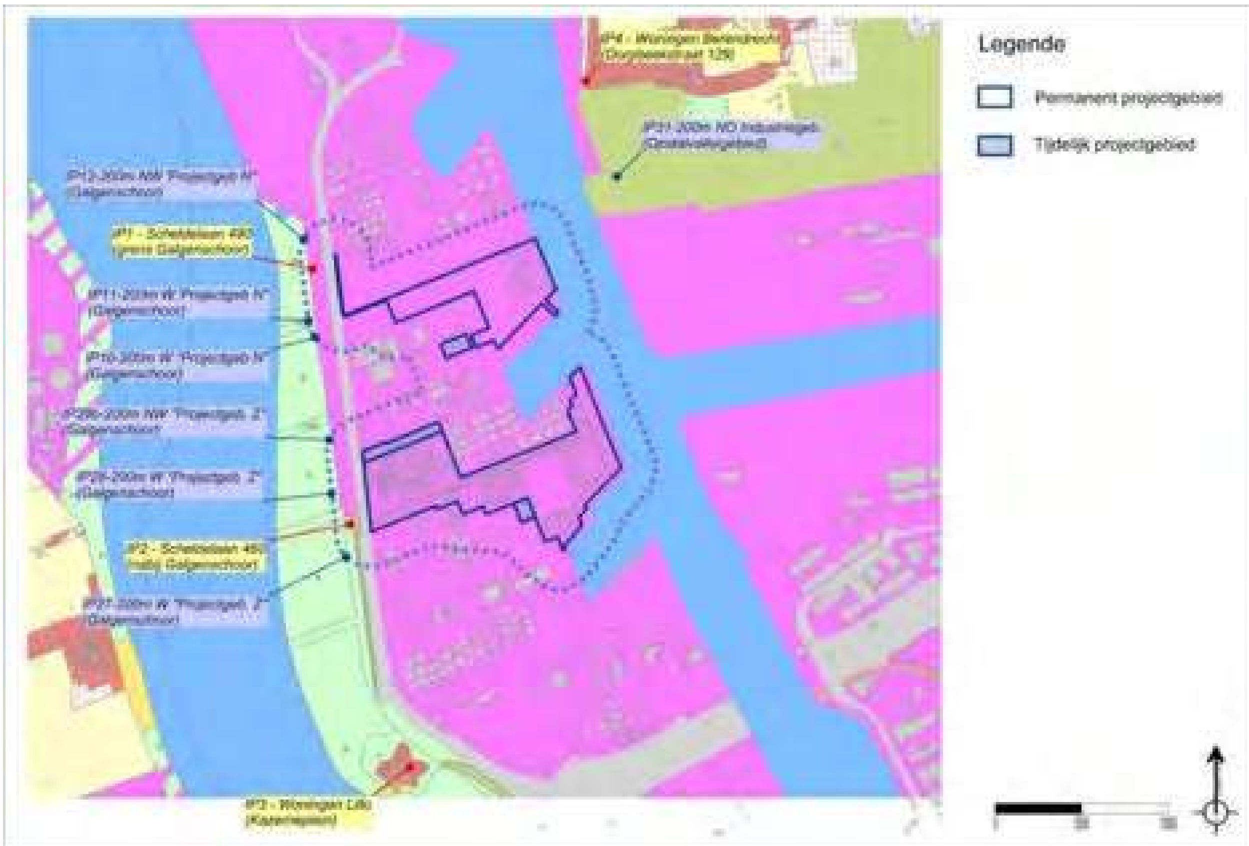


Figure 6-6: Location of discrete points for the construction phase assessment

6.4.2.1.1 Noise impact of construction activities and vehicles in the project area

In order to determine the effect of the construction phase on the current noise climate in the vicinity of the project area, the expected noise level during the three construction phases considered was compared with the reference situation (LAeq level). Table 6-9 below shows the quantitative change in the noise climate at the various discrete reference points as shown in Table 6-8. The expected noise level in the vicinity of the project area during construction phases A, B and C is the result of the logarithmic sum of the calculated specific noise from the construction activities using the acoustic transmission model and the existing ambient noise (reference situation).

The existing ambient noise at the reference points where no noise measurements were carried out has been estimated on the basis of the immission measurements carried out at reference points IP1, IP2, IP3 and IP4, taking into account industrial and road traffic noise as shown on the strategic noise pollution maps for the Antwerp agglomeration for the reference year 2016 (see Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4).

The values at reference points 1 and 2 are not suitable for assessment, as these points are located less than 200 m from the project area and have therefore been placed in brackets in the tables below.

The tables show that during the construction phase, the ambient noise in the vicinity of the project area may change compared to the reference situation and that this change is greatest during the daytime:

- At the homes in Lillo (IP3), an increase of 0.6 to 0.8 dB(A) during the day, resulting in a negligible or no effect (0) for the three construction phases.
- At the homes in Berendrecht (IP4), an increase of 0.2 to 0.6 dB(A) during the day, resulting in a negligible or no effect (0) for the three construction phases.
- In the northern half of Galgenschoor, west of the project area, there will be an increase during the day during construction phase A of 1.1 to 1.8 dB(A) on the higher dyke (IP10, IP12) and an increase during the day of 0.9 dB(A) further west on the embankment towards the Scheldt (IP11). During construction phases B and C, the change will remain the same.

limited to ≤ 1 dB(A) at the reference points at Galgenschoor north. For construction phase A, this results in a limited negative effect (-1) on the higher dyke (IP10, IP12) and a negligible or no effect (0) on the slope towards the Scheldt (IP11). For construction stages B and C, there is a negligible or no effect (0) on both the dyke and the embankment towards the Scheldt.

- In the southern half of Galgenschoor, west of the project area, there will be an increase during the day of 2.0 to 3.8 dB(A) on the dyke (IP27, IP29b) and an increase during the day of 1.5 to 2.3 dB(A) further west on the embankment (IP28). This results in a limited negative effect (-1), with the exception of the higher dyke at IP27 and IP29b – and therefore locally – a negative effect (-2) during construction phase B.
- At the Opstalvallei nature reserve northeast of the project area (IP31), an increase of 0.3 to 1.0 dB(A), which has a negligible or no effect (0) during the three construction phases.
- During the evening and night-time hours, the change will be limited to < 1dB(A) at the nearby homes in Lillo and Berendrecht and the nature reserves, with the exception of an increase to 1.2 dB(A) on the dyke near the southern half of Galgenschoor (IP29b) during construction phase B. There is therefore a negligible or no effect (0) during the three construction phases, with the exception of construction phase B at IP29b – and therefore very locally – where there is a limited negative effect (-1).

No vibration nuisance is expected in the vicinity of the project area during the construction phase. As shown in Table 6-6, screw foundation machines will be used during the construction phase to install the foundation piles and a hydraulic pressure machine will be used to install the sheet piling. Both of these methods produce less noise and vibration than the method involving the driving or vibrating of foundation piles and sheet piles. It can be assumed that at a distance of 11 m from the screw foundation machine, the vibration amplitude is already below the perception threshold, namely an amplitude of 0.10 mm/s cfr. DIN 4150 part 2, 1999.

Table 6-9: Calculation of the change in the noise climate during the construction phase

	Point	Ambient noise – LAeq level *in dB(A)*				Increase in ambient noise compared to the reference situation *in dB(A)*		
		Reference situation	Construction stage A	Construction stage B	Construction stage C	Construction stage A	Construction stage B	Construction stage C
Day Period	IP1	57	(58.6)	(57.5)	(57.4)	(1.6)	(0.5)	(0.4)
	IP2	57	(60.4)	(61.7)	(60.1)	(3.4)	(4.7)	(3.1)
	IP3	50	50.6	50.8	50.6	0.6	0.8	0.6
	IP4	54	54.6	54.2	54.2	0.6	0.2	0.2
	IP10	+/- 56 *(1)*	57.8	57.0	56.7	1.8	1.0	0.7
	IP11	+/- 56 *(1)*	56.9	56.5	56.3	0.9	0.5	0.3
	IP12	+/- 56 *(1)*	57.1	56.4	56.3	1.1	0.4	0.3
	IP27	+/- 56 *(1)*	58.2	59.2	58.0	2.2	3.2	2.0
	IP28	+/- 56 *(1)*	57.7	58.3	57.5	1.7	2.3	1.5
	IP29b	+/- 56 *(1)*	58.7	59.8	58.6	2.7	3.8	2.6
	IP31	+/- 55 *(1)*	56.0	55.4	55.3	1.0	0.4	0.3

	Point	Ambient noise – LAeq level *in dB(A)*				Increase in ambient noise compared to the reference situation *in dB(A)*		
		Reference situation	Construction stage A	Construction stage B	Construction stage C	Construction stage A	Construction stage B	Construction stage C
Avon d- and n ight period	IP1	54	(54.1)	(54.2)	(54.1)	(0.1)	(0.2)	(0.1)
	IP2	54	(54.2)	(55.8)	(55.0)	(0.2)	(1.8)	(1.0)
	IP3	46	46.0	46.3	46.1	0.0	0.3	0.1
	IP4	49	49.0	49.1	49.0	0.0	0.1	0.0
	IP10	+/- 53 *(1)*	53.1	53.3	53.1	0.1	0.3	0.1
	IP11	+/- 53 *(1)*	53.0	53.1	53.1	0.0	0.1	0.1
	IP12	+/- 53 *(1)*	53.0	53.1	53.0	0.0	0.1	0.0
	IP27	+/- 53 *(1)*	53.1	54.0	53.5	0.1	1.0	0.5
	IP28	+/- 53 *(1)*	53.1	53.7	53.4	0.1	0.7	0.4
	IP29b	+/- 53 *(1)*	53.1	54.2	53.6	0.1	1.2	0.6
	IP31	+/- 50 *(1)*	50	50.2	50.1	0.0	0.2	0.1

(1) The current ambient noise has been estimated on the basis of the immission measurements carried out and the strategic noise pollution maps for the Antwerp agglomeration (reference year 2016) for industrial and road traffic noise.

If these changes in ambient noise are converted into effect scores (interim scores) according to the assessment framework (see Table 6-3), the scores are assigned per construction stage and per evaluation point as shown in the table below.

Table 6-10: Impact assessment per construction stage and evaluation point

Point	Daytime			Evening and night period		
	Construction stage A	Construction stage B	Construction stage C	Construction stage A	Construction stage B	Construction stage C
IP1	(-1)	(0)	(0)	(0)	(0)	(0)
IP2	(-2)	(-2)	(-2)	(0)	(-1)	(0)
IP3	0	0	0	0	0	0
IP4	0	0	0	0	0	0
IP10	-1	0	0	0	0	0
IP11	0	0	0	0	0	0

Point	Day period			Evening and night period		
	Construction stage A	Construction stage B	Construction stage C	Construction stage A	Construction stage B	Construction stage C
IP12	-1	0	0	0	0	0
IP27	-1	-2	-1	0	0	0
IP28	-1	-1	-1	0	0	0
IP29b	-1	-2	-1	0	-1	0
IP31	0	0	0	0	0	0

6.4.2.2 Noise impact of road traffic in the vicinity of the project area

In addition to the work on the project site, the construction phase will also generate additional traffic on the roads in the vicinity of the project area, which may result in a change in traffic noise. The effect of road noise emissions due to additional road traffic during the construction phase has been qualitatively determined using the traffic intensities provided by the Mobility discipline.

Based on the mobility data, from the perspective of noise pollution, only those road segments where the additional traffic development resulting from the project will be greatest have been considered. These are, in particular, Scheldelaan between the 11-Lillo complex and the access road to the northern part of the project area, which is planned at the existing Vopak site, the R2 between the A12 and the 11-Lillo complex (Tijsman tunnel) and the junction of the A12 with the R2 from/to Antwerp. For the evaluation, traffic intensities during the busiest months of the construction phase (peak period) are taken into account in terms of the number of workers on the construction site. During this peak period, approximately 710 passenger cars, 29 buses, 38 minibuses and 94 lorries are expected per day (see also Chapter 10 Mobility). Converted to passenger car equivalents or PAE, this means a share of approximately 73% light motor transport (cars and minibuses), 4% medium-duty transport (buses) and approximately 23% heavy transport (lorries).

Taking into account both passenger and freight movements, the project will generate the highest traffic volumes during the construction phase during rush hour, which is expected to be between 5 a.m. and 7 a.m. and 4 p.m. and 6 p.m. During these rush hours, the vast majority of transport (mainly site personnel) will take place by car, minibus or bus to and from the project area. Freight transport will mainly take place between 6 a.m. and 6 p.m., accounting for approximately 15% of traffic during the relevant rush hour periods. This means that light transport will clearly predominate during rush hour.

A comparison of traffic volumes before and during the construction phase suggests that the following changes can be expected:

- For the morning rush hour, a 24% increase in the number of PAEs is expected at the junction of the A12 (from Antwerp) with the R2 (on the R2 itself, the increase appears to be < 15%), 29% at complex 11-Lillo and 40% on Scheldelaan between complex 11-Lillo and the Vopak site (entrance to the project area). This corresponds to a change in road traffic noise emissions of 0.9 dB at the junction of the A12 (from Antwerp) with the R2, 1.1 dB at the 11-Lillo complex and 1.5 dB on Scheldelaan between the 11-Lillo complex and the Vopak site.
- During the evening rush hour, an increase in PAE of 35% is expected on Scheldelaan between the Vopak site and complex 11-Lillo, 25% at complex 11-Lillo and 22% on the junction of the R2 with the A12 towards Antwerp (on the R2 itself, the increase appears to be < 10%). This will result in an increase in traffic noise on these roads of 1.3 dB, 1.0 dB and 0.9 dB respectively.

As described earlier, the noise climate in the vicinity of the project area is largely determined by existing industrial noise, in addition to noise emissions from road traffic. The strategic noise pollution maps for the Antwerp agglomeration for the reference year 2016 (see Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4) show that road traffic has little impact on the immediate vicinity of the project area, with the exception of Scheldelaan 410 - 460 (section between complex 11-Lillo and the Bayer industrial site) near the homes in Lillo, where road traffic noise emissions cannot be considered entirely negligible.

Taking into account the existing industrial noise, there will be a negligible or no effect (0) during both the morning and evening rush hours as a result of the changed noise emissions from road traffic, without taking into account the noise impact resulting from activities in the project area itself.

The overall effect on the noise climate is determined on the one hand by the change in traffic flows on the access roads and on the other hand by the activities in the project area itself. During the morning rush hour, the total noise increase shows a limited additional increase in ambient noise at Galgenschoor South and the residential area of Lillo compared to the evening and night-time values in Table 6-9 (a total noise increase of between 1.0 and 1.5 dB is expected here). During the morning rush hour, this results in a negligible (0) to limited negative effect (-1) at Galgenschoor south and locally at the residential area of Lillo during construction phases A and C and construction phase B, respectively. In the other areas near Scheldelaan, the R2 and the A12, where a change in traffic noise is also expected, the overall effect of the construction phase (road traffic + site activity) during the morning rush hour will remain negligible or have no effect (0).

During the evening rush hour between 4 p.m. and 6 p.m., construction activities in the project area are expected to be lower than during normal working hours, but will not yet have completely ceased to the extent seen during the evening and night-time periods.

The overall effect on the noise climate during the evening rush hour will be between a minimum of the evening/night period /night period and a maximum of the day period, as shown in Table 6-10.

Outside rush hour, the additional traffic developments resulting from the construction phase of the project are smaller. The increase in traffic flows is well below 25%, resulting in a noise increase of < 1dB and thus a negligible or no effect (0).

6.4.2.3 Noise impact of shipping traffic on canal dock B1/B2

Project One plans to use sea and inland vessels to transport soil and installation modules, particularly pre-assembled installation parts, during the construction phase, thereby minimising road transport.

The table below provides an estimate of the number of ship transports during the construction phase (see also Chapter 10 Mobility):

- Removal of topsoil: approx. 58 push convoys (there and back across the canal dock) spread over approx. 6 months (Q4 2022 – Q1 2023);
- Supply and removal of soil for levelling work: approx. 29 push convoys spread over approx. 6 months (Q2 2023 – Q3 2023), (Q2 2023 and Q1 2024);
- Removal of soil from various works that cannot be reused: approx. 37 push convoys spread over approx. 1.5 years (Q2 2023 – Q3 2024), (Q2 2023 – Q4 2024);
- Supply of modules: 5 to 10 seagoing vessels and 50 to 75 inland vessels spread over approx. 1 year (Q2 2024 – Q1 2025), (Q4 2024 – Q3 2025).

Based on the planned schedule, the various ship transports will overlap little or not at all, and during the busiest periods no more than one push convoy per day and one seagoing vessel per month are expected. This means that on a daily basis there will be no more than two ship movements involving a push convoy or a seagoing vessel.

For the qualitative assessment of the noise impact of the additional ship traffic, reference is made to the current number of ship movements on canal dock B1/B2, the data for which was obtained from the Antwerp Port Authority. The average number of ship passages over the past 5 years at the 'Vlam' passage point – measuring point at the Vopak flare – is shown in Table 6-11.

Table 6-11: Current number of ship passages on canal dock B1/B2 per 24 hours

Type	Average number of ship passages through the canal dock per 24 hours				
	Ref. year 2019	Ref. year 2020	Ref. year 2021	Ref. year 2022	Ref. year 2023
Inland vessels	186.8	199.8	229.8	221.1	225.2
Seagoing vessels	28.3	26.6	34.2	31.2	28.7

There appear to be no major fluctuations in the number of ship passages in canal dock B1/B2 throughout the year.

The current number of ship movements at canal dock B1/B2 can be determined based on the number of ship passages in 2022 and 2023 and averages 223 inland vessels and 30 seagoing vessels. Based on these traffic intensities, the expected maximum daily increase in the number of inland vessels/push convoys during the construction phase compared to the current traffic flow is +/- 1% and in the number of seagoing vessels +/- 7% at canal dock B1/B2.

This means that the change in noise emissions resulting from additional shipping traffic (sea-going and inland vessels) during the construction phase in the vicinity of the canal dock will be less than 1 dB and will have a negligible or no effect (0) on the current noise climate.

6.5 Operational phase

6.5.1 Description of the operational phase

For the description of noise emissions during the operation of Project One, the immission-relevant noise power level of the relevant installation zones and their respective locations has been provided by Project One. The specified noise power levels per zone are the result of the noise emissions of the individual installations based on supplier data and, in the absence of data (e.g. for pipes), based on assumptions from similar installations, and constitute a realistic estimate of the noise emissions from such installations. The spectral distribution of the noise emission has been determined on the basis of noise measurements on similar installation parts or units.

In addition to the production facilities, Project One provides two loading and unloading quays where ships can moor to deliver raw materials and remove some of the end products. Mooring ships are also considered part of the continuous noise emission of the installation, as the transfer of product between a ship and the installation or vice versa can take several hours to more than half a day. The noise emissions of the ships in question or similar ships were obtained from the client, with the noise emissions of the ships being expressed both globally and spectrally in octave bands, providing a realistic estimate of the noise emissions of such installations.

Table 6-12 below shows the relevant installation zones and vessels of Project One, their global continuous sound power level (Lw) and the calculated average sound power level per unit area (Lw/m² - determined on the basis of the area per installation zone).

Table 6-12: Sound power level of the relevant installation zones and vessels

Source reference	Description	Lw In dB(A)	Lw per m² In dB(A)
S1.1 Grid Intake	Transformer station	102.4	64.3
S2.1 Utilities	Supporting infrastructure	101.5	57.6
S3.1 Wastewater Treatment	Water treatment plants	101.7	56.2
S4.1 Cooling Towers	Cooling towers	103.9	68.5
S5.1 Boilers & STG	Boilers & steam turbine generator	109.7	68.4
S6.1 C3/C4/PGP Bullets	C3 / C4 / export, marine pumps, etc.	101.8	59.6
S7.1 C5+Tank	C5 + tank	101.0	64.0
S8.1 Ethane Tankage	Ethane tank + pumps, compressors, pipes, etc.	105.3	59.8
S9.1 Berth 2	Ship quay 2 pumps, pipes, etc.	96.2	54.9
S10.1 Berth 3	Ship quay 3 pumps, pipes, etc.	91.0	52.9
S11.1 ECR Unit+Cooling Tower	ECR + cooling tower	116.1	67.3
S12.1 Ship Berth2 Engine (VLEC)	Ship (large) at quay 2 - auxiliary engines	105.0	-
S12.1 Ship Berth 2 Cargo (VLEC)	Ship (large) at berth 2 - pumps	96	-
S13.1 Ship Berth2 Engine (Barge)	Ship (small) at quay 2 - auxiliary engines	97	-
S13.1 Ship Berth2 Cargo (Barge)	Ship (small) at quay 2 - pumps	90.0	-
S14.1 Ship Berth 3 Engine (Barge)	Ship (small) at quay 3 - auxiliary engines	97	-
S14.1 Ship Berth 3 Cargo (Barge)	Ship (small) at quay 3 - pumps	90	-

Based on the data obtained, the sound power level of the relevant installations for the ECR and supporting infrastructure is 118.1 dB(A). Including the sound power of two small ships (source ref. S13.1 and S14.1), this remains unchanged, and including the sound power level of one large ship and one small ship (source ref. S12.1 and S13.1), this becomes 118.3 dB(A). The average sound power level per unit area for the various installation zones is between 53 and 69 dB(A)/m² (rounded).

No continuous immission-relevant noise sources are expected during the operational phase in the administrative zone, which includes the administrative building, warehouse, workshop, etc. of Project One.

The noise impact of the operational phase under continuous and representative operating conditions is described in § 6.5.2.1.1.

In addition to the installation units described above, the project also provides for three ground flares, namely an ECR ground flare and a double tank ground flare (one in use, one as backup) and one ECR tower flare. The flare systems are described in § 3.4.11 of Chapter 3. Flaring will only take place during start-up or planned shutdown of a unit or in the event of a safety situation in the production process.

The following flare activities may occur:

- During start-up or a planned shutdown of the ethane cracker, flaring is expected from the ECR closed ground flare, which is designed to accommodate the gas flow during start-up and shutdown of the cracker.

During start-up, this is necessary as long as the ethylene produced does not meet the specifications. A normal start-up takes approximately 24 to 72 hours. The upper limit of the average hourly flare flow during the start-up phase is 80 t/h, which is lower than the maximum design capacity of the ECR ground flare of 125 t/h. During a planned shutdown, the ECR ground flare is used to burn residual gases that may be released, usually for a few hours. The expected average hourly flare flow rate is less than 80 t/h.

- In the event of a safety situation, a brief flare operation may occur on one or more flares. The process provides a series-connected system for the ECR flares, with primary control over the ECR ground flare and secondary control over the ECR ground flare and the ECR tower flare together. This limits the operation of the ECR tower flare to unplanned process interruptions only, during which short-term peak loads are released that exceed the maximum capacity of the ECR ground flare. Only in exceptional configurations can the ECR tower flare operate individually, but always limited to the period during which a safety situation occurs in the production process.

An overview of the flares and their assumed sound power levels, both at start-up/shutdown (flare flow rate 80 t/h) and in a safety situation (maximum flare flow rate per flare), is shown in Table 6-13. The sound power level of the flares was obtained by Project One, but estimated on the basis of empirical formulas taking into account the type and gas flow rate per flare, due to the (as yet) lack of concrete supplier data for these sources.

Table 6-13: Sound power level of the flares

Source reference	**Description**	**Sound power LwA** *in dB(A)*
At start-up or planned shutdown of the ECR		
S15.1 ECR Enclosed ground flare	ECR ground flare	112
In a safety situation *(1)*		
S15.1 ECR Enclosed ground flare	ECR ground flare	115.0
S16.1 Tank Enclosed ground Flare	Tank ground flare	115.0 *(2)*
S17.1 ECR Elevated Flare	ECR tower flare	132.6 / 133.5 *(3)*

(1) These noise emissions are not part of normal operations and are only intended to ensure safety on site in the event of an emergency.
(2) Double ground flare, one in use and one as backup.
(3) Left: standard configuration with simultaneous operation of the ECR ground flare and the ECR tower flare. Right: exceptional configuration with independent operation of the ECR tower flare.

The noise impact of operations during start-up or planned shutdown of the ECR, with the ECR ground flare in operation, is described in § 6.5.2.1.2. The noise impact in a safety situation with short-term operation of one or more flares is described in § 6.5.2.1.3.

Apart from the flares, there are no other non-continuous sources that could have a relevant impact on the noise climate in the surrounding area.

The emission-relevant installation zones, flares and ships are all located in the southern part of the project area. Their location has been determined on the basis of the most recent layout plan for the future site (Figure 6-7), with reference to the source references in Table 6-12 and Table 6-13. The mooring direction of the ships is indicated by an arrow, which indicates the bow of the ship and thus also the preferred position of the ships at the quay. The noise impact of the ships has been determined based on this configuration.

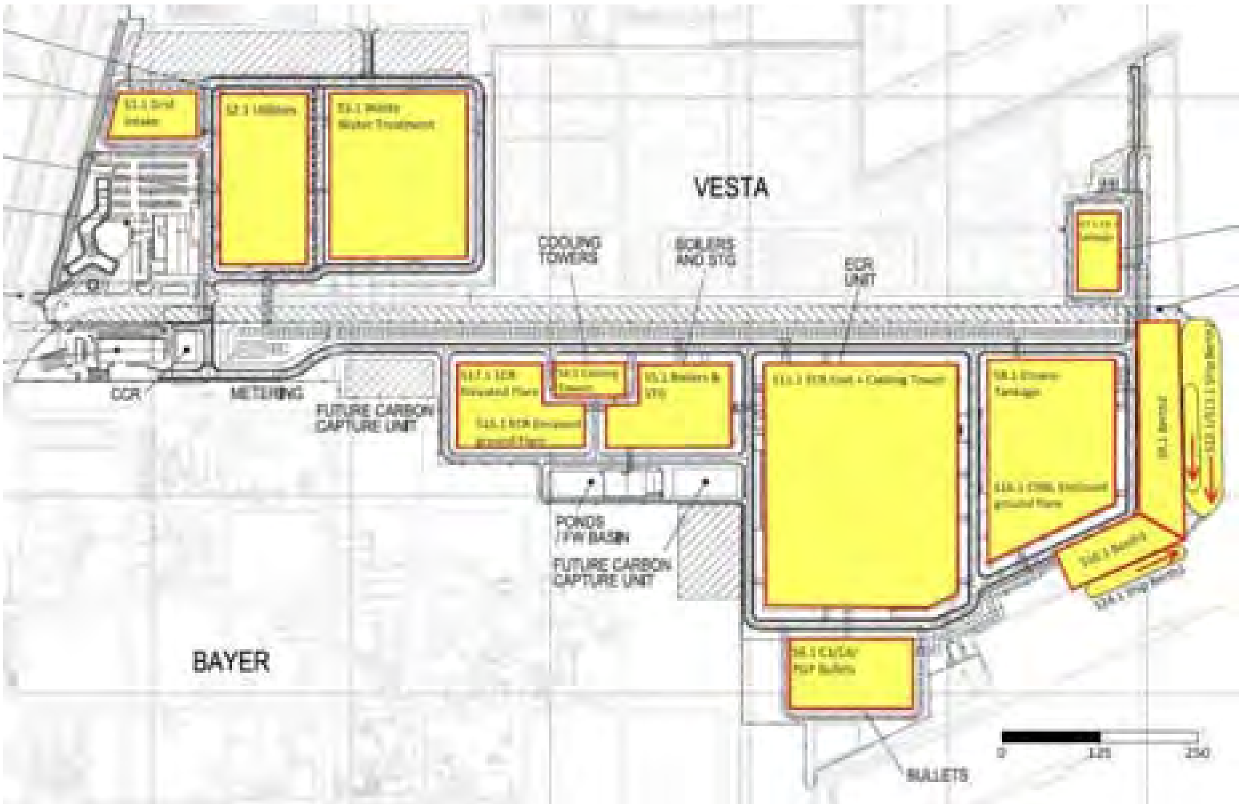


Figure 6-7: Layout plan showing the location of the emission-relevant installation zones, flares and ships in the project area.

6.5.2 Impact assessment and impact evaluation – operational phase

6.5.2.1 Dispersion calculations using the acoustic transmission model

The noise impact of Project One's operations (production installations, ships and flares) on its surroundings has been calculated using an acoustic transmission model.

The sound transmission calculations were performed in accordance with ISO 9613-2 using the IMMI 2020 calculation model. In the acoustic calculation model, the immission-relevant sources were modelled as follows:

- The relevant installation zone as flat sources at a height of 4 m. No buildings, silos or other obstacles within the installation zones are taken into account, which corresponds to the maximum noise emission of the zone. (The exact location – x, y and z coordinates – of the individual noise sources is not yet known at the time of writing this EIA. However, the zone where the sources will be located is known and clearly defined in this EIA). All buildings and relevant obstacles outside the installation zones are taken into account in the calculation model in order to account for reflections and screening effects caused by environmental elements. The calculations also take into account the distance between the source zone and the immission point, air absorption and the influence of the soil.
- A ship as two separate point sources:
  - the funnel of the ship's main and auxiliary engines (source height 38 m for the VLEC; source height <10 m for small ships);
  - the pumps for product transfer (source height 23 m for the VLEC; source height <10 m for small ships).

  The sound propagation from the exhaust pipes of the ships' main and auxiliary engines is considered to be directed towards the stern of the ship, based on the client's data. The preferred position of the ships is taken into account (see also Figure 6-7).
- A flare as a point source at a height of 20 m for ground flares and at a height of 208 m for tower flares. The sound propagation of the flares is considered to be directed upwards to a limited extent, based on the data obtained from the client.

The calculations are performed for the most critical wind direction, i.e. the wind direction from each noise source to each immission point. The humidity and temperature are set at 70% and 10°C respectively. The calculations are performed for the normalised 1/3 octave bands between 25 Hz and 10 kHz. The height of the immission points is 4 m (1st floor level) in accordance with the guidelines.

In accordance with the provisions of VLAREM II, the specific noise during the operational phase has been calculated at 200 m from the site boundaries of the southern part of the project area; which is the part of the project area where immission-relevant noise sources will be located, as well as at the level of the noise-sensitive areas located 200 m from the boundaries of the industrial area in which the project is located. The location of the discrete points is described in Table 6-14, indicating the area designation according to the regional plan or the GRUP Demarcation of the Antwerp Seaport Area and the applicable guideline values (RW). Figure 6-8 also visually represents the discrete reference points.

The Galgenschoor nature reserve is characterised from east to west by a sloping dyke approximately 30 metres wide, followed by an embankment down to the Scheldt (>100 metres depending on the tides of the Scheldt). This was taken into account when selecting the discrete reference points in Galgenschoor. Points on both the dyke and the embankment towards the Scheldt – all located 200 m from the project area – were selected in order to quantify the impact assessment for the entire nature reserve.

In addition to the discrete reference points, the specific noise contribution of the future project has also been determined on a fixed grid of 20x20 m to determine the noise contours of the specific noise over the entire surface of the study area. These noise maps can be used to consult the specific noise contribution during the operational phase of the project at all points in the immediate vicinity of the project area.

Table 6-14: Location of discrete points for the evaluation of the operational phase

Point	Location	Lambert coordinate X	Lambert coordinate Y	Distance to the plot boundary	Area according to regional plan / GRUP	RW
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve	144 005	224 523	Approximately 140 m to the west	Nature reserve < 500 m from industrial area	Day: 50 dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP2	Scheldelaan 460 – near Galgenschoor nature reserve	144 223	223 044	Approximately 115 m to the west		
IP3	Homes in Lillo – Kazerneplein Lillo	144 571	221 640	Approx. 1400 m south/southwest	Residential area < 500 m from industrial area	Day: 50 dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP4	Homes in Berendrecht – Dorpbeekstraat 129	145 586	225 609	Approximately 950 m to the northeast		
IP20	200 m N "Project area Z"	144,429	223,669	200 m north	Industrial area	Day: 60 dB(A) Evening: 55 dB(A) Night: 55 dB(A)
IP21	200 m N "Project area Z"	145	223,668	200 metres north		
IP22	200 m NE "Project area Z"	145 587	224 155	200 m northeast		
IP23	200 m E "Project area Z"	145 909	223 616	200 m east		
IP24	200 m SE "Project area Z"	145,854	223 129	200 m southeast		
IP25	200 m S "Project area Z"	145,550	222 714	200 m south		
IP26	200 m S "Project area Z"	145 137	222 938	200 m south		
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	144 202	222 857	200 m west	Nature reserve < 500 m from industrial area	Day: 50 dB(A) Evening: 45 dB(A) Night: 45 dB(A)
IP28	200 m W "Project area Z" (Galgenschoor)	144	223	200 m west		

Point	Location	Lambert coordinate X	Lambert coordinate Y	Distance to plot boundary	Area according to regional plan / GRUP	RW
IP29	200 m NW 'Project area Z' (Galgenschoor – on dyke)	144	223	200 m to the north-west		
IP31	200 m NE of industrial area (Opstalvallei)	145,767	225,057	Approx. 580 m northeast		

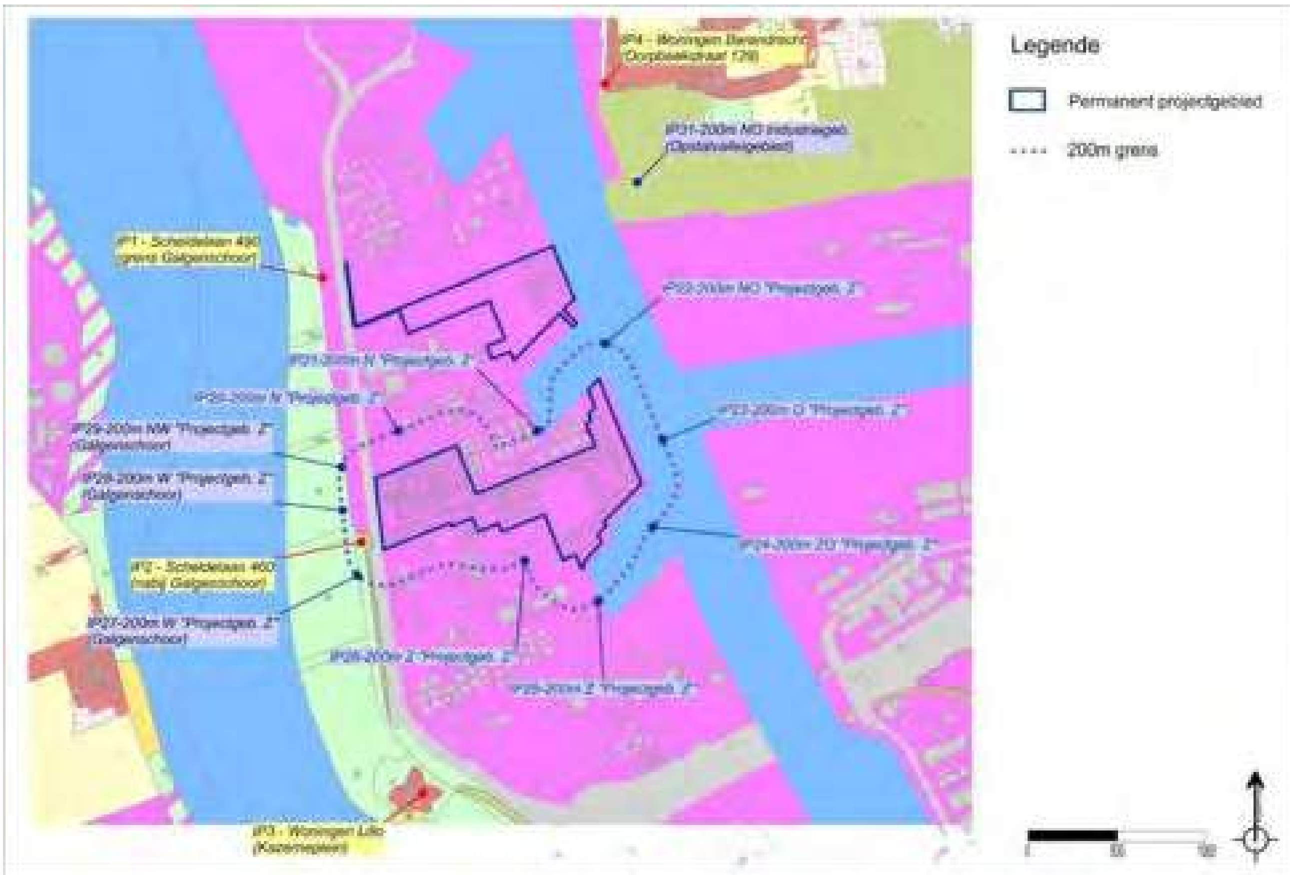


Figure 6-8: Location of discrete points for the evaluation of the operational phase

6.5.2.1.1 Noise impact of operation under continuous and representative operating conditions

Using the acoustic transmission model, the specific noise from the operation of Project One under a representative operating regime was calculated at the discrete reference points mentioned above.

For the evaluation of noise emissions, the specific noise must be compared with the conditions of VLAREM II (see § 6.2.4). In addition, the conditions for new establishments must be met, whereby the applicable limit values are determined on the basis of the applicable guideline value (RW) and the original ambient noise (LOOG).

The original ambient noise level can be determined from the most recent continuous immission measurements carried out in December 2023 – January 2024 and the reported strategic noise pollution maps for the Antwerp agglomeration for the reference year 2016 (see § 6.3.1).

An overview of the results of the continuous immission measurements and the determination of the original ambient noise (LOOG) at all reference points considered is described in § 6.3.2.

The results of the continuous immission measurements show that the LA95 level remains virtually constant throughout a full 24-hour period in the immediate vicinity of the project area.

Since the future installations will be characterised by a continuous production process, only the most critical night-time period will be considered in the following.

Taking into account the conditions for new installations, the limit values can be determined as described in Table 6-15 below.

Table 6-15: Determination of limit values according to VLAREM II

Point	Location	Original ambient noise LA95 – level *in dB(A)*	Limit values at night according to VLAREM II *in dB(A)*	
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve	52	45	MKN (1)
IP2	Scheldelaan 460 – near Galgenschoor nature reserve	50	45	MKN (1)
IP3	Homes in Lillo – Kazerneplein Lillo	44	40	RW-5
IP4	Homes in Berendrecht – Dorpbeekstraat 129	46	45	MKN (1)
IP20	200 m N "Project area Z"	> 60	55	RW
IP21	200 m N "Project area Z"	> 60	55	RW
IP22	200 m NE "Project area Z"	50-55	50	RW-5
IP23	200 m E "Project area Z"	50-55	50	RW-5
IP24	200 m SE "Project area Z"	50-55	50	RW-5
IP25	200 m S "Project area Z"	> 60	55	RW
IP26	200 m Z "Project area Z"	> 60	55	RW
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	+/- 50	45	RW
IP28	200 m W "Project area Z" (Galgenschoor)	+/- 50	45	RW
IP29	200 m NW "Project area Z" (Galgenschoor – on dyke)	+/- 50	45	RW
IP31	200 m NE of industrial area (Opstalvallei)	+/- 47	42	LA95-5

(1) These are not VLAREM evaluation points for future installations. The specific noise at these points will be compared with the environmental quality standard (MKN) for noise in open air in Appendix 2.2.1 of VLAREM II.

When calculating the specific noise, a distinction is made between the following variants:

- Specific noise from the ECR and supporting infrastructure;
- Specific noise from the ECR and supporting infrastructure, including 2 small vessels (inland vessels);
- Specific noise from the ECR and supporting infrastructure, including 1 large vessel (seagoing vessel) and 1 small vessel (inland vessel).

Table 6-16 below shows the calculated specific noise levels according to the three variants above, tested against the applicable limit values according to VLAREM II. In addition to the calculation at discrete reference points, the specific noise levels were also calculated across the entire surface area of the study area. The noise contours for the three variants above are shown in Appendices 2.7 to 2.9.

The values at reference point 2 are not suitable for assessment, as this reference point is located less than 200 m from the southern part of the project area and have therefore been placed in brackets in the tables below.

The following colour code is used in the table below to visualise the comparison between the calculated values and the limit values according to VLAREM II:

- Green: limit value is respected with a margin of 0.5 dB(A);
- Yellow: limit value is equalled with +/- 0.5 dB(A);
- Red: limit value is exceeded by at least 0.5 dB(A).

Table 6-16: Calculated specific noise levels of the ECR, supporting infrastructure and ships assessed against the limit values according to VLAREM II

Point	Calculated specific noise (Lsp) – *in dB(A)*			Limit values at night according to VLAREM II – *in dB(A)*
	ECR and supporting infrastructure	ECR and supporting infrastructure, including 2 small vessels	ECR and supporting infrastructure, including 1 large vessel and 1 small vessel	
IP1	31.6	31.7	32.4	45 *(1)*
IP2	(41.6)	(41.7)	(41.7)	45 *(1)*
IP3	30.6	31.0	31.1	40
IP4	26.0	28.2	33.0	45 *(1)*
IP20	45.2	45.2	45.2	55
IP21	45.8	45.8	46.1	55
IP22	42.1	43.1	48.1	50
IP23	48.7	49.0	49.7	50
IP24	50.0	50.2	50.3	50
IP25	47.6	48.0	48.1	55
IP26	50.5	50.6	50.6	55
IP27	38.3	38.5	38.5	45
IP28	39.5	39.5	39.6	45
IP29	44.1	44.1	44.1	45
IP31	29.9	30.7	32.9	42

(1) These are not VLAREM evaluation points for future installations. The specific noise at these points will be compared with the environmental quality standard for noise in open air in Appendix 2.2.1 of VLAREM II.

The calculations show that the specific noise from the ECR and supporting infrastructure, without and with consideration of the ships, complies with the applicable limit values at all points. The specific noise appears to be highest at 200 m from the eastern and south-eastern boundary of the site, particularly at slipway 1 (Bayer) / Canal Dock B2 (IP23, IP24), where the applicable limit value of 50 dB(A) may be reached. At the noise-sensitive areas (or at the evaluation points in the direction of these areas 200 m from the site boundary), the specific noise is well below the applicable limit value, at a minimum of 0.9 dB(A).

The above analysis assumes that the calculated specific noise of Project One and the ships is not characterised by tonal noise in the 1/3 octave bands.

The assessment framework described in § 6.2.5 will be used to assess the effects.

Given the continuous nature of the noise emissions from the installations, it is appropriate to carry out the impact assessment on the basis of the LA95,1h parameter. This involves comparing the total ambient noise before the project (reference situation) with the total ambient noise after the project has been implemented, i.e. the operational phase of Project One.

- The ambient noise prior to the project (= original ambient noise or $_{LOOG}$) was estimated on the basis of the immission measurements carried out at reference points IP1, IP2, IP3 and IP4 in December 2023 – January 2024 (see § 6.3.2) and the strategic noise pollution maps for the Antwerp agglomeration (reference year 2016).
- The environmental noise after implementation of the project was determined based on the logarithmic sum of the environmental noise before the project and the calculated specific noise (Lsp) of the future installations (see Table 6-16).

Tables 6-17 and 6-18 show the expected change in the noise climate (ambient noise after implementation of the project – ambient noise before the project) and the resulting impact scores at the various reference points during the night-time period for the future situation without and with consideration of the ships, respectively. It should be noted that reference points IP1, IP2 and IP4 are not VLAREM evaluation points. As no limit values apply here, only an interim score will be given for these points.

The assessment shows the following:

- In the Galgenschoor nature reserve (IP27, IP28, IP29), an increase of 0.3 to 1.0 dB in ambient noise is to be expected as a result of the operational phase, both with and without taking shipping activities into account. The calculated specific noise complies with the limit value throughout the nature reserve, resulting in a negligible or no effect (0).
- At the nearest homes in Lillo (IP3) and Berendrecht (IP4), the project is not expected to cause any significant change in ambient noise levels for any of the variants considered (max +0.2 dB). Given that the specific noise complies with the applicable limit value, the effect is negligible or non-existent (0).
- In the Opstalvallei nature reserve (IP31) to the northeast of the project area, there is also a negligible or no effect (0) for all variants considered. Here too, there is hardly any change in the current noise climate (max +0.2 dB) and the applicable limit value of 42 dB(A) is amply respected.
- On the eastern side of the project area in canal dock B2 (industrial area), during the operational phase, with and without taking into account two small ships, there will be a negligible or no effect (0) at 200 m to the northeast (IP22) (inlet dock 2 – Solvay) to a limited negative impact (-1) at 200 m southeast of the project area (IP24) (inlet dock 1 – Bayer). In between, at 200 m east of the project area (IP23), the impact score may vary between 0 and -1, depending on the current ambient noise level (which is not known exactly). As a result of the operational phase, taking into account the simultaneous activity of a large ship and a small ship, a limited increase in ambient noise can be expected, resulting in an impact score between 0 and -1 to the northeast and a limited negative effect (-1) to the east and southeast of the project area. For all variants, the specific noise complies with the strictest limit values of 50 dB(A) applicable to the industrial area.
- At 200 m north and south of the site boundary, located on the industrial sites of Inovyn (IP20), Vesta (IP21) and Bayer (IP25, IP26), the applicable limit value is also respected and there is a negligible or no effect (0) for all variants considered.

Table 6-17: Impact scores for the future situation without consideration of ships

Point	Location	Original ambient noise LA95 – level *in dB(A)*	ECR and supporting infrastructure				
			Lsp	Lna-Lbefore Δ LA95,1h	Interim score	Lsp > GW	Final score
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve *(1)*	52	31.6	0	**0**	n/a	n/a
IP2	Scheldelaan 460 – near Galgenschoor nature reserve *(1)*	50	(41.6)	(0.6)	(0)	n/a	n/a
IP3	Homes in Lillo – Kazerneplein Lillo	44	30.6	0.2	0	no	**0**
IP4	Homes in Berendrecht – Dorpbeekstraat 129 *(1)*	46	26	0	**0**	n/a	n/a
IP20	200 m N "Project area N"	> 60	45.2	0	0	no	**0**
IP21	200 m N "Project area Z"	> 60	45.8	0.2	0	no	**0**
IP22	200 m NE "Project area Z"	50-55	42.1	0.2 - 0.7	0	no	**0**
IP23	200 m O "Project area Z"	50-55	48.7	0.9 - 2.4	0 / -1	no	**0 / -1**
IP24	200 m SE "Project area Z"	50-55	50.0	1.2 - 3.0	-	no	**-1**
IP25	200 m Z "Project area Z"	> 60	47.6	0.2	0	no	**0**
IP26	200 m Z "Project area Z"	> 60	50.5	0.5	0	no	**0**
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	+/- 50	38.3	0	0	no	**0**
IP28	200 m W "Project area Z" (Galgenschoor)	+/- 50	39.5	0.4	0	no	**0**
IP29	200 m NW "Project area Z" (Galgenschoor – on dyke)	+/- 50	44.1	1	0	no	**0**
IP31	200 m NE of industrial area (Opstalvallei)	+/- 47	29.9	0	0	no	**0**

(1) These are not VLAREM evaluation points. As no limit values apply here, only an interim score will be given for these points.

Table 6-18: Effect scores for the future situation, taking ships into account

Point	Location	Original ambient noise LA95 – level *in dB(A)*	ECR, supporting infrastructure + 2 small vessels					ECR, supporting infrastructure + 1 large vessel and 1 small vessel				
			Lsp	Lna-Lfor Δ LA95,1h	Interim score	Lsp > GW	Final score	Lsp	Lna-Lbefore Δ LA95.1h	Interim score	Lsp > GW	Final score
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve *(1)*	52	31.7	0	**0**	n/a	n/a	32.4	0	**0**	n/a	n/a
IP2	Scheldelaan 460 – near Galgenschoor nature reserve *(1)*	50	(41.7)	(0.6)	(0)	n/a	n/a	(41.7)	(0.6)	(0)	n/a	n/a
IP3	Homes in Lillo – Kazerneplein Lillo	44	31.0	0.2	0	no	**0**	31.1	0.2	0	no	**0**
IP4	Homes in Berendrecht – Dorpbeekstraat 129 *(1)*	46	28.2	0.1	**0**	n/a	n/a	33.0	0.2	**0**	n/a	n/a
IP20	200 m N "Project area Z"	> 60	45.2	0	0	no	**0**	45.2	0.1	0	no	**0**
IP21	200 m N "Project area Z"	> 60	45.8	0	0	no	**0**	46.1	0.2	0	no	**0**
IP22	200 m NE "Project area Z"	50-55	43.1	0.3 - 0.8	0	no	**0**	48.1	0.8 - 2.2	0 / -1	no	**0 / -1**
IP23	200 m O "Project area Z"	50-55	49.0	1.0 - 2.5	0 / -1	no	**0 / -1**	49.7	1.1 - 2.9	-1	no	**-1**
IP24	200 m SE "Project area Z"	50-55	50.2	1.2 - 3.1	-1 / -2	no	**-1**	50.3	1.3 - 3.2	-1 / -2	no	**-1**
IP25	200 m Z "Project area Z"	> 60	48.0	0.3	0	no	**0**	48.1	0.3	0	no	**0**
IP26	200 m Z "Project area Z"	> 60	50.6	0.5	0	no	**0**	50.6	0.5	0	no	**0**
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	+/- 50	38.5	0	0	no	**0**	38.5	0.3	0	no	**0**
IP28	200 m W "Project area Z" (Galgenschoor)	+/- 50	39.5	0	0	no	**0**	39.6	0.4	0	no	**0**
IP29	200 m NW "Project area Z" (Galgenschoor – on dyke)	+/- 50	44.1	1	0	no	**0**	44.1	1.0	0	no	**0**
IP31	200 m NE of industrial area (Opstalvallei)	+/- 47	30.7	0	0	no	**0**	32.9	0.2	0	no	**0**

(1) These are not VLAREM evaluation points. As no limit values apply here, only an interim score will be given for these points.

6.5.2.1.2 Noise impact during start-up or planned shutdown of the ECR

During start-up or planned shutdown of the ethane cracker, the ECR ground flare may be operational in addition to the ECR and supporting infrastructure. This ground flare is generously dimensioned to accommodate the gas flow during start-up and shutdown of the ethane cracker (flare flow rate max. 80 t/h - see also § 6.5.1). The complete shutdown and restart of the ECR does not occur frequently, with a normal start-up taking 24 to 72 hours and a shutdown usually taking several hours.

The specific noise from operation during start-up or planned shutdown is calculated using the acoustic transmission model at the previously mentioned discrete reference points, analogous to operation under representative operating conditions (see § 6.5.2.1.1).

Table 6-19 below shows the calculated specific noise of the ECR and supporting infrastructure, including the ECR ground flare at maximum flare flow during start-up, tested against the applicable conditions according to VLAREM II for continuous noise.

The values at reference point 2 are not suitable for assessment, as this reference point is located less than 200 m from the southern part of the project area and have therefore been placed in brackets in the tables below.

The following colour code is used in the table below to visualise the comparison between the calculated values and the limit values according to VLAREM II:

- Green: limit value is respected with a margin of 0.5 dB(A);
- Yellow: limit value is equalled with +/- 0.5 dB(A);
- Red: limit value is exceeded by at least 0.5 dB(A).

Table 6-19: Calculated specific noise of the ECR, supporting infrastructure + ECR ground flare during start-up or shutdown tested against the limit values according to VLAREM II

Point	**Location**	**Calculated specific noise (Lsp)** – *in dB(A)* **ECR, supporting infrastructure + ECR ground flare during start-up or shutdown**	**Limit value for continuous noise according to VLAREM II (at night) – in dB(A)**
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve *(1)*	32.7	45 *(1)*
IP2	Scheldelaan 460 – near Galgenschoor nature reserve *(1)*	(42.3)	45 *(1)*
IP3	Homes in Lillo – Kazerneplein Lillo	32.1	40
IP4	Homes in Berendrecht – Dorpbeekstraat 129 *(1)*	27	45 *(1)*
IP20	200 m N "Project area N"	46	55
IP21	200 m N "Project area Z"	45.8	55
IP22	200 m NE "Project area Z"	42.5	50
IP23	200 m E "Project area Z"	49	50
IP24	200 m SE "Project area Z"	50.3	50
IP25	200 m S "Project area Z"	47.8	55
IP26	200 m Z "Project area Z"	52.4	55
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	39.3	45
IP28	200 m W "Project area Z" (Galgenschoor)	40.2	45
IP29	200 m NW "Project area Z" (Galgenschoor – on dyke)	44.3	45
IP31	200 m NE of industrial area (Opstalvallei)	31.4	42

(1) *These are not VLAREM evaluation points for future installations. The specific noise at these points will be compared with the environmental quality standard for noise in open air in Appendix 2.2.1 of VLAREM II.*

The calculations show that the specific noise from the ECR and supporting infrastructure, taking into account the ECR ground flare during start-up or planned shutdown, complies with the applicable limit value at all points.

Table 6-20 shows the expected change in the noise climate during the start-up phase of operation with the ECR ground flare in operation and the resulting impact scores at the various reference points during the night-time period. The impact scores are based on the assessment framework described in § 6.2.5. It should be noted that reference points IP1, IP2 and IP4 are not VLAREM evaluation points. As no limit values apply here, only an intermediate score will be given for these points.

The assessment shows the following:

- in noise-sensitive areas (residential areas and nature reserves) during the day, evening and night, there will be a negligible or no effect (0).
- Locally, 200 metres east of the project area in canal dock B2 (industrial area), there may be a limited negative impact (-1).

Table 6-20: Impact scores for the operational phase of the ECR and supporting infrastructure + ECR ground flare during start-up or shutdown

Point	Location	Original ambient noise LA95 – level *in dB(A)*	ECR and supporting infrastructure + ECR ground flare during start-up or shutdown				
			Lsp	Lna-Lbefore Δ LA95,1h	Interim score	Lsp > GW	Final score
IP1	Scheldelaan 490 – border with Galgenschoor nature reserve *(1)*	52	32.7	0	**0**	n/a	n/a
IP2	Scheldelaan 460 – near Galgenschoor nature reserve *(1)*	50	(42.3)	(0.7)	(0)	n/a	n/a
IP3	Homes in Lillo – Kazerneplein Lillo	44	32.1	0.3	0	no	**0**
IP4	Homes in Berendrecht – Dorpbeekstraat 129 *(1)*	46	27.5	0.1	**0**	n/a	n/a
IP20	200 m N "Project area N"	> 60	46.1	0.2	0	no	**0**
IP21	200 m N "Project area Z"	> 60	45.8	0.2	0	no	**0**
IP22	200 m NE "Project area Z"	50-55	42.5	0.2 - 0.7	0	no	**0**
IP23	200 m O "Project area Z"	50-55	49.0	1.0 - 2.5	0 / -1	no	**0 / -1**
IP24	200 m SE "Project area Z"	50-55	50.3	1.3 - 3.2	-1 / -2	no	**-1**
IP25	200 m Z "Project area Z"	> 60	47.8	0.3	0	no	**0**
IP26	200 m Z "Project area Z"	> 60	52.4	0.7	0	no	**0**
IP27	200 m W "Project area Z" (Galgenschoor – on dyke)	+/- 50	39.3	0	0	no	**0**
IP28	200 m W "Project area Z" (Galgenschoor)	+/- 50	40.2	0	0	no	**0**
IP29	200 m NW 'Project area Z' (Galgenschoor – on dyke)	+/- 50	44.3	1	0	no	**0**
IP31	200 m NE of industrial area (Opstalvallei)	+/- 47	31.4	0.1	0	no	**0**

(1) These are not VLAREM evaluation points. As no limit values apply here, only an interim score will be given for these points.

6.5.2.1.3 Noise impact in the event of a disaster

The project also provides for a flare system to dissipate excess pressure from the installations or storage tanks in the event of unplanned incidents. As described in § 3.4.11 of Chapter 3, in addition to the ECR ground flare, one ECR tower flare and a double tank ground flare (1 in use, 1 as backup) are provided, which are only intended as a safety measure in the event of unplanned incidents and will therefore not be used during normal operation of the future installations.

Despite the fact that the flare operation in the event of an incident only concerns an emergency situation, the specific sound of the flares at maximum operating conditions (see Table 6-13 – safety situation) has been calculated for information purposes using the acoustic transmission model. The following detailed results are presented in Appendix 2.10:

- The specific noise of the ECR and supporting infrastructure, including ship activities (1 large and 1 small ship) with the individual specific noise of the flares at maximum operating conditions, assessed against the conditions for incidental noise according to VLAREM II;
- The change in the noise climate as a result of the flare activities compared to the reference situation (existing situation).

The limit value applicable to incidental noise is determined from the applicable value, which for new establishments is the applicable guideline value - 5, increased by 15 dB(A) during the daytime and by 10 dB(A) during the evening and night-time (see also § 6.2.4). This gives a limit value of 60 dB(A) during the day and 50 dB(A) in the evening and at night for nearby homes and nature areas. In industrial areas, this is 70 dB(A) during the day and 60 dB(A) in the evening and at night.

The calculations show that the specific noise from the ground flares complies with the limit value during the day, evening and night-time periods. The specific noise from the ECR tower flare appears to comply with the limit value during the day, but exceeds it during the evening and night-time periods at the homes in Lillo, in Galgenschoor and locally 200 metres south of the project area (industrial area).

Furthermore, the calculations show that:

- At maximum operating conditions of the ground flares, there is hardly any change in the ambient noise level at the nearby homes in Lillo (IP3) and Berendrecht (IP4) and the Opstalvallei (IP31) (max. +0.4 dB). The change is limited to approximately 1 dB at Galgenschoor (IP27, IP28, IP29) and 200 m from the northern and southern boundaries of the project area (IP20, IP21, IP25, IP26). At 200 m from the site boundary to the east of the project area in canal dock B2 (industrial area) (IP22, IP23 and IP24), an increase of approximately 1 to 5 dB can be expected, depending on which ground flare is in operation.
- At maximum operating conditions of the ECR tower flare, both in a series configuration with the ECR ground flare and in individual operation (see § 6.5.1), there is an increase in ambient noise of approximately 8 dB at the height of the homes in Lillo (IP3) and in Galgenschoor (IP27, IP28, IP29) and up to 6 dB locally at 200 m from the southern boundary of the site in the industrial area (IP26). At the Berendrecht homes (IP4) and the Opstalvallei nature reserve (IP4), the change is limited to < 4 dB.
- The combined noise impact of the three flares is predominantly determined by the noise emission of the ECR tower flare and is therefore equal to the individual noise impact of the ECR tower flare.

It should be noted that the noise impact in the event of an emergency is based on a calculation of noise emissions according to the maximum gas flow rate for which the flares are designed. It is likely that a flare will only operate at this maximum gas flow rate for a limited period of time. Furthermore, the sequential configuration is designed to first use the maximum capacity of the ground flare in the event of an incident; only in the event of large residual gas flows will the ECR tower flare come into operation. Project One is also investing in the construction of a highly reliable installation in order to prevent the risk of unplanned outages, which could result in flaring (see § 6.7.2.2.1). The simultaneous operation of all flares is highly exceptional, as it can only occur during a general emergency situation affecting the entire site.

Apart from the flares, there are no real non-continuous sources that could have a relevant impact on the noise climate in the surrounding area. Normal loading and unloading activities by lorries on the site will not have a relevant impact on the noise level outside the company, taking into account the noise level according to the current and expected future situation in the industrial area.

6.5.2.2 Noise impact of road traffic in the vicinity of the project

During the operational phase of the project, additional traffic is expected on the roads in the surrounding area, both from passenger cars and lorries. The effect of noise emissions from the road due to additional road traffic during the operational phase has been qualitatively determined using the traffic intensities provided by the Mobility discipline (see also Chapter 10 Mobility).

According to the traffic intensities provided by the Mobility discipline, the expected change during peak times (arrival of employees and goods, shift changes, departure of employees, etc.) compared to the current traffic flow is less than 15% on the nearby roads (Scheldelaan, R2, A12, etc.).

It follows that the change in noise emissions from roads in the immediate vicinity during the operational phase will be less than 1 dB and that the additional road traffic will therefore have a negligible or no effect (0) on the current noise climate.

6.5.2.3 Noise impact of shipping traffic on canal dock B1/B2

The project anticipates 491 ship movements per year to and from one of the two berths that Project One will have at its disposal, comprising 37 seagoing vessels and 454 inland vessels, which will be responsible for the import and export of, among other things, ethane, C4 and C5+ hydrocarbons. ... In order to realise the product transhipment, the minimum stay time for a seagoing vessel at the quay is 24 hours and for an inland vessel an average of 10 to 14 hours. This means that Project One is expected to have a maximum of four ship movements with an inland vessel or a maximum of two with an inland vessel and one with a seagoing vessel per 24 hours.

For the qualitative assessment of the noise impact of the additional ship traffic, reference is made to the current number of ship movements at canal dock B1/B2, as shown in Table 6-11 (data provided by the Antwerp Port Authority). Taking into account the current number of ship movements on canal dock B1/B2, averaging 30 seagoing vessels and 223 inland vessels per 24 hours, an increase of +/- 2% in the number of inland vessels and +/- 3.5% in the number of seagoing vessels is calculated for the operational phase of the project.

It follows that the change in noise emissions from shipping in the immediate vicinity of canal dock B1/B2 during the operational phase will be significantly less than 1 dB and will therefore have a negligible or no effect (0) on the current noise climate.

6.6 Cumulative effects

6.6.1 Construction of quay wall Canal Dock B2

The Antwerp Port Authority is currently planning the construction of a new quay wall. The construction of this quay wall, located on the (south) eastern side of the project area of this EIA (see location of the ship quay in Figure 6-7), is expected to be completed in the course of 2024.

According to the Project EIA for the new quay wall, the construction of the quay wall will involve the use of machinery for earthmoving and wall construction, including a bulldozer, cable crane, concrete mixers, power generators, etc., as well as machinery for dredging the berths, primarily a cutter suction dredger. The construction activities will normally only take place during the day, with the exception of the dredging activities, which may take place around the clock.

The project EIA report states that during the construction activities, there will be a maximum specific sound pressure level (LAeq level at full load of machines) of 55 dB(A) at 200 m from the activity as a result of the dredging works. Without taking shielding into account, the 45 dB(A) contour appears to be approximately 600 m away and the 42 dB(A) contour approximately 1.2 km away from the activity. At the noise-sensitive areas, namely the Opstalvallei nature reserve (IP31 at +/- 1 km), the residential area of Berendrecht (IP4 at +/- 1.5 km), the Galgenschoor nature reserve (IP27 at +/- 1.4 km) and the residential area of Lillo (IP3 at +/- 1.7 km), this results in calculated sound pressure levels that are approximately 10 dB(A) lower than the current ambient noise (see Table 6-9) and has a negligible effect as a result of the construction of the quay wall. No relevant cumulative effects are therefore expected near the noise-sensitive areas as a result of the joint implementation of both projects. In addition to the activities on site, the construction of the quay wall also generates truck transport for the transport of soil, which can be estimated at 19 movements per day or 2 to 3 per hour on a working day of 8
h. Given the current traffic intensity on nearby roads (Scheldelaan, R2, A12), these additional traffic movements are not relevant and therefore no cumulative noise effect applies.

6.7 Mitigating measures

6.7.1 Mitigating measures – construction phase

6.7.1.1 Measures taken by Project One

In order to minimise noise emissions from activities during the construction phase of the project, Project One undertakes to implement the following measures:

- Screw foundation machines will be used for the foundation work for the installations and buildings of Project One. First, a shaft is drilled, which is then filled with concrete mortar. When installing the sheet piling, a pressure technique will be used, whereby the sheet piling is pushed into the ground using a crane and a hydraulic pressure machine. Both of these methods are low-noise and low-vibration alternatives to methods in which preformed foundation piles and sheet piling are driven into the ground using a percussion or vibration mechanism.
- Project One requires contractors to use construction machinery whose emissions (exhaust gases) at least meet the Stage IV requirements (see Chapter 7 Air), which means that the machinery used generally dates from after 2014.
  When selecting construction site machinery, particular attention will be paid to the noise emissions of the machines and, as far as possible, preference will be given to low-noise equipment. In any case, the noise power level of the construction machinery may not exceed the assumptions considered in this EIA. The client has also considered the use of battery-powered construction machinery, which can have lower noise emissions than diesel-powered construction machinery. However, this technology is still in the pilot phase for rolling stock with the required power and, taking into account the scale of the construction phase of Project One, is therefore not applicable.
- Project One provides measures to limit traffic movements during the construction phase of the project by reducing and shifting transport (see Chapter 10 Mobility for details). Measures will include working with modules transported by ship (pre-assembled installations that reduce the manpower required on site and the associated transport), bulk transport by ship (supply and removal of soil), shifting as much road freight transport as possible outside rush hour for site personnel, etc. These measures also have a reducing effect on noise emissions from road traffic.

6.7.1.2 Additional mitigating measures

Taking into account the above measures from Project One, limited negative effects and – very localised – negative effects are still possible. Although this is not a permanent situation, additional mitigating measures should be taken as far as possible to reduce the noise impact of the construction activities. The overview below provides a number of recommendations, distinguishing between source-related measures, measures relating to noise transmission and organisational measures. The list is not exhaustive.

6.7.1.2.1 Source-related measures:

As described in § 6.7.1.1, Project One undertakes to pay particular attention to the noise emitted by the relevant sources/machines on site in order to minimise noise emissions from activities during the construction phase. The following (additional) source-related measures are recommended in order to achieve the intended objective:

- Preparation of an inventory (every three months) of the relevant sources/machines on site, stating the sound power level, by the coordinator of the various site contractors in order to verify whether all sources can comply with the assumptions made in this EIA (see also Table 6-6 and Table 6-7), with the aim of respecting the total sound power level per site stage.
- Assessment of construction machinery against the requirements of European Directive CEE/2000/14, transposed into the Royal Decree of 6 March 2002 on the sound power level of equipment for outdoor use, by the coordinator of the various construction contractors. Some of the construction machinery has specific limit values imposed by this directive (the assumptions in this EIA take this into account), while others are required to state the guaranteed sound power level.
- Providing regular maintenance of the machines in accordance with the manufacturer's instructions.

6.7.1.2.2 Measures relating to noise transmission

- Arrange the site layout in such a way that non-mobile machinery (e.g. power generators, air compressors, drainage pumps, etc.) to be used on the western half of the project area is located as far away as possible from the nearby Galgenschoor nature reserve. The placement of these non-mobile machines close to the western boundary of the project area should therefore be avoided.
- Use of temporary or permanent local screening of construction site activities and machinery in the direction of noise-sensitive areas (residential and nature areas). This can take the form of acoustic movable screens, earth embankments, etc. The client investigated the installation of a barrier in the form of an earth embankment or container-shaped wall at the southern boundary of the project area to limit noise transmission from the entire construction site towards the Galgenschoor nature reserve. According to the information obtained, the available space at this construction site does not allow for the installation of a collective barrier along the entire western boundary of the site, so this option was not considered further.

6.7.1.2.3 Organisational measures

- Limit working hours outside daytime hours, particularly for activities that may cause significant noise impact in the vicinity of the project area.
- Prior to the execution of specific noise-generating activities that are expected to have a potential noise impact near residential areas, clearly inform local residents about the duration and type of work.

6.7.2 Mitigating measures – operational phase

6.7.2.1 Mitigation measures for continuous sources

6.7.2.1.1 Measures from Project One for continuous sources

Within the framework of this EIA, noise emissions from future sources were estimated on the basis of available supplier data or, in the absence thereof, on the basis of noise data from similar sources. Based on the average sound power level per unit of surface area (Lw/m^2) of the future installation zones (see Table 6-12), it can be said that Project One has made the necessary efforts to minimise noise emissions. To this end, Project One's design provides for the use of low-noise installations, supplemented by extensive noise reduction measures.

6.7.2.1.2 Additional mitigating measures for continuous sources

As the project progresses, it is important to check whether all supplier data is in line with the assumptions in this EIA and whether the maximum assumed noise emissions as described in Table 6-12 can therefore be met.

The impact assessment shows that during the operational phase of the project (during representative operating conditions and during a start-up or planned shutdown of the ECR), there may be a limited negative impact to the east of the project area in canal dock B2 (industrial area).

Given that Project One will comply with the applicable limit value at all points during the operational phase,

- complies with the applicable limit value at all points,
- the zone to the east of the project area is located entirely within canal docks/inlet docks 1 and 2, where there are no receptors or only very short-term receptors,
- has a negligible or no effect on the most noise-sensitive areas (residential areas and nature reserves) and on the nearby industrial estates,
- already provides for the necessary investments to use low-noise installations, supplemented by noise reduction measures where necessary (see § 6.7.2.1.1),

no additional specific mitigation measures are necessary.

6.7.2.2 Mitigation measures for flares

6.7.2.2.1 Measures from Project One for flares

Project One provides a single ground flare with a capacity for the ECR to prevent flaring via the ECR tower flare during a planned start-up or shutdown of the ECR. In addition, Project One provides a double tank ground flare (1 in use, 1 as backup) connected to the storage tanks (cryogenic tank and bullets), which can divert excess pressure from the tanks in the event of undesirable incidents. This limits the use of the ECR tower flare to unplanned process interruptions only, where gas flows are released that exceed the capacity of the installed ECR ground flare. This can happen after the start-up of the safety shutdown system, which can be activated after a major process failure, mechanical failure of rotating equipment or a failure of a vital service due to power or steam failures. In order to maintain stable operation of the production process and prevent the risk of unplanned downtime, Project One provides for the following investments:

- Use of reliable pumps with additional instruments to support stable operation and prevent improper activation of the shut-off system;
- Use of mechanical locks on installations (e.g. valves) that shut off when a temperature or pressure threshold is reached to prevent overpressure and release of a pressure relief valve for flaring;
- Use of a dual external power supply via two independent 380kV high-voltage cables (Elia) to ensure the electrical supply;
- Construction of an internal power supply for the ECR, which can prevent the ECR from stopping unexpectedly in the event of a power failure on the external electricity grid;
- Construction of two steam boilers that perform a dual function: on the one hand, they provide a continuous supply of steam to the process at all times to ensure normal operation (if one boiler fails, the other boiler takes over the entire steam demand) and, on the other hand, they consume the process exhaust gases in order to reduce the flaring of excess gas flows.
- Applying design standards for installation processes to ensure high technical availability and using automated systems that can limit the amount of waste gas sent to flares by automatically switching off equipment that can cause flaring.

6.7.2.2.2 Additional measures for flares

As the project progresses, it is important to check whether all assumed noise levels for the flares are in line with the assumptions in this EIA and whether the maximum assumed noise emissions as described in Table 6-13 can therefore be met.

When making the final choice of tower flare, preference should be given to the quietest type made available by the suppliers.

6.8 Decision

6.8.1 Construction phase

6.8.1.1 Noise impact of construction activities and vehicles in the project area

For the construction of Project One, work will be carried out throughout the project area for approximately 3 years and 8 months (from approximately August 2022 to March 2026). For the impact assessment within the discipline of Noise, this work has been divided into 3 construction phases with the following main activities:

- Construction phase A - vegetation removal, topsoil excavation and limited levelling of the site, construction of access roads, construction of a contractor village;
- Construction phase B - site profiling ("cut and fill"), foundation works, etc.;
- Construction phase C - construction of the project's buildings and installations, etc.

Construction phase A comprises similar activities in the northern and southern parts of the project area in preparation for the sites. During construction phases B and C, the majority of construction activities will shift to the southern part of the project area for the construction of Project One's installations and buildings, while the northern part of the project area will serve as a contractor village with a more limited number of construction machines.

To determine the noise emission level during the construction phase, the specified number, type, electrical power and utilisation rate of the construction machinery throughout the construction process were taken into account.

To determine the impact of the construction phase, the expected noise level during the day and night periods was compared with the reference situation. The construction activities are not classified as a facility or activity, which means that the conditions for specific noise according to VLAREM II do not apply.

During the daytime, calculations show a limited increase in ambient noise as a result of the construction phase. Near the nearby homes in Lillo, this increase remains limited to between 0.6 and 0.8 dB(A) and near the homes in Berendrecht to between 0.2 and 0.6 dB(A), resulting in a negligible or no effect (0) for the three construction phases.

In the northern half of Galgenschoor, west of the project area, a daytime increase of 1.1 to 1.8 dB(A) during the day on the higher dyke and 0.9 dB(A) further west on the embankment towards the Scheldt, resulting in a limited negative effect (-1) on the dyke and a negligible or no effect (0) on the embankment towards the Scheldt. During construction phases B and C, the change remains limited to ≤ 1dB and there is a negligible or no effect (0) on both the dyke and the embankment towards the Scheldt.

In the southern half of Galgenschoor, west of the project area, the increase in ambient noise is between 1.5 and 3.8 dB(A), resulting in a limited negative effect (-1) to a local and only during construction phase B negative effect (-2). In the Opstalvallei nature reserve, where an increase in ambient noise of between 0.3 and 1.0 dB(A) is expected, there will be a negligible or no impact (0) during the three construction phases.

During the night-time period, the change remains limited to < 1dB at the nearby homes in Lillo and Berendrecht and the nature reserves, with the exception of a rise to 1.2 dB(A) during construction phase B at the southern half of Galgenschoor (IP29b). There is therefore a negligible or no effect (0) during the three construction phases, with the exception of construction phase B at IP29b – and therefore very locally – where there is a limited negative effect (-1).

Recommendations for minimising noise emissions from activities during the construction phase of the project are described in § 6.7.1.

6.8.1.2 Noise impact of road and ship traffic

The noise impact of the additional traffic generated on nearby roads during the construction phase can be considered negligible or non-existent (0) during the busiest rush hour periods, taking into account the existing industrial noise. For the overall effect, which is determined on the one hand by the changed traffic flows on the access roads and on the other hand by the construction activities in the project area itself, a negligible or no effect (0) to a limited negative effect (-1) for construction stages A / C and construction stage B near Galgenschoor south and locally near the residential area in Lillo, respectively. During the evening rush hour, the overall effect on the noise climate will be between the minimum effect scores during the evening/night period and the maximum effect scores during the day period, as shown in Table 6-10.

Furthermore, the expected maximum increase on a daily basis in current shipping traffic at canal dock B1/B2 during the construction phase is approximately 1% for push convoys (taking into account the current number of inland vessel passages) and approximately 7% for seagoing vessels, meaning that the effect of the additional ship transport during the construction phase can be considered negligible or zero.

6.8.2 Operational phase

The future installations will be characterised by a continuous production process under representative operating conditions. In addition, the project provides for three ground flares and one tower flare: an ECR ground flare that can be used during the start-up/planned shutdown of the ECR or in a safety situation; an ECR tower flare and a double tank ground flare (one in use, one as a backup) that will only be used in a safety situation.

6.8.2.1 Noise impact of the operational phase

The noise impact of the continuous sources on the surrounding area was calculated using an acoustic transmission model for the ECR and supporting infrastructure, with and without consideration of ship activities at the two loading and unloading quays.

Based on the currently available source data, the calculations show that the specific noise from continuous sources, with and without consideration of ships, complies with or equals the applicable limit value at noise-sensitive areas (residential areas and nature reserves) in the immediate vicinity of the project as well as 200 metres from the site boundaries. At the Galgenschoor nature reserve, 200 m west of the site boundary, an increase in ambient noise of between 0.3 and 1.0 dB(A) is expected during the operational phase, resulting in a negligible or no effect (0). Near the homes in Lillo and Berendrecht, as well as in the Opstalvallei nature reserve, there is hardly any change in ambient noise to be expected (max +0.2 dB) and there is a negligible or no effect (0). This also applies 200 m north and south of the site boundary near the Inovyn, Vesta and Bayer companies in the industrial area. 200 m east of the site boundary in canal dock B2 (industrial area), the specific noise complies with the strictest limit value of 50 dB(A) applicable to the industrial area. Taking into account an increase in ambient noise of between <1 and rounded 3 dB(A), this may result in a negligible or no effect (0) to a limited negative effect (-1) 200 m east of the site boundary. For the operational phase without and with consideration of two small ships, an impact score of 0 to -1 applies to the east and southeast of the project area (canal dock B2, slipway 1 – Bayer). For the operational phase with simultaneous consideration of an activity involving large and small ships, this has been extended to a zone at
200 m northeast, east and southeast of the project area (inlet dock 2 – Solvay, canal dock B2 and inlet dock 1 – Bayer).

Project One provides for general maintenance with a complete shutdown and restart of the ECR, during which, in addition to the ECR and supporting infrastructure, the ECR ground flare may be operational (a normal start takes 24 to 72 hours, a shutdown usually takes several hours).

The calculations show that during these limited periods of shutdown and restart of the ECR, no relevant additional noise effects are to be expected compared to the continuous representative operating regime of the production installations as described above.

6.8.2.2 Noise impact in the event of an emergency

The project provides a flare system to divert excess pressure from the installations or storage tanks in the event of unplanned incidents. As described earlier, in addition to an ECR ground flare, there is also an ECR tower flare and a double tank ground flare (1 in use, 1 as backup). These are only intended as a safety feature that comes into play in the event of unplanned incidents and are therefore not used during normal operation of the future installations.

Despite the fact that the flare operation in the event of an incident only concerns an emergency situation, the specific sound of the flares at maximum operating conditions has been calculated using the acoustic transmission model for information purposes.

The calculations show that the specific noise at maximum operating conditions of the ground flares complies with the limit value for incidental noise during the day, evening and night. At the most noise-sensitive areas (residential areas and nature reserves), the change in ambient noise during maximum operation of the ground flares appears to be negligible to small (rounded to 1 dB).

Under maximum operating conditions of the ECR tower flare, the limit value for incidental noise during the day is respected, but is exceeded in the evening and at night at the homes in Lillo, in Galgenschoor and locally 200 m south of the project area (industrial area). Under these operating conditions, the calculations show an increase in ambient noise of approximately 8 dB at the homes in Lillo and Galgenschoor and up to 6 dB locally 200 m south of the site boundary in the industrial area. At the homes in Berendrecht and the Opstalvallei nature reserve, the increase is limited to <4 dB.

The assessments of flaring activities in a safety situation are all based on a calculation according to the maximum gas flow rate for which the flares are designed. It is plausible that a flare will only operate at this maximum gas flow rate for a limited period of time.

As described in § 6.7.2.2.1, Project One has deliberately invested in ground flares in order to avoid the use of the tower flare as much as possible. The tower flare will only be activated in an emergency to discharge residual gas flows from the ECR in the event of an incident, which are too large for the ground flares.

Apart from the flares, there are no real non-continuous sources that could have a relevant impact on the noise climate in the surrounding area.

6.8.2.3 Noise impact of road and shipping traffic

During the operational phase, the expected change in the current traffic flow on the nearby roads and waterways (canal dock B1/B2) is significantly less than 15% and 5% respectively, leading to the conclusion that the change in noise emissions from road and waterway traffic will be less than 1dB and that the effect on the current noise climate will be negligible.

7 Air

7.1 Study area

With regard to potential pollution, the study area is determined by the possible spread of pollutants around the Project One site. Since the effects of atmospheric emissions also occur in other disciplines (especially 'Biodiversity' and 'Human Health'), the dispersion calculations in the Air discipline must be carried out at a sufficient distance to enable the evaluation of all possible effects.

It was decided to model the emission dispersion within a project area extending in all directions to a distance of 20 km from the project area. This distance is the maximum distance to which the air dispersion model (IMPACT) prescribed in the EIA Guidelines System Air has been validated.

7.2 Methodology

7.2.1 Construction phase

The following activities, which will take place during the construction phase, may have an impact on air quality:

- Local earthworks (cut and fill);
- Use of construction machinery and vehicles;
- Soil transport;
- Supply of building and construction materials;
- Transport of site personnel.

During this construction phase, account will be taken of air emissions from exhaust gases from site machinery and transport, as well as dust emissions resulting from earthworks and construction works.

7.2.1.1 Exhaust gases

The effect of the emissions is modelled using the IMPACT air dispersion model (see § 7.2.3) for the following emission sources:

- Construction machinery and vehicles on site;
- Shipping for the delivery and removal of soil and materials;
- Road traffic.

The emissions of all pollutants are taken into account. The effect is evaluated for NOx, more specifically NO_2. This is the pollutant for which emissions from such exhaust gases are known to have the most significant effect on air quality. For NO_2, the ratio of the contribution of exhaust gas emissions to background concentrations is greater than for other pollutants present in exhaust gases (particulate matter, VOCs, etc.). As a result, activities with limited emissions can have a more rapid relevant effect on air quality for NO_2 than for other exhaust gas pollutants.

7.2.1.2 Particulate matter emissions

Local earthworks and construction works may cause local dust nuisance. The extent of emissions is determined by various factors, such as the materials and raw materials used, the machinery and equipment deployed, the procedures applied, the measures taken, weather conditions, etc. As these factors can vary greatly, even from day to day, it is not possible to make a reliable estimate of dust emissions and therefore a quantitative assessment of their effects.

Activities that may cause dust nuisance are assessed qualitatively, taking the following points into consideration:

- the circumstances under which dust nuisance may occur;
- measures already taken and possible additional measures to limit dust dispersion;
- maximum effort to integrate measures to prevent dust nuisance.

Other emissions (exhaust gases from construction machinery, transport, etc.) resulting from all activities are quantified using the available data. For road transport, this is done on the basis of the evaluation of the Mobility discipline (see Chapter 10).

7.2.2 Operational phase

The operation of Project One will be accompanied by various types of emissions from different sources. Below is an overview of the emission sources and their expected emissions.

In this chapter, dispersion modelling will be carried out on the basis of the available emission data for the relevant pollutants in order to map the geographical distribution of the effect on air quality.

7.2.2.1 Types of emission sources and method for estimating emissions

7.2.2.1.1 Chimney emissions

During operation, a number of chimneys will be present, but only in the southern part of the project area.

The chimney emissions are the result of the use of fuel gas (with a high hydrogen content) and natural gas in the furnaces and steam boilers. In addition, there will also be other process emissions and emissions from certain utilities.

This EIA identifies all emission points. It explains the source of the emissions, lists the emission reduction measures and estimates the emissions. It uses the design data for the installation: emission rates, planned gas purification and the expected emission concentration.

An estimate of the expected emissions is used based on the available design data.

7.2.2.1.2 Storage and transhipment emissions

A description is provided of the storage of gases and volatile liquids in tanks and the measures applied to minimise emissions resulting from tank operations.

Storage and transfer emissions are calculated on the basis of transfer volumes and taking into account the emission reduction techniques used (gas shuttle, gas purification, etc.).

7.2.2.1.3 Fugitive emissions

Fugitive VOC emissions can occur at flanges, valves and pumps, among other places, which contain gaseous or volatile liquid product flows.

These emissions are explained in the EIA, with attention to emission-reducing measures (use of leak-free installation parts). These emissions are then estimated.

It is well known that emission factors available in VLAREM for each installation component are very outdated and lead to an unrealistic overestimation of emissions if they are applied in accordance with current BAT. Therefore, emissions will be estimated on the basis of recent literature data (EMEP/EEA - European Monitoring and Evaluation Programme / European Environment Agency) from comparable installations, whereby the estimate is no longer made per installation component but on the basis of the throughput or capacity of the installation.

When evaluating measures to limit fugitive emissions and estimating emissions, all pollutants will be screened and the focus will be on those pollutants with relevant health effects. The health impact of specific parameters is discussed further in the Human Health section (see Chapter 13).

7.2.2.1.4 Flaring emissions

Four flares are provided. These consist of one high open tower flare (ECR) and three low closed ground flares: one ground flare for the ECR and a double ground flare for the tank storage facility. The operation and use of the flares is explained in § 3.4.11 (project description) and § 7.4.2.1.9 (air emissions).

The continuous emissions resulting from the pilot burners of the flares are calculated on the basis of emission data provided by the flare supplier. The occasional flare emissions depend heavily on the scale of the incidents that cause them and are therefore difficult to estimate accurately. These emissions will be described in a semi-quantitative manner.

7.2.2.1.5 Traffic emissions

The site will have loading and unloading quays where ships can moor to deliver raw materials and remove some of the end products. Mooring ships are considered local emission sources. Emissions at the quay and along the shipping route within the study area are estimated on the basis of available data (number of ships, type of ships, etc.) and emission factors.

The Mobility discipline (see Chapter 10) will map the traffic generation of road traffic (commuting and freight transport). Emissions at the most relevant roads (mainly Scheldelaan) will be modelled using an air dispersion model (IMPACT).

7.2.2.1.6 Odour

The main chemicals present on the site are odourless, but there are sub-installations where odour emissions are possible and where measures are being taken to prevent or limit these. The EIA will indicate which measures will be taken to prevent relevant emissions of odorous substances.

7.2.2.2 Critical pollutants

The total emissions from the above-mentioned emission sources will be mapped out. A realistic worst-case scenario for the entire facility will be determined.

Critical pollutants will be selected based on the following criteria (MER Air Directive System – consulted on 11/04/2024):

1) the total annual atmospheric emission load of the pollutant exceeds 1/10 of the threshold load for inclusion in the integrated annual emission report;
2) the pollutant can be identified as a critical parameter, as the measured value in the environment exceeds 80% of the environmental quality standard;
3) The pollutant poses a potential human toxicological risk (transfer to the Human Health discipline). The immission for these

pollutants will then be modelled.

In addition, acidifying and eutrophying deposits will also be calculated for the Biodiversity discipline.

7.2.3 Dispersion modelling and testing against immission limit values

The latest version of the IMPACT mathematical dispersion model (IMmission Prognosis Air Concentration Tool, modelling carried out in February 2024 with an update in July/August 2024 for nitrogen deposition), developed by VITO, is used to evaluate the contribution of emissions to immissions. This model is prescribed in the EIA Guideline System Guideline System Air.

The following data are used as input for the model calculations:

- Emission height;
- Chimney diameter;
- Dry flue gas flow rate under reference conditions (Nm^3/h);
- Flue gas temperature;
- Number of operating hours/operating regime;
- Location - XY coordinates;
- Expected emission concentration or emission load of the relevant parameters.

The calculations and assessment of immissions are generally based on maximum emissions based on realistic worst-case assumptions. Where useful, this can be supplemented with an estimate of average emissions.

The results of the modelling of potentially significant pollutants are further processed as follows: the calculated immission value in the zone of maximum impact and in the vulnerable areas is assessed against the applicable environmental quality standards applicable to the government, in particular the air quality standards from VLAREM II:

- the limit values: the values that must be strictly adhered to according to the legislation;
- the guideline values: these are less binding in nature and are more of a long-term objective.

The IMPACT model is also used to determine the emission contribution of ships (a ship is considered a point source when moored and a line source when sailing) and to determine the emission contribution of road traffic.

The acidifying and fertilising deposition is calculated at the level of the surrounding nature areas. The calculated deposition is evaluated in the Biodiversity discipline (see Chapter 11). In Flanders, this calculation is performed using the IMPACT model. Deposition in the Netherlands is calculated using the Dutch AERIUS model, as prescribed for permit procedures under Dutch nitrogen policy.

7.2.4 Assessment framework

The assessment framework in accordance with the Air Quality Guidelines is applied. The following assessment framework is applied to all locations that must be assessed in accordance with the Air Quality Framework Directive:

Table 7-1: Significance framework for air (source: Air Quality Guidelines)

Impact on the environment		Interim score	Final score after correction: No exceedance of 80% of the MKN after completion of the plan/project?	Final score after correction: Exceedance after completion of plan/project of 80% of the MKN?
Plan/project ensures a reduction of X in immission	X > 10% of the MKN	3	3	2
	X > 3% of the MKN or permitted number exceedances	2	2	1
	X > 1% of the MKN or permitted number exceedances	1	1	0
Plan/project has noneorvery limited contribution to immission	X≤1% oftheMKNor permitted number exceedances	0	0	0
Plan/project causes increase X of immission	X > 1% of the MKN or permitted number exceedances	-1	-1	-
	X > 3% of the MKN or permitted number exceedances	-2	-2	-3
	X > 10% of the MKN or permitted number exceedances	-3	-3	-3
With X: average calculated immission contribution and/or number of exceedances;				
MKN: environmental quality standard (current limit value and future target/limit value); If the MKN cannot be determined, the interim score is equal to the final score.				

The assessment framework is linked to the obligation to investigate mitigating measures. Whether or not mitigating measures are investigated is linked to the final scores from the assessment framework (when assessed against air quality standards):

Table 7-2: Link to mitigating measures (source: Air Quality Guidelines)

Assessment of the effect	Link to mitigating measures
Limited negative (score -1)	Research into mitigating measures is less compelling. **Negative (score -2)**
	Research into mitigating measures is required. **Significantly negative (score -3)**
	Mitigating measures should be proposed in any case.
The underlying principle: the more negative the effects, the more effort must be made to find mitigating measures. If no mitigating measures can be proposed, this must be justified.	

The above assessment framework applies to the annual average effects. No separate assessment framework is provided for percentiles. The expert determines the immission contribution or the number of exceedances and assesses the need for mitigating measures on the basis of expert judgement.

For a description of the 7-point scale used in the impact assessment and the negative scores linked to the mitigating measures, please refer to § 5.3 (general methodology).

7.2.5 Mitigating measures

If the evaluation according to the assessment framework reveals that there are (significant) negative effects, measures will be formulated to mitigate the effects and, if possible, the effect of the measures will be assessed.

7.3 Reference situation

When describing the reference situation, the local air quality of the study area is first mapped out. Air quality is mainly determined by global background concentrations, specific contributions from local sources, building heating, transport emissions and industrial emissions.

The existing air quality in the vicinity of the project area is described on the basis of the following most recent data:

- Modelled background values from VMM for 2022 (VMM interpolation maps) for NOx, PM10, PM2.5 and SO2: data available at https://www.vmm.be/lucht
- Immission data from relevant VMM measuring station(s) and reported in VMM report - Air quality in the Port of Antwerp 2022 for the other relevant parameters (SO2, BTEX, VOC): data available via https://www.vmm.be/data/evaluatie-luchtkwaliteit

The quality of the ambient air is measured by the Flemish Environment Agency (VMM) via various measuring stations spread across Flanders. VMM has an extensive measuring network in the port of Antwerp. Figure 7-1 shows the location of the VMM measuring stations in the port of Antwerp, indicating the pollutants that are measured.

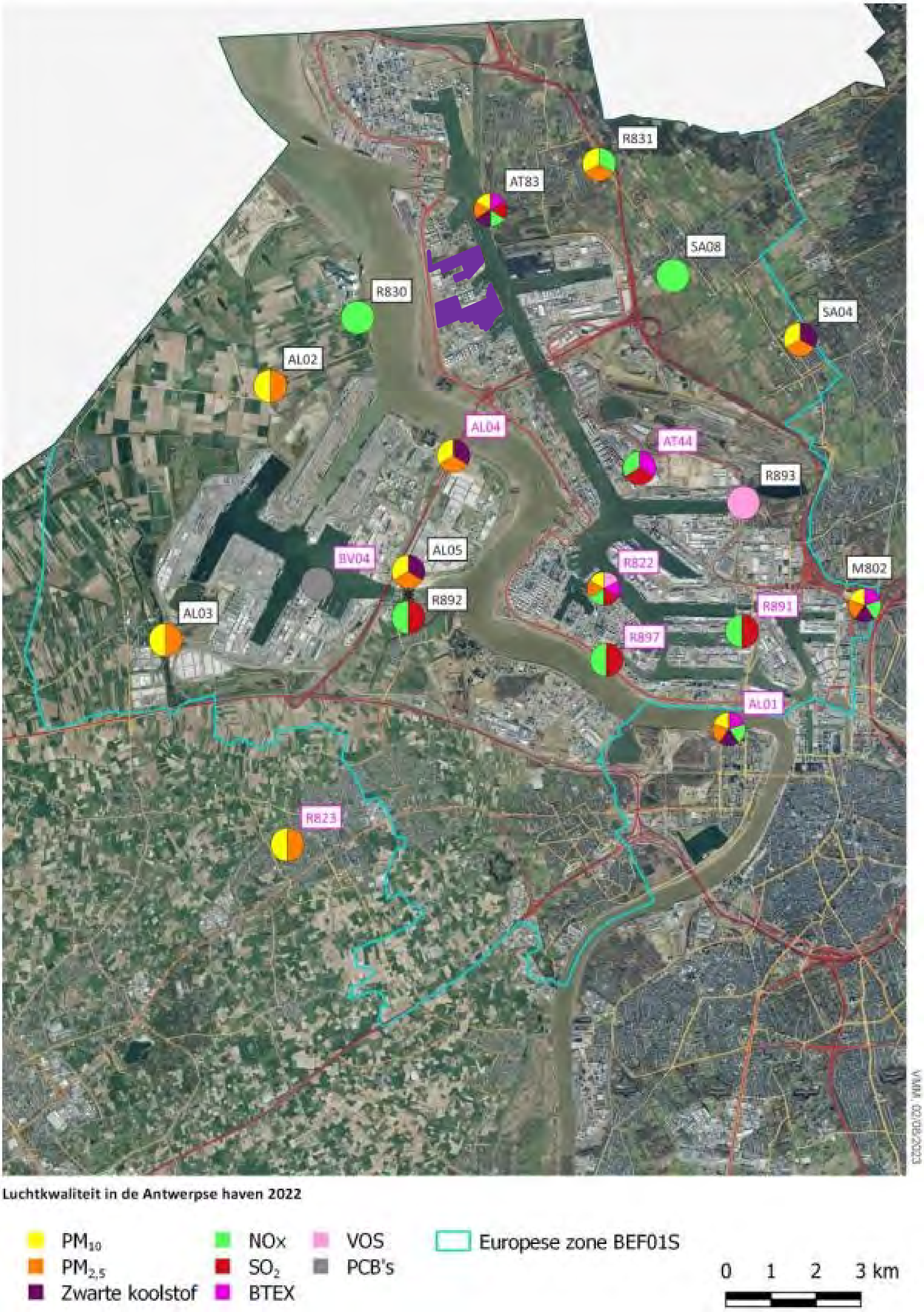


Figure 7-1: Location of VMM measuring stations in the port of Antwerp (source: VMM (2024), Air quality in the port of Antwerp - annual report 2022)

7.3.1 NO_2, PM_{10}, $PM_{2.5}$

There are a number of measuring stations for these pollutants in the Port of Antwerp. VMM determined the virtual average for NO_2 and PM_{10} in the Port of Antwerp and compared this with the virtual Flemish urban and rural average for the period 2012 to 2022. A virtual average is the average of all measurements of this pollutant in a specific area over the course of a year. For the NO2 average, there is a noticeable downward trend in the port of Antwerp and in urban and rural locations in Flanders. Until 2016, we see higher NO2 concentrations in urban locations. The introduction of the low emission zone (LEZ) in Antwerp led to an accelerated greening of the vehicle fleet, both within the LEZ and in the rest of Flanders, resulting in lower NO2 emissions in cities. In 2020, NO2 concentrations fell more sharply than in previous years due to the effect of the coronavirus measures. In 2021, the annual averages rose slightly again and remained at the same level in 2022. At rural measuring stations, concentrations are much lower than in cities or in the port of Antwerp, and the decline is less pronounced.

For PM_{10}, there is a general downward trend at all virtual measuring stations. In the port of Antwerp, the concentration fell until 2014. Since then, the concentration has varied only slightly. The Flemish virtual national average is generally lower than what we measure in the port or in cities.

For $PM_{2.5}$, there is a general downward trend at all virtual measuring stations. The concentrations in the port of Antwerp are fairly similar to those at urban measuring stations. Over the last three years, the concentration in the port of Antwerp has stagnated. The concentrations are lowest at rural measuring stations, but do not differ greatly from what we measure in urban areas or in the port of Antwerp.

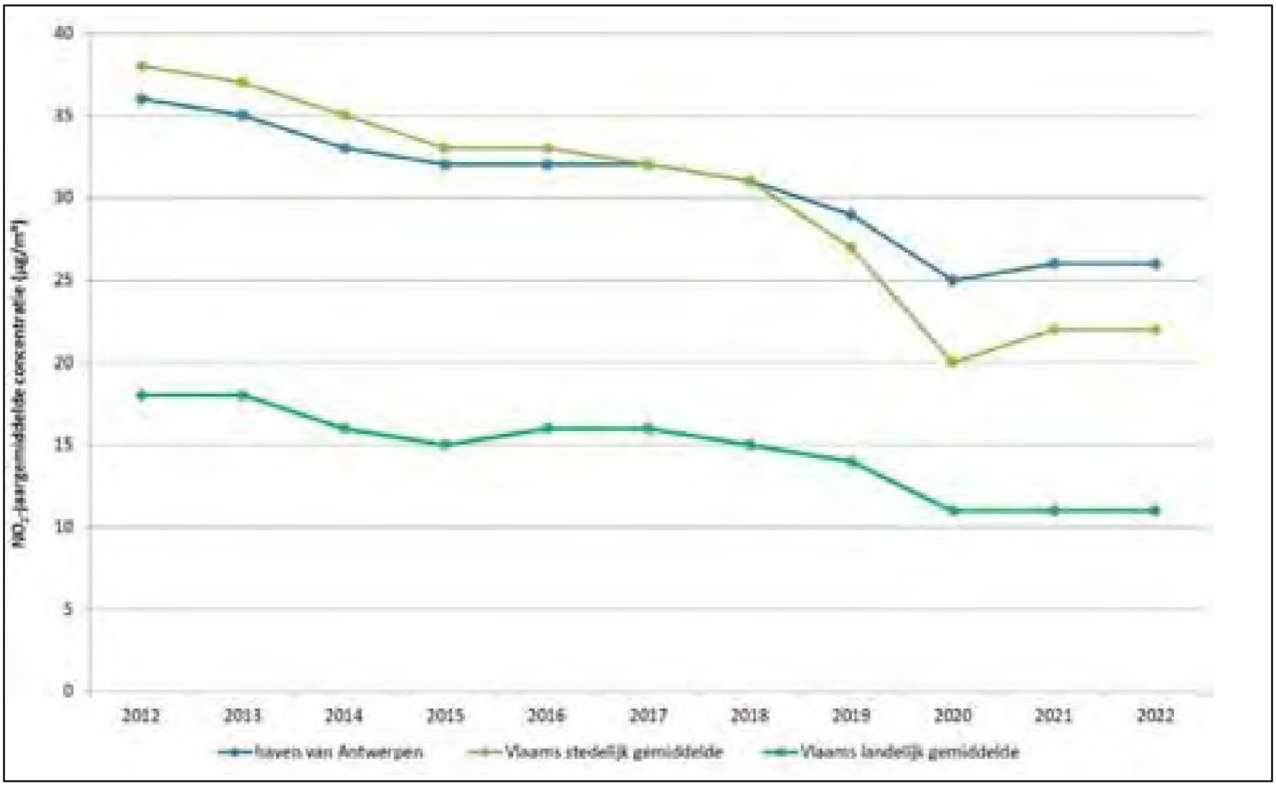


Figure 7-2: Annual average NO2 levels in the Port of Antwerp compared to urban and rural Flanders (source: VMM (2024), Air quality in the Port of Antwerp - annual report 2022)

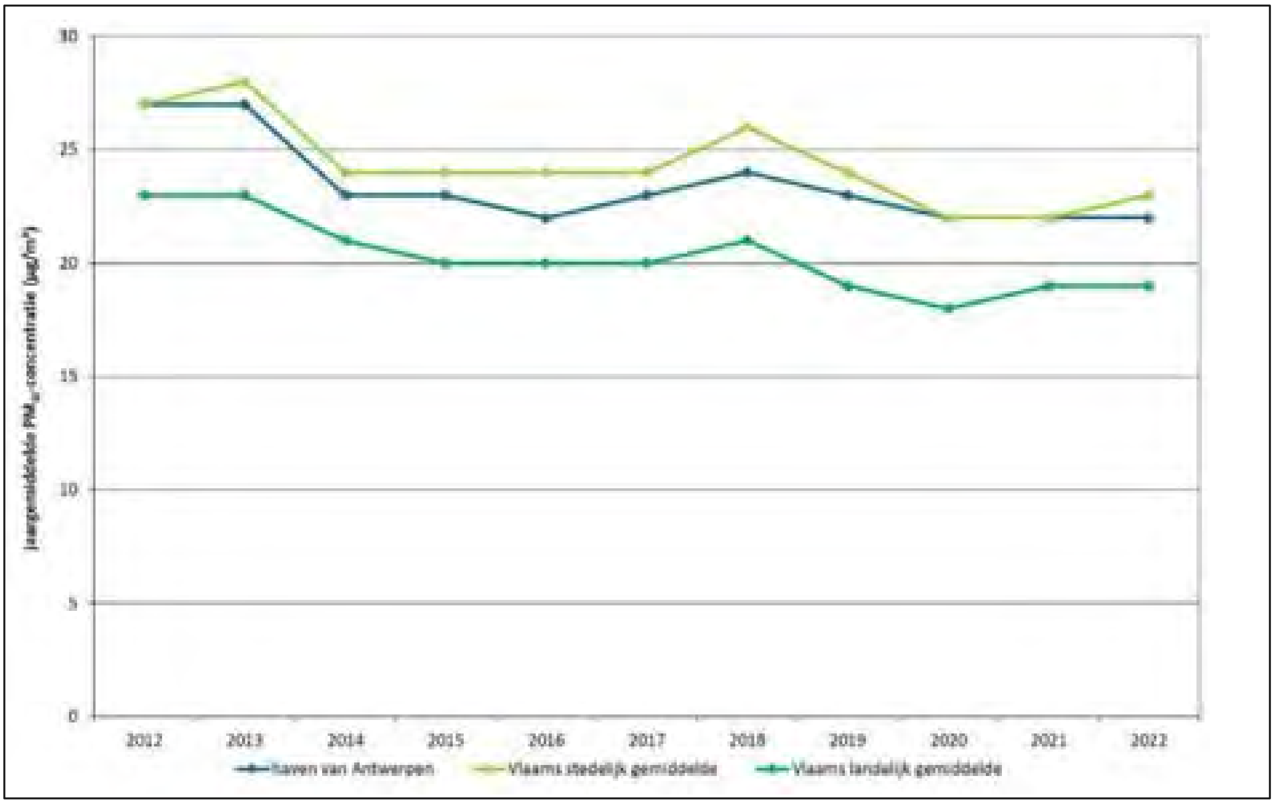


Figure 7-3: PM10 annual average in the Port of Antwerp compared to Flanders (source: VMM (2024), Air quality in the Port of Antwerp - annual report 2022)

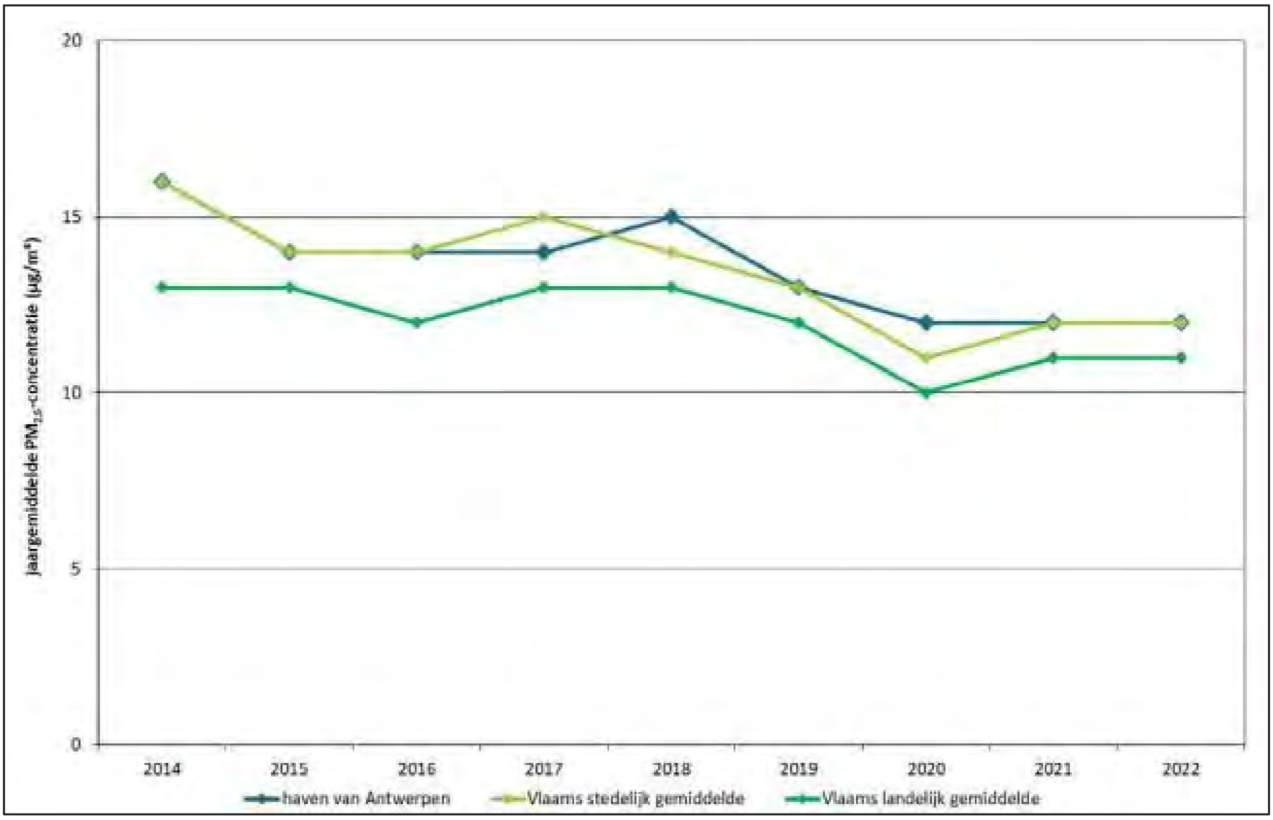


Figure 7-4: PM2.5 annual average in the Port of Antwerp compared to Flanders (source: VMM (2024), Air quality in the Port of Antwerp - annual report 2022)

Based on the results from the measuring stations and modelling of known emissions, VMM also produces annual interpolation maps for these pollutants, which show local variations in air pollution.

The VMM interpolation maps provide the most useful information for the annual average concentrations of NO_2, PM10 and PM2.5. The maps are based on a computer model that interpolates the measurement results from the VMM's telemetric measuring stations for the whole of Flanders. The map showing the annual average adds calculations using the 'IFDM' and 'OSPM' models, which take into account local sources, traffic, etc. The calculation method provides an approximate picture of the distribution of pollution.

The figures below show the results of the VMM interpolation maps for the annual average concentrations of NO_2, PM10 and PM2.5. The annual average concentration at the relevant measuring stations is also shown (coloured dots). In summary, the following can be said about air quality in the study area:

- Annual average NO_2:
  - Annual average limit value[12] : 40 µg/m³;
  - Within the port area on the right bank, the background concentration is 21-30 µg/m³, outside the port area the concentrations fall below 21 µg/m³ (with the exception of certain roads);
  - Above certain docks (including Canal Dock B2 southeast of the site), concentrations are higher than in the rest of the port area (31-40 µg/m³).
  - Motorways such as the A12 and R2 are clearly visible due to the increased concentrations (26-40 µg/m³), and the tunnel entrances on the R2 are also recognisable.

- PM10 annual average:
  - Annual average limit value[13] : 40 µg/m³;
  - Within the port area on the right bank, the background concentration is almost everywhere 21-25 µg/m³, while at some distance outside the port area, concentrations fall below 21 µg/m³ (with the exception of certain roads).

- PM2.5 annual average:
  - Annual average limit value[14] : 20 µg/m³;
  - Within the port area on the right bank, the background concentration is 10.6-15 µg/m³. Outside the port area, concentrations remain below 12.6 µg/m³ and fall further to below 10.6 µg/m³ at greater distances (with the exception of certain roads).

In certain limited parts of the study area, namely in the port area on the right bank near certain docks, 80% of the environmental quality standard for NO_2 is exceeded (32 µg/m³). For PM10 and PM2.5, 80% of the environmental quality standard (32 and 16 µg/m³ respectively) is respected throughout the port area.

[12] In April 2024, the European Parliament approved an agreement setting the above annual average limit value for NO_2 at 20 µg/m³ by 1 January 2030. However, this agreement still needs to be formalised and transposed into national or regional legislation.

[13] In April 2024, the European Parliament approved an agreement setting the above annual average limit value for PM10 at 20 µg/m³ by 1 January 2030. However, this agreement still needs to be formalised and transposed into national or regional legislation.

[14] In April 2024, the European Parliament approved an agreement setting the above annual average limit value for PM2.5 at 10 µg/m³ by 1 January 2030. However, this agreement still needs to be formalised and transposed into national or regional legislation.

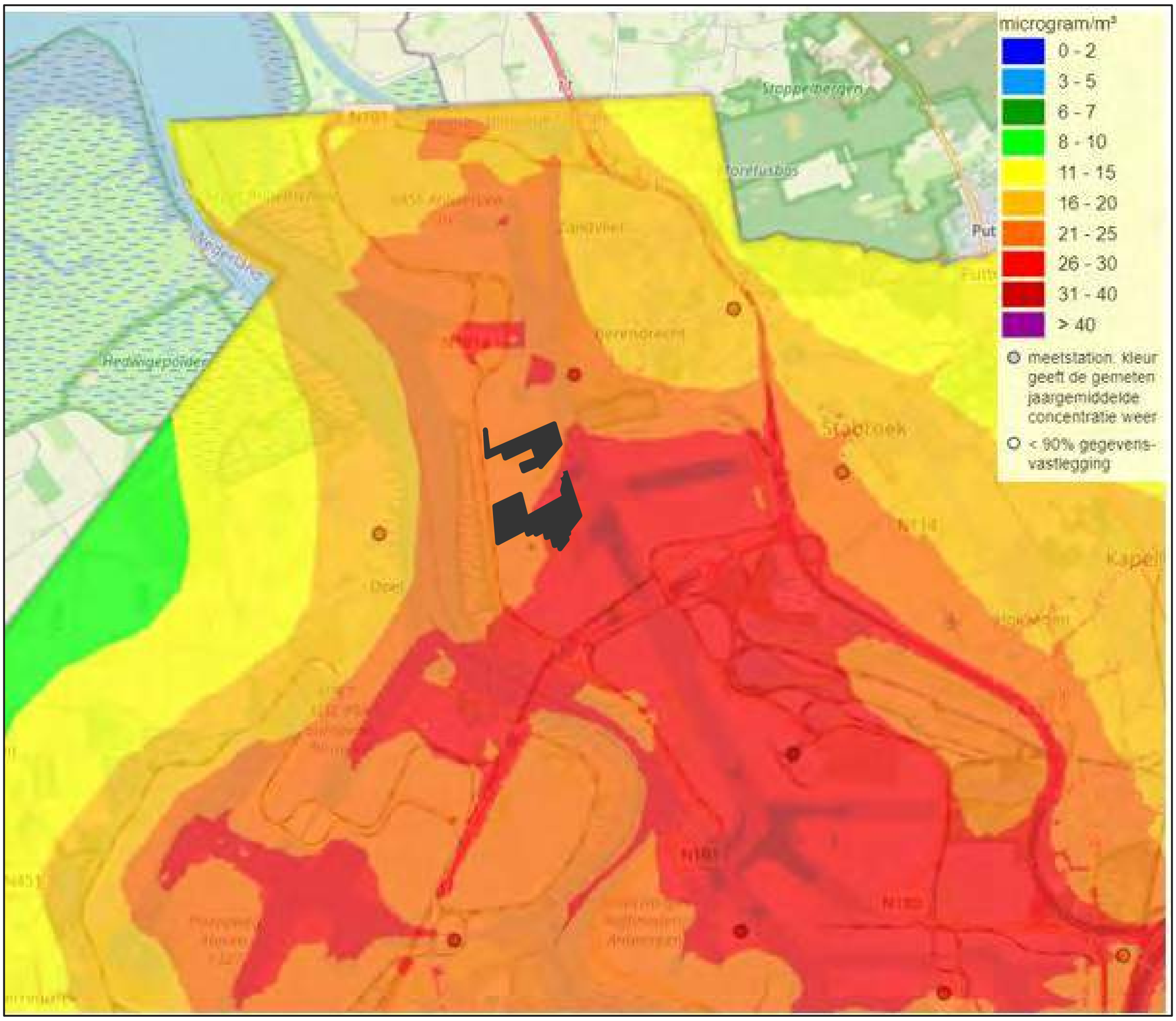


Figure 7-5: NO2 annual average in the project area (source: VMM, interpolation map 2022)

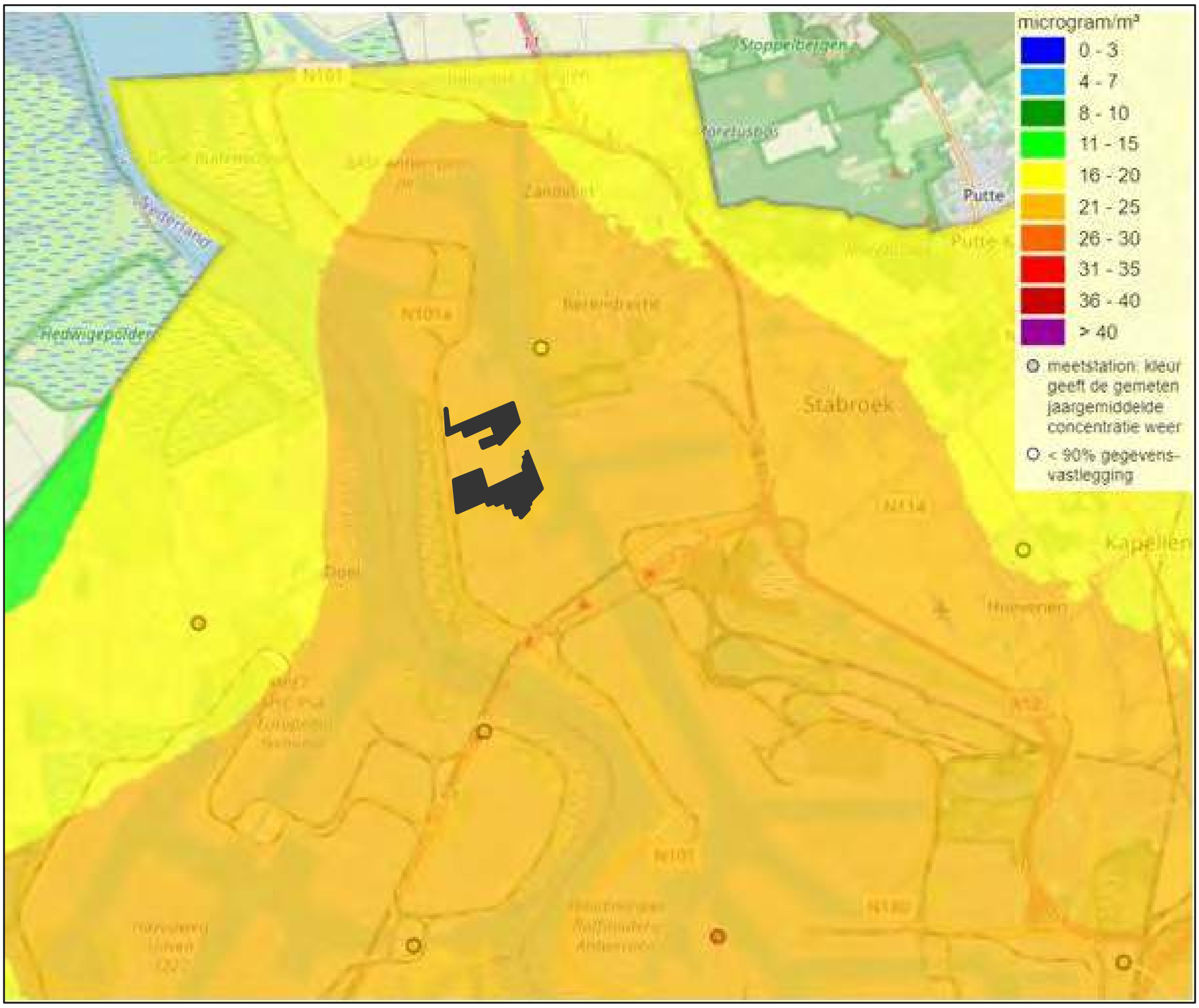


Figure 7-6: PM10 annual average in the project area (source: VMM, interpolation map 2022)

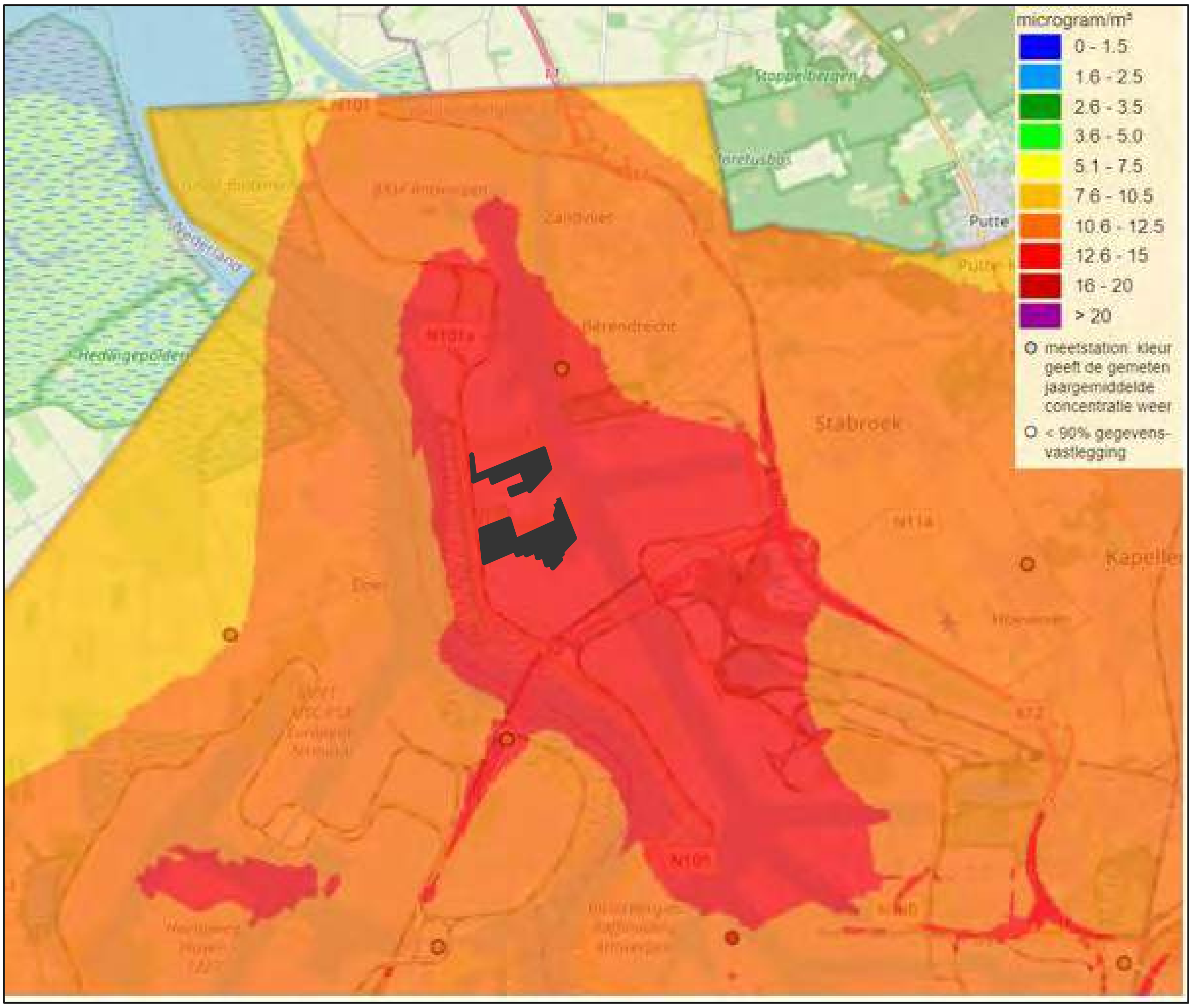


Figure 7-7: PM2.5 annual average in the project area (source: VMM, interpolation map 2022)

7.3.2 SO_2

SO_2 is measured at a number of measuring stations in the Port of Antwerp. VMM determined the virtual average for the Port of Antwerp and compared this with the virtual average for urban Flanders. A virtual average is the average of all measurements of this pollutant in a specific area over the course of a year. The SO2 average in the Port of Antwerp is higher than the Flemish average. However, both follow the same trend.

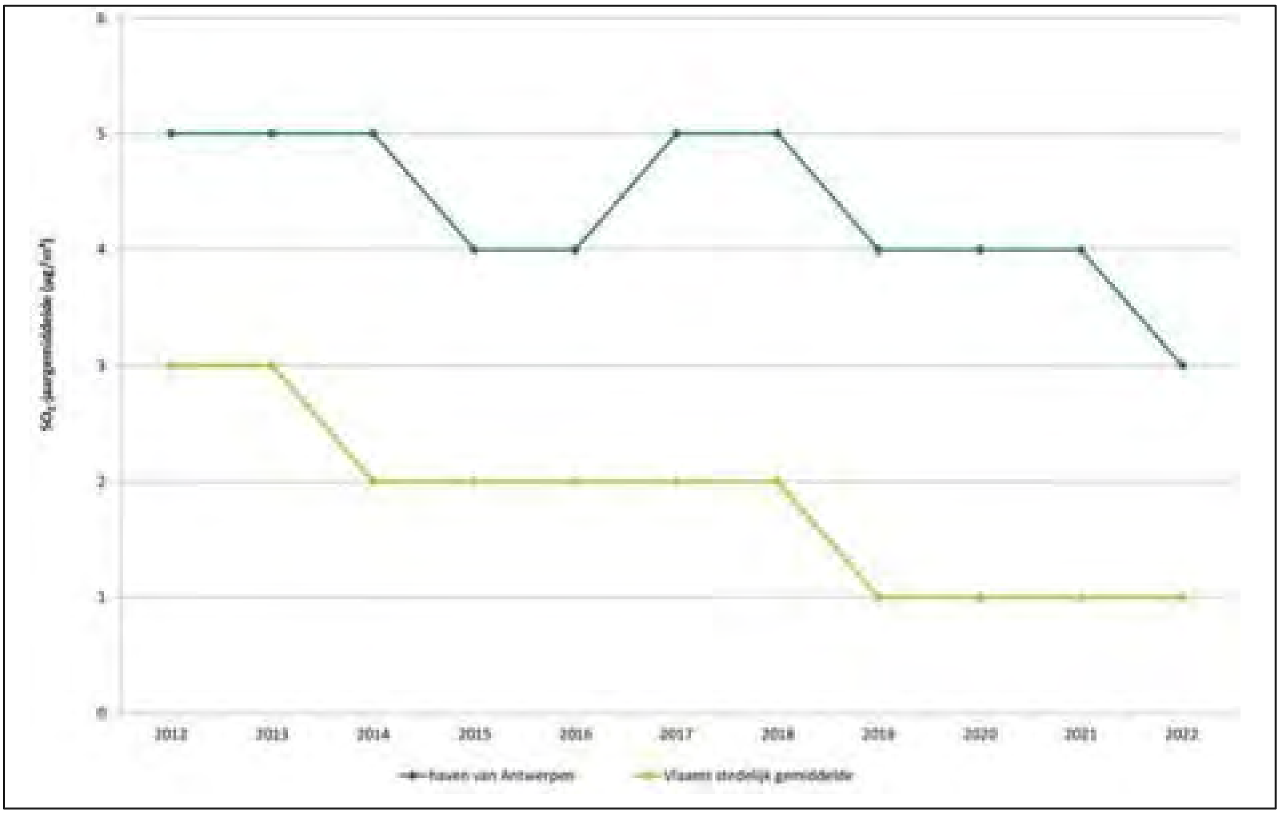


Figure 7-8: Annual average SO2 levels in the Port of Antwerp compared to Flanders (source: VMM (2024), Air quality in the Port of Antwerp – annual report 2022)

The European standards for SO_2 (see Table 7-27, on page 215) were complied with everywhere in 2022.

The geographical distribution of SO2 concentrations in the Port of Antwerp is mapped by VMM using the VLOPS[15] model. The model estimates that the highest concentrations occur in the centre of the port area, around the largest refineries. In the wider conurbation, where there are also residential areas, and also in the vicinity of the Project One project area, the VLOPS model estimates lower concentrations.

[15] Flemish Operational Priority Substances Model

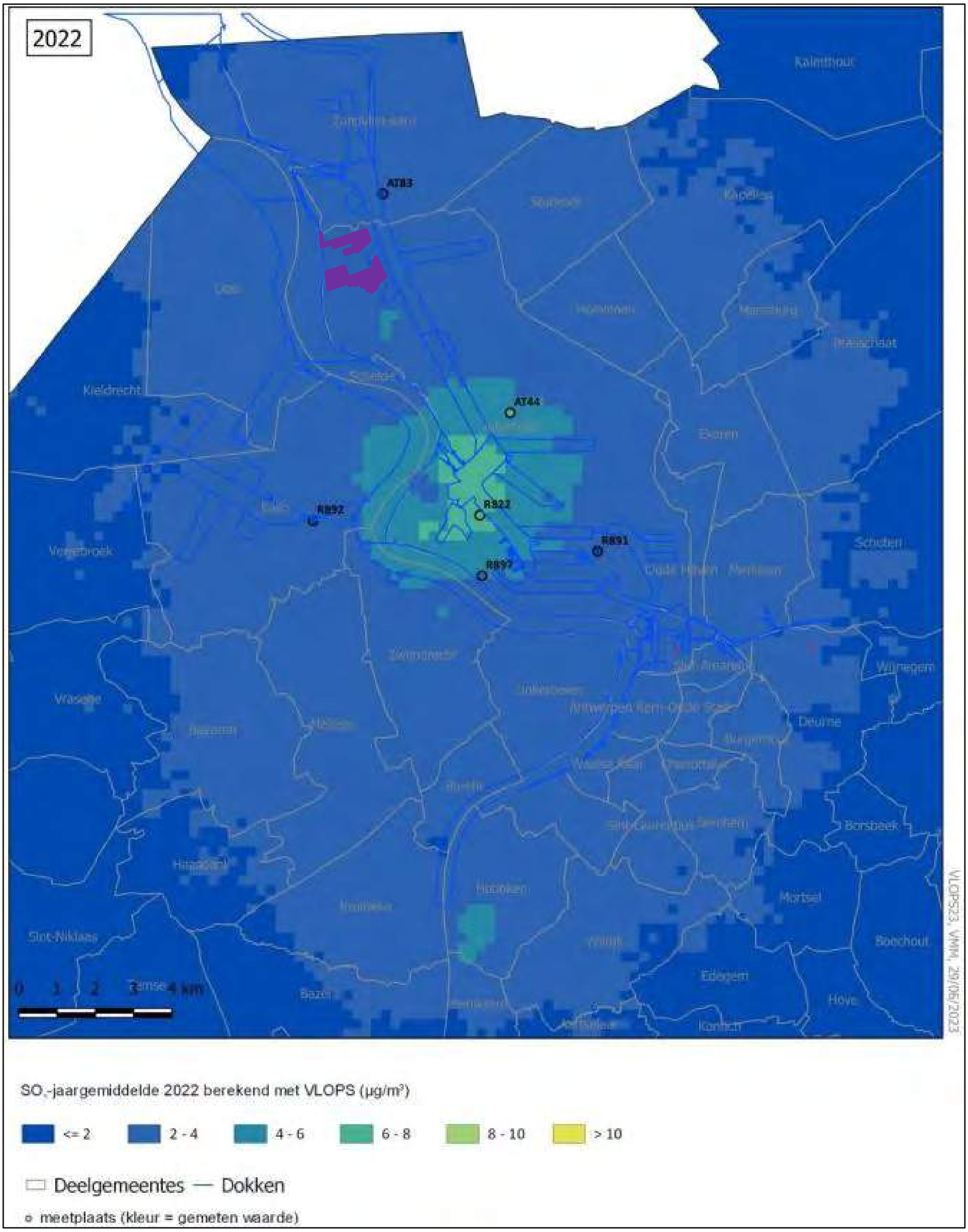


Figure 7-9: Modelled annual average SO2 concentration in the Port of Antwerp in 2022 (source: VMM (2024), Air quality in the Port of Antwerp – annual report 2022)

7.3.3 Benzene

The reference situation for benzene is determined by combining two sets of data: local measuring stations in the Port of Antwerp and the average measured values for Flanders. This gives us a good picture of air pollution with benzene.

Benzene is measured automatically at five measuring stations in the Port of Antwerp (see the location of these measuring stations in Figure 7-11):

- Locations in the industrial port area:
  - Polderdijkweg (R822)
  - Ordamstraat (AT44)
- Locations near residential areas:
  - Antwerp Luchtbal (M802)
  - Antwerp – Wandeldijk (AL01)
  - Berendrecht (AT83)

The measurements at the measuring locations vary greatly due to specific nearby industrial activities. The highest annual average for benzene was measured in 2022 at the Antwerp-Polderdijkweg (R822) measuring station (2.52 µg/m³). This measuring station is located in the middle of the industrial area and is influenced by the proximity of several petroleum refineries, as can be deduced from the pollution roses in Figure 7-11. The Berendrecht measuring station (AT83) is located closest to the project area (approx. 1.2 km to the northeast), where an annual average concentration of 0.68 µg/m³ was measured in 2022. Given the relatively short distance, this value can be considered sufficiently representative of the local background concentration at the Project One site.

If we compare the measured annual average at the measuring stations in the port of Antwerp with the average benzene concentration in Flanders, we can conclude that they are similar. This can be deduced from the graph below, which shows the trend in benzene concentration in Flanders. For each year, the highest and lowest annual averages of the individual measuring stations are shown, as well as the virtual average for Flanders. These values range between 0.5 and 0.8 µg/m³. For information, the European limit value is 5 µg/m³.

Based on the above data, the benzene concentration in the project area can be estimated to be in the order of 0.8 µg/m³.

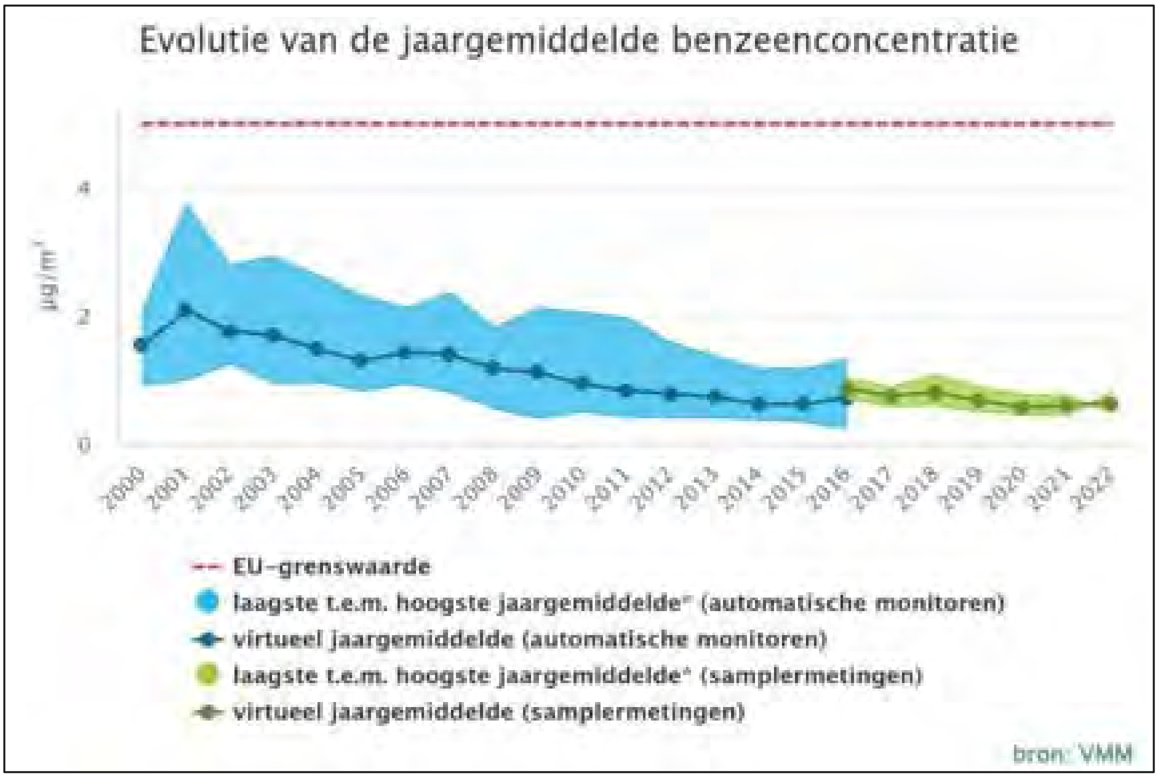


Figure 7-10: Trend in benzene concentrations in Flanders, 2000-2022 (µg/m³) (source: VMM (2024), Concentration of volatile organic compounds (VOCs) in ambient air)

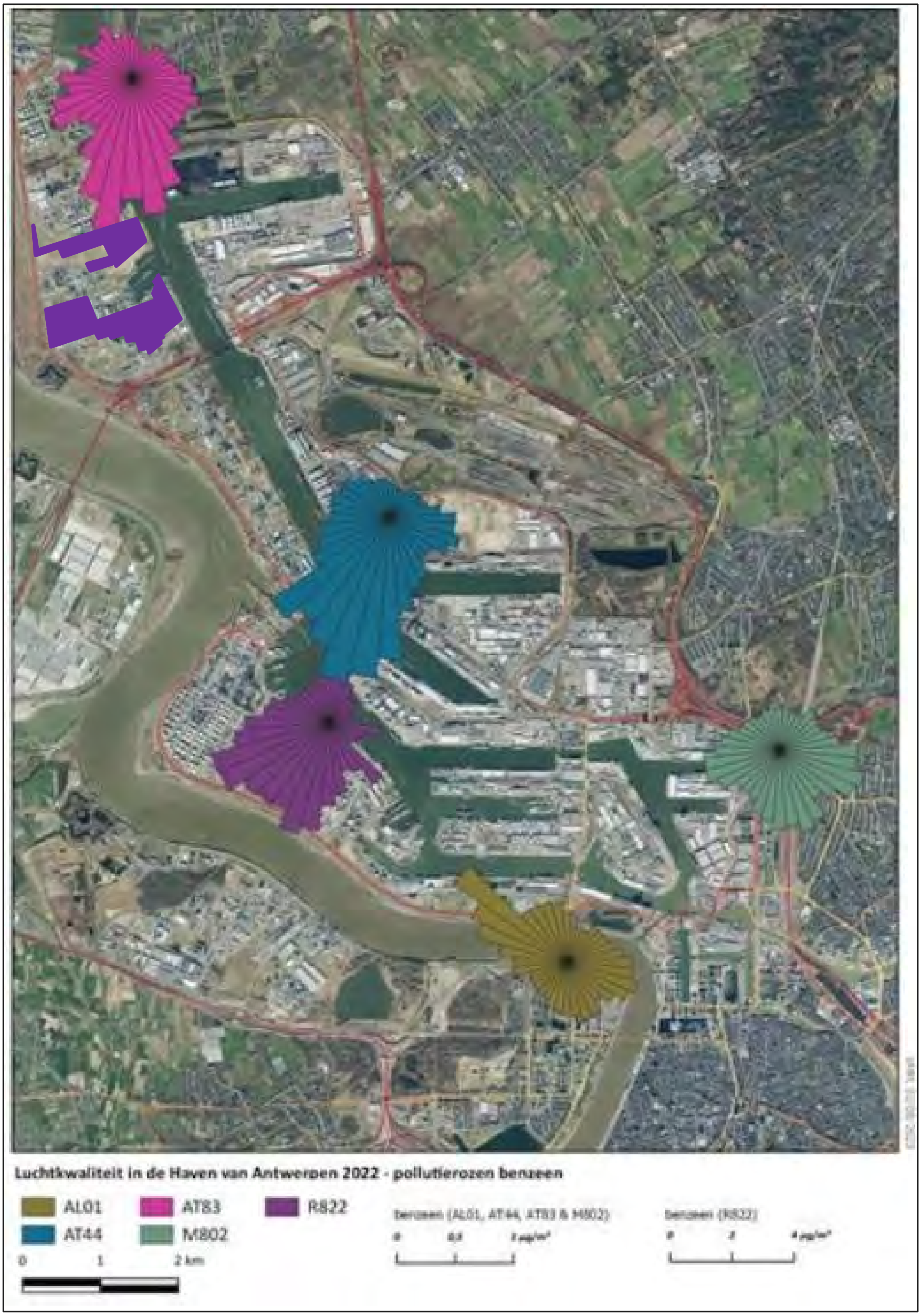


Figure 7-11: Location of benzene measuring points and pollution roses (source: VMM (2023), Air quality in the Port of Antwerp - annual report 2022)

7.3.4 VOCs (Volatile Organic Compounds)

In 2022, passive measurements were carried out in the Port of Antwerp at the Ekerse Dijk (R893 – 14-day measurements) and Polderdijkweg (R822 – weekly measurements) locations. Both VMM measuring stations are located some distance from the project area:

- R822: approx. 6.5 km south of the project area
- R893: approx. 7 km southeast of the project area.

Table 7-3 below shows the annual average concentration of VOC components for measuring locations R893 and R822 and the virtual average for Flanders. This virtual average shows the average of all passively measured locations, with the exception of measuring location R822 (VMM does not include R822 in the virtual average due to the increased values caused by local emission sources).

These data show that these measuring stations in the Port of Antwerp indicate higher measurements for a number of VOCs than the annual average for all Flemish measuring stations. For these two measuring stations, this is mainly due to the proximity of several petroleum refineries (see also § 7.3.3). These values are not representative of the northern part of the port area near the Project One site. There are no VMM measuring stations near the project area that carried out VOC measurements.

The component that is relatively highest compared to the Flemish average for measuring station R893 is 1-hexene (factor 3.3 higher); 1-hexene is an isomer of hexene, which is used as a raw material in certain chemical applications. At measuring station R822, the largest relative difference is for the component n-nonane (factor 11.3 higher). N-nonane is used, among other things, as a solvent.

Table 7-3: Annual average concentration of VOC components R893, R822 and Flemish average in 2022 (source: VMM (2023), Air quality in the Port of Antwerp - annual report 2022)

Pollutant (µg/m³)	Annual average R893	Annual average R822	Annual average Flanders
1,2,3-trimethylbenzene	0.15	0.58	0.1
1,2,4-trimethylbenzene	0.42	1.65	0.29
1,2-dichloroethane	0.03	0.08	0.03
1,3,5-trimethylbenzene	0.11	0.43	0.08
1-hexene	0.56	0.64	0.17
3-methylhexane	0.31	1.40	0.19
3-methylpentane	0.43	2.10	0.19
chlorobenzene	0.09	0.20	0.03
isopentane	0.64	3.11	0.37
meta-ethyltoluene	0.22	0.88	0.16
n-heptane	0.38	2.12	0.19
n-hexane	0.87	3.79	0.36
n-nonane	0.20	1.24	0.11
n-octane	0.29	1.26	0.20
n-pentane	0.58	3.30	0.31
ortho-ethyltoluene	0.17	0.67	0.11
p-ethyltoluene	0.13	0.46	0.09
propylbenzene	0.11	0.40	0.08
tetrachloroethylene	0.10	0.12	0.10
benzene	0.81	2.52	0.64

Pollutant (µg/m³)	Annual average R893	Annual average R822	Annual average Flanders
Toluene	1.72	5.56	1.14
Ethylbenzene	0.45	1.31	0.24
m+p-xylene isomers	1.26	2.80	0.65
o-xylene	0.43	1.11	0.23

*measurement results from continuous, automatic measurements (more detailed).

7.3.5 Acidifying and fertilising deposition

Acidifying deposition includes the deposition of SO_2, NO_2 and NH_3; fertilising deposition or nitrogen deposition includes NO_2 and NH_3.

The evaluation of these effects is based on emissions in the Air discipline. Based on these emissions, the project's contribution to deposition in the surrounding area is calculated. However, the evaluation of the effects is also determined by the sensitivity of the biotopes in the nature reserves where the deposition takes place. The effect is therefore evaluated in the Biodiversity discipline.

For a description of the reference situation, please refer to Chapter 11 Biodiversity.

7.4 Description and estimation of emissions

7.4.1 Emissions during the construction phase

The construction phase is estimated to last 3 years and 8 months (August 2022 to March 2026). During this period, work will be carried out continuously across virtually the entire site. The initial work on the site (vegetation removal) and the subsequent construction work (levelling, road construction, foundation work, installation of structures, etc.) will follow on directly from each other. As the permanent contractor village (which will also serve as a site village) will be built in the northern part of the project area, construction activity in that area will be rather limited. The construction work for the industrial installations in the southern site zone will be more extensive.

During the construction phase, the following emissions into the air are expected:

- Emissions from construction machinery and vehicles on site;
- Emissions from ship transport;
- Traffic emissions from the daily commuting of site personnel and from lorry transport (including earthmoving);
- Dust emissions, mainly as a result of earthworks.

7.4.1.1 Construction machinery and vehicles on site

The emissions from construction machinery and vehicles on site depend on the type of machinery used, the number of machines, the operating time, the age of the machines, etc. These factors depend in part on how the site is organised and planned, but also on the choices made by the various contractors and operators on site. The estimate of site emissions is therefore based on the expected site planning.

We will examine the effect of shipyard emissions on air quality for NOx. In order to fully evaluate the effect of N deposition, we will also estimate NH_3 emissions.

Please refer to Appendix 6.1 for the detailed data for this calculation.

NOx emissions from vehicles and machinery on site during the construction phase were estimated based on an estimate of the expected number of vehicles and machinery on site throughout the construction phase.

- It is estimated that during the construction phase, an average of 250 to 300 vehicles/machines will be used on the site each day. During the busiest periods, this will increase to 400 to 450 vehicles/machines. These are spread across the entire site. [16]
- Depending on the period in the construction phase, this involves a combination of various earth-moving and soil-working machines, asphalt machines, road rollers, various vehicles (including dumper trucks, lorries, tractors, forklift trucks, bulldozers, concrete mixers, SPMTs[17], ...), lifting cranes, welding equipment, air compressors, power generators, drainage pumps, etc.
- Based on the site planning and similar site activities (size of the site), an estimate was made of the number of generators required, taking into account the use of electricity from the grid. In this way, a worst-case scenario of 6 generators in the southern zone and 2 generators in the northern zone (each approx. 500 $_{kWe}$) was taken into account.

The calculation is based on 21 working days per month and a varying number of actual operating hours per day (2 to 12 hours), depending on the type of machine. A limited number of machines (some generators, lorries, mobile cranes and forklift trucks) will also remain in operation at night. For fuel consumption (diesel) and emissions, 70% of the maximum engine power during operating hours is taken into account.

Emissions are calculated using emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2023, Non-road mobile sources and machinery. For emissions from diesel vehicles and machinery, reference is made to European Directives 97/68/EC and 2004/26/EC for "non-road machinery". These directives impose emission limits on (among other things) construction machinery, which have been tightened in various phases.

Table 7-4: Date of introduction of emission restrictions for construction machinery

Stage	Transition phase from	Mandatory from
Stage I	1999	-
Stage II	2001-2004	2007
Stage IIIA	2006-2008	2011–2012
Internship IIIB	2011-2013	-
Stage IV	2014	2014
Stage V		2019-2020

The emission factors based on the emission limits are shown in the table below.

Table 7-5: Emission factors for construction machinery and vehicles - NOx emissions (g/kWh)

Engine power (kW)	Stage II	Stage IIIA	Stage IV	Stage V
0-20	11.20	11.20	11.20	6.08
20-37	6.50	6.08	6.08	3.81
37-56	5.50	3.81	3.81	3.81
56-75	5.50	3.81	0.40	0.40
75-130	5.20	3.24	0.40	0.40
130-560	5.20	3.24	0.40	0.40
> 560 *	14.40	14.40	14.40	3.50

Note: Not every 'Stage' provides for a reduction in emissions for every power category. If no tightening is planned, we use the emission limits from the previous 'Stage'.

[16] More than 500 parking spaces are provided for site vehicles, spread across the entire site, to allow for some flexibility so that vehicles can always be parked within a workable distance when not in use.

[17] Self-Propelled Modular Transporter

*: For machines > 560 kW, emission restrictions only apply from Stage V onwards. For the earlier Stages, a worst-case emission factor for older, unregulated machines is stated.

Project One is committed to using Stage IV or better vehicles/machines for all medium and heavy vehicles/machines (from 56 kW). Approximately three quarters of the vehicles/machines used fall into this category. For the lighter types (below 56 kW), there is little or no difference in function depending on the 'Stage' of the machines. These are only subject to stricter emission requirements from Stage V onwards (types from 2019-2020).

Stage IV or better generators with a capacity of < 560 kW are used. In order to limit the emissions from the diesel generators as much as possible, no large (> 560 kW), unregulated generators are used.

The above commitments mean that NOx emissions will be significantly reduced. Based on the above assumptions, emissions are estimated as follows.

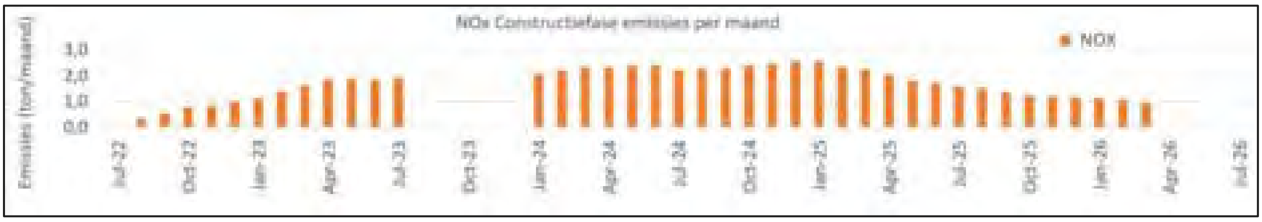


Figure 7-12: Estimated NOx emissions during the construction phase (with interruption due to revocation of the permit).

Table 7-6: NOx and NH_3 emissions during the construction phase

	Total site	Northern construction zone	Southern construction zone
Average emissions over 4 years	18.2 tonnes/year NOx 0.078 tonnes/year NH_3	3.2 tonnes/year NOx 0.014 tonnes/year NH_3	15.0 tonnes/year NOx 0.064 tonnes/year NH_3
Highest year * (March 2024 – February 2025)	28.6 tonnes/year NOx 0.123 tonnes/year NH_3	3.3 tonnes/year NOx 0.016 tonnes/year NH_3	25.3 tonnes/year NOx 0.107 tonnes/year NH_3

*: for the highest year, we take the 12-month period with the highest emissions for the entire site Please refer to Appendix 6.1

for detailed information on this calculation.

7.4.1.2 Ship emissions from ship transport

The following ship transport is planned during the construction phase:

Removal of topsoil – inland shipping:

- The topsoil (30 cm top layer) that is removed immediately after vegetation removal is largely (approx. 90%) transported away by ship;
- Estimated amount transported by ship: 370,170 tonnes of topsoil;
- 58 push convoys (6,400 tonnes);
- Removal (Q4 2022 – Q1 2023).

Transport of soil levelling works – inland waterway transport:

- Some parts of the site will be raised slightly during levelling work. Soil will be brought in for this purpose. Contaminated soil will also be removed during the levelling of the site. Transport to and from the site will mainly (90%) be by ship;
- Estimated amount of transport by ship: 178,200 tonnes of soil (47,790 tonnes removed + 130,410 tonnes delivered);
- 29 push convoys (6,400 tonnes);
- Transports Q2 2023 and Q1 2024).

Removal of soil from various works that cannot be reused – inland shipping:

- Removal of excavated soil for underground structures (foundations, etc.);
- Estimated quantity transported by ship: 231,660 tonnes of soil;
- 37 push convoys (6,400 tonnes);
- Removal planned within approximately 1.5 years (Q2 2023 and Q4 2024).

Delivery of modules – inland and sea transport:

- The largest installations (especially the ECR) are being built elsewhere and transported to the Project One site in modules (sub-installations). A number of larger devices are also being transported by ship;
- Estimated volume of ship transport:
  - Inland vessels: 50 to 75 inland vessels with a maximum of 2,000 tonnes/vessel or a maximum of 150,000 tonnes;
  - Seagoing vessels: 5 to 10 wide deck carriers with a load capacity of approximately 15,000 tonnes;
- Deliveries spread over approximately 1 year (Q4 2024 – Q3 2025).

Based on the schedule above, there will be little overlap between the various shipments. The removal of topsoil and the delivery/removal of soil will take place consecutively. The modules will be delivered later, spread over approximately 12 months in 2024-2025.

The emissions from these transports are estimated below.

Table 7-7: Ship emissions during the construction phase

Transport type	Quantity/number	NOx emission factor *	NOx emissions along the shipping route	Spread over (indication)
Inland vessels topsoil	370 170 tonnes 58 push convoys	0.325509gNOx/tonne.km	120.5 kg/km	6 months
Inland vessels supply/removal of soil levelling	178200tonnes 29(pushconvoys)	0.325509 g NOx/tonne.km	58 kg/km	6 months
Inland vessels discharge ground foundations	231,660 tonnes 37 push convoys	0.325509gNOx/tonne.km	75.4 kg/km	18 months
Inland waterway vessels modules	150,000 tonnes 75 ships	0.325509gNOx/tonne.km	48.8 kg/km	12 months
Seagoing vessels modules	150,000 tonnes 10 ships (15,000 tonnes/ship)	3.3 kg NOx/km.ship (ships of 10,000 to 30,000 tonnes)	33 kg/km	12 months

* Emission factor inland vessels: MER Air Directive System - worst case assumption based on:

- Large Rhine vessel (max. 2,160 tonnes/vessel): 0.3034405 g NOx/tonne.km
- Push boats and combination vessels (1,500 tonnes/barge): 0.325509 g NOx/tonne.km

Emission factor for seagoing vessels: Key figures for seagoing vessels for emission and dispersion calculations in Aerius, update 2018 – TNO (2019 R11040), J.H.J. Hulskotte, July 2019.

Taking into account the distribution of ships over the construction phase, around five ships per week are expected during the busiest periods. During certain other periods, there will be virtually no ship traffic. The worst-case scenario is calculated at 150 kg/km per year along the shipping route through the canal dock in a southerly direction (only inland vessels) and 50 kg/km per year along the shipping route through the canal dock and the Scheldt in a northerly direction (mainly seagoing vessels).

7.4.1.3 Traffic emissions

The construction activity will also generate external road traffic, partly due to the daily commute of construction personnel and partly due to truck transport.

Given that the effect of traffic emissions on air quality is greatest and most evident for NO_2, we will first examine the extent to which this pollutant has a significant impact.

For a description and assessment of these traffic flows, please refer to Chapter 10 Mobility. Traffic emissions are calculated in the dispersion model used (IMPACT) on the basis of traffic flows.

The effect of traffic emissions on air quality is discussed in § 7.6.1.2.

7.4.1.4 Particulate emissions, mainly as a result of earthworks.

During the construction phase, dust emissions occur that are typical of site activities. Earthmoving (excavation, backfilling, etc.) in dry periods in particular can cause dust emissions, which can cause dust nuisance at some distance. However, soil storage in temporary storage sites (TSSs) can also cause dust emissions. No other large quantities of dust-sensitive materials are expected to be handled (e.g. concrete is delivered, so no large cement storage is planned).

The nearest homes are located in Berendrecht (approx. 890 m from the project area) and Lillo (approx. 1.3 km from the project area). The likelihood of relevant dust nuisance for local residents at this distance is virtually non-existent if the codes of good practice are applied during excavation work, when handling (loading, unloading, ...) of any dust-sensitive (construction) materials and during their storage. These mainly include the following aspects:

- During loading, unloading and excavation work, techniques will be used that cause as little dust as possible (using appropriate equipment/machinery, limiting the drop height of moved materials, etc.);
- During excavation work where relevant dust emissions are possible (e.g. during longer dry periods), spraying will be used to limit the raising of dust;
- The temporary storage areas for soil will be moistened if necessary.
- The spreading of soil or other dust-sensitive materials outside the site area will be prevented or limited, if necessary by using a wheel washing installation and/or by periodically sweeping the roads outside the site area. The speed of site vehicles will be limited on (site) roads where dust is blown up (unpaved roads, roads that are difficult to clean, etc.).

The specific application of these measures will be considered for each site and adapted to the specific circumstances that arise. This means:

- The measures to be taken are laid down in procedures, adapted where possible to the specific situation at the site.
- These procedures and more specific agreements are communicated to the contractors (builders, etc.).
- The application of the procedures is monitored regularly. Where procedures are not followed or where, despite the measures taken, relevant dust emissions occur, an assessment is made of how the situation can be improved.

The application of the above principles is enshrined in environmental legislation (VLAREM II, Section 4.4.7, Control of fugitive dust emissions) and is implemented in accordance with this.

Due to the planned soil storage, a Work Plan has been drawn up and a Dust Report has been added to the permit application. These documents further elaborate on how the above-mentioned codes of good practice will be applied.

The working method is in accordance with the applicable BAT reports:

- 'Reference Document on Best Available Techniques on Emissions from Storage', European Commission, July 2006.
- Guide to reduction techniques for diffuse dust emissions during the storage and transhipment of dry bulk goods, VITO, December 2012.

7.4.2 Operational phase

7.4.2.1 Emissions via point sources

7.4.2.1.1 Overview

The operation of the site will involve a number of emissions via point sources. We can distinguish between three types of emissions via point sources:

- chimney emissions from the process and combustion installations;
- captured and treated storage and transhipment emissions;
- flare emissions.

The following table contains the physical characteristics of the point sources that were included in the impact assessment.

Table 7-8: Physical characteristics of the emission points considered

Number	Emission point	Lambert X [m]	Lambert Y [m]	Height (m)	Diameter (m)	Nominal thermal input power (MWth)
ECR						
E-1	Process furnace 1	145 290.76	223,266.62	65	1.8	115
E-2	Process furnace 2	145,292.58	223,262.11	65	1.8	115
E-3	Process furnace 3	145 301.96	223 238.82	65	1.8	115
E-4	Process furnace 4	145 303.78	223,234.32	65	1.8	115
E-5	Process furnace 5	145 313.19	223,210.98	65	1.8	115
E-6	Process furnace 6	145 315.00	223,206.50	65	1.8	115
E-7	Decoke process furnace 1	145,275.17	223,270.11	54	0.7	-
E-8	Decoke process furnace 2	145,283.75	223,248.78	54	0.7	-
E-9	Decoke process furnace 3	145,286.27	223,242.30	54	0.7	-
E-10	Decoke process furnace 4	145,294.95	223,220.94	54	0.7	-
E-11	Decoke process furnace 5	145,297.57	223,214.46	54	0.7	-
E-12	Decoke process furnace 6	145,306.18	223,193.13	54	0.7	-
E-13	ECR Ground flare	144,993.84	223,190.62	20	1	-
E-14	ECR Tower flare	144,916.42	223,197.11	208	1	-
Supporting infrastructure						
E-15	Steam boiler 1	145,158.18	223,262.35	60	1.5	142.5
E-16	Steam boiler 2	145 186.00	223 273.60	60	1.5	142.5
E-17	WZI Thermal oxidiser	144,604.62	223,438.84	20	0.3	3
E-18	WZI Biotreatment	144,678.10	223,442.57	20	1.6	-
E-19	C5+/Pyoil tank and loading emissions	145,539.47	223,680.12	20	0.3	-
E-20 / E-21	Tank Ground flare*	145,557.83 / 145,569.53	223,296.42 / 223,267.43	20	1	-

* The ground flare for the tank storage facility is double, with one always in service and the other serving as a reserve (only used when the first is out of service, e.g. for maintenance).

Below, we first provide a description of the various emission sources, followed by a summary table quantifying the emissions (in Table 7-17 and Table 7-18).

7.4.2.1.2 Application of SCR DeNOx gas purification

From the outset of the design and engineering of Project One, attention was paid to limiting emissions to the air. In this regard, considerable attention was paid to potential NOx emissions. The following approach was adopted:

- Achieving a high conversion rate in the production process, thereby reducing the specific emissions per tonne of end product.
- Various process-related optimisations of energy efficiency, so that energy consumption is limited.
- Application of gas purification using various BAT techniques; combining these BAT techniques achieves an emission level that is lower than for each BAT technique individually.

The effect was evaluated for two scenarios:

A. NOx emissions in accordance with the emission levels associated with BAT (BAT-GENs), through the application of upstream reduction techniques such as low-NOx burners.
B. NOx emissions that are lower than the emission levels associated with BAT (BAT-GENs), through the use of upstream reduction techniques such as low-NOx burners combined with downstream SCR-DeNOx gas purification (see below); by combining these BAT techniques, an emission level is achieved that is lower than for each BAT technique individually.

In the further quantification of emissions and impact assessment, we evaluate both scenarios side by side. The aim of this is to clarify the difference between the two scenarios.

Based on this evaluation, IOB has decided that all major emission points of Project One will use SCR-DeNOx gas purification (Selective Catalytic Reduction) to limit NOx emissions, in addition to upstream reduction techniques such as low-NOx burners. The combination of these techniques achieves a lower emission level than any BAT technique used individually. The application of SCR-DeNOx gas purification is also seen as a project-integrated mitigation measure. The permit application takes this into account (e.g. storage of ammonia for the operation of the SCR-DeNOx).

An SCR-DeNOx gas purification system consists of catalytic beds in which NOx is reduced to nitrogen gas with NH3. To achieve this, NH3 must be added to the flue gases.

The removal efficiency of an SCR-Denox installation depends on the amount of catalyst, the activity of the catalyst, the inlet NOx concentration, the temperature and pressure, the homogeneous mixing of the ammonia with the flue gases at the inlet and the homogeneous distribution of the flue gases over the catalyst.

The purification efficiency also depends on the age of the catalyst beds. After a number of years, the removal efficiency will slowly decrease. The decline in removal can be partially compensated for by increasing the dosage of NH3. The slow degradation of the catalyst bed and the increased, compensatory dosage of NH3 will increase the possibility of NH3 emissions. Eventually, a point will be reached where a decision must be made to replace the catalyst beds. The service life of a catalyst bed depends on various factors. For Project One, the catalyst beds are designed for a service life of at least 5 years. This corresponds to the frequency with which the ECR installations will be shut down for various major maintenance works.

For a more detailed explanation of how the SCR catalytic converter works, please refer to Appendix 6.4.

The further quantification of emissions is based on the emission concentrations below.

Table 7-9: Expected NOx and NH_3 emission concentrations

	Scenario A BBT burner without SCR Maximum emissions	Scenario B BBT burner with SCR	
		Maximum emissions (daily average per chimney)	Expected emissions (average of all chimneys over 3 years)
NOx (mg/Nm³) *			
ECR Cracking furnaces (6)	100	40	25
Steam boilers (2)	80	40	25
NH3 (mg/Nm³)			
ECR Cracking Stoves (6)	0	6	3
Steam boilers (2)	0	6	3

* Combustion plants with flue gases at 3% O_2

In Table 7-10, we compare the proposed emission limit values for the chimneys of Project One with the emission limit values from VLAREM and the emission levels from the applicable BREFs. This comparison shows that the guaranteed emission levels are significantly lower than the prescribed emission concentrations.

Table 7-10: Comparison of proposed NOx and NH_3 emission limit values for Project One with VLAREM and BREFs

	Proposed EGW Project One (daily average)		VLAREM III – 12 (combustion plants)		VLAREM III – 13 (LVOC)		BREF LCP		BREF LVOC	
[mg/Nm³]	NOx	NH3	NOx	NH3	NOx	NH3	NOx	NH3	NOx	NH3
ECR (6)	40	6	85/100	-	100	15	-	-	60-100	5-15
Boilers (2)	40	6	85/100	10	-	-	30-85/ 100	3-10	-	-

Blue numbers for natural gas – Black numbers for process gases
BREF values apply to annual averages
LCP = Large Combustion Plants
LVOC = Large Volume Organic Chemicals (Processes for large quantities of organic products)

7.4.2.1.3 Chimney emissions ECR - Cookers

The ethane cracker contains six parallel cracking furnaces in which the cracking processes take place. They are arranged in three pairs, each pair consisting of two mirror-image furnaces placed back-to-back. The furnaces are heated by burners fuelled by fuel gas (residual gas from the cracking process, see
§ 3.4.6) and/or, in exceptional circumstances, with natural gas. The flue gases do not come into contact with the chemicals to be cracked in the furnaces. After heat recovery (through heat recovery in the process and through steam production), the flue gases are conducted to a chimney per furnace.

It is assumed that the furnaces are in production for 8,343 hours per year and undergo decoking for 417 hours per year (see below). During the decoking stage, the furnaces are still heated, albeit at 20 to 40% of their normal production capacity.

The quantification of emissions is included in Table 7-17 and Table 7-18.

To limit NOx emissions, low-NOx burners are used and the flue gases from each cracking furnace are treated in an SCR-DeNOx gas purification system. This consists of catalytic beds in which NOx reduction takes place, for which NH_3 must be added to the flue gases. An explanation of how the SCR-DeNOx works is included in Appendix 6.4. By combining these BAT techniques, an emission level is achieved that is lower than for each BAT technique individually.

Furthermore, the flue gas pollutants CO, VOC and $PM_{10}/PM_{2.5}$ are also present in the flue gases.

Under normal production conditions, there is sufficient fuel gas available and therefore no natural gas is used. The fuel gas from the ECR does not contain sulphur. Sulphur-containing components in the process (dimethyldisulphide (DMDS) used to passivate the reactor tubes) are separated in a waste water stream. The fuel gas from the ECR consists mainly of hydrogen and methane (see § 3.4.6).

7.4.2.1.4 Chimney emissions ECR - Decoking

The cracking reactions in the cracking furnaces take place at high temperatures in tube reactors (coils), which are heated on the outside. Over time, coke deposits form on the inside of these coils. The speed at which this coke is formed is kept as low as possible by using the appropriate coil material, diluting the reaction mixture (with steam), adding sulphur components (DMDS) to the reaction mixture, etc. However, the formation of this coke cannot be completely avoided. Over time, the coke forms an insulating layer on the inside of the coils. When this insulating layer becomes too thick, the wall temperature of these coils approaches its structural limit and the coke layer must be removed in a decoking step.

Since the six furnaces each need to undergo decoking approximately 5% of the time, the decoking of the furnaces can be organised in turns, so that normally at least five furnaces are always in production.

During decoking, the coils are heated to a limited extent and a mixture of steam and air is passed through them. The steam/air ratio is varied in a number of predetermined steps. The coke is partially oxidised, producing CO and CO_2, but is largely carried along as particles in the gas stream.

The decoking gas stream undergoes dust separation to limit the emission of coke dust. The dust is separated using two cyclones in series and the gases are then emitted via a chimney. In addition to the chimney for flue gas emissions, each furnace also has a chimney for decoking emissions.

The CO concentration of these emissions varies and averages 3,200 mg/Nm³. Since the CO does not originate from production installations with complete oxidative combustion processes, VLAREM II does not specify an emission limit value for these emissions. Similar emissions occur in similar ECR installations. They are considered BAT.

The presence of coke dust also varies during the decoking cycle. With dust separation, emissions are limited to 30 mg/Nm³ PM10.

In addition, a limited concentration of NOx is also expected in the residual gases from decoking (50 mg/Nm³). The quantification of the emissions is included in Table 7-17 and Table 7-18.

7.4.2.1.5 Steam boilers

Two steam boilers are planned. The steam boilers have a capacity of 2 x 142.5 MWth (thermal input power). These will use the surplus ECR fuel gas supplemented with natural gas.

The steam boilers are dimensioned to provide the necessary steam when the ECR installations are started up. At that point, there is no recovery of process heat from the processes. The start-up of the ECR will represent the largest steam demand. At that point, only natural gas will be used.

Under normal operating conditions – with the installations functioning normally – the ECR will export net steam. This steam is fed through a turbine and converted into electricity. The surplus steam from the ECR is supplemented with steam produced in the steam boilers in order to generate sufficient electricity to operate the ECR. The production of the additional steam in the steam boilers is achieved partly with the surplus fuel gas from the ECR and partly with natural gas.

In all possible scenarios, the two steam boilers will be flexibly activated so that:

- the process installations always have sufficient steam available, even in situations where their own steam production is reduced and/or the steam demand is increased;
- the available fuel gas from the processes is always used as efficiently as possible.

When estimating the expected emissions, it is assumed that the boilers:

- 6,176 hours per year operating at 38.5% of their capacity (all 6 ECR furnaces in operation);
- 2,584 hours per year operating at 41.8% of their capacity (5 ECR furnaces in operation, usually due to decoking of one of the furnaces).

The fuel gas for the steam boilers consists of a mixture of natural gas, ECR fuel gas and gases formed during the unloading of an ethane tanker. The ECR fuel gas consists mainly of hydrogen and methane; the fuel gas produced when unloading an ethane tanker consists of methane and ethane (see § 3.4.6 in Chapter 3).

In order to limit NOx emissions, it has already been decided to equip the boilers with low NOx burners. An SCR-DeNOx gas purification system is also planned as an additional project-integrated mitigation measure. This consists of a catalytic bed in which NOx reduction takes place, for which NH_3 must be added to the flue gases. An explanation of how SCR-DeNOx works is included in Appendix 6.4.

The quantification of emissions is included in Table 7-17 and Table 7-18.

Furthermore, the pollutants CO and PM_{10} are also present in the flue gases to a (very) limited extent. There are no relevant emissions of SO_2, as both the fuel gas and natural gas contain virtually no sulphur compounds.

7.4.2.1.6 Water treatment - Thermal oxidiser

In some stages of water treatment, VOCs evaporate from the wastewater, especially during stripping and flotation stages (see Chapter 9 Water). These vapours are extracted and the volatile organic compounds are destroyed in a thermal oxidiser (afterburner). Only gases are diverted to the thermal oxidiser (no liquid flows).

The following residual gases will be diverted to the thermal oxidiser:

- Spent Caustic: this is a specific high-load wastewater stream from the ECR, for which separate pre-treatment is provided (Wet Air Oxidation);
- Oil separation wastewater: most wastewater streams undergo oil separation as a first treatment (e.g. plate separator + flotation);
- Off-spec wastewater: a tank is provided for exceptional wastewater streams. These can be further treated in the water treatment plant or discharged externally.

Both the gas phase from the tanks in which these wastewater streams are collected and the vapours extracted from the specific pre-treatment steps (wet air oxidation, separators, flotation, etc.) are fed into the thermal oxidiser.

Since the vapours are extracted from closed installations, the extraction flow rate will be rather limited. The extracted vapours may contain harmful substances, which are destroyed in the thermal oxidiser. Fuel gas or natural gas is used as fuel in the oxidiser.

The quantification of the emissions is included in Table 7-17 and Table 7-18.

In accordance with the applicable BAT Reference Document (BREF "Common Waste Gas Treatment in the Chemical Sector"), emissions will have a maximum VOC emission concentration of 20[18]mg/Nm³.

The most harmful substances expected to be present are benzene and butadiene, with a maximum emission concentration of 1 mg/Nm³ each.

The flue gas pollutants NOx and, to a limited extent, CO and PM10/PM2.5 are also present in the flue gases.

7.4.2.1.7 Water treatment – Odour control

During further biological treatment of the pre-treated wastewater streams, odorous substances may be produced as a result of the decomposition processes. Aerating the water can also remove a limited amount of volatile substances.

In addition, odorous substances will also be released from the treated sewage sludge during sludge treatment.

The installations in which biological treatment takes place and the installations in which sludge treatment takes place will be closed or housed in a building and equipped with an extraction system. The extracted air is sent through a communal odour removal installation. A packed gas scrubber is provided, with micro-organisms for removing odorous substances, or an equivalent alternative purification system. The gases purified in this way are then emitted.

The quantification of emissions is included in Table 7-17 and Table 7-18.

The emissions will have a maximum VOC emission concentration of 5 mg/Nm³. In practice, an even lower concentration is expected. Based on these steps in the water treatment process and after the gas treatment applied, no harmful substances such as benzene and butadiene are expected in the emissions.

7.4.2.1.8 Storage and transhipment emissions

With one exception, the products supplied and removed are gases or highly volatile liquids which, due to their properties, are stored in completely closed systems:

- Ethane: storage in cryogenic storage tanks;
- Propylene and C4 fraction: storage in pressure tanks (interrupted bullets).

Under normal conditions, the closed storage systems mentioned above do not emit any emissions into the ambient air:

- In the cryogenic tank, the product is stored in liquid form at very low temperatures. The product that evaporates is continuously diverted to a BOG (Boil Off Gas) system, where it is condensed by cooling and returned to the tank.
- The pressure tanks are continuously monitored to ensure that the pressure does not exceed the design pressure of the tank (e.g. in the event of a temperature increase).

If, in certain exceptional situations, the pressure in the storage system rises too high despite continuous monitoring, the gases are diverted to a flare system (see below).

Only the tanks for storing the C5+ fraction and pyrolysis oil are atmospheric tanks, from which emissions may occur during storage and transfer. The following emissions occur at these tanks:

- Storage emissions: these occur when filling the tank from the processes, due to the expulsion of gases from the tank;

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[18] This emission concentration is based on the BREF "Common Waste Gas Treatment in the Chemical Sector" (WGC).

- Loading emissions: these occur when loading a ship (C5+) or tanker (pyrolysis oil) from the tanks. A vapour return line returns vapours to the tanks or directly to a gas purification system.

For these emissions (storage emissions, loading emissions), there is a joint gas purification system that significantly reduces emissions, with an emission point to the ambient air. The gas purification system comprises an activated carbon filter or a membrane filter (or an equivalent alternative).

The quantification of the emissions is included in Table 7-17 and Table 7-18.

Emissions are calculated based on the expected flow rates when filling the tank and loading ships and tankers, the number of hours per year that emissions can occur, and the maximum emissions in accordance with the applicable BAT Reference Document (maximum VOC emission concentration of 20 mg/Nm³ cfr. BREF 'Common Waste Gas Treatment in the Chemical Sector').

The C5+ fraction contains benzene (maximum emission concentration 1 mg/Nm³) and (to a very limited extent, < 0.07% of the C5+ fraction) butadiene as the most harmful substances.

7.4.2.1.9 Flaring emissions

A total of three flares are planned, one of which is double. A flare system with two flares is planned for the ECR:

- A low, shielded ground flare (screen flare) (approx. 20 m), which captures residual gas flows of up to 125 tonnes/hour, thereby limiting the operation of the tower flare to exceptional emergencies;
- A high open tower flare (approx. 208 m), which is only intended to handle emergency situations/incidents (involving residual gas flows above 125 tonnes/h).

In addition, a flare system is provided for gas storage in the cryogenic tank and pressure tanks:

- A (double) low, shielded ground flare (screen flare) (approx. 20 m): only one of the two ground flares is in operation at any given time; the second is a reserve that is only used when the first is out of service (maintenance, repair, etc.).

The flame of the ground flares is enclosed within a screen and is therefore not visible (screen flares). The flame of the tower flare is not shielded. A description of the flares with an estimate of the frequency and duration of operation (for both ground flares and tower flares) can be found in § 3.4.11 in Chapter 3.

The installations and processes are designed in such a way that no residual gases are fed to the flares during normal operation. The flares have limited continuous emissions due to the use of natural gas (approx. 50 kg/h) for the pilot burners (pilot flame), which ensure that the flares can always be activated immediately. The ground flares only come into operation when the installations are started up or shut down. The tower flare only comes into operation in emergency situations/incidents:

- The ECR ground flare is used to burn residual gases released during planned shutdowns or maintenance of the installation, usually lasting several hours, and during start-up of the ECR, lasting 1 to 3 days. Complete shutdown and restart of the ECR is planned every 5 years.
- The ECR tower flare and the (double) ground flare connected to the gas storage facility are only intended as a safety measure to divert excess pressure from the installations or storage tanks in the event of unplanned incidents. Their operation in such an incident is limited to a maximum of two hours and will only occur very rarely.

As indicated above, emissions from flare operation are rare and short-lived. The effect on air quality is partly determined by the meteorological conditions (wind direction, wind speed, etc.) at the time.

The emissions from the flares (NOx, CO, SO_2 and VOCs) are based on the design data provided by the flare suppliers.

The quantification of the emissions is included in Table 7-17 and Table 7-18.

7.4.2.2 Fugitive emissions

Fugitive VOC emissions can occur at flanges, valves and pumps, among other places, which contain gaseous or volatile liquid product flows. In the new installations, technically sealed installation components will be used wherever such product flows occur.

To prevent and limit such fugitive emissions, measures will be taken in the areas of design, construction, commissioning, maintenance and monitoring.

7.4.2.2.1 Design – structural measures

An important aspect in limiting fugitive emissions is the provision of so-called 'technically sealed' installation components. According to Chapter IV of Annex 4.4.6 of VLAREM II, this concerns the following types of installation components:

- Pumps: Bus motor pumps, pumps with magnetic couplings, pumps with multiple slide ring seals (with barrier or buffer medium), diaphragm pumps or bellows pumps;
- Compressors: Compressors with multiple slide ring seals where the barrier fluid (wet seal) or degassing (dry seal) does not vent to the open atmosphere, or with seals with a pressure chamber;
- Valves: Valves with bellows seals with downstream stuffing box seals or equivalent sealing systems (verification tests are explained in VDI 2440 (November 2000) § 3.3.1.3, and in DIN-ISO 15848);
- Flanges: Limit the number of flanges. Remaining flanges with metal or welded seals, or equivalent sealing systems. The flanges are installed by a technician trained in accordance with EN1591-4:2013;
- Sampling systems: Closed sampling systems, i.e. with complete collection of the pre-flow and post-flow or return to the installation.

Project One provides such 'technically sealed' installation components in all sub-installations where hydrocarbons are present. Specifications are drawn up for contractors, including specifications regarding the applicable VLAREM II conditions, in order to guarantee that these can be met.

7.4.2.2.2 Mitigation by design - structural measures

At all stages of the project, opportunities for cost-effective reduction of VOC emissions will be evaluated. Efforts will be made to implement all practical options for eliminating or reducing emissions from plant components by:

- limiting the number of potential emission sources by applying the best available techniques as a starting point in the design;
- installing best practices for emission reduction technologies where possible;
- selecting and configuring equipment components, including:
  - limitation of the number of potential emission sources:
    - correct design of the pipe layout (in accordance with internal standards imposed on contractors), with:
      - minimising pipe length;
      - reducing the number of flanges, valves and screwed pipes; flange connections are only considered for specific applications:
        - integration of in-line pipes and instrument components;
        - connection to equipment and packages supplied by the supplier;
        - as a provision for dismantling and maintaining equipment (e.g. shafts and rotors, heat exchanger heads, etc.);
        - where frequent dismantling of pipes is required for commissioning (chemical cleaning, steam blowing), factory operations, maintenance and inspection;
      - where possible, use welded fittings and pipes;
    - reducing the number of pumps by using other means of fluid transfer, such as gravity, where possible;
    - maximising inherent process control functions, including:

- closed discharge systems for waste water and tanks or installations used for storage/treatment of waste water;
- extracting and destroying diffuse emissions from the enclosed parts of the wastewater treatment plant;
- minimising emissions during sampling by using closed sampling systems or in-line analysers;
- installing a maintenance drainage system to eliminate open drainage of volatile flows;

- selecting high-quality equipment for light, volatile, high-temperature and high-pressure products (in accordance with internal procedures on piping materials), such as:
  - valves with double gasket seals or equally efficient equipment such as bellows-sealed with welded caps;
  - All other non-bellows valves are equipped with spring-loaded gland seals and comply with Class A of the international standard for fugitive emissions from industrial valves (EN ISO 15848).
  - installation of high-quality gaskets that comply with the European standard for flanges and couplings with gaskets BS EN 1591;
  - Pumps and seals:
    - Centrifugal pumps are the preferred pump type for most applications, with API 610; pumps for heavy-duty applications and hydrocarbons;
    - Pumps for general use and utilities must comply with ISO 5199;
    - Dosing pumps must be hydraulically activated in accordance with API 675; with double diaphragm and breakage indication; diaphragms are without penetration/holes;
    - lubricating oil pumps are rotary, positive displacement pumps;
    - Pumps in hazardous (toxic or carcinogenic) or flammable applications must have double mechanical seals, preferably in a back-to-back configuration.
    - For pumps used in benzene applications, acids or highly volatile hydrocarbons, pumps without seals (either magnetic coupling or sealed) should be considered.
  - Compressors and seals:
    - Centrifugal compressors for hydrocarbons should be of the single shaft type, not integrally coupled.
    - Compressors should have double dry gas sealing systems, including buffer gas filters and stainless steel pipes. Radial and thrust bearings and dry gas seals should be able to withstand reverse rotation without damage.
    - seal venting arrangements must follow best available technology (BAT);
    - Couplings must be of the non-lubricated diaphragm disc type in accordance with API 671.
    - The machine shafts must be tapered and designed for hydraulic mounting. Provision must be made for disassembly (expansion of conical device) of couplings by means of oil pressure.
  - if mechanical seals are used, these must be either double seals or high-quality sealing fluid systems; no gaskets may be used;
- select suitable materials to:
  - ensure that all equipment, such as gaskets, is suitable for each process application;
  - prevent corrosion and resulting leaks;
  - prevent corrosion by coating or lining equipment, painting pipes to protect against external corrosion and using corrosion inhibitors for materials that come into contact with equipment;
- use of a specific flange management programme in accordance with European standard EN1591:
  - adapted calculation method for bolt tension;
  - qualification of personnel competence in the assembly of bolted joints;
  - detailed inspection and traceability programme for flange connections;
- The following principles were applied in the design of new storage tanks and product loading facilities:
  - equipping the C5 storage tank with vapour recovery; using tank venting systems that minimise breathing losses;
  - reducing the temperature impact in storage tanks by painting them white;
  - installing vapour recovery at loading points for products with high vapour pressure or high toxicity values;

- facilitating maintenance activities and Leak Detection and Repair (LDAR) activities by ensuring good access to components with a relatively high leak potential;
- collected emissions, such as ventilation openings from tanks, are captured and treated (see § 7.4.2.1.8).

7.4.2.2.3 Construction and Completion

During construction, all leak-sensitive components (e.g. flanges, etc.) are handled by contractors who specialise in this field and assemble the installations according to established protocols, paying particular attention to preventing leaks. Upon delivery for the start-up of the installations, a leak test is carried out on the installations. To this end, all parts of the installation are pressurised according to a predetermined procedure. If the pressure in a part of the installation cannot be maintained, the leak is located and repaired.

7.4.2.2.4 Maintenance and Monitoring

After the installations have been started up, fugitive emissions will be monitored in collaboration with a specialised contractor. This includes:

- Processes, installations and equipment will be ranked based on the likelihood of fugitive emissions occurring, the potential scale of the emissions and the presence of priority substances such as benzene or butadiene. Monitoring will be more intensive for the highest-ranked processes, installations and equipment.
- An LDAR (Leak Detection And Repair) programme will be launched within a few months of the installations being commissioned. The aim of this programme is to confirm the overall leak tightness of the installations. Any leaks will be repaired and subjected to a new inspection. These campaigns will involve a combination of measurements at installation components (sniffing method) and the use of advanced infrared cameras (OGI = Optical Gas Imaging). The latter are mainly used for checks after repairs and/or interim inspections, as they allow rapid screening to identify relevant sources for further, more detailed inspection.
- Interim targeted checks on priority processes, installations and equipment, and annual full checks of fugitive emissions based on the results of the first campaign. This will provide an annual quantification of fugitive emissions.
- In collaboration with the specialist contractor, an assessment will be made of the extent to which innovative techniques, such as DIAL (Differential Adsorption Light) systems and SOF (Solar Occultation Flux), can be used to supplement or improve monitoring after start-up. These techniques are primarily intended to provide a global picture at site level, whereas the LDAR measurement campaigns already planned will specifically identify potential leak losses at the level of individual installation components. Once identified, a repair action will be immediately linked to this in order to prevent further leak losses. DIAL and SOF offer little added value in terms of concrete definition of the need for repair.

7.4.2.2.5 Estimation of fugitive emissions

Even with the maximum use of leak-proof installation components, a certain amount of fugitive emissions cannot be ruled out.

In order to estimate the expected fugitive emissions, we use the emission factors published by EMEP/EEA (European Monitoring and Evaluation Programme / European Environment Agency). These are determined on the basis of measured values at existing similar cracking installations.

The EMEP/EEA Tier 2 emission factor for fugitive emissions is 0.03 to 6 tonnes/kton of production (95% confidence interval). This range reflects the difference in the age of the installations and the associated design standards applied, as well as the way in which they are maintained.

A comparison of the data from existing European installations with the installations that Project One will build shows the following differences:

- The existing large cracking plants in Europe are all more than 15 years old. The techniques for limiting fugitive emissions at Project One will apply the latest technical developments, which will lead to lower emissions. The above-mentioned approach in terms of design, construction, delivery, maintenance and monitoring will guarantee this.
- Most existing cracking plants use naphtha as their base feedstock, making them significantly more complex than Project One, which uses ethane as its feedstock.

Based on these differences, we can assume that Project One's installations will have the lowest fugitive emissions of all comparable European installations. To estimate the emissions, we can use the lower limit of the above-mentioned emission factor: 0.03 tonnes/kton of production. For the ECR, with a production of 1,450 ktonnes of ethylene, we estimate the fugitive emissions at 43.5 tonnes/year of volatile organic compounds.

Based on design data from the ECR, the proportion of harmful substances butadiene and benzene in the product streams in the installations is estimated at a maximum of 1.15% butadiene and 1.4% benzene. Assuming a similar presence in fugitive emissions, this results in fugitive emissions of 500 kg/year of butadiene and 609 kg/year of benzene.

Table 7-11: Estimation of fugitive emissions ECR

Emission point	VOC load (kg/year)	Benzene (kg/year)	Butadiene (kg/year)
Fugitive emissions ECR	43,500	609	500

7.4.2.3 Ships at berth

The Project One site will use two berths for ships (see § 3.4.2.2). The ships that transport raw materials and end products will be moored at one of the berths for a period of time for loading and unloading. The ships are equipped with installations (including pumps, cooling installations, etc.) that are mainly used for unloading products (pumping from the ship to the quay) and for keeping cooled products (ethane) cool. To operate these installations, the ships are equipped with diesel-powered generators.

These engines require constant high power. Project One envisages the use of modern gas tankers, but these ships are not equipped to receive shore power. According to information obtained from the shipbuilder, converting such ships is very challenging, due to factors such as safety in a potentially flammable zone and the considerable power of > 2 MW required to drive the pumps for product transfer and the power supply on the ship. Shore power can already be used for a ship's general 'emergency' energy requirements (such as lighting and hotel services), but not for loading and unloading activities. For the above reasons, we assume in this EIA that shore power will not be used.

Project One is already anticipating the future provision of shore power for cargo activities in the design of its electrical infrastructure.

We consider the use of diesel to be the most realistic worst-case scenario here. These emissions are quantified below.

Table 7-12: Data on ship emissions at the quay

Berth	Type of ship	Product	Number (per year)	Quay time per ship (hours)	Diesel consumption (tonnes/24 hours)
Berth 2	VLEC (seagoing vessel)	Ethane supply	37	24	10.0
Berth 2 or 3*	Inland vessel	Propylene(CGP) supply	200	8	0.91
	Barge	C4 supply	84	8	0.91
	Inland vessel	C4 discharge	90	8	0.34
	Inland vessel	C5 discharge	34	8	0.34

* For the impact calculations, we assume that inland vessels are moored at berth 3.

The location of ship emissions at the quays is assumed to be as follows:

Table 7-13: Physical characteristics of the ship types considered.

Emission point	Lambert X [m]	Lambert Y [m]	Height (m)	Diameter (m)
Berth 2	145 735	223 495	35	0.40
Berth 3	145 690	223 225	5	0.20

The engines of large tankers mooring at Berth 2 are equipped with SCR DeNOx gas purification systems. This reduces NOx emissions by a factor of approximately 4. We calculate these emissions based on the test results of the engines of these ships.

The emissions are calculated using the following assumptions and emission factors:

- The engines run on marine diesel oil (seagoing vessels) or diesel oil (inland vessels);
- Emission factors without gas purification (European Environment Agency Guidebook 2023, Table 3-13):
  - 55.5 kg NOx/tonne of fuel;
  - 2.04 kg VOC/tonne of fuel;
  - 1.11 kg PM10/tonne of fuel;
- Emission factor for NOx for ships with SCR-DeNOx gas purification (VLEC) [19] :
  - 15.1 kg NOx/tonne of fuel;
- Sulphur content of maximum 0.1% in the fuel (1 kg sulphur/tonne of fuel).

We arrive at the following estimate of emissions per quay.

Table 7-14: Budget for shipping emissions (at the quay)

Emission point	Temperature (°C)	Flow rate (Nm³/h)	NOx cargo (kg/year)	SO2 emissions (kg/year)	PM10 load (kg/year)	VOC load (kg/year)
Berth 2	250	4,200	5,590	740	410	750
Berth 3	250	450	5,590	200	110	210

7.4.2.4 Traffic emissions

There will be traffic emissions from both shipping and road transport.

7.4.2.4.1 Shipping

For a description and estimate of the emissions from the ships, we use the above-mentioned numbers of ships (see Table 7-12 in § 7.4.2.3). In the table below, the emissions are calculated per km (there and back).

[19] Ambient and Gaseous Emission Data (Tier III, Diesel mode with EGR) Engine type of ships: Hyundai-Man B&W 6G60ME-C9.35-GIE
Test date 12/09/2017

Average specific emission of the engine: 2.7 g/kWh (engine power) Fuel consumption of the engine: 179.1 to 197.0 g/kWh
Specific emissions per fuel quantity: 13.7 to 15.1 kg NOx/tonne of fuel

For seagoing vessels, the route from the Project One site to the north is via the Kanaaldok, through the Zandvliet or Berendrecht locks and on via the Scheldt to the North Sea.

For inland vessels, it is assumed that they will travel via the Canal Dock from/to the south.

Table 7-15: Budget for shipping emissions (sailing)

		Number per year	Tonnage per ship	kg NOx/km.ship	kg NOx/km.year
Tankers	VLEC	37	30 000à 59 999	1.2	44.4
Tugboats	For tankers	37	30 000à 59,999	4.8	177.6
Total seagoing vessels	**Single journey**				**222.0**
	Round trip				**444**
		Number per year	**tonnage per ship**	**g NOx/tonne.km**	**kg NOx/km.year**
Inland vessels	CEMTClassIII (M4)	200	1,000	0.4183864	83.7
Inland waterway vessels	CEMTClassIVa (M6)	174	1,250	0.3770476	82.0
Inland vessels	CEMTClassVa (M8)	34	2,000	0.3034405	20.6
Total inland vessels	**Single route**				**186.3**
	Round trip				**372.6**

Emission factors for seagoing vessels: Key figures for seagoing vessels for emission and dispersion calculations in Aerius, updated in 2018 - TNO, J.H.J. Hulskotte, July 2019.

* For tankers, the emission factor without SCR-DeNOx gas purification is 4.4 kgNOx/km.ship. Taking into account the emission reduction achieved by the SCR-DeNOx gas purification systems installed on these ships, the emission factor has been reduced to 1.2 kgNOx/km.ship (analogous to the emissions at the quay, see above).

Emission factor for inland vessels: MER guideline system Air.

7.4.2.4.2 Road traffic

During the operational phase, Project One's activities will generate road traffic due to the daily commuting of employees on the one hand and truck transport on the other.

For a description and assessment of these traffic flows, please refer to Chapter 10 Mobility. Traffic emissions are calculated in the dispersion model used (IMPACT) on the basis of traffic flows.

The effect of traffic emissions on air quality is discussed in § 7.6.2.8.

7.4.2.5 Odour

There are two points of attention for the reduction of odour emissions: odorous substances present in the processes and odour emissions from wastewater treatment.

The main chemicals used in Project One's processes are odourless or virtually odourless. No strong odorous substances are present in large quantities in the processes. The sulphur-containing compounds resulting from the use of DMDS (to limit coke deposits) end up in a waste water stream (spent caustic).
Any emissions of chemicals are minimised by:

- preventing emissions from storage and loading and/or treating them in a specific gas purification system (see § 7.4.2.1.8)
- the application of measures to limit fugitive emissions (see § 7.4.2.2).

At the water treatment plant, provisions are made to capture and treat emissions from the wastewater before they are emitted. To this end, a thermal oxidiser is provided for the incineration of the most concentrated emissions from the initial wastewater treatment stages (see § 7.4.2.1.6) and a gas purification system for the treatment of odour emissions from the further biological treatment of the wastewater (see § 7.4.2.1.7).

These measures ensure that all potentially relevant odour emissions are treated. It is expected that the residual emissions will not cause any odour nuisance outside the site.

7.4.2.6 Other emissions

The preceding paragraphs identified all relevant continuous stack emissions and fugitive emissions, including fugitive emissions, storage and transfer emissions, and emissions from water treatment. Emissions resulting from larger leaks or incidents involving the release of volatile substances have not been taken into account (e.g. larger quantities of hydrocarbons in rainwater basins, emissions via cooling towers due to a leak in a heat exchanger, etc.). Given the high level of attention to safety, which guarantees an immediate response to major leaks, the preventive measures (e.g. close monitoring of processes) and the focus on 'good housekeeping', it is assumed that such emissions can only occur in exceptional and short-term circumstances and therefore do not play a relevant role in the normal or average emission pattern of the site.

The administrative building will be heated with heat pumps. This means there will be no flue gas emissions.

A number of diesel-fired emergency generators will be provided. Their operation will be tested periodically. Given the negligible number of expected operating hours (typically 52 hours per year), they will not be included in the assessment in this EIA.

7.4.2.7 Quantification of emissions

Table 7-17 below presents the NOx and NH_3 emissions for the scenarios considered.

- This shows that Scenario A (application of BBT, but without additional SCR-DeNOx gas purification) results in NOx emissions of 591 tonnes/year for all emission sources combined.
- In Scenario B (with additional SCR-DeNOx gas purification), these NOx emissions fall to 167 tonnes/year. This represents a reduction in NOx emissions of 424 tonnes/year.
- In scenario B, there is also an additional emission of 18 tonnes/year of NH_3 as a result of the operation of the SCR-DeNOx gas purification system.

As previously indicated, Project One will implement Scenario B, with SCR-DeNOx on the main chimneys. The SCR-DeNOx gas purification systems can be considered a project-integrated mitigation measure. The combination of these techniques achieves a lower emission level than for each BAT technique individually.

The following emission limit values are proposed for the emission sources on which SCR-DeNOx will be installed (ECR furnaces and steam boilers):

Table 7-16: NOx and NH_3 emission limit values for the 6 cracking furnaces and the 2 steam boilers

Emission limits for 6 crackers and 2 steam boilers	NOx	NH3
Concentrations during normal operating conditions		
Hourly average per chimney	60 mg/Nm³	8 mg/Nm³
Daily average per chimney	40 mg/Nm³	6 mg/Nm³
Annual load		
Moving three-year average for the eight chimneys combined*	148.8 tonnes/year	17.9 tonnes/year

* These annual loads are calculated based on an expected emission concentration, averaged across the various chimneys and over the lifetime of the catalytic converter, of 25 mg/Nm³ NOx and 3 mg/Nm³ NH_3 under normal operating conditions (see Table 7-17). These loads are used to calculate the effects.

A more detailed explanation of these emission values is included in Appendix 6.4.

The installations are designed in such a way that these concentrations can be guaranteed throughout the entire service life of the catalysts in the SCR-DeNOx.

Table 7-18 below presents the expected maximum emissions of the other pollutants (SO_2, PM_{10}, CO and organic substances), calculated using the emission limit values that will be respected (scenarios A and B do not differ in this respect).

For most emission points, a continuous operating regime is assumed.

Table 7-17: Expected emissions for the emission points considered (point sources) for the parameters NOx and NH_3 in the scenarios considered

Number	Emission point	Temperature (°C)	Operating hours (h/year)	Flow rate (Nm³/h)	Scenario A – Without SCR DeNOx		Scenario B – With SCR DeNOx Expected emissions			
					NOx concentration (mg/Nm³)	NOx load (kg/year)	NOx concentration (mg/Nm³)	NOx load (kg/year)	NH_3 concentration (mg/Nm³)	NH_3 load (kg/year)
E1a	Cooker 1 – Production*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E2a	Cooker 2 – Production*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E3a	Cooker 3 – Production*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E4a	Cooker 4 – Production*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E5a	Cooker 5 – Production*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E6a	Cooker 6 – Decoking*	108	8,343	94,700	100	79,008	25	19,752	3	2,370
E1b	Cooker 1 – Decoking*	258	417	36,700	100	1,530	25	383	3	46
E2b	Cooker 2 – Decoking*	258	417	36,700	100	1,530	25	383	3	46
E3b	Cooker 3 – Decoking*	258	417	36,700	100	1,530	25	383	3	46
E4b	Cooker 4 – Decoking*	258	417	36,700	100	1,530	25	383	3	46
E5b	Cooker 5 –	258	417	36,700	100	1,530	25	383	3	46
E6b	Cooker 6 –	258	417	36,700	100	1,530	25	383	3	46
E7	Decoking 1	165	417	33	50	690	50	690		-
E8	Decoking 2	165	417	33	50	690	50	690		-
E9	Decoking 3	165	417	33 100	50	690	50	690		-
E10	ECR Decoking 4	165	417	33	50	690	50	690		-
E11	Decoking 5 ECR	165	417	33 100	50	690	50	690		-
E12	Decoking 6	165	417	33 100	50	690	50	690		-
E13	Ground flare	500	8,760	670		613		613		-
E14	Tower flare	500	8,760	670		613		613		-

Number	Emission point	Temperature (°C)	Operating hours (h/year)	Flow rate (Nm³/h)	Scenario A – Without SCR DeNOx		Scenario B – With SCR DeNOx Expected emissions			
					NOx concentration (mg/Nm³)	NOx load (kg/year)	NOx concentration (mg/Nm³)	NOx load (kg/year)	NH_3 concentration (mg/Nm³)	NH_3 load (kg/year)
E15	Steam boiler 1*	170	8,760	63,900	80	44,781	25	13,994	3	1,679
E16	Steam boiler 2*	170	8,760	63,900	80	44,781	25	13,994	3	1,679
E17	WZI Thermal oxidiser	300	8,760	1,100	100	964	100	964		-
E18	WZI Biotreatment	20	8,760	38,300		-		-		-
E19	C5+/Pyoil storage Tank	20	8,760	10 – 1,650		-		-		-
E20/E21	Ground flare	500	8,760	670		613		613		-
Quay 2	Seagoing vessels	250		4,200		5,590		5,590		-
Quay 3	Inland vessels	250		450		5,590		5,590		-
TOTAL						**590,917**		**166,920**		**17,856**

* Combustion plants with flue gases at 3% O_2

Table 7-18: Expected maximum emissions for the emission points considered (point sources) for the parameters SO_2, PM_{10}, CO and organic substances (Valid for Scenarios A and Scenario B)

Number	Emission point	SO_2 concentration (mg/Nm³)	SO_2 Load (kg/year)	PM_{10} ** concentration (mg/Nm³)	PM_{10} ** load (kg/year)	CO concentration (mg/Nm³)	CO load (kg/year)	VOC concentration (mg/Nm³)	VOC cargo (kg/year)	benzene concentration (mg/Nm³)	benzene load (kg/year)	Butadiene concentration (mg/Nm³)	Butadiene load (kg/year)
E1a	Furnace 1 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E2a	Cooker 2 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E3a	Cooker 3 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E4a	Cooker 4 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E5a	Cooker 5 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E6a	Cooker 6 – Production*		-	5	3,950	25	19,752	5	3,950		-		-
E1b	Furnace 1 – Decoking*		-	5	77	10	153	2	31		-		-
E2b	Cooker 2 – Decoking*		-	5	77	10	153	2	31		-		-
E3b	Cooker 3 – Decoking*		-	5	77	10	153	2	31		-		-
E4b	Cooker 4 – Decoking*		-	5	77	10	153	2	31		-		-
E5b	Cooker 5 – Decoking*		-	5	77	10	153	2	31		-		-
E6b	Cooker 6 – Decoking*		-	5	77	10	153	2	31		-		-
E7	Decoking 1		-	30	414	3,200	44,169		-		-		-
E8	Decoking 2		-	30	414	3,200	44,169		-		-		-
E9	Decoking 3		-	30	414	3,200	44,169		-		-		-
E10	Decoking 4		-	30	414	3,200	44,169		-		-		-
E11	Decoking 5		-	30	414	3,200	44,169		-		-		-
E12	Decoking 6		-	30	414	3,200	44,169		-		-		-
E13	Ground flare ECR		9		-		2,716		1,139		-		-
E14	Tower flare ECR		9		-		2,716		1,139		-		-
	Fugitive emissions								43,500		609		500
E15	Steam boiler 1*		-	1.5	840	25	13,994		-		-		-
E16	Steam boiler 2*		-	1.5	840	25	13,994		-		-		-
E17	WZI Thermal oxidiser		-	1.5	14	50	482	20	193	1	10	1	10
E18	WZI Biotreatment		-		-		-	5	1,678		-		-
E19	C5+/Pyoil storage		-		-		-	20	16	1	0.77	1	0.02
E20/E21	Tank storage Ground flare		9		-		2,716		1,139		-		-
Quay 2	Seagoing vessels		740		410		-		750		-		-
Quay 3	Inland vessels		200		110		-		210		-		-
TOTAL			**967**		**28,860**		**421,060**		**73,649**		**620**		**510**

* Combustion plants with flue gases at 3% O_2

** PM10 dust includes finer $PM_{2.5}$ dust, for which no separate estimate is available. As a worst-case assumption, $PM_{2.5} = PM_{10}$.

7.4.2.8 Total emissions versus emissions in Flanders and NEC ceilings

The higher calculated additional emissions from Project One are compared in the table below with the emission ceilings that apply to Flanders based on the NEC Directive.

The NEC Directive (National Emission Ceilings), published in 2001 (2001/81/EC) and revised in 2016 (2016/2284/EU), sets out agreements on maximum emissions per EU Member State. In order to improve air quality and mitigate effects on health and nature, it was agreed within the EU that maximum emissions for five pollutants would be imposed on each Member State. These emission ceilings per Member State were first set for 2010 and have been gradually reduced since then. In Belgium, the emission ceiling is further divided among the regions, each of which is responsible for achieving its emission ceiling.

Table 7-19: Emissions from Project One, compared with emissions from the whole of Flanders

	NEC ceiling for Flanders 2030 [kton/year]	Project One Operational phase [kton/year]	Project One Operational phase % relative to NEC 2030
NOx	71.8	0.167	0.2
NH_3	41.5	0.018	0.04
SO_2	32.5	0.001	0.003
$PM_{2.5}$	11.9	0.029 **	0.2
VOC	58.7	0.074	0.1

* Source: https://www.vmm.be/data/internationale-rapporteringen

NEC emissions exclude international aviation and international maritime navigation.

** For the emissions from Project One, we state the emissions of PM_{10} as the worst-case assumption for the emissions of $PM_{2.5}$.

According to the proposed schedule, Project One's emissions must be taken into account for a full year from 2027 onwards. We are therefore comparing Project One's emissions with the Flemish NEC ceilings for 2030. The table shows that the additional emissions from Project One for NOx and $PM_{2.5}$ will account for approximately 0.2% of the NEC ceilings for 2030. For the other pollutants, the contribution is lower.

7.5 Selection of critical pollutants

7.5.1 Selection criteria

To evaluate the effect of emissions on ambient air, dispersion calculations are performed using the IMPACT model. This modelling is carried out for pollutants that are expected to have a relevant effect on air quality. These are the pollutants with the highest emissions and/or pollutants that require extra attention for other reasons. The Air Quality Guidelines System sets out the agreements that are followed to determine the relevant pollutants.

Impact assessments must be carried out for a pollutant if one of the following conditions is met (unless it can be argued that other criteria make it unnecessary to study the pollutant further):

The total annual atmospheric emission load of the pollutant exceeds 1/10 of the threshold loads for inclusion in the integrated annual environmental report.

The table below shows the total emission loads for the various parameters.

Table 7-20: Total annual emissions for the various pollutants

	Emissions Operational phase	Threshold value IMJV
NOx load (tonnes/year)	167	50
NH_3 load (tonnes/year)	18	10
SO_2 load (tonnes/year)	1	100
PM_{10} load (tonnes/year) $PM_{2.5}$ load (tonnes/year)	29	20 10
CO load (tonnes/year)	421	200
VOC freight (tonnes/year)	74	20
Benzene freight (tonnes/year)	0.6	0.1
Butadiene freight (tonnes/year)	0.5	-

IMJV = Integrated Environmental Annual Report

During the operational phase, emissions of NOx, NH_3, PM_{10}, CO, VOCs and benzene exceed 1/10 of the IMJV threshold loads. The threshold load for SO_2 is not exceeded. No threshold value for butadiene is included in the integrated environmental annual report, and the effects are therefore being further evaluated.

1. ***The pollutant can be identified as a critical parameter. A critical parameter is a parameter for which the measured value in the environment exceeds 80% of the environmental quality standard.***

The air quality in the study area, i.e. in the port area on the right bank, is better than 80% of the environmental quality standard for NO_2, PM_{10} and $PM_{2.5}$ almost everywhere. Only in very localised areas near certain busy roads or shipping routes is 80% of the environmental quality standard for NO_2 exceeded. The average SO2 level in the port of Antwerp is higher than the Flemish average.

Based on the available background emissions (local elevated values), NO_2 is selected as the critical parameter. SO_2 is also selected due to the emissions already present in the port of Antwerp.

2. ***Pollutants with the following risk phrases are always studied:***
   a. ***suspected of causing cancer (H351)***
   b. ***may cause cancer (H350)***
   c. ***may cause genetic damage (H340)***
   d. ***causes damage to organs through prolonged or repeated exposure (H372)***
   e. ***may cause cancer by inhalation (H350i)***
   f. ***may damage fertility or the unborn child (H360)***

During the chemical cracking processes, various hydrocarbons are produced as by-products in addition to the intended ethylene. The substances produced in relevant quantities consist of 2 to 6 carbon atoms, although larger hydrocarbons are also produced to a limited extent, which are collected in the heavier fractions (C5+ fraction and pyrolysis oil). These substances may occur to a greater or lesser extent in certain emissions. Of these hydrocarbons, benzene (H340, H350, H372) and butadiene (H340, H350) are the most harmful. All others are significantly less harmful or are considered harmless. Therefore, benzene and butadiene are retained as indicator parameters.

3. ***The expert evaluates the relevance of the above criteria together with:***
   a. ***method of emission;***
   b. ***presence of (sensitive) population groups in the study area;***
   c. ***presence of fauna and flora in the immediate vicinity;***
   d. ***any existing structural complaints or unrest.***

Given the presence of nature reserves, in addition to the above-mentioned pollutants, an evaluation of acidifying and fertilising deposition must be carried out.

7.5.2 Selected pollutants

Based on the above considerations, we decide:

- Dispersion modelling for immission concentrations during the operational phase to be carried out for the parameters: NOx, SO_2, PM10/PM2.5, CO, NH_3, benzene and butadiene.
  - For the pollutants NOx, SO_2, PM10/PM2.5, CO and benzene, the Air discipline will carry out an assessment against the air quality objectives set out in Vlarem II.
  - There are no air quality targets for NH_3 (VLAREM II); however, the effects on health are being further evaluated (as for all other pollutants) in the Human Health discipline.
  - There are no assessment standards for the group parameter VOC, so modelling this group parameter is not useful. The effect is evaluated for the main indicator parameters for health effects: butadiene and benzene.
    - For benzene, this chapter on air quality assesses the contribution of Project One to the air quality objectives.
    - There is no statutory air quality target for butadiene, so this assessment cannot be carried out. However, the effects on health are evaluated further (as for all other pollutants) in the Human Health discipline.
- NOx is retained as a critical pollutant for the construction phase.
- Modelling of fertilising deposition (NOx, NH_3) to be carried out for evaluation in the Biodiversity discipline (construction phase and operational phase).

7.6 Effect description and effect assessment

The effects on air quality of the pollutants selected in the previous section are evaluated below.

7.6.1 Construction phase

7.6.1.1 Emissions from construction machinery and ships

7.6.1.1.1 Model construction IMPACT

Dispersion modelling was carried out using the IMPACT model for the NOx parameter. The following emission points were added to the model as sources:

- Emissions from construction machinery and vehicles on site (see Table 7-6, year with highest emissions): the higher calculated emissions (see § 7.4.1.1) are spread across point sources distributed across the construction zones: 5 point sources for the smaller, northern construction zone, 10 point sources for the larger, southern construction zone.
- Ship emissions from ship transport during the construction phase (see Table 7-7): line sources along the shipping routes.

The results of the modelling show the cumulative impact of all these sources.

We used weather data from 2017 because it's seen as a pretty normal year climate-wise (check out the Air Guidelines System). The model automatically picks the measuring station based on where the sources are. In this case, we went with the 'Antwerp – Luchtbal' measuring station.

Traffic emissions resulting from the daily commuting of site personnel and from truck transport are calculated separately using IMPACT.

7.6.1.1.2 Verification of calculated effects

The air quality targets for nitrogen oxides included in VLAREM II are shown in the table below.

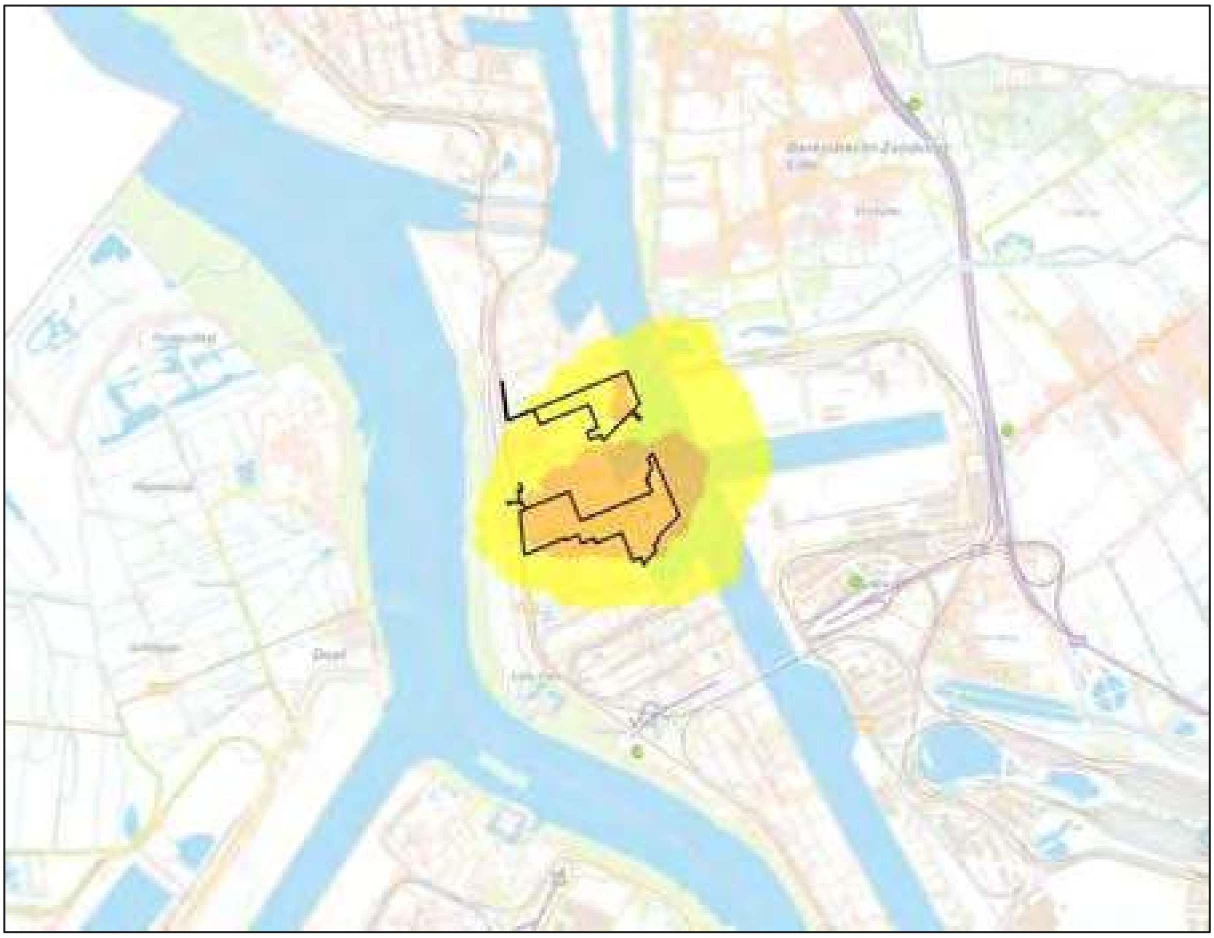
Table 7-21: NOx limit values (source: VMM)

	Subject	Averaging time	Objective
NO2	Limit values for health protection	1 hour max. 18 exceedances per year (P99.8)	200 µg/m³
		1 year	40 µg/m³
	Alarm threshold	For 3 consecutive hours	400 µg/m³
NOx	Critical level for vegetation protection	1 year	30 µg/m³

The annual average NO2 immission was calculated directly in IMPACT using the chemical module that takes into account the chemical interaction of NOx with ozone. In order to calculate only the NO2 concentration of the project, the total NO2 concentration (background + project) was reduced by the NO2 background concentration. A NO/NOx ratio of 95% was assumed in the emissions (standard value), and therefore a NO2/NOx ratio of 5%.

A calculation was performed for the period with the highest expected emissions (March 2024 – February 2025). The figure below

shows the annual average NO2 emission concentrations.



Key:		
Yellow	0.4 to 1.2 µg/m³	1 to 3% of the air quality target
Orange	1.2 to 4.0 µg/m³	3 to 10% of the air quality target
Red	> 4.0 µg/m³	> 10% of the air quality target

Figure 7-13: Annual average immission contribution of NO_2 during the construction phase

The table below provides an overview of the effects with regard to the annual average contribution for NO_2 compared to the annual average standard (40 µg/m³).

Table 7-22: Overview of effects relating to the annual average NO2 immission during the construction phase in the year with the highest emission

effect score	description of effect	concentration	location (see map)
0	negligible	< 0.4 µg/m³	From 0.5 to 1 km from the site
-	limited negative	0.4 to 1.2 µg/m³	Up to 0.5 to 1 km from the site
-2	Negative	1.2 to 4 µg/m³	Canal dock (only very locally)
-3	Significantly negative	> 4 µg/m³	-

The effects described are temporary during the construction phase (3 years and 8 months). They already take into account the use of Stage IV or better vehicles/machines for all medium and heavy vehicles/machines (between 56 and 560 kW). Approximately three quarters of the vehicles/machines used fall into this category. For the lighter types (below 56 kW), there is little or no difference depending on the age of the machines. These are only subject to stricter emission requirements from Stage V onwards. No machines heavier than 560 kW are used.

The zone with negative effects (-2) is located on the company premises and very locally above the Kanaaldok. The zone with limited negative effects (-1) extends to 0.5 to 1 km from the site. Within this distance are limited parts of the Galgenschoor and Opstalvallei nature reserves, but no residential areas.

At the nature reserves that are affected, the total NO2 air pollution is less than 80% of the environmental quality standard.

7.6.1.2 Road traffic emissions

The IMPACT model is used to calculate traffic emissions and immissions. The traffic figures were taken from the Mobility discipline. The model structure and input data used for the calculations are included in Appendix 6.2.

The table below summarises the results of the modelling for the construction phase. The annual average project contribution (i.e. concentration increase after deduction of background values) was calculated for the NO_2 parameter and tested against the annual average standard.

The results show that the contribution is less than 1% compared to the annual average standard for NO_2 almost everywhere. The impact of the additional traffic generation can therefore be considered negligible (0). Given the lack of impact, it is not useful to further detail the model with tunnel files.

Table 7-23: Project contribution as a result of road traffic generation during the construction phase

Name	Project contribution NO_2 annual average (µg/m³)	% contribution relative to annual average standard NO_2 (40 µg/m³)
Scheldelaan North (north of IOB	<0.2	<0.5
Scheldelaan Midden (south of IOB)	<0.2	<0.5
Scheldelaan South (past junction R2)	<0.2	<0.5
R2 - between Scheldelaan junction and A12 junction	<0.2	<0.5
R2 Scheldelaan junction	0.2 - 0.4	0.5 - 1
A12 north	<0.2	<0.5%

7.6.2 Operational phase

The discussion below outlines the effects during the operational phase for each pollutant.

7.6.2.1 Model structure IMPACT

Dispersion modelling was carried out using the IMPACT model. All the above-mentioned emission points that were considered relevant were added to the model as sources, namely:

- ECR chimneys, steam boilers and water treatment: point sources; since the chimneys of the
  If six cracking furnaces are built two by two at a very short distance from each other, the emission plumes will merge immediately after the emission point and the plume rise and dispersion will occur as a single combined plume; the emissions from the six cracking furnaces are therefore entered into the model as three combined chimneys.
- Flares: point sources;
- Fugitive emissions ECR: surface sources;
- Storage and transhipment emissions: point sources;
- Traffic emissions from shipping: point sources (moored) and line sources (sailing). The input data

for the model are shown in Appendix 6.3.

The results of the modelling show the cumulative impact of all these sources.

Meteorological data from 2017 was used, as recommended in the Air Quality Guidelines. The selection of the measuring station is done automatically in the model based on the location of the sources; in this case, this is the 'Antwerp – Luchtbal' measuring station.

7.6.2.2 Nitrogen oxides

The targets for nitrogen oxides included in VLAREM II are shown in Table 7-21.

The annual average NO2 immission was calculated directly in IMPACT using the chemical module that takes into account the chemical interaction of NOx with ozone. The NOx emissions mentioned above include NO and $_{NO2}$ and are always expressed as $_{NO2}$. A NO/NOx ratio of 95% was assumed for the emissions (standard value IMPACT model)[20].

To calculate only the NO2 concentration of the project, the total NO2 concentration (background + project) was reduced by the NO2 background concentration.

As indicated earlier (see § 7.4.2.1.2), we evaluate the effect of NOx emissions for two scenarios:

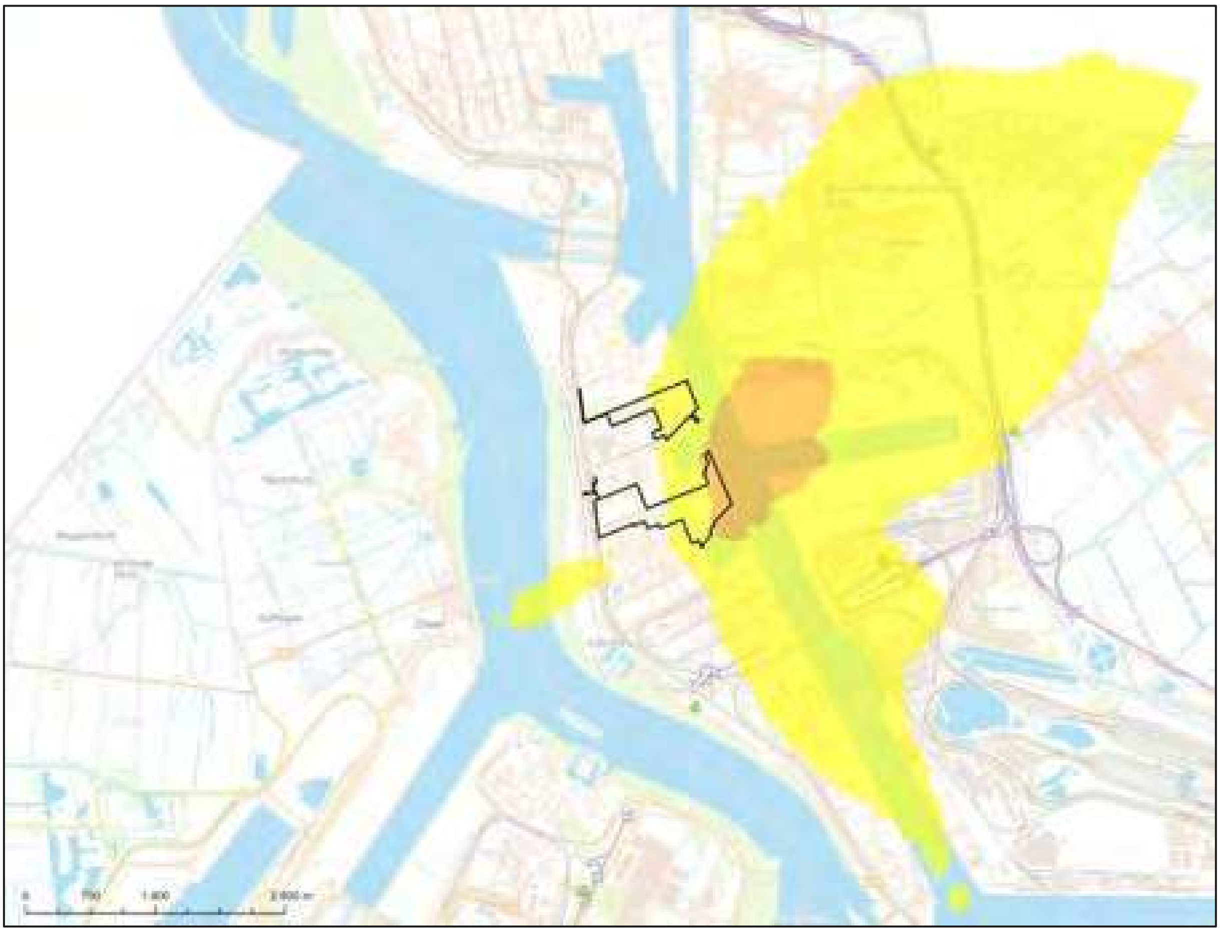
8. NOx emissions in accordance with the emission levels associated with BAT (BAT-GENs), through the application of upstream reduction techniques such as low-NOx burners;
9. NOx emissions exceeding the emission levels associated with BAT (BAT-GENs), through the use of upstream reduction techniques such as low-NOx burners combined with downstream SCR-DeNOx gas purification (see below); the combination of these techniques achieves a lower emission level than for each BAT technique individually.

The aim here is to clarify the difference between the two scenarios. Project One has decided to implement Scenario B, specifically the application of a combination of techniques that will achieve a lower emission level than each BAT technique individually.

[20] For substantiation of this assumption, see, among others:
Best Available Techniques (BAT) Reference Document for Large Combustion Plants, Joint Research Centre, 2017 (EUR 28836 EN), pp. 108– https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC_107769_LCPBref_2017.pdf
Environmental Technology Newsletter, October 2007 (Kluwer, volume 14, number 9) – Nitrogen oxides - https://trevi-env.com/assets/assets/publicaties/315.pdf

7.6.2.2.1 Operational phase – Scenario A: Without additional SCR-DeNOx gas purification

We provide a brief evaluation for Scenario A based on the modelled annual average contribution.



Key:		
Yellow	0.4 to 1.2 µg/m³	1 to 3% of the air quality target
Orange	1.2 to 4.0 µg/m³	3 to 10% of the air quality target
Red	> 4.0 µg/m³	> 10% of the air quality target

Figure 7-14: Annual average NO_2 immission contribution for the operational phase – Scenario A

The table below provides an overview of the effects with regard to the annual average contribution for NO_2 compared to the annual average standard (40 µg/m³).

No significant negative effects are expected. The zone with a negative effect (-2) extends to 1 to 1.5 km northeast of the site, but does not affect the residential area of Berendrecht. The zone with a limited negative impact (-1) includes Berendrecht and part of Zandvliet in Belgium and also extends across the Belgian-Dutch border, without however affecting residential areas in the Netherlands.

In the port area, only parts of certain docks exceed 80% of the environmental quality standard for NO_2; this is not the case in residential areas.

Table 7-24: Overview of effects relating to the annual average NO_2 immission in the operational phase – Scenario A

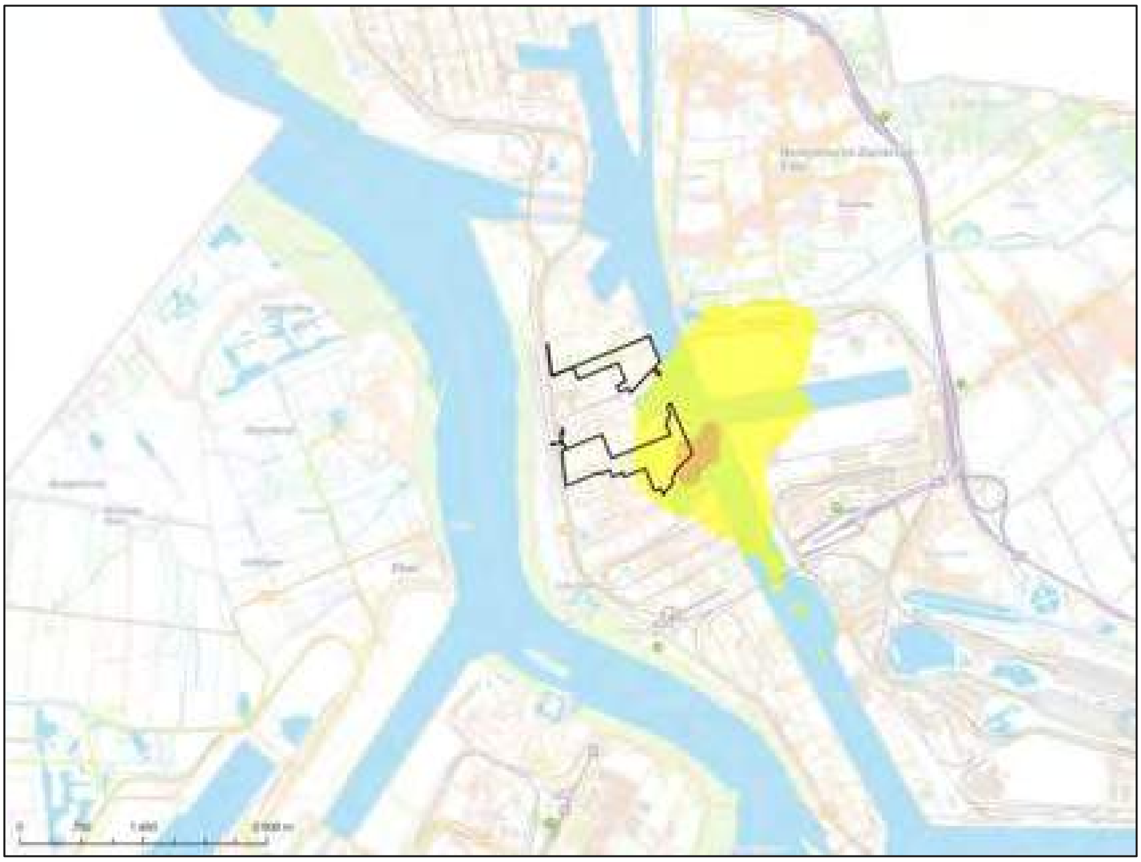
Effect score	Description of effect	Concentration	Location (see map)
0	Negligible	< 0.4 µg/m³	*from 1 to 7 km from the project area*
-1 (yellow)	limited negative	0.4à1.2µg/m³	*Residential areas:* Berendrecht, Zandvliet (partly) *nature reserves:* Galgenschoor (partly), Scheldt and Durme estuary (partly), Opstal Valley, Brabantse Wal (NL - partly).
-2 (orange)	negative	1.2à4µg/m³	*residential areas*: - *nature reserves*: Opstalvallei (partly)
-3 (red)	significantly negative	> 4 µg/m³	-

7.6.2.2.2 Operational phase - Scenario B: With additional SCR-DeNOx gas purification

As explained above, the decision to install additional SCR-DeNOx gas purification on the eight main chimneys will reduce NOx emissions from 591 tonnes of NOx/year (Scenario A, without SCR-DeNOx) to 167 tonnes/year (Scenario B, with SCR-DeNOx). This reduces Project One's emissions by 72% (see § 7.4.2.7).

This results in the reduced effects shown below. Annual average

The figures below show the annual average NO_2 immission concentrations for the operational phase – Scenario B.



Key:		
Yellow	0.4 to 1.2 µg/m³	1 to 3% of the air quality target
Orange	1.2 to 4.0 µg/m³	3 to 10% of the air quality target
Red	> 4.0 µg/m³	> 10% of the air quality target

Figure 7-15: Annual average immission contribution of NO2 for the operational phase – Scenario B

The table below provides an overview of the effects with regard to the annual average contribution for NO_2 compared to the annual average standard (40 µg/m³).

No significant negative effects are expected.

The zone with a negative impact (-2) is limited to the area above the Kanaaldok.

The zone with a limited negative effect (-1) extends to approximately 2 km and does not affect the nearest residential area of Berendrecht.

In the port area near parts of certain docks, 80% of the environmental quality standard for NO_2
exceeded, this is not the case in residential areas (see § 7.3.1).

Table 7-25: Overview of effects relating to the annual average NO2 immission in the operational phase – Scenario B

Effect score	Description of effect	Concentration	Location (see map)
0	Negligible	< 0.4 µg/m³	*from 0 to 2 km from the project area*
-1 (yellow)	limited negative	0.4 to 1.2 µg/m³	*residential areas:-* *nature reserves:* Opstal Valley (partly)
-2 (orange)	negative	1.2 to 4 µg/m³	*maximum plume:* 3.0 µg/m³ *residential areas*: - *nature reserves*: -
-3 (red)	significantly negative	> 4 µg/m³	*residential areas:-* *nature areas*: -

Percentiles - peak values

The above method for calculating annual average NO_2 concentrations is not applicable to NO_2 percentiles. The combination of percentile calculations with ozone chemistry makes it impossible to provide a ready-made formula for visualising the percentile concentrations of the project contribution alone. This is also the reason why no direct link is made between percentile values and the implementation of mitigating measures.

Therefore, an informative approach was used to calculate and assess the P99.8 percentile for NO_2, whereby the NOx concentration was calculated for that percentile (without background) and then multiplied by a factor of 0.6.

Table 7-26: Overview of effects relating to the 99.8 percentile for NO_2 in the operational phase - Scenario B

Effect score	Description of effect	Concentration	Location (see map)
0	Negligible	< 2 µg/m³	From 6 to 12 km from the project area.
-	limited negative	2 to 10 µg/m³	Up to 6 to 12 km from the project area.
-2	negative	10à40µg/m³	Only project area and limited adjacent zone above Kanaaldok.
-3	Significantly negative	>40µg/m³	Only on the site at the southern part of the project area. *Peak plume:* 92.5 µg/m³ (on the site itself)

Based on the 99.8 percentile, which takes into account the 19 highest hourly values per year, a limited negative effect (-1) can be expected up to 6 to 12 km from the site. Negative effects (-2) outside the site are limited to the southern part of the project area and a limited adjacent zone above the Kanaaldok.

7.6.2.3 Sulphur oxides

The targets for sulphur dioxide included in VLAREM II are shown in the table below.

Table 7-27: SO_2 limit values (source: VMM)

	Subject	Averaging period	Target
SO_2	Limit value for health protection	1hour	350 µg/m³; max. 24 exceedances per year (P99.7)
		1day	125 µg/m³; max. 3 exceedances per year (P99.2)
	Alarm threshold	During 3 consecutive hours	500 µg/m³
	Critical level for vegetation protection	Year and winter season*	20 µg/m³

* The winter season runs from 1 October to 31 March

Project One will only cause very limited additional SO2 emissions (<1 tonne/year, see Table 7-18).

The annual average contribution, the 99.2 percentile (day) and 99.7 percentile (hour) for SO_2 were modelled for the operational phase. The concentrations in the plume maxima are respectively:

Table 7-28: Overview of effects relating to SO_2 for the operational phase

Parameter	Contribution Project One (plume max.)	Air quality target	Contribution (%) relative to target	Evaluation
Health				
99.7 percentile (hour)	5.4 µg/m³	350 µg/m³	1.5%	Limited negative (-1)
99.2 percentile (day)	3.6 µg/m³	125 µg/m³	2.9%	Limited negative (-1)
Vegetation				
Annual average	0.29 µg/m³	20 µg/m³	1.5%	Limited negative (-1)

The effects are very localised and attributable to emissions from ships. Concentrations are between 1.5 and 3% of the limit values for the annual average and percentile values. The effect is limited negative (-1) and only occurs near the site (Kanaaldok).

Key:		
Green	0.38 to 1.25 µg/m³	0.3 to 1% of the air quality target
Yellow	1.25 to 3.75 µg/m³	1 to 3% of the air quality target

Figure 7-16: 99.2 percentile immission contribution SO_2 for the operational phase – Scenario B

7.6.2.4 Carbon monoxide (CO)

The targets for CO included in VLAREM II are shown in the table below.

Table 7-29: CO limit values (source: VMM)

	Subject	Averaging time	Target
CO	Limit value	Highest 8-hour average in a day	10 mg/m³

The annual average contribution for CO was modelled for the operational phase: the concentration at the plume maximum is 5.1 µg/m³ (or 0.005 mg/m³). The highest hourly value is 0.05 mg/m³. This is less than 1% of the limit value. The effects are negligible. (0).

7.6.2.5 Particulate matter

The targets for particulate matter (PM10, PM2.5) included in VLAREM II are shown in the table below.

Table 7-30: Limit values for PM10 and PM2.5 (source: VMM)

	Subject	Averaging time	Target
PM10	Limit value	1 day	50 µg/m³; max. 35 exceedances per year (P90)
		1 year	40 µg/m³
	Subject	**Averaging period**	**Target**
PM2.5	Limit value	1 year	25 µg/m³ from 2015
			20 µg/m³ from 2020

The annual average contribution for PM10 was modelled for the operational phase. By definition, the PM2.5 fraction is always smaller than the PM10 fraction (since the PM2.5 fraction is part of the PM10 fraction). As a worst-case scenario, it is assumed that the PM2.5 concentration can be equated to the PM10 concentration, which means that the PM10 concentration is tested against the PM2.5 limit value.

The plume maximum is 0.19 µg/m³, which is less than 1% of the limit values for both PM10 and PM2.5. The effects are negligible (0).

7.6.2.6 Volatile organic compounds (VOCs)

7.6.2.6.1 General

Project One's emissions of VOCs during the operational phase were estimated at approximately 74 tonnes/year (see § 7.4.2.7). The main emission sources are:

- ECR – Stoves: 23.9 tonnes/year
- ECR – Fugitive emissions: 43.5 tonnes/year

These emissions contribute to the following effects:

- Possible direct effects of harmful substances present in emissions. These mainly concern benzene and butadiene. These effects are discussed further for each pollutant and evaluated primarily in the discipline of Human Health.
- Secondary effects due to the role that VOCs play in (photo)chemical conversion between various pollutants in the atmosphere, leading to the formation of ozone (ozone smog) and particulate matter, among other things. The contribution of Project One emissions to this effect cannot be evaluated using the IMPACT model calculations due to the complex interaction between different pollutants and the influence of other parameters, such as temperature and sunlight. As a result, this effect cannot be meaningfully quantified (see also § 7.6.2.7.2 and § 7.6.2.7.4).

Limiting these emissions is important in this regard. Measures have been taken for each of the emission sources to limit emissions so that they comply with the applicable emission limit values and BAT, and also take into account the environmental quality standard set by the government.

7.6.2.6.2 Specific volatile organic compounds

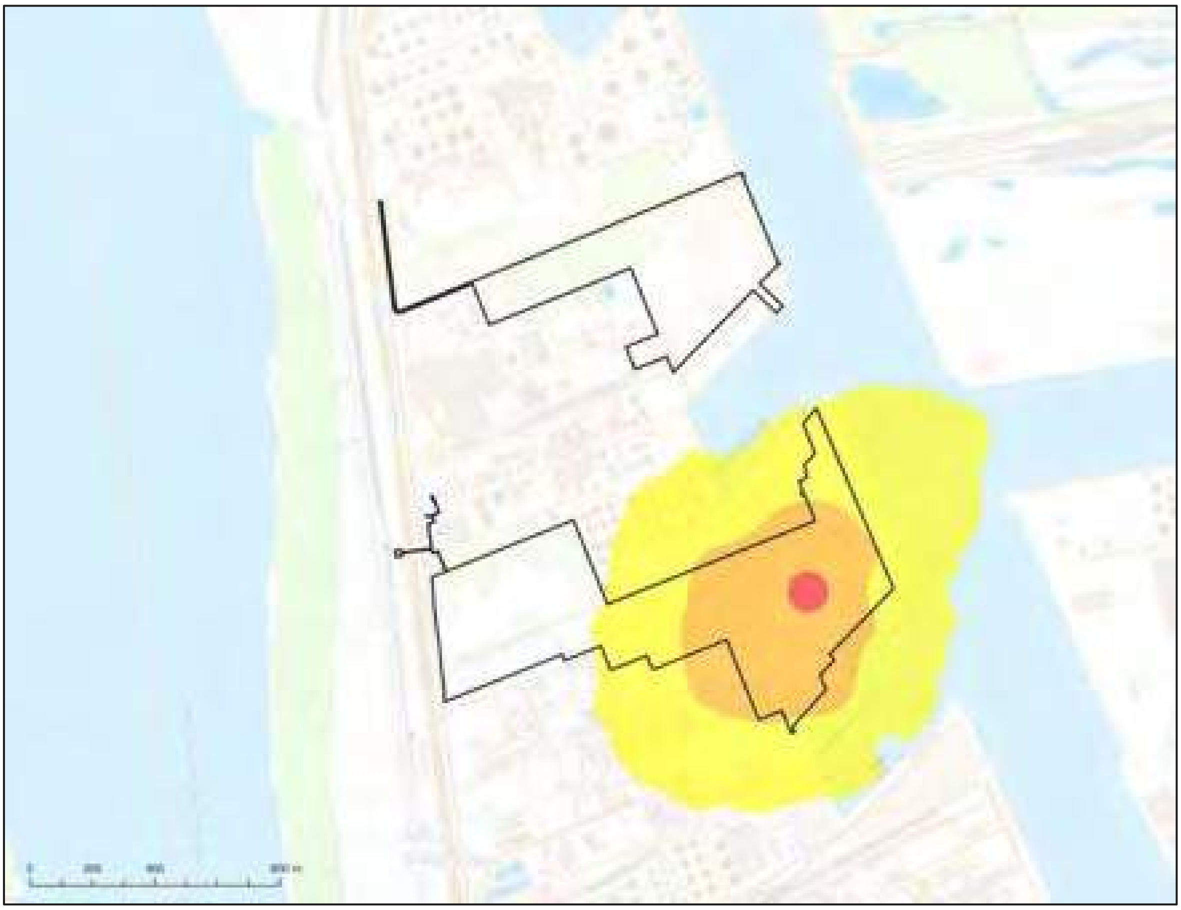
The targets for benzene included in VLAREM II are shown in the table below.

Table 7-31: Limit values for benzene (source: VMM)

	Subject	Averaging time	Target
Benzene	Limit value	1 year	5 µg/m³
Benzene	Limit value	1 year	50 µg/m³ as P98

The annual average immission concentration was modelled for the operational phase. At the point of maximum impact, near the ECR, the concentration is 0.66 µg/m^3. Compared to the annual average limit value, only limited negative effects (-1) are to be expected in the immediate vicinity of the industrial site, near the ECR. In the surrounding residential and nature areas, the effect is negligible (0).

This parameter is further evaluated in the Human Health discipline.



Key:		
Yellow	0.05 to 0.15 µg/m^3	1 to 3% of the air quality target
Orange	0.15 to 0.5 µg/m^3	3 to 10% of the air quality target
Red	> 0.5 µg/m^3	> 10% of the air quality target

Figure 7-17: Annual average immission contribution of benzene for the operational phase.

There are no air quality standards for butadiene. The evaluation is carried out in the Human Health discipline on the basis of scientific advisory values.

7.6.2.7 Secondary effects

The direct (primary) effects of emissions on pollutant concentrations in the air have been evaluated in the sections above. In addition, there are also secondary effects resulting from conversions in the ambient air, whereby the primary pollutants (or precursors) react to form other secondary pollutants.

7.6.2.7.1 Conversion of NO/NO_2

NOx emissions from chimneys mainly occur as NO (nitrogen monoxide). In the atmosphere, NO is converted into NO_2. As a rule of thumb, it is assumed that within a distance of ten kilometres, this conversion is in the order of 60% (MER Air Directive System), but aspects such as the presence of other pollutants, temperature, etc. also play a role. The photochemical conversion of NO to NO_2 is taken into account in the calculation model used (IMPACT). This secondary effect was therefore also considered in the previous evaluation for NO_2. The default assumption of the IMPACT model was used for the NO/NO_2 ratio in the flue gases: 95% NO and 5% NO_2.

7.6.2.7.2 Formation of ozone

Ozone is a pollutant that is virtually not emitted by human activities. Ozone that occurs at ground level in the ambient air is formed by reactions between certain pollutants such as VOCs, NOx and CO under the influence of sunlight. The contribution of a particular emission source to the complex process of ozone formation is difficult to determine, as it is mainly the combination of various emissions that gives rise to this secondary effect, whereby there is no longer a clear relationship between specific emission sources and effects at short or longer distances. It is therefore not meaningful to quantify the contribution of an emission source (or group of emission sources).

A European approach has been developed to limit emissions of the precursors of various secondary pollutants (including ozone), thereby also reducing their secondary effects. This European approach has led to emission ceilings being set for each country. For an explanation and evaluation of this, please refer to section 7.4.2.8.

The emissions of precursors for ozone formation were quantified in detail in section 7.4 of this EIA, which also discusses the emission reduction measures applied for each type of emission source. A summary overview of emissions during the operational phase is included in section 7.4.2.7. The emission control measures taken are summarised in section 7.9.1 and the possibilities for further emission control measures are evaluated in section 7.9.2.

7.6.2.7.3 Eutrophicating and acidifying deposition

Emissions of NOx, NH_3 and SO_2 in particular are converted in the atmosphere into acidifying and fertilising (or eutrophying) compounds that precipitate from the atmosphere onto trees, crops, buildings, etc. via raindrops (wet deposition) or through direct contact (dry deposition). ... This deposition can cause effects (displacement of species that specialise in nutrient-poor biotopes, damage to acidification-sensitive species, etc.), especially in a number of biotopes in nature reserves that are sensitive to this.

This deposition is calculated using the dispersion model (IMPACT for Flanders and AERIUS for the Netherlands) and the results are presented and evaluated in Chapter 11 Biodiversity.

7.6.2.7.4 Formation of particulate matter

Particulate matter in the ambient air is partly the result of various dust emissions (primary particulate matter), but also partly of the conversion of gaseous pollutants (precursors: NO_x, NH_3, SO_2, VOCs) into fine dust particles (secondary particulate matter).

Sources of primary particulate matter include various combustion processes involving both fossil fuels and other fuels such as wood (industry, households, transport, agriculture, etc.) through the emission of soot fractions (also known as EC, or elemental carbon) and organic matter in particulate matter, emissions from soil (cultivation of fields, excavation work), emissions from metals (wear and tear on tyres and brakes and industry), etc.

The conversion mechanisms involved in the formation of secondary particulate matter include a number of chemical reactions between the precursors NO_x, NH_3, SO_2, VOCs and their complexes. The formation of secondary particulate matter is determined by the background concentration of the precursors already present, the contribution of numerous local emission sources of precursors (especially traffic, industry and livestock farming) and other factors such as:

- Background concentrations of OH
- Background concentrations of NH3

- Background concentrations of O3
- Background concentrations of NOx
- Background concentrations of VOCs (specified)
- The ratio of NO2 to NH3 in ambient air
- Emissions of NOx (NO and NO2), SO2, NH3, VOCs (specified)
- Reaction rate of NO2 and SO2 with OH to form HNO3 and numerous reaction rates for specified VOCs
- Conversion rate of HNO3 and NH3 to ammonium nitrate in particles; this is highly dependent on temperature and humidity and is a reversible reaction
- The number and characteristics of primary PM that can act as nuclei for the formation of secondary PM
- Water content of the particles
- Meteorological data (wind speed, temperature, humidity, precipitation, UV intensity) and their variations during a day/night and/or seasonally.

The extent to which a particular emission source contributes to the formation of secondary particulate matter is therefore determined not only by the emissions from that source, but also by all the other factors mentioned above. The conversion takes place gradually during the transport of air pollution and is thus spread over tens to hundreds of kilometres. Due to the dispersion and dilution of emissions over such distances, the effect on the formation of secondary particulate matter from a particular emission source is also widely dispersed, and therefore greatly reduced, over a large area.

However, these mechanisms also mean that, at a single location, the low effects of many different emission sources (within tens to hundreds of kilometres) combine to have a significant impact on air quality. Because of these long-range effects, which are often transboundary, a European approach has been developed to limit emissions of precursors, thereby also reducing their secondary effects. This European approach has led to emission ceilings per country. For an explanation and evaluation of this, please refer to section 7.4.2.8.

When assessing the effects of a particular emission source during the licensing process, calculating its contribution to the formation of secondary particulate matter is not useful due to the slow and highly dispersed nature of this effect, which is therefore very low. It is important, however, that emissions of precursors are limited as much as possible, not only to limit the primary effect of the precursors on air quality within the study area, but also because of their very low contribution to the secondary effects that occur at greater distances.

For the reasons above, we are not aware of any project EIA reports in Europe that evaluate the impact of secondary particulate matter from an individual project. However, studies do quantify the effects of secondary particulate matter at a higher policy level, on a larger scale and/or for activities with very high emissions of precursors, much higher than those of Project One[21].

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[21] Below are two examples of studies in which the effect of secondary particulate matter was modelled as a case study for one industrial installation. These are not EIA reports, but separate policy support studies, each for a large coal-fired power plant. We also compare the emissions from the coal-fired power plants in these studies with the emissions from Ineos Project One. This shows that the emissions evaluated in these studies are at least one to two orders of magnitude higher than those from Project One for most pollutants. As far as we know, no similar studies have been conducted for installations with emissions in the order of magnitude of Project One.

The study cited below by Oleniacz et al, 2016, explicitly states in its conclusions that performing such calculations is by no means straightforward: "*The application of these modules requires the introduction of additional data such as NH3, H2O2, and O3 background in the air (preferably at the highest spatial and temporal resolution), and such data are not always available for the given modelling domain, and their possible designation using photochemical models is time consuming and can be highly biased*."

EMISSIONS OF PRECURSORS OF SECONDARY PARTICULATE MATTER	EMISSIONS TOTAL DUST (TONNES /YEAR)	EMISSION SO2 (TONNES/YEAR)	EMISSION NOX (TON/Y)	EMISSIONS NH3 (TON/Y)

Specifically for Project One, the main contribution to the formation of secondary particulate matter is expected to come from NOx emissions. This formation is mainly limited by the reaction to form HNO_3 from NO_2 and OH, prior to the reaction of HNO_3 and NH_3 to form ammonium nitrate. This NO_2 + OH reaction is slow, which means that the timescale for secondary particulate matter formation is slow, i.e. the process takes hours or days. Therefore, in the case of Project One, with mainly NOx emissions and further low precursor emissions, the formation of secondary particulate matter would largely take place at large distances (e.g. more than 50 km) from the site, with the precise details being highly dependent on all the above variables. At such distances, emissions from the site will be greatly diluted in the atmosphere and indistinguishable from other background pollutants, including particulate matter.

The emissions of the precursors NO_x, NH_3, SO_2, and VOCs for the formation of secondary particulate matter were quantified in detail in section 7.4 of this EIA, which also discusses the emission control measures applied for each type of emission source. A summary overview of the emissions during the operational phase is included in section 7.4.2.7. The emission control measures taken are summarised in section 7.9.1 and the possibilities for further emission control measures are evaluated in section 7.9.2.

7.6.2.8 Traffic emissions

Road traffic

The project contribution was calculated for road traffic emissions during the construction phase (see § 7.6.1.2). This showed that the contribution was less than 1% of the annual average standard for NO_2.

The expected traffic generation during the operational phase is significantly lower than the traffic generation during the construction phase. This means that only negligible effects (0) from road traffic are expected during the operational phase.

Shipping

Emissions from shipping traffic were also evaluated in the impact calculations discussed above using the IMPACT model (together with emissions from chimneys, flares, diffuse emissions, etc.).

COAL-FIRED POWER PLANT IN POLAND OLENIACZ ET AL 2016 (HTTPS://DOI.ORG/10.1515/ECES-2016-0043)	700	6505	4178	-
COAL-FIRED POWER PLANT IN ITALY MANGIA ET AL 2015 (HTTPS://WWW.NCBI.NLM.NIH.GOV/PMC/ARTICLES/PMC4515683/)	730	10175	9282	-
INEOS PROJECT ONE	29	1	167	18

7.7 Cumulative effects

7.7.1 Retaining wall

The Antwerp Port Authority has obtained an environmental permit for the construction of a new quay wall. Work on the construction of this quay wall started in March 2021 and will be completed in the course of 2024 (this means that most of the work had already been carried out when this EIA was drawn up). The data in this report is based on the EIA dated 02/06/2020, drawn up by Antea on behalf of the Antwerp Port Authority.

7.7.1.1 During the construction phase

The construction phase of the quay wall at canal dock B2, between docks 1 and 2, overlaps with the construction phase of Project One. Cumulative effects may occur during the construction phase of both projects.

The following information is included in the EIA for the construction of the quay wall:

- Approximately 1-3 ships per day were expected to be required for the removal of dredged material. For the dredging activity itself, a worst-case scenario was assumed in which three dredgers would be present within the project area for one year. In reality, it will probably be a combination of dredgers and dredging pontoons, whereby it is plausible that three units will be dredging simultaneously. The emissions from a dredger are significantly higher than those from a dredging pontoon, which means that the calculation with three dredgers can be considered a worst-case scenario.
- In the Biodiversity discipline, NOx emissions of 3.1744 kg/h and SO2 emissions of 0.12490 kg/h per ship were taken into account for the calculation of acidifying and eutrophying deposits. These emissions are of the same order of magnitude as the emission factors used in this EIA for inland vessels.
- The number of operating hours per year is not specified. Assuming a working regime of 12 hours per day for 250 days per year, the annual emissions amount to approximately 28 tonnes of NOx/year and approximately 1 tonne of SO2/year for three ships.

Emissions during the construction phase of Project One are mainly attributable to construction machinery and vehicles (including earth-moving equipment) on site and are in the order of 18.2 to 28.6 tonnes of NOx/year. The impact of these emissions is limitedly negative (-1) and extends to 0.5 to 1 km from the site. For a maximum of one year, there will be cumulative effects with the emissions from the dredgers working on the construction of the quay wall.
Given that the expected emissions from the dredgers are of the same order of magnitude as the expected emissions from the construction phase of Project One, the impact zone of the cumulative emissions may increase. Limited negative effects (-1) can be expected for 1 year up to a maximum of 1.5 km from the site.

7.7.1.2 During the operational phase

Once the quay wall has been (partially) completed, it can be put into use for the further construction work on Project One. At that point, no cumulative effects are expected; on the contrary, the quay wall will provide additional mooring places and facilitate the supply of materials by ship.

The EIA for the quay wall estimated that the new quay wall would result in an increase of approximately 1% in the number of ships compared to the total number of ships handled annually in the port.

Given that there are no homes in the immediate vicinity of the project area, this impact was assessed as negligible to at most limited negative (0/-1). The new quay wall will mainly be used by IOB ships and, in the long term, possibly by other companies and other ships on special request (subject to obtaining permits and constructing the necessary loading and unloading infrastructure). The emissions from Project One ships were also evaluated in this EIA.

7.7.2 Oosterweel

The project area is located approximately 10 km from the location where the Oosterweel link is to be built. In order to manage traffic during the construction of the Oosterweel link, there may be interaction with the construction phase of Project One, particularly in the vicinity of the Oosterweel site. For more information, please refer to the Mobility section.

No relevant mutual impact is expected for the Air discipline in the Project One project area. The effects on air quality will not differ significantly for this development scenario.

7.8 Development scenarios

7.8.1 ECA

For a description of the Complex Project 'Realisation of additional container handling capacity in the Antwerp Port Area' (abbreviated to ECA), please refer to section 5.5.1.

The realisation of the complex ECA project would result in additional NOx emissions due to the extra seagoing vessels, container handling, road traffic, inland shipping and rail traffic. According to the strategic EIA for ECA (dated 27/09/2019), the total expected worst-case emissions for all sub-projects of the preferred alternative are in the order of 1,407 tonnes of NOx/year. These emissions occur in a number of zones spread across the area.

spread across the port area, on both the left and right banks of the Scheldt. If the proposed mitigation measures are implemented, emissions can be halved. The implementation of the mitigation measures, which were mentioned in the strategic EIA for the ECA project, is currently being further investigated in the elaboration phase and will be finalised when applying for permits for the sub-projects of the complex project.

Project One will result in additional NOx emissions in the order of 167 tonnes NOx/year, which is significantly lower than the additional emissions expected from the realisation of ECA (in the order of 1,407 tonnes NOx/year for the preferred alternative for the entire ECA project).

Based on the data currently available (only a strategic EIA is available), it is not useful to assess where and how these cumulative effects would occur. Such calculations are made during the permit procedures for the specific sub-projects of ECA.

To date, several separate EIA dossiers have been initiated and/or permits have been applied for to expand or construct container terminals and/or container transhipment infrastructure that connect to or fit within the ECA. These include:

- Expansion of the North Sea Terminal of PSA Antwerp NV: EIA exemption October 2021.
- Renovation of the Europe Terminal of PSA Antwerp NV: EIA January 2022.
- New Maxiterminal Antwerp by Lanfer Logistics Belgium (bimodal rail terminal): EIA in preparation.

It is noteworthy that new container infrastructure or the expansion of existing container infrastructure is focusing on electrification in various ways (cranes, rolling stock, shore power for ships, etc.), which contributes to limiting the emissions and impact of container terminals.

As explained in section 5.4.4, insofar as data is already available from an ongoing or completed permit procedure, no significant cumulative effects with those of Project One are expected that could lead to the effects of Project One being assessed differently and/or to more or different mitigating measures being included in the EIA for Project One.

7.9 Mitigating measures

7.9.1 Project-integrated measures

Please refer to § 7.4 for a description of the emission reduction measures that have been integrated into this project. In summary, the following measures are planned:

<u>For the construction phase:</u>

- The use of Stage IV or better vehicles/machines for all medium-duty and heavy-duty vehicles/machines (from 56 to 560 kW).

- Approximately three quarters of the vehicles/machines used fall into this category.
- For lighter types (below 56 kW), there is little or no difference depending on the 'Stage' of the machines. These are only subject to stricter emission requirements from Stage V onwards (types from 2019-2020).
- The use of less strictly regulated diesel generators of the heaviest type (> 560 kW) is excluded.

- Applying codes of good practice during excavation work, when handling (loading, unloading, etc.) any dust-sensitive (construction) materials and when storing them, for example by spraying materials and/or roads in dry weather and cleaning the roads periodically.
- Where possible, transport is planned using ships rather than lorries. This is the case for most soil transport and for the supply of the largest process installations (modules) and equipment.

For the operational phase:

- Limiting NOx emissions:
  - Use of low-NOx burners in all combustion plants.
  - SCR-DeNOx on 8 chimneys (6 ECR chimneys, 2 steam boilers) to reduce NOx emissions (implementation of the above-mentioned scenario B).
  - The combination of these techniques achieves a lower emission level than for each BAT technique individually (72% reduction in NOx emissions for the entire Project One). The following table presents the guaranteed emission limit values.

Table 7-32: NOx and NH_3 emission limits

Emission limits for 6 cracking furnaces and 2 steam boilers	NOx	NH_3
Concentrations during normal operating conditions		
Hourly average per chimney	60 mg/Nm³	8 mg/Nm³
Daily average per chimney	40 mg/Nm³	6 mg/Nm³
Annual load		
Moving three-year average for the 8 chimneys combined*	148.8 tonnes/year	17.9 tonnes/year

* These annual loads are calculated based on an expected emission concentration, averaged across the various chimneys and over the lifetime of the catalytic converter, of 25 mg/Nm³ NOx and 3 mg/Nm³ NH_3 under normal operating conditions. The effects were calculated using these loads.

- The design of the installations (cracking furnaces and boilers) and their gas purification systems took into account the possible application of carbon capture in the future. To this end, space was provided in the installations for additional pipes and space on the site for additional installations.
- The decoking emissions from the ECR are limited by dust removal using cyclones.
- The installations in which the physico-chemical (primary) and biological wastewater treatment (secondary treatment) take place will be closed and equipped with an extraction system:
  - For the primary treatment steps, where larger quantities of hydrocarbons are expected, the extracted gases will be incinerated in a thermal oxidiser, in accordance with BAT.
  - For the secondary biological treatment steps, including sludge treatment, the extracted air will be sent through an odour removal installation, in accordance with BAT.
- To limit storage and loading emissions from the tanks for the C5+ fraction and pyrolysis oil, an activated carbon filter or a membrane filter (or equivalent technology) is provided, in accordance with BAT.
- The ground and tower flares mainly serve a safety function. The ECR ground flare is used during planned start-up and shutdown procedures. The ECR tower flare and the ground flares of the gas storage facility are only used when gases need to be evacuated for safety reasons. The use of the flares is limited to these situations.
- To prevent and limit fugitive emissions, measures are taken in the areas of design, construction, commissioning, maintenance and monitoring. This means that technically sealed installation components are used in all parts of the installation where gaseous or volatile liquid product flows occur. During construction, specialised, trained personnel are deployed to install flanges, valves, etc. correctly. Before the installations are commissioned, leak tests are carried out and any leaks are repaired before the installations are actually put into service. In terms of monitoring, a combination of measurements at installation components (sniffing) is provided in collaboration with the specialised contractor.

method) and the use of advanced infrared cameras (OGI = Optical Gas Imaging). With this approach all aspects of BAT are applied.

- The supply and removal of raw materials and end products is largely carried out by ship and pipeline.

7.9.2 Additional measures: Possibility of mitigating measures with regard to NOx and NH3 emissions during the operational phase.

The effects of N compound emissions (NOx and NH_3) are being evaluated as a point of attention in the disciplines of Air (NO_2), Human Health (NO_2) and Biodiversity (N deposition).

These effects already take into account maximum emissions per stack which, as a result of the use of low-NOx burners in combination with SCR-DeNOx, comfortably comply with the emission levels associated with BAT (BAT-GENs). The combination of these techniques achieves a lower emission level than for each BAT technique individually.

The emission concentrations are as follows:

- Maximum emission concentration with SCR: concentrations expected at the end of the catalyst bed's service life (this needs to be replaced every 5 years).
- Expected emissions: average emissions over the lifetime of the catalytic converter: takes into account the slow deactivation of the SCR-DeNOx catalytic converter.

Table 7-33: Expected NOx and NH_3 emission concentrations

	Scenario A BAT without SCR Maximum emissions	Scenario B BAT with SCR	
		Maximum emissions (daily average)	Expected emissions (average over 3 years)
NOx (mg/Nm³)			
ECR Cracking furnaces (6) *	100	40	25
Steam boilers (2) *	80	40	25
NH_3 (mg/Nm³)			
ECR Cracking furnaces (6)	0	6	3
Steam boilers (2)	0	6	3

* Combustion plants with flue gases at 3% O_2

The table below shows that the use of SCR-DeNOx gas purification results in a significant reduction in NOx emissions (a 72% reduction for Project One as a whole). Project One has already decided to apply this purification method to the eight chimneys concerned. This will result in limited NH3 emissions.

Table 7-34: Expected emission load for Project One NOx and NH_3

	Without SCR	With SCR
NOx	591 tonnes/year	167 tonnes/year
NH_3	0 tonnes/year	18 tonnes/year

The above-mentioned emission limits are set for each chimney separately and must always be complied with. In addition, the above-mentioned expected values should be considered as target values, which must be complied with for Project One as a whole and in the longer term. It is assumed that Project One's emissions will be below 167 tonnes of NOx and 18 tonnes of NH_3 per year, which corresponds to:

- a guideline value of 25 mg/Nm³ NOx for all chimneys with SCR-DeNOx;
- a guideline value of 3 mg/Nm³ NH_3 for all chimneys with SCR DeNOx.

As all chimneys with the most relevant NOx and NH3 emissions will be equipped with continuous measuring equipment, actual emissions can be monitored and quantified accurately. This guarantees that:

- the efficiency of the SCR catalyst is continuously monitored so that the emission limits are respected;
- the overall emissions from Project One are continuously quantified, demonstrating that they correspond to or are lower than the expected emissions mentioned above;
- The emissions from each chimney are well known, allowing the effect of the emissions to be verified using dispersion modelling based on actual emissions, where necessary.

The higher-estimated emissions have already been mitigated by additional mitigation measures, resulting in emission levels that are significantly lower than the emission levels associated with BAT (BAT-GENs). The possibilities for further reducing emissions were investigated but are limited:

- NOx emissions are reduced as much as possible by expanding the SCR catalyst beds and/or replacing them more regularly. However, the target concentration (guideline value of 25 mg/Nm³ with SCR) is close to the technical limits of the SCR, so there are no guarantees that even lower emissions will be achieved. In addition, it appears that the additional investment and operating costs (increased pressure drop across the SCR catalytic converter; replacement of the catalytic converter, production shutdown, etc.) for more far-reaching measures are high in relation to the unit reduction cost of 8.6 used.
EUR/kg NOx removed. For a more detailed explanation, please refer to Appendix 6.4.
- The NH3 emissions from SCR-DeNOx are inherent to the operation of this technology and are kept as low as possible through continuous monitoring of the installation's operation. The BAT (BAT 7 for the LVOC and LCP sectors, see Annex 8) states that NH3 emissions can be limited by optimising the design and/or operation of the SCR system (e.g. optimised reagent/NOx ratio, homogeneous distribution of the reagent and optimal size of the reagent droplets). This is applied in the design of Project One. NH3 emissions cannot be further reduced by modifying the SCR-DeNOx. The expected emission concentrations of NH3 (lower than 6 mg/Nm³) can therefore already be considered low for the planned installations.
According to BAT, there are no techniques available for further reduction of this concentration using a downstream technique. A commonly used downstream technique for NH3 removal is gas scrubbing. VITO mentions (https://emis.vito.be/nl/bbt/bbt-tools/techniekfiches/zure-wasser) mentions a few reference examples and a typical precondition for the concentration of ammonia to be removed of 200 to 1,000 (and sometimes 20,000) mg/Nm³ in the technical data sheet for scrubbers that remove NH3. The NH3 concentration after the SCR (< 6 mg/Nm³) is significantly lower, which means that a gas scrubber would not achieve efficient removal and is therefore not BAT in this case.

7.10 Conclusion

The effects of Project One on air quality were outlined in this chapter. Both the effects of the construction phase and the operational phase were discussed.

7.10.1 Reference situation

The data for air quality in the study area in the reference situation show that the entire study area meets the air quality objectives for all relevant pollutants, with no exceedances.

7.10.2 Construction phase

During the construction phase, the greatest impact is caused by the construction machinery. NOx is the main pollutant. To limit emissions, recent Stage IV or better types of machinery above 56 kW will be used, and no heavy diesel generators (>560 kW) will be used, as these are even less well regulated. By applying these measures, emissions can be reduced to 28.6 tonnes/year (highest year). The construction phase is expected to take approximately 3 years and 8 months.

The effect of air emissions from construction machinery during the construction phase is negligible (0) in all nearby residential areas. At shorter distances, there is a limited negative effect (-1) extending to 0.5 to 1 km from the site. Within this distance are limited parts of the Galgenschoor and Opstalvallei nature reserves, but no residential areas. At very short distances (above the canal dock), the effect is negative (-2). In the residential and nature areas, the current NO2 air pollution is less than 80% of the environmental quality standard.

The contribution of road traffic emissions generated by Project One to air pollution is negligible (0).

7.10.3 Operational phase

During operation, various emission sources will be present on the site. An overview of all emission sources with their respective annual loads can be found in Table 7-17 and Table 7-18.

The coking furnaces are the main sources of emissions on the site for the parameters NOx, NH_3 and PM_{10} during normal operation. During the decoking phase, CO emissions are particularly relevant. Fugitive VOC emissions (including benzene and butadiene) can also be attributed to a significant extent to ECR activities. The ships used to supply ethane and to transport some other raw materials and end products also contribute to emissions, although this contribution is limited in relation to the total emission load (approx. 7% for NOx).

A total NOx load of approximately 167 tonnes NOx/year is expected, of which approximately 149 tonnes/year will come from the cracking furnaces and steam boilers.

The total annual VOC load is approximately 74 tonnes/year, of which 43.5 tonnes/year are fugitive emissions. We note that the fugitive emissions could only be estimated in terms of order of magnitude. LDAR campaigns after start-up will provide a more accurate picture of the actual diffuse leakage losses and, if necessary, enable repairs to be made.

The contribution of the supporting installations (flares, storage tanks, water treatment) was also taken into account, but this is limited compared to the other emission sources.

An impact assessment was carried out for various pollutants. The main pollutant is

NOx.

- The impact calculations show that the zone with a relevant NOx impact is greatly reduced by using low NOx burners and the additional application of SCR-DeNOx gas purification on the eight most important chimneys. The combination of these techniques achieves a lower emission level than for each BAT technique individually.
- The zone with a limited negative impact (-1) extends to approximately 2 km and does not affect the nearest residential area of Berendrecht.
- The zone with a negative impact (-2) is located only above the Kanaaldok.
- No significant negative effects are expected anywhere.
- In the port area near certain docks, 80% of the environmental quality standard for NO_2 is exceeded, This is not the case in residential areas. The possibilities for further reducing emissions, beyond the reduction achieved through the combination of BAT measures already to be implemented by Project One, are limited by the technical constraints of the available gas purification techniques.

The effect of all other pollutants evaluated on air quality is negligible (0) or sometimes slightly negative (-1) near the site.

The impact of N deposition (combination of NOx and NH_3) is addressed in the Biodiversity discipline. The impact of VOC emissions, specifically benzene and butadiene, as well as pollutants already evaluated in the Air discipline, such as NO_x and $PM_{2.5}/PM_{10}$, is further addressed in the Human Health discipline.

8 Soil

8.1 Methodology

8.1.1 Description of the reference situation

When discussing the reference situation for the Soil discipline, a description is provided of:

- the geographical location and topography of the study area: for this purpose, use is made of literature data, the topographical map, topographical measurements carried out within the framework of this project and the Digital Elevation Model Flanders II;
- the pedological characteristics in the study area: these are examined on the basis of the soil map of Belgium, the Flemish Subsurface Database (DOV) and boreholes drilled in the project area;
- the geological conditions: the geological structure is studied on the basis of data from DOV;
- land use: discussion based on site knowledge and photographic material;
- soil and groundwater quality: discussion based on soil surveys carried out in the project area.

8.1.2 Impact description and assessment

In the description and assessment of the effects, a distinction is made between the construction phase (including site preparation and construction work) and the operational phase. As the construction phase has already been partially completed (see planning in sections 3.1 and 3.2), we indicate below, where appropriate, which items have already been carried out or realised. However, the assessment in the section on soil covers the entire project. An explanation is provided of which parts are already being implemented or have been implemented.

The following effects will be discussed:

- change in land use: qualitative, with reference to the disciplines of Biodiversity and Human Health;
- erosion: qualitative, based on the erosion sensitivity of the study area and land use after site preparation;
- change in soil stability: qualitative, based on the soil texture in the study area and possible drainage;
- change in soil quality: qualitative assessment based on available studies on soil remediation and earthworks; description of possible future risks of soil and groundwater contamination; measures planned to prevent or limit contamination (legislation prescribes minimum soil protection measures);
- Description of effects of earthworks: the earthworks are described. No assessment is linked to this discipline. However, certain aspects of earthworks are assessed in the disciplines Climate, Mobility, Air, Noise and Human Health.
- Soil compaction and profile modification: qualitative assessment based on the planned soil interventions;

The **impact assessment** will be carried out as follows for:

Table 8-1: Assessment criteria for expected effects on soil

Significance level	Score	Assessment criteria	Mitigating measures
Change in land use: This effect group is described qualitatively but not assessed.			
Erosion			
Significantly negative effect	-3	Increased risk of erosion, whereby the project may have an impact on a wider area or on areas further away (downstream) from the project area	Mitigation measures required or justification
Negativeimpact	-2	Increased risk of erosion where the effect is limited to the immediate vicinity of the project area	Mitigation measures desirable or justification
Limited negative effect	-1	Increased risk of erosion and its impact only applies within the project area	No specific measures required in addition to existing regulations
Negligible effect	0	No change in erosion sensitivity expected	N/A
Limited to significant positive effect	+1 to +3	The project will eliminate erosion bottlenecks	N/A
Change in soil stability – risk of soil settlement			
Significantly negative effect	-3	The soil is susceptible to subsidence/settlement and there is infrastructure covering a large area that could be adversely affected.	Mitigating measures required or accountability
Negative effect	-2	Soil is susceptible to subsidence/settlement and there is infrastructure present over a limited area that could be negatively affected	Mitigating measures desirable or justification
Limited negative impact	-	Soil is moderately susceptible to subsidence/settlement, but no impact on existing infrastructure is expected	No specific measures required in addition to existing regulations
Negligible impact	0	Soil is not susceptible to subsidence/settlement	N/A
Change in soil quality			
Significantly negative effect	-3	Risk of spreading or causing soil contamination with human toxicological or ecological risks, requiring remediation	Mitigating measures required or justification
Negative effect	-	Risk of spreading or causing soil contamination without human toxicological or ecological risk. Remediation not necessary	Mitigating measures desirable or justified
Limited negative effect	-	Existing contamination remains without risk of spreading and without human toxicological or ecological risks.	No specific measures required in addition to existing regulations

Significance level	Score	Assessment criteria	Mitigating measures
Negligible effect	0	No impact on soil hygiene expected	N/A
Limitedpositiveeffect	+1	Limited improvement in soil hygiene. Remediation of contaminated soil without risk of spreading.	N/A
Positive effect	+2	Moderate improvement in soil hygiene. Risk reduced to acceptable level. Remediation of contaminated soil with risk of spreading but without human toxicological risk, or prevention of spreading.	N/A
Significant positive effect	+3	Clear improvement in soil hygiene. Risk is reduced to a negligible level or eliminated completely. Remediation of contaminated soil with spread risk and human toxicological risk.	N/A
Soil compaction and profile alteration			
Significantnegative effect	-	Disturbance of valuable soils[22]	Mitigating measures required or accountability
Negative effect	-2	Disturbance of soils in natural soil use/agricultural soil use or disturbance of sensitive soils	Mitigation measures desirable or justification
Limitednegativeeffect	-1	Disturbance of (recently) disturbed soils or disturbance of less sensitive soils	No specific measures required in addition to existing regulations
Negligible effect	0	Disturbance of paved soils or insensitive soils	N/A
Limited positive effect	+1	Restoration (restructuring) to agricultural use	N/A
Positive effect	+2	Restoration (restructuring) to natural soil use	Not applicable
Significant positive effect	+3	The guidelines state that a significant positive effects, given that soil formation is a very long-term process, cannot be assigned	N/A

For a description of the 7-point scale used in the above significance frameworks and the negative scores linked to the mitigating measures, please refer to § 5.3.

[22] Abstracting from its functional use, soil can be considered valuable from a scientific or social point of view. An initial exploratory study was carried out by KULeuven, Ghent University and the Belgian Soil Science Service on behalf of the Land and Soil Protection Service (Project Valuable Soils in Flanders, 2004). The study formed the basis for the creation of a database containing an initial series of valuable soils. The map of soil heritage is available at DOV.Vlaanderen.be.

8.2 Reference situation

8.2.1 Geography and topography

The project area is part of the old Scheldt polders, which used to be regularly flooded by the Scheldt. The terrain on which the project area is located was below the average flood level of the Scheldt. The micro-relief was determined by flooding and drainage, resulting in a complex network of channels, creeks, dykes and sandbanks. Before the port expansion, the area was mainly characterised by agricultural activities.

In the early 1960s, the industrial zone in which the project area is located was constructed using, among other things, soil from the excavation of Canal Docks B1 and B2. Canal Docks B1 and B2 were excavated down to the tertiary subsoil. The excavated material was used to artificially fill the current industrial site. The artificial elevation at the project site is approximately 4 to 5 metres. Pressed dikes were used to raise the site. The project area is generally located between +7 and +9 metres TAW (Second General Levelling).

8.2.2 Pedology

The soil map of Belgium (see Appendix 1 Map 6) provides information about the original soil profile to a depth of 1.25 m below ground level. According to the soil map of Belgium (mapping in 1956), the project area originally consisted of moderately wet to wet, light sandy loam to (heavy) clay soils without profile development (mainly soil types Pep, Eep, Udp):

- Texture class: light sandy loam (P), clay (E) to heavy clay (U)
- Drainage class: moderately wet, moderately gleyyish (d) to wet, strongly gleyyish with reduction horizon (e)
- Profile development: no profile development (p)

The anthropogenic soil that was created in the early 1960s has a sandy texture and no profile structure to a depth of 4 to 5 m below the current ground level. The fieldwork carried out as part of the various soil investigations confirms the sandy texture of the soil. The embankments that were constructed when the site was raised contain more clay. For a description of the groundwater levels in the project area, based on the measurements carried out as part of Project One, please refer to Chapter 9 Water.

8.2.3 Geology

The geological structure of the project area consists of the following successive deposits (see also Figure 8-1):

Table 8-2: Geological layers in the project area

Layer	Formation	Thickness (m)	Natur
Raising	Anthropogenic	Approx. 4 to 5 m	Artificial embankment: mainly Tertiary sand, but also clay sediments from the excavation of the Canal Docks. The nature of the material varies considerably. The embankments usually consist of heterogeneous, fine to medium-coarse sands with low glauconite content and occasional layers of silt.
Polder	Flanders	Approx. 4 m	Quaternary alluvial sediments, polder clay, the original ground level. This formal unit was formed during the Quaternary and consists mainly of coarse sand, fine sand and clay with peat.
Quaternary sand	Ghent and Rozebeke	Approx. 2 up to 10 m	These units were formed in the Quaternary period and consist of aeolian cover sands (Ghent Formation) and clay, sand and gravel (Rozebeke Formation).

Low	Formation	Thickness (m)	Natur
Sand from Merkplas	Merksplas 0	Approx. up to 2 m	This unit was formed during the Neogene and consists mainly of medium to very coarse sand with clay/silt laminae and glauconite.
Sand from Zandvliet and Merksem	Lillo and Poederlee	Approx. 9 to 27 m	This unit was formed during the Neogene period and consists mainly of fine to medium clay-rich sand with shells and glauconite.
Clay from Kruisschans			
Sand from Oorderen and Luchtbal			
Sandy clay from Kattendijk and Kasterlee	Kattendijk	Approx. 6 m	This unit was formed during the Neogene period and consists mainly of fine to medium clay-rich sand with glauconite.
Sand from Diest	Diest	Ca.0.5 to 1 m	This unit was formed during the Neogene and consists mainly of medium to coarse sand with glauconite.
Berchem sand	Berchem	Ca.9 up to11 m	This unit was formed during the Palaeogene to Neogene and consists mainly of fine to medium sand with glauconite and shells.
Boom clay	Boom	Ca.80 up to85 m	This unit was formed during the Palaeogene and consists mainly made of stiff clay with septaria and silt.

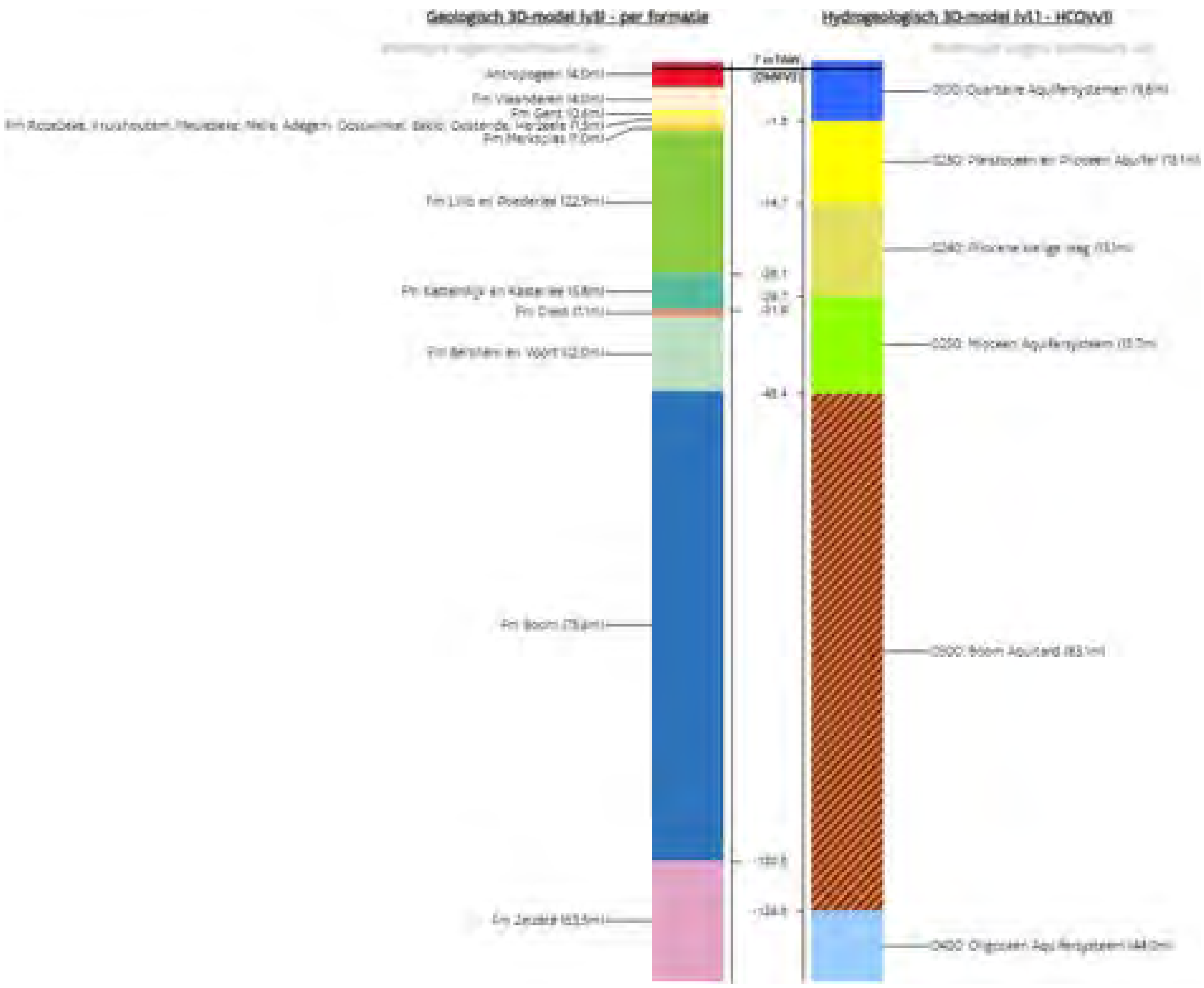

Figure 8-1: Virtual borehole at the project site (Source: DOV)

8.2.4 Land use

The project area was characterised by forest, shrub vegetation and fallow land. It belongs to zoning type V, industrial area, but was not in use for industrial purposes. Over the years, part of the site had become spontaneously overgrown with forest. For a detailed description of land use in the project area, please refer to the reference situation in Chapter 11 Biodiversity.

8.2.5 Soil investigations - soil and groundwater quality

The known soil files and the demarcation of the cadastral parcels are shown in Figure 8-2.

It is striking that the demarcation of the available residual land to be occupied by Project One does not coincide with the demarcation of the cadastral parcels. The Project One project area is located on parcels, some of which will be occupied entirely by Project One, but some of which will also be shared with the surrounding businesses. Some concessions were transferred to allow the construction of Project One on its own concession.

Plots that will only be occupied by Project One are 77F, 61V, 61T, 387A, 387C and 387D.

Plots that are shared are 77C, 77G, 61M, 61W, 392B, 392A, 150F, a section of 150H and 150C. Plot 150C is currently undergoing a cadastral division procedure.

To describe the contamination present in the reference situation, we rely on the available soil surveys that have been carried out to date, usually for each complete cadastral parcel. Below is an overview of these parcels and surveys. The information included in this chapter is taken from known soil investigation files that have been submitted to and approved by OVAM. This overview therefore contains information about the Project One project area and the surrounding areas with which a cadastral parcel is shared. The cadastral parcels that will be shared with a neighbouring company also only partially belong to the project area of the project EIA for Project One. Some cadastral parcels are included in the discussion due to the fact that a number of pipelines from the Project One installations, belonging to the project area, are present on these parcels.

Figure 8-2. Designation and numbering of cadastral parcels and OVAM soil files

Cadastral parcel 77C - VEPA

Only an access road for Project One will be built on plot 77C. Cadastral plot 77C was under concession to Gunvor until 2023. In May 2023, the shares were transferred to VOPAK (VEPA). The southern part of plot 77C is undeveloped and overgrown with vegetation. There used to be a refinery on the northern part of plot 77C. The part of plot 77C that is part of the project area is a narrow strip located in the south-western corner of plot 77C. No industrial activities are currently taking place on this strip.

An S-facility[23]has already been licensed for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. The situation report for this plot is: Preliminary soil investigation Gunvor Petroleum Antwerp, Scheldelaan 490, 2040 Antwerp, Arcadis Belgium NV, 04/03/2021.At various locations on the plot, the soil remediation standard for arsenic in groundwater was exceeded. This is typical for the port area. The exceedance for arsenic is mainly due to imported soil rich in arsenic and sulphide. The arsenic problem in the fill soil (derived from glauconite-containing sand from the Tertiary period) is due to oxidation-reduction reactions during soil disturbance, which causes the arsenic to become mobile. The sulphide and arsenide are oxidised in the process. The sulphide is converted into sulphate, while the arsenide can form both arsenate As(V) and the more mobile arsenite As(III). The formation of arsenite is generally regarded as a natural cause of elevated arsenic levels in groundwater. Naturally occurring arsenic is present in non-mobile form at greater depths (and therefore under reducing conditions). Near the water table, where more oxygen is present, mobile arsenic compounds can be formed. The exceedance of the soil remediation standard for arsenic in groundwater is of natural origin, so there is no indication of a serious threat. This plot was included in the register of contaminated sites for arsenic in groundwater.

On plot 77C – outside the Project One project area – there is contamination with oil components, volatile oil, mineral oil, BTEXN (benzene, toluene, ethylbenzene, xylenes and naphthalene), MTBE (methyl tert-butyl ether), ETBE (ethyl-tert-butyl ether) in the solid part of the earth, in the groundwater and as a pure product. Several of these contaminants require remediation; a soil remediation project (BSP) must be carried out (outside the scope of Project One). There is also new contamination with FAME (consisting of vegetable oils and used cooking oil) at T2263 in the solid part of the earth, in the groundwater and as a pure product. Remediation is necessary. The contamination does not occur in the Project One project area. There is also historical contamination with anions and cations in the groundwater, with VOCl (chlorinated solvents) in the groundwater and new contamination with NH_4 and SO_4 in the solid part of the earth and in the groundwater. There is no need for remediation of this contamination and no further measures are necessary.

A descriptive soil investigation must still be carried out for the following contaminants. The extent of these contaminants is therefore not yet known:

- Mixed-predominantly-new and new asbestos contamination in the solid part of the earth. Pending the BBO, the following usage advice is noted: GA1 Due to the soil movement regulations, there are restrictions on the use of excavated soil. During excavation work, it is advisable to take measures to prevent exposure to the contamination. This contamination falls outside the scope of Project One.
- new contamination with PFAS in the groundwater and in the solid part of the earth. As no BBO has yet been drawn up for this, it cannot be conclusively determined whether this contamination is located outside the investigation site or not.

([23])All GPBV installations ('GPBV' stands for 'Integrated Pollution Prevention and Control') that use, produce or emit relevant hazardous substances are indicated in column 8 of the Vlarem II classification list with the letter 'S'. For these installations, the implementation of a situation report is mandatory. https://www.ovam.be/situatierapport

- New mineral oil contamination in the solid part of the earth at the northern end of the production zone. This contamination falls outside the scope of Project One.

Cadastral parcel 61W - Inovyn

A Project One pipeline corridor will be located in the western part of parcel 61W. In the current situation, Inovyn stores and loads salts in the north-eastern part of parcel 61W, next to the canal dock.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. The status report for this plot is: Preliminary soil investigation Inovyn Manufacturing Belgium, Scheldelaan 480, 2040 Antwerp, Envirosoil NV, 24/02/2016.

According to the descriptive soil investigation (BBO) carried out at the Inovyn site[24] there is historical soil contamination with conductivity, sodium and chloride in the groundwater at the NaOH loading quay (southwest of the salt storage facility); contamination with cyanides in the solid part of the earth to the northeast of the salt storage and salt loading area, and contamination with conductivity, sodium, chloride and cyanides in the groundwater near the salt storage and salt loading area. The contamination originated on this plot. The contamination is considered historical given the many years of exploitation, the increasing attention to environmental issues, the implementation of soil protection measures (foil) and the absence of serious calamities.

- For the contamination at the NaOH loading quay (southwest of the salt storage facility) in the groundwater with conductivity, sodium and chloride, the risk analysis shows that no remediation is necessary.
- Due to the risk of contamination spreading, remediation is necessary for the contamination of the solid part of the earth with cyanides and for the contamination of the groundwater with conductivity, sodium, chloride and cyanides at the salt storage and salt loading sites.
- For the contamination with conductivity, cyanide, chloride and sodium in the groundwater, a limited soil remediation project was launched in 2021, starting with a pilot test.

The remediation is currently being carried out on behalf of Inovyn. The cyanide contamination in the solid part of the earth was excavated to a depth of 4.0 metres below ground level. According to the interim excavation report, some residual cyanide contamination remains locally[25]. The contamination with conductivity, sodium, chloride and cyanides in the groundwater still needs to be remediated. This contamination has also spread to plot 61V, which is also part of the project area.

On plot 61W, the OBO[26] of 2016 identified mixed, predominantly historical contamination with VOCl in the groundwater and mineral oil in the groundwater and the solid part of the earth. No descriptive soil investigation was necessary for this contamination. Elevated levels of pH, lead and arsenic were also detected. No further measures were required for these historical contaminants.

[24] Descriptive soil investigation, Envirosoil NV, dated 16/12/2016. Plots 61W and 61V, section A, division 18, Antwerp. Ref. EB1503/031. Commissioned by Inovyn Manufacturing Belgium NV.

[25] Interim report, Envirosoil NV, 20/04/2020. Plot 61W, section A, division 18, Antwerp. Commissioned by Inovyn Manufacturing Belgium NV.

[26] Preliminary soil investigation, Envirosoil NV, dated 24/02/2016. Plot 61W, section A, division 18, Antwerp. Ref. EB1503/030. On behalf of Inovyn Manufacturing Belgium NV.

In the area with rectifiers in the middle of the plot – outside the Project One project area – mineral oil contamination was detected in the solid part of the soil and groundwater. There was also a floating layer. Soil remediation was carried out for this contamination in the period 2014-2016. After the remediation, it was decided that there was still some residual contamination present.
However, the residual contamination detected does not constitute serious soil contamination and no additional measures are required. An elevated pH and contamination with chromium and nickel were detected in the groundwater near the wastewater basins. A BBO was carried out for this historical contamination and it was decided that no remediation was necessary. At the electrolysis maintenance workshop, historical contamination with mercury was observed in the solid part of the earth and in the groundwater; this contamination does not constitute serious soil contamination and no remediation is necessary.

On the plot – outside the Project One project area – several findings were made as a result of previous incidents. These findings are summarised below.

In the 2016 OBO, increased conductivity and pH were detected in the groundwater as a result of an incident involving sulphuric acid. This damage was remediated and no further measures are necessary.

In 2016, an incident occurred at the former fuel oil storage site, resulting in new soil contamination with mineral oil in the solid part of the earth and in the groundwater. As the soil contamination does not pose a serious threat, no remediation is necessary.

In 2019, another incident occurred, this time as a result of a break in the valve of the brine saturation tank S300/3 on 19 July 2019. An unknown quantity of brine (NaCl and water) was released. The brine was immediately excavated and the valve repaired. Elevated conductivity and chloride values had already been detected in this area. After the brine was removed, control samples were taken from the soil and groundwater; these showed no significant increase in conductivity and chloride contamination. It was decided that no additional contamination had occurred as a result of the damage.

In September 2020, a reduced pH was detected at pump pit P1 during a test run of a drainage system. The cause of this contamination is a leak at the pump pit and pipe in zone C1. Sulphuric acid is stored and unloaded in this zone. The connection of the northern part of the drainage channel, near the chemical sewer, was repaired. This contamination, with reference number 34, was dealt with in the BBO of 27 July 2022 (fifth phased descriptive soil investigation) and was completely contained. Recommendations for use still apply. This contamination is not located within the Project One project area.

In 2022, an incident occurred. Due to a loss of flow in a pipe containing 22% NaOH, soil contamination occurred within the factory premises, in zone L. Product was released. The response was immediate: the leak was repaired and the asphalt was cleaned. This incident caused contamination with an increased pH in the solid part of the earth. The area affected by the incident was excavated. After taking control samples (in soil and groundwater), it was concluded that the contamination had been removed. There are no recommendations for use. As no GIS files were available in the OVAM database, it was not possible to determine whether this contamination occurred within the Project One project area.

Cadastral parcel 61V - IOB

No industrial activities are currently taking place on plot 61V. The site is being prepared for construction. The plot is undeveloped.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. In addition, the latest exploratory soil investigation includes an overview of all contamination found on the plot to date. The status report for this plot is: Exploratory soil investigation Area I, Scheldelaan 480, 2040 Antwerp (Lillo), ABO NV, 22/05/2019.

There is historical soil contamination with conductivity, sodium, chlorides and cyanides in the groundwater in the vicinity of the salt storage and salt loading areas. The contamination did not originate on this plot, but on source plot 61W. The identified soil contamination requires soil remediation. A pilot test will be launched in the fourth phased limited soil remediation project of 18 February 2021. Existing monitoring wells on this plot will be used in the follow-up programme of the pilot test. Arsenic contamination of natural origin (see above) is present in the groundwater throughout the plot. In the solid part of the earth, there is historical mercury contamination at the former sludge basins. This area has already been remediated in the past. Concentrations of zinc and PAHs above the guideline values have been observed throughout the site. These contaminants are linked to the fill material used to construct the site and are historical in nature. Concentrations of mercury above the soil remediation standard were found scattered across the site. This contamination is linked to the former production of chlorine with mercury, which is why it is also considered historical. No remediation is necessary for the contamination in the solid part of the earth.

Cadastral parcel 61Y – IMB

IMB is located on cadastral parcel 61Y.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. The status report for this plot is: Preliminary soil investigation Ineos Manufacturing Belgium N.V., Scheldelaan 482, 2040 Antwerp, RSK Benelux BV, 05/05/2009.

On plot 61Y – outside the Project One project area – the exploitation survey[27] in 2019 found an excess of mineral oil in the solid part of the earth. This is a new contamination, as it was caused by a leak at a compressor. No further measures were necessary.

Cadastral plot 61M – IMB

IMB is located on cadastral plot 61M.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. In addition, the latest exploratory soil investigation includes an overview of all contamination found on the plot to date. The status report for this plot is: Exploratory soil investigation Ineos Manufacturing Belgium N.V., Scheldelaan 482, 2040 Antwerp, RSK Benelux BV, 05/05/2009.

In 2001, an exceedance of the soil remediation standard for toluene in the solid part of the earth and in the groundwater was detected on plot 61M following an incident in which toluene was released. Remediation was carried out by excavation. In 2005, a final evaluation study (EEO) was drawn up and approved for this purpose. In the 2005 OBO, mercury contamination was observed in the solid part of the earth; this contamination originated on plot 61V and plot 61M is considered to be a dispersion plot. The 2019 exploitation study found that the soil remediation standard for arsenic in groundwater had been exceeded; this concerns contamination of natural origin (see above), and no further measures are required.

This investigation also revealed historical contamination with trichloromethane. The guideline value in the groundwater was exceeded, but it was decided that no further measures were necessary.

[27] Preliminary soil investigation-exploitation investigation, RSK Benelux BVBA, dated 04/03/2019. Parts of plots 61Y, 61P and 61M, section A, division 18, Antwerp. Ref. 554248-R01(01). On behalf of INEOS Manufacturing Belgium NV.

Cadastral plot 77G – IMB

Cadastral parcel 77G is largely undeveloped. In 2020, a situational investigation – exploratory soil investigation - was carried out on this parcel[28]. The conclusions of this investigation are summarised below.

For plot 77G, no contamination was found on the site during the situation investigation carried out in 2020. Elevated levels of arsenic were observed in the groundwater. This increase is considered to be naturally occurring. In previous investigations, concentrations above the guideline value for polycyclic aromatic hydrocarbons (PAHs) were found in the solid part of the earth. These elevated concentrations are considered to be historical contamination, as it is assumed that they were caused by the raising of the site in the 1960s and 1970s. It was decided that no descriptive soil investigation was necessary for the above contamination. Consequently, no recommendations for use, restrictions on use, safety measures or precautions apply. As described in the soil legislation, there is no clear indication of serious soil contamination and therefore no descriptive soil investigation is necessary.

In 2021, a new situation report was drawn up for this plot[29], which was approved by OVAM on 10/05/2021. No new fieldwork was carried out on this plot for this situation report; the conclusions of the 2020 investigation remain unchanged.

A new situation report was drawn up in 2023 and this report was approved by OVAM on 8 April 2024[30]. No contamination was found in this investigation. The plot is not suspected of containing asbestos in the unpaved areas or in the paved areas. There is no need to carry out a descriptive soil investigation. There are no precautionary and safety measures and no restrictions on use.
-advice applies. It was decided that no further investigation or remediation is necessary. As described in the soil legislation, there is no clear indication of serious soil contamination and no descriptive soil investigation is necessary.

Cadastral parcel 77F - IOB

Cadastral parcel 77F is largely undeveloped, and preparatory work is being carried out. In 2020, a situational investigation - exploratory soil investigation was carried out on this parcel[31]. The conclusions of this investigation are summarised below.

For plot 77F, no contamination was found on the site during the situation investigation carried out in 2020. Elevated levels of arsenic were observed in the solid part of the earth and in the groundwater. This increase is considered to be naturally occurring. Consequently, no usage recommendations, usage restrictions, safety measures or precautions apply. The investigation concluded that no follow-up investigation or remediation is necessary. As described in the soil legislation, there is no clear indication of a serious threat and therefore no descriptive soil investigation is necessary.

In 2021, a new situation report was drawn up for this plot[32], which was approved by OVAM on 10/05/2021. No new fieldwork was carried out on this plot for this situation report; the conclusions of the 2020 investigation remain unchanged.

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[28] Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 12/08/2020. Project One, Scheldelaan z/n (plots 77F and 77G), 2040 Lillo (Antwerp). On behalf of INEOS Manufacturing Belgium II NV.
[29] Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 03/05/2021. Project One, Scheldelaan z/n (plots 77F and 77G), 2040 Lillo (Antwerp). On behalf of INEOS Olefins Belgium NV.
[30] Situation investigation - Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 26 March 2024: Ineos Olefins Belgium, Scheldelaan 482 (plots 77F and 77G), 2040 Lillo (Antwerp), commissioned by INEOS Olefins Belgium NV.
[31] Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 12/08/2020. Project One, Scheldelaan z/n (plots 77F and 77G), 2040 Lillo (Antwerp). On behalf of INEOS Manufacturing Belgium II NV.
[32] Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 03/05/2021. Project One, Scheldelaan z/n (plots 77F and 77G), 2040 Lillo (Antwerp). On behalf of INEOS Olefins Belgium NV.

A new situation report was drawn up in 2023 and this report was approved by OVAM on 8 April 2024[30]. New PFAS contamination was detected in the groundwater. No PFAS analyses had been carried out previously. The source/location of the contamination is unknown. No activities have taken place on the site. There are no clear indications of serious soil contamination and there is no need to carry out a descriptive soil investigation. No precautionary or safety measures are necessary for the soil contamination with PFAS. In order to limit exposure to PFAS soil contamination, 'no regret' measures may apply, as advised by the Care and Health Agency, which can be found at:www.vlaanderen.be/pfas-vervuiling . No restrictions on use are necessary. The plot is not suspected of containing asbestos in the unpaved areas; the plot is completely unpaved. No further investigation or remediation is required.

Cadastral parcels 150F and 392A – IOB, Vesta

The access road to Vesta is located on cadastral parcels 150F and 392A. These parcels fall entirely within the Project One project area. In the future, a pipe rack from Ineos Olefins Belgium will be built on parcel 150F. No activities will be carried out on parcel 392A.

In 2020 and 2021, a situational investigation and preliminary soil investigation was carried out on the former plot 150B, which includes 150F and 392A[33][34]. No contamination was found.

In 2024, a new situation assessment – exploratory soil investigation – was carried out on the basis of existing data for plot 150F. No additional contamination was found on the site. The plot is not suspected of containing asbestos in the unpaved areas or in the paved areas. The conclusions of the 2021 situation assessment remain unchanged.

Cadastral plot 150H – Vesta, Ineos Olefins Belgium

Vesta is mainly located on cadastral parcel 150H. The majority of this parcel falls completely outside the Project One project area. A very limited area on the access road and on the border of cadastral parcels 150G and 150H still belongs to the Project One project area. However, no activities will be carried out there.

In 2020 and 2021, a situational investigation – exploratory soil investigation – was carried out on former plot 150B, to which 150H belongs[35][36].

Within the Project One project area, contamination with ammonium and phosphate was detected in the groundwater. No descriptive soil investigation needs to be carried out. No precautionary or safety measures, restrictions on use or recommendations for use apply.

Outside the Project One project area, various types of contamination are present. These include contamination with mineral oil, BTEX, MTBE, heavy metals and PAHs. Some of these contaminants require remediation, which is being carried out. For certain other contaminants, no further investigation is necessary.

An incident occurred at this plot on 24/11/2020, involving diesel spillage as a result of a leaking pipe. The incident took place outside the Project One project area. The excavation has been carried out. No further measures are necessary. No concentrations were detected that could be linked to the incident.

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33 Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 18/08/2020. Project One, Scheldelaan z/n (plots 150B and 150C), 2040 Lillo (Antwerp). On behalf of INEOS Manufacturing Belgium II NV.
34 Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 03/05/2021. Project One, Scheldelaan z/n (plots 150B and 150C), 2040 Lillo (Antwerp). On behalf of INEOS Olefins Belgium NV.
35 Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 18/08/2020. Project One, Scheldelaan z/n (plots 150B and 150C), 2040 Lillo (Antwerp). On behalf of INEOS Manufacturing Belgium II NV.
36 Situation investigation – Preliminary soil investigation within the framework of Article 33bis of the Soil Decree, Arcadis Belgium nv, dated 03/05/2021. Project One, Scheldelaan z/n (plots 150B and 150C), 2040 Lillo (Antwerp). On behalf of INEOS Olefins Belgium NV.

No site report is required for this plot and for the limited area on the access road and on the boundary of cadastral plots 150G[37] and 150H. This is because no S activities are carried out in this zone. Only a small part of this plot will be paved.

Cadastral plot 150G (replacement subplot of 150C[37]) – IOB

Plot 150G (future new plot replacing plot 150C, which is being split) is largely undeveloped. The site is being prepared for construction and a groundwater purification plant is in place.

In 2020 and 2021, a situation assessment – exploratory soil investigation was carried out on former plot 150C[37], to which 150G belongs[35,36]. In 2022, a technical report was drawn up for the Project One works. In 2023, a new situational investigation – exploratory soil investigation was carried out. The following contaminants are present on this plot:

- Historical contamination with mineral oil, zinc, polycyclic aromatic hydrocarbons and PCBs in the solid part of the earth spread across the site

The source is unknown in each case. No further investigation is necessary for these contaminants. No descriptive soil investigation needs to be carried out. There are no recommendations for use, precautionary and safety measures, or restrictions on use.

During a technical report, PFAS contamination was found in the solid part of the earth. In addition, new PFAS contamination was detected in the groundwater during the 2023 situation report (previously, no samples had been analysed for PFAS). No precautionary or safety measures are necessary for PFAS contamination. To limit exposure to PFAS soil contamination, 'no regret' measures may be applied on the advice of the Care and Health Agency, which can be found at:www.vlaanderen.be/pfas-vervuiling . A follow-up investigation is necessary. There is a clear indication of serious soil contamination and a descriptive soil investigation must be carried out.

Plot 150G is not suspected of containing asbestos in the unpaved areas or in the paved areas.

Cadastral plots 392B, 387A, 387C, 387D and 388A

Only part of cadastral plot 388A will be used as an access road during the construction phase. No industrial activities are currently taking place on this plot.

Cadastral parcels 387A, 387C, 387D and 392B fall entirely within the Project One project area and are currently a construction site. No industrial activities are taking place in the current situation.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. The status report for this plot is: Preliminary soil investigation Monsanto Europe NV, Scheldelaan 460, 2040 Antwerp, OVAM file: 4014, Arcadis Begium NV, 23/07/2018.

In the 2018 OBO[(38)] ,concentrations above the guideline values were found for zinc, cadmium, polycyclic aromatic hydrocarbons (PAHs), mineral oil and monochlorobenzene in the solid part of the earth, and concentrations above the guideline value for chromium in the groundwater.

The elevated concentrations of zinc in the solid part of the earth and chromium in groundwater are considered to be historical contamination, as it is assumed that they were caused by the fill sand used to raise the level of the site before 1960. The elevated concentrations of cadmium,

[37] Cadastral parcel 150C is currently undergoing a cadastral division procedure. The parcel will be divided into parcels 150G and a residual parcel, the future number of which is not yet known.

[38] Preliminary soil investigation, Arcadis Belgium nv/sa, dated 23/07/2018. Parcels 162S, 162G and 162N, section A, division 18 and parcel 112H, section F, division 18, Antwerp. Ref. BE0111002196.1620. On behalf of Monsanto Europe NV.

PAHs, mineral oil and monochlorobenzene are considered to be historical contamination, as it is assumed that they were caused by the former storage of filter cakes and lagoon sludge in this zone. The OBO shows that there is no clear indication that the elevated concentrations pose a serious soil contamination risk to humans or the environment. Consequently, no BBO needs to be carried out.

Also in the 2018 OBO, concentrations above (80% of) the soil remediation standards were determined for this plot for monochlorobenzene, mercaptobenzothiazole, benzothiazolol, benzothiazole, diallate, triallate, triethylamine, alachlor and trichloropropane in the groundwater and triallate, trichloropropane and aniline in the solid part of the earth. These contaminants are considered historical, as it is assumed that they were caused by the historical storage of filter cakes and lagoon sludge in this zone. The OBO shows that there are clear indications that this historical soil contamination constitutes serious soil contamination. A BBO[39]was already carried out in 2016 for contamination with monochlorobenzene, mercaptobenzothiazole, benzothiazolol, benzothiazole, diallate, triallate, triethylamine, alachlor and trichloropropane in the groundwater. The 2016 BBO concluded that remediation was necessary. Soil remediation was carried out using pump & treat for the contamination in the groundwater. An initial phased final evaluation study[40] (EEO) was carried out for this soil remediation project.

It was established that residual contamination is still present, which does not constitute serious soil contamination and for which no additional remediation measures are necessary. The following usage advice applies to the established residual contamination when extracting groundwater:

- GA2a: When carrying out drainage, it is advisable to take measures to prevent the spread of groundwater contamination (see OVAM infographics[41]).

For the contamination with triallate, trichloropropane and aniline in the solid part of the earth, a BBO[42] was carried out in 2019. This BBO also investigated historical contamination with mercaptobenzothiazole caused by the former storage of contaminated soil. This BBO found that these contaminants do not pose any serious threats and that remediation is not necessary. When digging in soil, the following usage advice should be taken into account for this plot:

- GA1: Under the earthmoving regulations, there will be restrictions on the use of excavated soil. When digging in the soil, it is advisable to take measures to prevent exposure to contamination.

At the northern boundary of the plot, there is contamination in the solid part of the earth with diallate, triallate, mercaptobenzothiazole and mineral oil. These contaminants are considered to be historical contamination, as it is assumed that they were caused by the former storage of contaminated soil near the northern road. The 2018 OBO[43] shows that there are clear indications that the historical soil contamination with diallate, triallate and mercaptobenzothiazole constitutes serious soil contamination. A BBO[44]was carried out in 2019 at the northern boundary of the plot. This BBO states that the historical contaminants do not pose a human toxicological risk (current/potential) and/or ecotoxicological risk (current/potential). No serious threat from spread has been identified. Remediation is not necessary. A usage recommendation applies to the identified contaminants:

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[39] Additional descriptive soil investigation, Arcadis Belgium nv/sa, dated 26/02/2016. Plots 162l, 162s, 162r, 162n, 162p, 162g, 112m, 150b, 378a, 380b, 162d, 112h, section A, Antwerp. Ref. BE01110021960320. On behalf of Monsanto Europe NV.
[40] First phased final evaluation study, zone 4 – plot 162G, Arcadis Belgium nv/sa, dated 16/07/2019. Plot 162G, section A, Antwerp. Ref. BE01110021962020. On behalf of Bayer Agriculture BVBA.
[41]https://www.ovam.be/sites/default/files/atoms/files/17001.ARCA_.offerte%20OVAM.gebruiksadviezen.GA2a.v2.pdf
[42] Phased descriptive soil investigation zone 4 and zone 6 – Bayer Agriculture bvba, Arcadis Belgium nv/sa, dated 19/04/2019. Plots 162S and 162 G, section A, division 18, Antwerp. Ref. BE0111.002196.2020. On behalf of Bayer Agriculture bvba.
[43] Preliminary soil investigation, Arcadis Belgium nv/sa, dated 23/07/2018. Plots 162S, 162G and 162N, section A, division 18 and plot 112H, section F, division 18, Antwerp. Ref. BE0111002196.1620. Commissioned by Monsanto Europe NV.
[44] Phased descriptive soil investigation zone 4 and zone 6 – Bayer Agriculture bvba, Arcadis Belgium nv/sa, dated 19/04/2019. Plots 162S and 162 G, section A, division 18, Antwerp. Ref. BE0111.002196.2020. On behalf of Bayer Agriculture bvba.

- GA1: When carrying out earthworks, digging in soil and performing activities in the contaminated zone, it is advisable to take measures to prevent the spread of soil contamination and to avoid direct exposure to the contamination.

In the northern zone, there is also zinc contamination in the solid part of the earth. These elevated concentrations are considered to be historical contamination, as it is assumed that they were caused by the fill sand used to raise the terrain before 1960. The 2018 OBO shows that there is no clear indication that the elevated concentrations constitute serious soil contamination for humans or the environment. Consequently, no BBO needs to be carried out.

The 2018 OBO also mentions contamination with benzothiazole, diallate, sulphur, monochlorobenzene, triallate and triethylamine in the groundwater within the Project One project area. The preliminary soil investigation shows that there are clear indications that the above contaminants constitute serious soil contamination.

Several BBO reports have already been drawn up for these contaminants in the groundwater; the most recent BBO report covering all these contaminants dates from 2016[45]. The 2016 BBO report concluded that remediation is necessary. Remediation is currently underway.

The Port of Antwerp opted to remediate the contamination with triallate, trichloropropane, aniline and mercaptobenzothiazole in the solid part of the soil on this plot, even though there was no need for soil remediation. On behalf of the Antwerp Port Authority, a soil remediation project was drawn up in which the best available techniques for carrying out the soil remediation work were investigated. A quality plan was submitted for this soil remediation project in 2019[46]. The area was remediated at the end of 2019 by excavation using drainage. This soil remediation project was carried out on behalf of the Antwerp Port Authority and was not part of the present project. In 2020, a final evaluation study was carried out for this contamination, which showed that residual contamination is present. There is no serious soil contamination and no additional measures are necessary. The above recommendations for use remain valid.

In OBO[47] of 2020, contamination with PCBs and PAHs was found in the solid part of the earth. It was assumed that this was caused by the use of fill sand during the construction of the site or by the storage of products on the vacant parts of the plot. No further measures are necessary for these contaminants.

A second phased final evaluation study was conducted in 2022[48]. There is historical soil contamination present on plot 387A, which is residual contamination. No further measures are necessary, but recommendations for use apply if groundwater is used or extracted.

A report was drawn up on the damage caused by a fire engine with extinguishing foam on 8 July 2022. This damage occurred on plot 389A, which is outside the Project One project area. Measures were taken. No descriptive soil investigation is necessary for the PFAS contamination in the solid part of the earth. However, rules do apply to earthworks. There is still PFAS contamination in the groundwater on plot 389A. However, the incident is not the cause of the contamination.

[45] Additional descriptive soil investigation, Arcadis Belgium nv/sa, dated 26/02/2016. Plots 162l, 162s, 162r, 162n, 162p, 162g, 112m, 150b, 378a, 380b, 162d, 112h, section A, Antwerp. Ref. BE01110021960320. On behalf of Monsanto Europe NV.

[46] Quality plan for the Third Phased Soil Remediation Project; Area III - Contamination with triallate, 1,2,3 trichloropropane, aniline and mercaptobenzothiazole in the solid part of the earth at zone 4, Scheldelaan 460, 2060 Antwerp, ABO NV, dated 22/08/2019. Plot 162S, section A, division 18, Antwerp. Ref. 25277 On behalf of Antwerp Port Authority NV under public law

[47] Preliminary soil investigation, ABO NV, dated 10.01.2020. Scheldelaan 460, Area III, plot 162S, on behalf of Antwerp Port Authority

[48] Second phased final evaluation study: Zone 6 – plot 387A: Bayer Agriculture BV, Scheldelaan 460, 2040 Antwerp. Zone 6 –

reference number 22, Arcadis Belgium NV, dated 22 December 2022, commissioned by Bayer Agriculture NV

A descriptive soil investigation is necessary for this contamination in order to map the exact extent of the contamination. This descriptive soil investigation is being prepared.

A PFAS in groundwater investigation report was drawn up on 15 December 2023[49]. Plots 388A and 387A are not covered by this report. This report therefore concerns an area outside the Project One project area. A descriptive soil investigation is needed to map the exact extent of the contamination. The impact of this contamination is being investigated in a new soil remediation project that is being drawn up.

Cadastral plot 61T – IOB

Plot 61T is mainly undeveloped. The site is being prepared for construction. There are a few temporary construction facilities on site.

In 2019, an OBO[50] was carried out in connection with a transfer of the plot. In this OBO, it was decided, based on previous soil investigations, that the following contaminants are present:

- historical contamination with conductivity present in the groundwater. As described in the soil legislation, there is no clear indication of a serious threat and no descriptive soil investigation is necessary;
- arsenic contamination in the groundwater. This contamination is of natural origin.
- Contamination with VOCl in the groundwater. This contamination was remediated. After remediation, residual contamination was still present without any risk of spreading.
- increased mercury concentrations in the solid part of the earth. The contamination is considered to be historical in nature. No follow-up investigation or remediation is necessary;
- an exceedance of the guideline value for PAHs in the solid part of the earth. The contamination is considered to be historical in nature. No follow-up investigation or remediation is required.

As part of this project, an OBO was carried out in 2020[51], with the following results:

- Based on the asbestos action plan, the OBO decided that plot 61T near the pavement is suspected of containing asbestos. Since no samples were taken from the material under the pavement, the investigation cannot rule out the possibility that there are concentrations of asbestos above the test value in any layer of rubble under the pavement. Furthermore, the decision-making process for the investigated, unpaved areas cannot be extended to the paved areas, as it cannot be concluded on the basis of the available information that the layers of rubble present on the site all have the same composition or origin. Assuming a potential scenario in which asbestos contamination is present, neither a human nor a dispersion risk is expected, as any contamination is sufficiently covered by the existing paving. As described in the soil legislation, there is no clear indication of a serious threat and no descriptive soil investigation is necessary. No precautionary measures are necessary. The plot will be given an asbestos label: 'There is a layer of rubble on the site that may contain asbestos.'
- To prevent exposure and spread in the future, the following recommendations for use are formulated for the potentially asbestos-contaminated layer of rubble under the pavement:
  - GA1: The soil movement regulations impose restrictions on the use of excavated soil. When excavating, it is advisable to take measures to prevent exposure to the contamination.
  - GA3a: It is not advisable to remove the existing paving on the site.

[49] Research report, PFAS in groundwater zone 1, Bayer Agriculture bv, Arcadis Belgium NV, dated 15 December 2023, commissioned by Bayer Agriculture BV
[50] Exploratory soil investigation in the context of strategy 5C; Area II (Parcel 61T), ABO NV, dated 3 June 2019. Parcel 61T, section A, Antwerp. Ref. 25277.R.04. Commissioned by Antwerp Port Authority NV under public law
[51] Preliminary soil investigation INEOS Manufacturing Belgium II nv, Scheldelaan 480 (plot 61T), 2040 Lillo (Antwerp), OVAM file: 4798, Arcadis Belgium nv/sa, dated 31/08/2020. On behalf of INEOS Manufacturing Belgium II nv.

An S-facility has already been approved for this plot and various exploratory soil investigations are already available. We are using the most recent investigation as the situation report, as this is closest to the baseline situation of the plot before the start of the new activities. In addition, the latest exploratory soil investigation includes an overview of all contamination found on the plot to date. The status report for this plot is: Preliminary soil investigation: Ineos Manufacturing Belgium II nv, Scheldelaan 480 (plot 61T), 2040 Lillo (Antwerp), Arcadis Belgium NV, 31/08/2020.

8.3 Impact description and impact assessment – construction phase

8.3.1 Change in land use

This impact group examines whether a particular land use in the project area or surrounding area will be significantly affected by the project.

In the initial situation, the project area was characterised by grasslands and scrub vegetation with forest. The vegetation present in the project area has already been removed, and the project area has already been levelled. Parts of the structures to be constructed have already been built. The description and assessment of the impact of the loss of biotopes and ecotopes is discussed and quantified in the Biodiversity discipline.

Once the complete development of the project area into an industrial estate has been completed, the land use at the location will have changed to industrial applications. The effects of this use on humans and biodiversity are discussed and assessed in the discipline of Human Health and Biodiversity.

8.3.2 Erosion

Erosion is the displacement of soil material by the action of wind and water. Erosion can occur as a result of changes in soil cover, changes in relief and changes in water management. Hardened surfaces are not susceptible to erosion.

Vegetation removal could cause erosion if the deforested area were left fallow after the works. However, this is not the case for this project. The project area also still has a flat relief. In addition, the soil texture is coarse-grained. Due to the above factors, no significant erosion was expected (negligible effect (0)).

8.3.3 Change in soil stability

Soil settlement, or subsidence of the original ground level, is caused by external loads. It is an irreversible process that is limited to the area where the load is applied. Soil settlement depends on the compressibility of the soil and the thickness of the soil layer. Heavy (loam, clay) and peat-containing soils are most susceptible to soil settlement. Sandy soils are less susceptible to settlement. Given the sandy subsoil of the project area, no significant settlement is expected.

Settlement can occur when wet compressible soil layers are drained. Wet peat soils are most susceptible to settlement. Sandy soils are less susceptible to settlement. Given the sandy subsoil of the project area, no significant settlement is expected.

During the entire construction phase, temporary drainage works will be carried out in connection with various construction works below ground level (foundations, underground pipes, collection pits, basins, etc.). Some of these works have already been carried out (see schedule in sections 3.1 and 3.2). The specific drainage locations, duration, depths and volumes of the drainage works still required are set out in Chapter 9 Water. As part of the EIA, groundwater modelling was carried out to assess the effects of drainage on the environment. The groundwater model calculated the settlement risks with regard to the surrounding infrastructure. As a rule, 20 mm is taken as the limit value for the total settlement of a structure, but the groundwater model also uses 15 mm (see Chapter 9 Water for more information). If greater settlement occurs, damage to neighbouring buildings may be caused, which is considered negative. Preventive measures are taken to limit the impact of groundwater extraction.

provided for, in particular the installation of sheet piling down to the deeper clay layer. The sheet piling has been installed in preparation for the start of the drainage works. In the meantime, the settlements in the surrounding area have been monitored and no violations have been detected.

The risk of unacceptable settlement occurring can therefore be considered low. The effect of possible soil settlement or subsidence as a result of drainage during the construction phase can therefore be assessed as limited negative (-1) to negligible (0).

8.3.4 Change in soil quality

Accidental contamination

During the construction phase, accidental soil and groundwater contamination may occur as a result of leaks in (fuel) pipes or spillage of mainly oil and/or fuels during the use and maintenance of machinery on site. Given the size of the site, site facilities will be spread across a number of locations throughout the project area during the construction phase. In addition, areas for storing materials (laydown zones) will be provided in a few locations. The following facilities will be provided at the site facilities and laydown zones:

- diesel storage in single-walled above-ground containers equipped with pumps;
- refuelling stations;
- areas for rinsing materials.

The containers are placed on a bund. The tank sites and areas for rinsing materials are equipped with liquid-tight paving. The containers, tank sites and areas for rinsing materials comply with VLAREM conditions. The collected water is considered potentially contaminated and is discharged for external processing.

Contaminants that end up on or in the soil can be washed out by seeping rainwater and migrate to the groundwater. Taking into account the fact that such soil and/or groundwater contamination is considered new according to the provisions of the Soil Decree, the contractor must intervene immediately in the event of an emergency and take the necessary measures to prevent soil and groundwater contamination. The necessary procedural agreements have been made; in addition, appropriate and sufficient means of intervention have been provided (see also Chapter 9 Water for project-integrated measures). The impact of any incidents is assessed as limited negative (-1) to negligible (0).

Earthworks

After removing the vegetation, test trenches were dug and then filled in again with the same soil. Drilling and probing were carried out in accordance with the International Standard EN ISO 22475-1:2006 and in accordance with the code of good practice (VLAREM II appendix 5.53.1.). These guidelines stipulate, among other things, that the pits must be properly sealed to prevent soil and groundwater contamination through seepage.

The earthworks during the construction phase have largely been completed and are divided into three phases:

- Volumes to be excavated and removed during the **excavation of the topsoil** (already completed);
- Volumes to be excavated, partly removed and partly replenished during the **levelling** of the sub-base (already completed);
- Volumes to be excavated, partly removed and partly replenished as part of the **construction work** itself.

For an overview of the volumes and a detailed description of the various earthworks, please refer to Chapter 3 Project Description.

Earthmoving will be carried out in accordance with current legislation, taking into account the recommended usage guidelines. In order to control the spread of soil contamination, the Flemish Government has drawn up regulations regarding the use of excavated soil.

These regulations are described in Chapter XIII of the VLAREBO (the Flemish Regulations on Soil Remediation). The PFAS Research Directive (revised in April 2022) also applies. In addition, new guidelines on reporting and testing PFAS parameters will apply from 15/01/2024, as changes have been made to CMA and WAC.

Specifically for cadastral parcels 387A and 388A of the project area, the phased descriptive soil investigation[52] applies the usage recommendation (see § 8.2.5):

GA1: Under the earthmoving regulations, there will be restrictions on the use of excavated soil. When digging in the soil, it is advisable to take measures to prevent exposure to contamination.

The following recommendations for use from the preliminary soil investigation apply specifically to cadastral parcel 77C:

- GA1: The soil movement regulations impose restrictions on the use of excavated soil. When carrying out excavation work, it is advisable to take measures to prevent exposure to contamination.

Specifically for cadastral parcel 61T, the following recommendations for use apply from the preliminary soil investigation[53]in relation to soil movement:

- GA1: The earthmoving regulations impose restrictions on the use of excavated soil. When carrying out excavation work, it is advisable to take measures to prevent exposure to contamination.
- GA3a: It is not advisable to remove the existing paving on the site.

In the context of earthworks, a technical report has been drawn up by a certified soil remediation expert describing the environmental quality of the soil. When removing soil from the project area, the quality of the soil and exposure to contamination (negligible (0) to limited negative impact (-1)) will be taken into account.

Part of the earthworks for the construction phase have already been carried out. The soil excavated and/or brought in during the construction phase will be temporarily stored at a number of locations on the site, pending backfilling/use on site or removal. An impermeable membrane will be provided for the storage of contaminated soil in the temporary storage areas to prevent leaching of potentially contaminated soil into the soil and groundwater. To prevent contamination of rainwater runoff, the most heavily contaminated soil will also be covered, as indicated by the soil remediation expert. The temporary storage sites (TSSs) will be set up in accordance with the Best Available Techniques (BAT). The total storage of soil during the construction phase will extend over a period of more than one year (for which Section 61 of the environmental permit is requested). However, this will involve soil storage at varying locations, depending on the progress of the construction work (< 1 year per location). Due to limited space, excavated soil will be reused as soon as possible in order to limit the space required for soil storage on the Project One site to the absolute minimum. Potentially contaminated soil will be removed as quickly as possible (this is also requested in Section 2.1.3 of the environmental permit). The effect on soil quality is considered negligible (0) to limited negative (-1).

The possible change in soil and groundwater quality as a result of the drainage works is described in Chapter 9 Water.

[53] Preliminary soil investigation INEOS Manufacturing Belgium II nv, Scheldelaan 480 (plot 61T), 2040 Lillo (Antwerp), OVAM file: 4798, Arcadis Belgium nv/sa, dated 31/08/2020. On behalf of INEOS Manufacturing Belgium II nv.

8.3.5 Soil compaction and profile change

Compaction can occur when heavy machinery is driven over the soil, when heavy materials are stored (temporarily) on it, when embankments are built on it, etc., above compressible or structurally sensitive soils. The sensitivity of the soil to compaction is largely determined by its texture and moisture content.
Sandy soils are less sensitive than loamy or clayey soils. Dry soils are more stable than wet soils (from drainage class e onwards). Hardened surfaces are not sensitive to compaction.

The project area is a reclaimed site with a predominantly sandy texture, with moisture content varying from dry to moderately wet to very wet. The subsoil is slightly to moderately susceptible to compaction. Taking into account the land use designation, an industrial area that will mainly be built on, any compaction caused by the use of construction machinery and storage of materials during the construction phase is assessed as negligible (0).

Excavating soil and introducing foreign materials into the soil disrupts the original soil profile. During the milling work to remove the tree roots, profile changes of up to approximately 1 metre in depth were expected. Since the milling work is being carried out in filled-in soil without profile development, the effect of the profile change is considered negligible (0).

After removing the vegetation, trial trenches were dug to identify underground pipes, and test drilling and probing were carried out for geotechnical research and to check for the possible presence of explosives. Levelling work followed. For the contractor village, wells were dug for the separate collection of sanitary waste water, rainwater and industrial waste water. Excavation work was and is still being carried out for the construction of the supporting infrastructure for Project One, including facilities for drainage, rainwater buffering and reuse, sanitary and industrial waste water, underground storage tanks and underground pipes and cables. During the construction phase, part of the pile foundations (up to 25 to 30 metres deep) have already been laid. As the aforementioned earthworks are taking place in reclaimed land without profile development, the effect of profile change is considered negligible (0).

8.3.6 Mitigating measures and recommendations

Based on the impact assessments, mitigating measures are not considered necessary.

A number of project-integrated measures will be taken to prevent or limit accidental contamination during the construction phase:

- Strict adherence to the recommendations for use formulated in the completed and ongoing soil investigations and strict adherence to the provisions in the technical report in order to prevent the spread of contaminated soil;
- In the event of emergencies: take immediate action in consultation with the soil remediation expert to minimise/eliminate the impact on soil quality;
- Draw up and follow work procedures that must be checked periodically for efficiency;
- Hosing down materials at one or more central locations that are equipped with liquid-tight paving;
- Avoid using barrels and jerry cans as much as possible; if they are used, they must be equipped with good spouts and flexible filling hoses;
- Where possible, use environmentally friendly lubricating oils and greases (e.g. biodegradable oil).

8.4 Impact description and impact assessment – Operational phase

8.4.1 Change in soil quality

8.4.1.1 Storage of hazardous substances

Chapter 3 Project description of the EIA provides an overview of the storage of hazardous substances during the operational phase.

Ethane – the main raw material – will be stored in a large cryogenic tank. Ethane is gaseous at ambient temperature, which means it is stored at a very low temperature (-88.5 °C). At that temperature, ethane is liquid at atmospheric pressure (condensed gas). In the event of a leak, ethane will evaporate again, so there is no risk of soil contamination.

The main storage facilities for by-products and other chemicals are:

- Storage of C3 and C4 by-products in pressure tanks (so-called 'bullets');
- Storage of C5+ by-products in closed, atmospheric tanks;
- Storage of chemicals for the processes, water purification, water treatment, etc.: this concerns various, rather small tanks and chemical storage facilities, which are provided at several locations on the site.

A significant volume of the hazardous substances stored is gaseous under atmospheric conditions. This does not pose a risk of soil contamination.

All storage tanks are equipped with the soil protection measures prescribed by VLAREM (liquid-tight paving, containment, collection of potentially contaminated rainwater, overfill protection, etc.).

During the operational phase, the necessary measures will therefore be taken to prevent soil and groundwater contamination as a result of accidents during the storage of hazardous substances. The effects on soil and groundwater quality are assessed as limited negative (-1) to negligible (0).

8.4.1.2 Loading and transport of hazardous substances

Ship loading

The raw material ethane is transported by ship in liquid form at very low temperatures and unloaded from the ships into the cryogenic storage tank. Ethane is therefore also loaded in the form of a deeply cooled liquid (condensed gas). The loading installations used are completely closed. This loading process does not pose a risk of soil contamination, as any ethane that leaks will evaporate.

C3 and C4 hydrocarbons are transported in the form of liquefied gas. The transport installations used are completely closed. Here too, transport poses no risk of soil contamination, given the rapid evaporation under atmospheric conditions.

C5+ is transported in liquid form at normal pressure. The transport installations used are completely closed, including a closed drainage system to provide protection in the event of an incident.

Pipelines

The following products will be transported via (pipeline) pipeline:

- Ethylene (discharge),
- Propylene (discharge),
- C4 hydrocarbons (discharge),
- NaOH (supply).

The pipeline is designed to prevent leakage.

Lorries

For products transported by lorry, a loading area is provided at the respective storage tanks.

Loading and unloading of ships at the new jetty and loading and unloading of lorries is carried out in accordance with VLAREM (liquid-tight paving with capacity to collect leaks, collection and diversion of potentially contaminated rainwater to the water treatment plant) and also in accordance with the Code of Good Practice for Bulk Deliveries of Liquid Chemicals (Belgian Association of Chemical Distributors, 2007). During the operational phase, the necessary measures will therefore be taken to prevent soil and groundwater contamination as a result of accidents during the loading and unloading of hazardous substances.
Effects on soil and groundwater quality are assessed as limited negative (-1) to negligible (0).

8.4.2 Mitigating measures and recommendations

Based on the impact assessments, mitigating measures and recommendations for the operational phase are not considered necessary.

8.5 Cumulative effects

8.5.1 Quay wall

Construction of the new quay wall commenced in March 2021 and will be completed during the construction work for Project One. The construction of the quay wall was requested by and granted to the Antwerp Port Authority and was evaluated in an EIA during this permit process. The dredging and earthworks during the construction of the new quay wall overlap in time with the earthworks in the construction phase of Project One. However, the dredging and earthworks for the quay wall will be strictly separated from the earthworks during the construction phase of Project One. This means that soil and dredged material excavated and removed during the construction of the new quay wall will not come into contact with the soil excavated, removed and brought in during the construction work for Project One. No cumulative effects on the soil quality of the soils in the project area are therefore expected.

8.6 Mitigating measures

Based on the impact assessments, no additional mitigating measures are deemed necessary.

For an overview of the project-integrated recommendations to prevent or limit accidental pollution during the construction phase, please refer to §8.3.6.

8.7 Conclusion

The effects on the soil system are outlined in this chapter. Both the effects of the construction phase and the operational phase are discussed.

Construction phase

The construction phase has already been partially completed (see also the schedule in sections 3.1 and 3.2). In the initial situation, the project area was characterised by grasslands and scrub vegetation with forest. At the start of the project implementation, the vegetation on the entire site was removed and levelled. Once the entire development of the project area has been completed, the land use at the site will have changed to industrial applications.

Because construction took place immediately after site preparation, because the project area also has a flat relief in the planned situation, and because the soil texture is coarse-grained, no significant erosion is expected (negligible effect (0)).

During the further construction phase, drainage works will still be carried out that may affect soil stability.

To limit the impact of groundwater extraction, sheet piling has already been installed. The risk of unacceptable settlement can therefore be considered low. The effect of possible soil settlement or subsidence as a result of drainage during the construction phase can therefore be assessed as limited negative (-1) to negligible (0).

Accidental soil and groundwater contamination may occur during the construction phase. According to the provisions of the Soil Decree, the contractor must intervene immediately in the event of an emergency and take the necessary measures to prevent soil and groundwater contamination. The containers, tank sites and areas for hosing down materials comply with the VLAREM conditions. The necessary procedural agreements have been made; in addition, appropriate and sufficient intervention measures have been provided for. The impact of any incidents is assessed as limited negative (-1) to negligible (0).

Drilling, probing and earthmoving during the construction phase were carried out in accordance with current legislation. In the context of earthworks, a technical report was drawn up by a certified soil remediation expert describing the environmental quality of the soil. The quality of the soil and its exposure to contamination (negligible (0) to limited negative effect (-1)).

The soil that was and is being excavated and/or delivered during the construction phase will be temporarily stored at a number of locations on the site pending backfilling/use on site or removal. The temporary storage sites (TSSs) have been set up in accordance with the Best Available Techniques (BAT). The effect on soil quality is considered negligible (0) to limited negative (-1).

The subsoil of the project area is slightly to moderately sensitive to compaction. Taking into account the land use designation (industrial area), any compaction caused by the use of construction machinery and storage of materials during the construction works is assessed as negligible (0).

Since the earthworks will take place in reclaimed land without profile development, profile changes resulting from earthworks are considered negligible (0).

Based on the impact assessments, mitigation measures are not considered necessary for the construction phase; nevertheless, §8.3.6 contains a number of project-integrated recommendations to prevent or limit accidental pollution during the construction phase.

Operational phase

All storage tanks for hazardous substances are equipped with the soil protection measures prescribed by VLAREM (liquid-tight paving, containment, collection of potentially contaminated rainwater, overfill protection, etc.); liquid-tight paving is also provided for the loading areas. During the operational phase, the necessary measures will therefore be taken to prevent soil and groundwater contamination as a result of accidents during the storage of hazardous substances. The effects on soil and groundwater quality are assessed as limited negative (-1) to negligible (0).

Loading and unloading of ships at the new jetty and loading and unloading of lorries is carried out in accordance with VLAREM regulations (liquid-tight paving with capacity to collect leaks, collection and diversion of potentially contaminated rainwater to the water treatment plant).

During the operational phase, the necessary measures will therefore be taken to prevent soil and groundwater contamination as a result of accidents during the loading of hazardous substances. The impact on soil and groundwater quality is assessed as limited negative (-1) to negligible (0).

Based on the impact assessments, additional mitigation measures and recommendations for the operational phase are not considered necessary.

The dredging and earthworks for the construction of the quay wall will be strictly separated from the earthworks during the construction phase of Project One. There will be no cumulative effects on the soil quality of the soils in the project area.

9 Water

9.1 Groundwater

9.1.1 Methodology

9.1.1.1 Construction phase

The effects that will be discussed within the groundwater sub-discipline:

- The effect on groundwater quantity as a result of site preparation and the construction of (temporary) paved surfaces will be discussed in qualitative terms.
- Effect on groundwater levels, groundwater flow and quality as a result of drainage activities: The evaluation of the expected impact radius of planned drainage is determined on the basis of groundwater modelling, which takes into account, among other things, the groundwater reduction to be achieved, the duration of the drainage and soil characteristics. Based on the groundwater modelling, the secondary effects are assessed, namely:
  - Assessment of whether groundwater contamination is attracted or displaced by the drainage
  - Evaluation of the risk of salinisation
  - Estimation of the expected groundwater decline at sensitive locations (buildings, nature reserves);
  - Impact on groundwater extraction;
  - Impact on surface water quality as a result of the discharge of drainage water: qualitative discussion;
  - Impact on groundwater-dependent vegetation: this is discussed in Chapter 11 Biodiversity.
- Effect on groundwater quality as a result of the work (other than drainage): this is discussed in Chapter 8 Soil.

9.1.1.2 Operational phase

The following effects on groundwater are relevant in the operational phase:

- Effect on groundwater levels and flow as a result of adjustments (raising/lowering) to ground level, construction of drainage systems, influence of increasing paving on groundwater quantity: this is discussed on the basis of the groundwater model;
- Effect on groundwater quality: potential contamination of groundwater as a result of exploitation: for this, please refer to Chapter 8 Soil.

9.1.1.3 Groundwater model layout

A 3D hydrogeological model was created using ModFlow 2005 (impact on groundwater extraction and groundwater levels), linked to MT3DMS (version 5.30) (impact on contamination) and SEAWAT (version 4) (impact on saltwater intrusion).

Model area

The **model area** is based on the hydrological boundaries in the project area and is determined on the basis of the preconditions below. The surface area of the model area is therefore 14 km². The model area is shown in Figure 9-1. The 3D grid has a horizontal resolution of 10 m at the height of the Project One area. The cell size then increases by a factor of 1.1; at the model boundaries, the cell size is 100 m. Ten hydrogeological layers are included in the 3D grid. Vertically, the boundary of the model is determined by the top of the Boom formation, which forms a 75 m thick aquitard.
The following preconditions have been taken into account:

- The Scheldt, including bathymetry and water level;
- The Canal Dock, including bathymetry and water level of the Canal Dock;
- The Zandvliet lock;
- The southern model boundary is a no flow boundary.
- The tidal action in the Scheldt;
- The existing quay walls and the new quay wall at the Canal Dock and Insteekdok 1 and 2 (Antwerp Port Authority);
- The current ground level based on the DHM vII (Digital Elevation Model version 2);
- The existing drainage on the IMB site;
- Groundwater supply;
- Existing groundwater extraction.

Details regarding the boundary conditions of the groundwater model are included in Appendix 5 to this EIA.

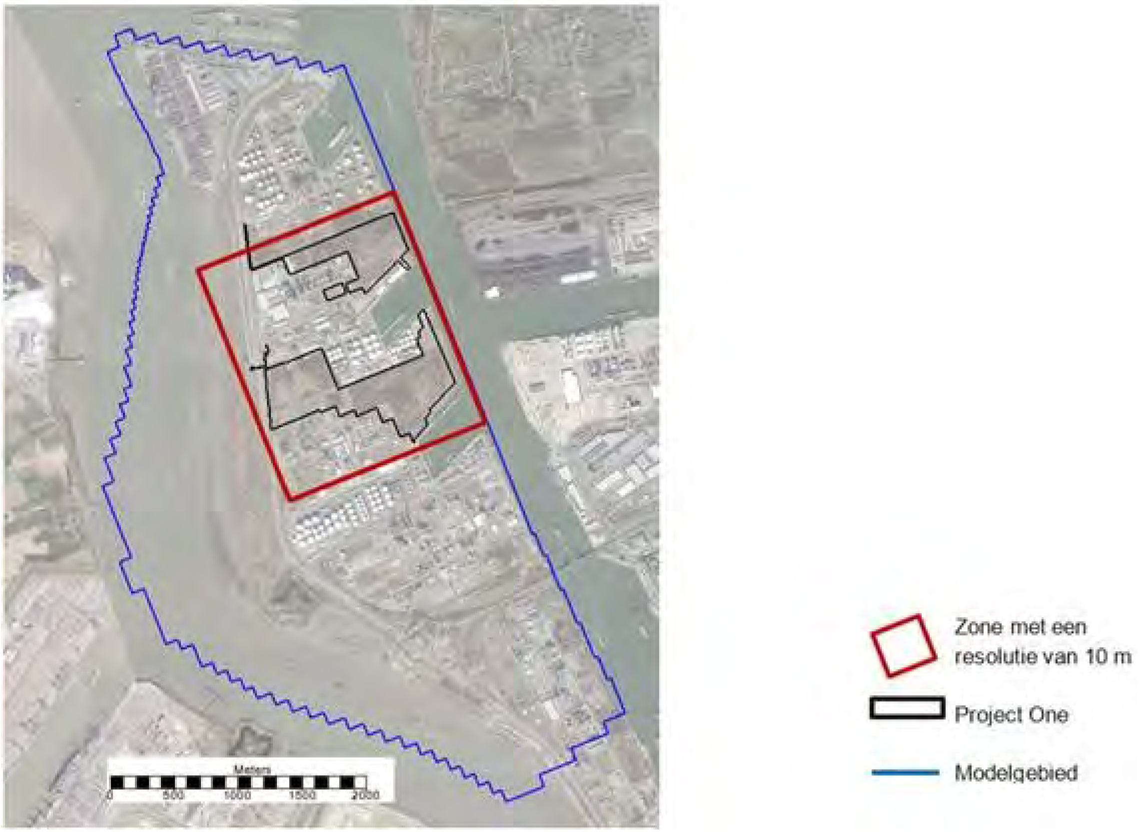

Figure 9-1: Demarcation of the model area

Geological layers

The 3D hydrogeological model has been drawn up for the project area and the local environment, based on the local hydrogeology. The following **geological layers** are taken into account:

- Artificial embankment resulting from the excavation of the Canal Dock.
- Formation of Flanders: this Quaternary deposit consists mainly of coarse sand, fine sand and clay with peat.
- Ghent Formation: this Quaternary deposit consists mainly of aeolian sand.
- Rozebeke Formation: this Quaternary deposit consists mainly of clay, sand and gravel.
- Merksplas Formation: this Neogene deposit consists mainly of medium to very coarse sand with clay/loam layers and glauconite.
- Formation of Lillo and Poederlee: this Neogene deposit consists mainly of fine to medium clayey sand with shells and glauconite.
- Kattendijk and Kasterlee Formation: this Neogene deposit consists mainly of fine to medium clayey sand with glauconite.
- Diest Formation: this Neogene deposit consists mainly of medium to coarse sand with glauconite.

- Berchem Formation: this Palaeogene to Neogene deposit consists mainly of fine to medium sand with glauconite and shells.
- Boom Formation: this Palaeogene deposit consists mainly of clay and loam.

Model properties

- The various model layers are listed in Table 9-1. The 3D hydrogeological model contains the various aquifers up to the Boom clay. Given the thickness of the Boom clay (approx. 75 m), the top of the Boom clay is the bottom of the model. The hydraulic aquifer/aquitard properties are derived from existing studies and model calibration.
- The existing saltwater distribution is derived from EM39 electromagnetic measurements carried out in the Project One area on 7 August 2020 (see § 9.1.2.3).

Table 9-1: Hydrogeological layers for Project One in the 3D hydrogeological model (Source: HCOV version 2)

Layer	Formation	Aquifer/Aquitard	Thickness [m]	Period	Model layer	Horizontal permeability (m/day)
Elevation	Anthropogenic	Aquifer	2 – 5	Quaternary	1	4
Polder	Flanders	Aquitard	1 – 8		2	0.01
Quaternary sand	Ghenten Rozebeke	Aquifer	1 – 2		3	10
Sand from Merkplas	Merksplas	Aquifer	2	Tertiary	4	10
Sand from Zandvliet and Merksem	Lillo and Poederlee	Aquifer	12		5	10
Clay from Kruisschans		Aquitard	3		6	0.1
Sand from Oorderen and Luchtbal		Aquifer	8		7	10
Sandy clay from Kattendijk and Kasterlee	Kattendijk	Aquifer	6		8	0
Sand from Diest	Diest	Aquifer	1.5		9	10
Sand from Berchem	Berchem	Aquifer	12		10	10
Boom clay	Boom	Aquitard	75		N/A	

-

The model was calibrated based on measurements of the groundwater level in monitoring wells. This is provided in Appendix 5 to this EIA.

The model includes the groundwater pollutants present in order to assess the impact of drainage on the spread of pollutants during the construction phase. The impact of interventions resulting from the operational phase is also determined.

Scenarios

In order to correctly assess the risks to and from the surrounding plots (settlement and spread of contamination), various scenarios are calculated. This allows the effectiveness of various preventive measures (infiltration and/or sheet piling) to be assessed.

The following **scenarios** are calculated using the groundwater model (see § 9.1.3.2.1):

For the construction phase:

- a. Scenario without measures: groundwater lowering (maximum lowering) as a result of drainage, without the provision of preventive measures.
- b. Sheet piling scenario: groundwater lowering as a result of drainage with implementation of the following preventive measures: in this scenario, the southern part of the Project One project area is completely surrounded by sheet piling or equivalent technology. For clarity, the term 'sheet piling' is used throughout the rest of this discussion to refer to sheet piling or equivalent technology. The sheet piling will be installed down to the polder clay. The main purpose of the sheet piling is to mitigate the effects of

limit groundwater extraction in the surrounding area if infiltration is not possible or cannot sufficiently mitigate the effects.

- In the previous EIA Ineos 'Project One' in Lillo, dated 16 July 2021 (and supplemented for biodiversity on 2 October 2023), another scenario was discussed, namely the infiltration scenario. Based on advancing insights and experience, this scenario was not retained, and only the sheet piling scenario is taken into account for the current EIA. The scenario without measures (scenario a) will not be implemented and is included in the EIA purely for comparison purposes.

For the operational phase:

- change in groundwater level as a result of the adjusted ground levels, the construction of a drainage system in zones K1, K2 and L1 (see Figure 9-26 in § 9.1.4.1) and the changes to the site's paving

In the northern part of the project area, drainage during the construction phase will be limited and an impact assessment will be carried out without specific preventive measures. Any necessary measures will be identified in the impact assessment and, if required, will be proposed at that stage.

Rise height maps will be drawn up for each aquifer.

9.1.1.4 Secondary effects of groundwater lowering

Salinisation

The impact on salinisation is calculated using the ModFlow groundwater module linked to SEAWAT. The impact is assessed on the basis of the increase in salinity and the possible change in the salinity class of the groundwater, based on the distribution class (according to De Moor & De Breuck, 1969, see Table 9-2). If the interventions cause a shift in quality class from fresh to salt, this is assessed as limited negative (-1), while a shift from salt to fresh is assessed as limited positive (+1). If the shift involves multiple classes, the salinisation is assessed as more negative/positive.

Table 9-2 Relationship between salinity (TDS) and conductivity (EC) for different salinity classes on the North Sea coast (De Moor & De Breuck, 1969)

Kwaliteitsklasse (De Moor & De Breuck, 1969)	TDS (mg/l) (De Moor & De Breuck, 1969)	Geleidbaarheid ot (mS/m)
VF : zeer zoet	<200	> 5
F : zoet	200 - 400	5 - 10
MF : matig zoet	400 - 800	10 - 20
WF : zwak zoet	800 - 1600	20 - 40
MB : matig brak	1600 - 3200	40 - 80
B : brak	3200 - 6400	80 - 160
VB : zeer brak	6400 - 12800	160 - 320
MS : matig zout	12800 - 25600	320 - 640
S : zout	>25600	> 640

Groundwater contamination

The possible movement of existing groundwater contamination is modelled using Modflow-MT3DS. The movement of the contamination is assessed in terms of possible damage and possible adverse effects on humans and the environment.

Soil settlement

The influence of drainage on **soil settlement** is calculated.

The reduction in the groundwater level increases the grain stresses in the subsoil. The settlement resulting from this increase is calculated using Terzaghi's formula (VMM 2019). This formula calculates the settlement per layer of 0.02 m (CPT value). The total settlement is the sum of the settlement calculated in the different layers.

$$s = \sum_i s_i = \sum_i \frac{\Delta h_i}{C_i} \ln\left[\frac{\sigma'_{nieuw;\,i}}{\sigma'_{oud;\,i}}\right] \text{, with} \quad C_i = \alpha_i \frac{q_{c,i}}{\sigma'_{o,i}}$$

- si = settlement of the layer [m]
- Δh = thickness of soil layer [m]
- Ci = compression constant of layer i [-], is determined based on Sanglerat's formula (VMM, 2019). This requires parameters that are estimated for each layer based on the sounding results and the soil type.
- σ'n,i = grain stress after load increase/groundwater lowering [kN/m²]
- σ'o,i = initial grain stress (before load increase/groundwater change) [kN/m²]

The settlement is calculated on the basis of the calculated groundwater lowering and the lowest measured groundwater level in the monitoring wells in the project area. It is assumed that settlements resulting from this lowest groundwater level have already occurred (WTCB, 2009). To this end, data from the measured groundwater levels in the existing monitoring wells were used. The details are shown in Appendix 5.

Groundwater extraction

For groundwater extraction within the drainage influence zone, the groundwater lowering is calculated at the groundwater extraction point using the groundwater model.

Groundwater-dependent vegetation

The impact of groundwater lowering on groundwater-dependent vegetation is described in Chapter 11 Biodiversity.

9.1.1.5 Assessment framework

The expected effects are described and assessed as follows:

Table 9-3: Assessment criteria for expected effects Groundwater

Significance level	Assessment criteria	Mitigating measures
Groundwater quantity		
Significant negative effect (-3)	Significant change in groundwater quantity with clear negative secondary effects (e.g. impact on groundwater-dependent vegetation).	Mitigating measures required or justification
Negative effect (-2)	Limited change in groundwater quantity with limited negative secondary effects.	Mitigating measures desirable or justification
Limited negative effect (-1)	Limited change in groundwater quantity without negative secondary effects.	No specific measures required in addition to existing regulations
Negligible effect (0)	No change in groundwater quantity expected.	N/A
Limited positive effect (+1)	Limited change in groundwater quantity without resulting in positive secondary effects.	N/A
Positiveeffect(+2)	Limited change in groundwater quantity with limited positive secondary effects.	N/A
Significant positive effect (+3)	Significant change in groundwater quantity with clear positive secondary effects.	N/A

Significance level	Assessment criteria	Mitigating measures
Groundwater quality		
Significant negative effect (-3)	Clear deterioration in groundwater quality. Risk of spread or occurrence of groundwater contamination with human toxicological or ecological risk, requiring remediation.	Mitigating measures required or justification
Negative impact (-2)	Moderate deterioration of groundwater quality. Risk of spreading or developing soil contamination without human toxicological or ecological risk. Remediation not necessary.	Mitigating measures desirable or justification
Limited negative effect (-1)	Limited deterioration in groundwater quality. Existing contamination without risk of spreading and without human toxicological or ecological risks remains.	No specific measures required in addition to existing regulations
Negligible effect (0)	No change in groundwater quality expected.	N/A
Limited positive effect (+1)	Limited improvement in groundwater quality.	N/A
Positiveeffect(+2)	Moderate improvement in groundwater quality. Risk reduced to acceptable level.	N/A
Significant positive effect (+3)	Clear improvement in groundwater quality. Risk is reduced to negligible level or eliminated entirely.	N/A

9.1.1.6 Mitigating measures

If negative effects occur as a result of the project, mitigating measures will be proposed (see § 5.3 for more information).

9.1.2 Reference situation

9.1.2.1 Hydrogeology

9.1.2.1.1 Hydraulic parameters

The Boom Formation, the basis of the overlying hydrogeological complex, is virtually impermeable. The sandy sediments above the Boom Formation form a coherent aquifer. This Tertiary, partly Quaternary aquifer is covered by Quaternary polder clay, which is considered to be poorly permeable from a hydrogeological point of view, but which has nevertheless been penetrated in various places during construction work (e.g. pile foundations for other projects). In the project area, the polder clay is covered by artificial embankments, which are also water-bearing and form the phreatic layer.

The hydrogeological characteristics of the geological formations are described in § 9.1.1.3. The hydrogeological coding (HCOV) versions 1 and 2 are given in Table 9-4.

Table 9-4: Hydrogeological structure and HCOV coding versions 1 and 2 (Source: DOV)

Layer	Formation	Aquifer/Aquitard	HCOV coding -v1	HCOV coding - v2
Raising	Anthropogenic	Aquifer	0110 - Landfills	A0110 Quaternary Aquifer Systems - Raised Areas
Polder	Flanders	Aquitard	0130 - polder deposits	A0131 Quaternary Aquifer Systems - clayey polder deposits of Waasland-

Low	Formation	Aquifer/Aquitard	HCOV coding -v1	HCOV coding - v2 Antwerp
Kreekrug	Flanders	Aquifer	0130- polder deposits	A0132 sandy creek ridges
Quaternary sand	Ghenten Rozebeke	Aquifer	0150 cover layers	A0151 – sandy cover layers A0170 Pleistocene deposits A0222 Sand from
Sand from Merkplas	Merksplas	Aquifer	0231- sands of Brasschaat and/or Merksplas	Merksplas
Sand from Zandvliet and Merksem	Lillo and Poederlee	Aquifer	0233 – sandy top of Lillo	A0223- Sands of Zandvliet and Merksem
Clay from Kruisschans		Aquitard	0200 – Kempen aquifer system	A0224 clayey sand from Kruisschans
Sand from Oorderen and Luchtbal		Aquifer	0200 – Kempen aquifer system	A0225 – Sands from Oorderen and Luchtbal
Sandy clay from Kattendijk and Kasterlee	Kattendijk and Kasterlee	Aquifer	0200 – Kempen aquifer system	A0240 Clayey Sands of Kattendijk and Kasterlee
Sand from Diest	Diest	Aquifer	0252 Sand of Diest	A0251Sandfrom Diest
Sand from Berchem	Berchemand Voort	Aquifer	0254 Sands of Berchem and/or Voort	A0254 Sand of Berchem
Boom clay	Boom	Aquitard	0300Formationof Boom	A0300 Formation of Boom

9.1.2.1.2 Groundwater levels and groundwater flow patterns

The water level measurements carried out as part of Project One (10/2019-10/02/2021) show that the groundwater level in the first aquifer at the project site varies between 0 and 3 m below ground level, with an average depth of 1.37 m below ground level. In the second aquifer, the groundwater level varies between 2.4 and 4.9 m below ground level, with an average depth of 3.4 m below ground level. The location of the monitoring wells is shown in Figure 9-2. The summary of the data is included in Table 9-5 and Table 9-6.

Figure 9-2 Location of existing monitoring wells

Table 9-5: Summary of the measurement series from the shallow monitoring wells in the project area.

Monitoring wells	Filter [m TAW]		Measurements		Water level m TAW			Water level m-mv		
	Bottom	Top	of	to	Min	Max	Average	Min	Max	Avg
BH005_shallow	5.47	4.47	15/10/19	11/07/22	6.51	7.79	7.06	1.70	0.42	1.15
BH011_shallow	4.8	3.8	15/10/19	10/07/22	5.42	6.30	5.76	1.89	1.01	1.55
BH018_shallow	5.3	4.3	15/10/19	18/06/22	4.73	6.75	6.23	2.96	0.94	1.46
BH025_shallow	7.02	6.02	11/12/19	08/07/22	6.99	8.31	7.47	1.81	0.49	1.33
BH027_shallow	6.29	5.29	11/12/19	07/07/22	7.15	8.38	7.67	1.08	-0.15	0.56
BH035_shallow	6.43	5.43	11/12/19	07/07/22	6.42	7.88	6.99	1.49	0.03	0.92
BH037_shallow	5.64	4.64	11/12/19	15/03/21	4.65	5.77	5.04	2.50	1.38	2.11
BH039_shallow	1.97	0.97	11/12/19	08/07/22	4.73	5.80	5.18	2.19	1.12	1.74
GW01	6.4	5.4	01/09/20	08/07/22	5.72	6.85	6.29	/	/	/
GW02	6.39	5.39	01/09/20	06/07/22	7.02	8.25	7.57	/	/	/

Table 9-6: Summary of the measurement series from the deep monitoring wells in the project area.

Monitoring wells	Filter (m TAW)		Start of measurement	Last measurement	Water level m TAW			Water level m-mv		
	Below	Top			Min	Max	Average	Min	Max	Avg
BH005_deep	0.34	-0.66	15/10/19	11/07/22	4.08	4.70	4.39	4.13	3.51	3.82
BH011_deep	-3.35	-4.35	15/04/20	11/07/22	4.49	4.93	4.74	2.82	2.38	2.57
BH18_deep	-2.8	-3.8	15/04/20	11/07/22	4.21	5.20	4.84	3.48	2.49	2.85
BH025_deep	-3.97	-4.97	11/12/19	08/07/22	3.58	4.38	4.01	5.23	4.42	4.79
BH027_deep	-3.27	-4.27	15/04/20	07/07/22	3.88	4.76	4.39	4.36	3.47	3.84
BH35_deep	-2.07	-3.07	15/04/20	07/07/22	3.95	5.53	5.00	3.96	2.38	2.91
BH37_deep	-2.73	-3.73	15/04/20	15/03/21	4.21	4.78	4.56	2.94	2.37	2.59

The figure below shows the groundwater level in the current situation in the phreatic aquifer. The recently approved quay wall by the Port of Antwerp is included in the reference situation because the quay wall or the sheet piling for the construction of the quay wall will be in place when the drainage of Project One starts. A local depression in the groundwater level is observed at Vesta, as a result of Vesta's pump and treat installation (as part of their groundwater remediation).

The general groundwater flow in the project area runs roughly eastwards, towards the Kanaaldok. In the confined aquifer (Figure 9-4), the flow is mainly towards the Scheldt.

Local groundwater flow is determined by site-specific characteristics such as the heterogeneous structure of the deposited sand layer, the variable thickness and composition of the underlying polder clay, the presence of the Scheldt and the Canal Docks, the presence of old pressure dikes, quay walls, drainage systems in the vicinity of the project area, etc.

Figure 9-3: Groundwater level (m TAW) in the current situation in the phreatic aquifer, including the permitted construction of the quay wall (dotted lines: watersheds)

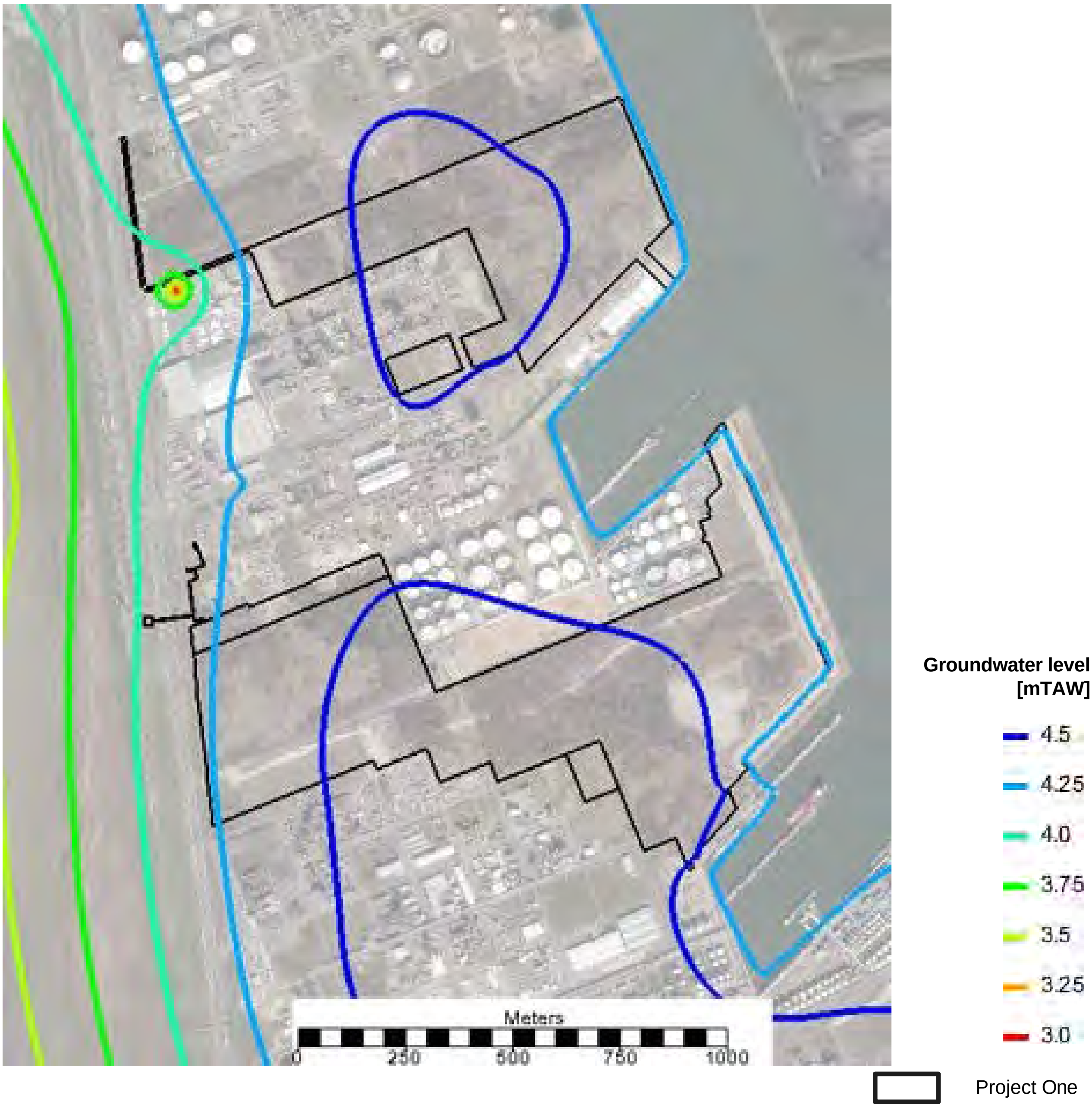

Figure 9-4: Groundwater level (m TAW) in the current situation in the confined aquifer

9.1.2.1.3 Drainage systems and sewerage

In the project area itself, PoAB installed a drainage system along the new quay wall at Insteekdok 1, which is currently under construction. At the IMB production site, there is an operational drainage system (with a flow rate of up to 20 m³/h) at a depth of 3.2 m below ground level, which determines the local groundwater level. The system runs under all installations and drains into Kanaaldok B2 via Inovyn's rainwater sewer system. A drainage system is also operational at Nippon Gases.

As part of Project One, a drainage system will be installed in several areas (see § 9.1.4.1).

9.1.2.2 Groundwater extraction

An overview of the licensed groundwater abstractions within a radius of 5 km from Project One is provided in Table 9-7. The overview is based on two selections (Figure 9-5 and Figure 9-6) made on DOV in March 2024. Given the size of the project area, Figure 9-5 and Figure 9-6 show the selection in relation to the northern and southern parts of the project area.

There are 115 groundwater extraction sites within a 5 km radius of the project area, as shown in Table 9-7. The project area is located outside the protection zones for water extraction areas; therefore, there will be no impact from the project.

The groundwater extraction by the Antwerp Port Authority concerns the permit for drainage for the construction of the quay wall and is therefore a temporary permit. The groundwater extraction by Vesta was requested in the context of soil remediation works.

Figure 9-5: Selection of groundwater extraction sites within a 5 km radius of the northern part of the project area (source: DOV, March 2024)

Figure 9-6: Selection of groundwater abstractions within a radius of 5 km from the southern part of the project area (source: DOV, March 2024)

Table 9-7. Licensed groundwater abstraction sites in the vicinity of the project area (source: DOV, March 2024)

Installation	Operator name	Water number	Permitted annual flow (m³/y)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2019-056948	INEOS MANUFACTURING BELGIUM NV (O & D BELGIUM)	ANT/gw1 -3972	,30000.0		0000 - Unknown	
2019-057425	GABRIELS	ANT-gw2/7454	3000.0	720	0252 - Sand from Diest	38
2019-057463	MOUS PETER	ANT-gw2/7474	4500.0	90.0	0251 - Sand from Kattendijk and/or lower sand layer from Lillo	25.0
2019 057636	Colas North	OVL-85641	12,500.0	84	0250 - Miocene Aquifer System	30
2019-058442	Denys	OVL-84797	30,000.0		0160 - Pleistocene deposits	
2019-058460	INEOS PHENOL GMBH & CO.KG	OVL-83895	30000.0	6000	0160 - Pleistocene deposits	5
2019-058463	HESSE-NOORD NATIE	OVL-83894	30000.		0160 - Pleistocene deposits	
2019-058472	THV ARTES - GROUP	VLA-00101-A	1344.0		0100 - Quaternary aquifer systems	
2019 058473	THV ARTES - GROUP	VLA-00102-A	4032.0		0100 - Quaternary aquifer systems	
2019-064100	GILLIS ERIC	OVL-83508	2939.0	10.	0400 - Oligocene Aquifer System	132.0
2019-069433	ASHLAND SPECIALTIES BELGIUM (FORMERLY HERCULES DOEL)	OVL-71168	70000.0	240.0	0400 - Oligocene Aquifer System	127.
2019-069434	ASHLAND SPECIALTIES BELGIUM (FORMERLY HERCULES DOEL)	OVL-71168	285,000.0	800.0	0100 - Quaternary aquifer systems	5
2019-069620	INDAVER	VLA-00192-A	400,000.0	2500.0	0254 - Sands of Berchem and/or Voort	52
2019-069620	INDAVER	VLA-00192-A	400,000.0	2500.0	0254 - Sands of Berchem and/or Voort	52
2019-070483	DINGEMANS MOUT NV	ANT/gw1 -3991	350,000.0	1100.0	0250 - Miocene Aquifer System	50.0
2019 070841	MOUS PETER	ANT-gw3/322	2000.0		0230 - Pleistocene and Pliocene aquifer	25.0
2019 070842	Mous Lia	ANT-gw3/321	3000		0230 - Pleistocene and Pliocene aquifer	25.0

Installation	Operator name	Water number	Permitted annual flow (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2019-070714	LAUNDRY STABROEK	ANT-gw2/4735	2000		0252 - Sand from Diest	41
2019-071298	PROVINCIAL GOVERNMENT OF ANTWERP	ANT/gw1-3009	,000.0	54	0250 - Miocene Aquifer System	52.
2019-085744	NOVA NATIE LOGISTICS	OVL-80810	5636.0	40.0	0400 - Oligocene Aquifer System	110.0
2019-087075	ANTWERP WELDING SUPPLY NV	ANT/gw1-2845	400.0		0233 - Sandy top of Lillo	20
2019-088030	CASSIMON LUC	ANT/gw2-6210	1460.0	4	0254 - Sands of Berchem and/or Voort	70.0
2019-088214	COSTERMANS LV	ANT-00219-A	2648	10	0254 - Sands of Berchem and/or Voort	64.
2019-088215	COSTERMANS LV	ANT-00219-A	360	360.0	0233 - Sandy top of Lillo	30
2019-089456	WEST CONSTRUCT	VLA-00138-A	36720		0100 - Quaternary aquifer systems	5.0
2019-089714	Shell Netherlands Refinery	VLA-00160-A	1288		0100 - Quaternary aquifer systems	
2019-089715	Shell Netherlands Refinery	VLA-00161-A	882.0		0100 - Quaternary aquifer systems	1.5
2019-089718	Shell Netherlands Refinery	VLA-00164-A	812		0100 - Quaternary aquifer systems	
2019-089725	STADSBADER	ANT-00628-A	131760.0		0000 - Unknown	4.
2019-089740	CANALCO	OVL-00378-A	1800.0		0100 - Quaternary aquifer systems	2.
2019-089761	THV ARTES - GROUP	VLA-00166-A	2688		0100 - Quaternary aquifer systems	
2019-089762	THV ARTES - GROUP	VLA-00167-A	1344.0		0100 - Quaternary aquifer systems	2.
2019-089763	THV ARTES - GROUP	VLA-00168-A	2688.		0100 - Quaternary aquifer systems	
2019-089801	Air Liquide Industries	ANT-00513-A	65000.0		0000 - Unknown	

Installation	Operator name	Water number	Permitted annual flow (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2019-089835	ELIA ASSET	VLA-00171-A	75000.0		0230 - Pleistocene and Pliocene aquifer	10.0
2019-089994	GRAVO	VLA-00183-A	3360.		0100 - Quaternary aquifer systems	5.
2019-090017	Van Hooydonck Sonja	ANT 00769-A	3360.0		0100 - Quaternary aquifer systems	5.
2019-090295	Shell Netherlands Chemicals	VLA-00202-A	3360.0		0100 - Quaternary aquifer systems	
2019-091939	AQUAFIN	ANT-00838-A	1.4016E+06		0100 - Quaternary aquifer systems	6.0
2020-092731	ELIA ASSET	ANT-01245-A	27000.		0100 - Quaternary aquifer systems	10
2020-092838	Air Liquide Industries and Fluxys	VLA-00098-A	77853		0100 - Quaternary aquifer systems	
2020-093099	Sludge and Co Processing Plant	VLA-00633-A	108000.0	120	0100 - Quaternary aquifer systems	3.5
2020-093111	BELLEAQUA	ANT-01260-A	1680.0		0100 - Quaternary aquifer systems	5.
2020-093227	GRAVO	ANT-01308-A	9408.0	192.0	0100 - Quaternary aquifer systems	5.0
2020-093228	LARECO - Infrastructure	ANT-01309-A	30000.		0000 - Unknown	4
2020-093238	Visser & Smit Hanab	ANT-01313-A	57888.0	864.0	0100 - Quaternary aquifer systems	4.5
2020-093496	THV ARTES - GROUP	ANT-01474-A	672.0	96.0	0100 - Quaternary aquifer systems	2.5
2020-093529	INOVYN Manufacturing Belgium	ANT 00970-A	20000		0100 - Quaternary aquifer systems	
2020-093834	BELLEAQUA	ANT-01585-A	1200.0	240.	0100 - Quaternary aquifer systems	5
2020-094579	Covestro	ANT 01479-C	30000.0		0000 - Unknown	
2020-095288	JT Renovation	ANT-01882-A	151537.0		0230 - Pleistocene and Pliocene aquifer	8.0

Installation	Operator name	Water number	Permitted annual flow rate (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2020 095322	LARECO - Infrastructure	ANT-02071-A	4000.0		0000 - Unknown	4
2020 095450	Temporary partnership ARTES ROEGIERS - ARTES DEPRET - AERTSSEN - GHENT DREDGING	VLA-00644-A	2.433E+06		0251 - Sand from Kattendijk and/or lower sand layer from Lillo	5.0
2020 095450	Temporary partnership ARTES ROEGIERS - ARTES DEPRET - AERTSSEN - GHENT DREDGING	VLA-00644-A	2,433E+06	6651.0	0251 - Sand from Kattendijk and/or lower sand layer from Lillo	5
2020-095618	Thimbles Kurt	ANT-02156-A	25200.0	360	0000 - Unknown	2
2021 096026	VESTA TERMINAL ANTWERP	VLA-00300-A	28603.0	910.8	0100 - Quaternary aquifer systems	
2021-096407	OP de Beeck	OVL-01343-A	6000.0	144.0	0100 - Quaternary aquifer systems	8
2021-097165	AQUAFIN	ANT-02819-A	220000.		0200 - Kempens Aquifer System	8.0
2021 098213	DURABRIK CONSTRUCTION COMPANIES - DURABRIK ENTREPRISES DE CONSTRUCTION	ANT-03130-A	259200.0	1920.0	0230 - Pleistocene and Pliocene aquifer	5.56
2021-100190	Van den Berghe Brothers	OVL-02096-A	7087.0	168	0000 - Unknown	4
2022 101490	Antwerp Port Authority	VLA-00408-A	5.790178E+06		0200 - Kempen Aquifer System	44.0
2022-101,490	Antwerp Port Authority	VLA-00408-A	5.790178E+06	15863.5	0200 - Kempen Aquifer System	44
2022-101861	Monument Chemical	OVL-02636-A	15000.0		0000 - Unknown	
2022-102157	Visser & Smit Hanab	OVL-02768-A	2400.0		0100 - Quaternary aquifer systems	5
2022-102284	Antwerp - Limburg - Liège Pipeline - Pipe-Line Anvers-Limbourg-Liège	VLA-00483-A	2550.0		0100 - Quaternary aquifer systems	
2022-102414	DILIEN METALWORKS	ANT-02884-A	165.0	22	0100 - Quaternary aquifer systems	5
2022-102417	Sludge and Co - Processing Centre	VLA-00502-A	25000		0100 - Quaternary aquifer systems	
2022-102965	MANUS	ANT-02792-A	163500.0	2356.0	0230 - Pleistocene and Pliocene aquifer	9

Installation	Operator name	Water number	Permitted annual flow (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2022-103237	Van de Perck Peter	ANT-02950-A	2904.0	134.	0000 - Unknown	4
2022-103406	Verstrepen Wim	OVL-03273-A	204.0		0100 - Quaternary aquifer systems	3.5
2022-103437	VERBRAEKEN INFRA	OVL-03290-A	4206.		0100 - Quaternary aquifer systems	3.
2022-103460	PETROCHEMICAL PIPELINE SERVICES BV	VLA-00544-A	504.		0100 - Quaternary aquifer systems	4.0
2022-103461	PETROCHEMICAL PIPELINE SERVICES BV	VLA-00545-A	1344.0		0100 - Quaternary aquifer systems	4.0
2022-103462	PETROCHEMICAL PIPELINE SERVICES BV	VLA-00546-A	504.		0100 - Quaternary aquifer systems	4.
2022-103554	THV ARTES - GROUP	VLA-00575-A	672.		0100 - Quaternary aquifer systems	2.5
2022-103609	THV ARTES - GROUP	VLA-00580-A	672		0100 - Quaternary aquifer systems	2.5
2022-103614	THV ARTES - GROUP	VLA-00582-A	672		0100 - Quaternary aquifer systems	2.5
2022-103627	THV ARTES - GROUP	VLA-00588-A	672		0230 - Pleistocene and Pliocene aquifer	2.5
2022-103629	THV ARTES - GROUP	VLA-00589-A	672.		0100 - Quaternary aquifer systems	2.5
2022-104109	Bayer Agriculture	ANT-02999-A	27000.0	336.0	0100 - Quaternary aquifer systems	11
2022-104542	Van den Berghe Brothers	OVL-03543-A	1085		0000 - Unknown	5
2022-104581	LANXESS	OVL-4836-A	25000.0		0100 - Quaternary aquifer systems	8
2022-104596	Van den Berghe Brothers	OVL-03569-a	5263.		0000 - Unknown	3
2022-104665	D'Hollander Equipment	deceased 05394-A	1200.0		0000 - Unknown	3.55
2022-104741	THV ARTES - GROUP	OVL-03635-A	672.		0230 - Pleistocene and Pliocene aquifer	2.5
2022-		OVL-				

Installa tion	Operator name	Water number	Permitted annual flow (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2022-104760	THV ARTES - GROUP	OVL-03644-A	672.0		0100 - Quaternary aquifer systems	2.5
2022-105365	Lareco Infra	OVL-04025-A	1509.		0000 - Unknown	4
2022-105616	Keymolen Bert Petrus	OVL-04178-A	30000		0000 - Unknown	
2022-105871	Port of Antwerp	VLA-00625-A	438000.0		0000 - Unknown	
2022-106048	Van den Berghe Brothers	OVL-04422-A	10000.		0000 - Unknown	3
2022-106087	Fabricom Infra Sud	OVL-04449-A	3089.		0100 - Quaternary aquifer systems	4.0
2022-106129	Van Goethem Toon	OVL-04477-A	3024.		0000 - Unknown	2
2022-106388	Heyrman-De Roeck	OVL-04585-A	30000		0000 - Unknown	
2022-106454	VAN MOER HECTOR AND SONS	OVL-04617-A	2000		0100 - Quaternary aquifer systems	5
2022-106728	Van den Berghe Brothers	OVL-04748-A	15000		0000 - Unknown	5
2023-107081	WILLEMEN INFRA	2022171 167-A	,129,900		0000 - Unknown	3.5
107694 2023-	LARECO - Infrastructure	756-A 2023004	560.0		0000 - Unknown	6.0
107722 2023- 107807	road construction	329-A 2022169 584-A	856.0		0130 - Polder deposits	5.6
2023-108015	STADSBADER	2022172 454-A	29663.0		0100 - Quaternary aquifer systems	6.0
2023 108026	GRAVO	2023015 449-A	3600.0	240.	0100 - Quaternary aquifer systems	5.0
2023-108915	GRAVO	2023015 880-A	3600.0	240.	0100 - Quaternary aquifer systems	5.0
2023-	WILLEMEN INFRA	2023031	32673.0		0000 - Unknown	2.0

Installation	Operator name	Water number	Permitted annual flow rate (m³/a)	Permitted daily flow rate (m³/d)	Aquifer (licence)	Permitted depth (m)
2023-109015	THV ARTES - GROUP	2023041093-A	6268.0		0100 - Quaternary aquifer systems	2.0
2023-109052	Van Dyck Willem	2023042445-A	3360.0		0100 - Quaternary aquifer systems	6.0
2023 109106	Van Dyck Willem	2023042372-A	3360.0		0100 - Quaternary aquifer systems	6.0
2023-109107	Vercauteren Ludo	2023005571-A	5018.0		0100 - Quaternary aquifer systems	5.0
2023-109322	DE NEEF CHEMICAL PROCESSING	2023029403-A	3000.0		0000 - Unknown	4.0
2023-109740	FLUXYS BELGIUM	VLA-00655-A	93870.0	1800.0	0160 - Pleistocene deposits	
2023-109740	FLUXYS BELGIUM	VLA-00655-A	2400.0	146580.	0160 - Pleistocene deposits	3.5
2023-109849	LARECO - Infrastructure	2022108899-A	,1771.0		0000 - Unknown	4.0
2023-109939	Artes Roegiers	2019116694-A	672.0		0100 - Quaternary aquifer systems	2.5
2023-109940	Artes Roegiers	2019116751-A	672.0		0100 - Quaternary aquifer systems	2.5
2023-109942	Artes Roegiers	2019117194-A	672.0		0100 - Quaternary aquifer systems	2.5
2023 109945	Denys	2019149229-A	9840.0		0000 - Unknown	
2023-110097	LARECO - Infrastructure	2023062873-A	45.0		0000 - Unknown	4.5

9.1.2.3 Groundwater vulnerability and salinisation

According to the Groundwater Vulnerability Map of Antwerp (De Breuck, 1986, available at www.dov.vlaanderen.be), the project area is entirely located in a zone characterised as **highly vulnerable (index Ca1)**. This means that:

1. the exploitable aquifer consists of sand;
2. there is no covering layer;
3. the thickness of the unsaturated zone is no more than 10 metres.

Based on these characteristics, the groundwater in the project area is classified as highly vulnerable.

The groundwater is designated as saline on the groundwater salinisation map (De Breuck, 1989, available at www.dov.vlaanderen.be). Near the Scheldt, in the former polders, the water in the phreatic zone is naturally saline. Data on the depth of the interface between salt and fresh groundwater are missing from this map (Figure 9-7). In 2014/2017, a new salinisation map was drawn up based on helicopter measurements. However, the project area was not surveyed during these helicopter flights in 2014/2017.
Due to this gap in the salinity map, two deep boreholes with salinity measurements were drilled as part of Project One. Two monitoring wells, BH55A and BH55B, were installed (see Figure 9-8) to determine the fresh-salt groundwater distribution. The monitoring wells were installed to the top of the Boom clay, i.e. to 60 m below ground level and 58 m below ground level, respectively. The fresh-salt groundwater distribution was determined using EM-39 measurements. The measurements were carried out on 7 August 2020. Four parameters were measured:

1. The apparent electrical conductivity at short distances ("Short Conductivity or SCON");
2. The apparent electrical conductivity at long distances ("Long Conductivity or LCON");
3. Natural gamma radiation;
4. The internal temperature of the probe.

The profiles are shown in Figure 9-9. The following can be deduced from this:

- **BH55A**: the measured conductivity is relatively low at the top and varies between 100 and 150 mS/m to 32.0 m below ground level. The conductivity values then increase to approximately 400 mS/m at a depth of 40.0 m below ground level. Deeper down, a less pronounced linear increase is visible up to approx. 500 mS/m at a depth of 53.0 m below sea level, after which the conductivity values remain stable.

- **BH55B:** the measured conductivities are between 50 and 250 mS/m up to approx. 20.0 m below ground level. Between 10.0 and 11.0 m-mv, a peak of up to 250 mS/m was measured, after which the conductivity values decrease to approx. 50 mS/m between 13.0 and 16.0 m-mv. Between 20.0 and 44.0 m-mv, the conductivity values gradually increase from approximately 250 mS/m to 400 mS/m, after which they remain stable between 350 and 400 mS/m.

The relationship between the salt content expressed in Total Dissolved Solids and the conductivity is shown in Table 9-8. A comparison of the conductivities on the measurement profiles and the values in Table 9-8 clearly shows that the transition between fresh and salt groundwater is gradual rather than sudden.

At monitoring well BH55A, it can be stated that there is a transition in salinity at approximately 35 metres below ground level. Based on Table 9-8, the shallow groundwater is brackish and the deeper groundwater is moderately salty.

At monitoring well BH55B, the groundwater is moderately brackish to brackish to a depth of approximately 18 m below ground level, and deeper groundwater is very brackish to moderately salty.

Compared to surface water bodies, the average conductivity of the Scheldt[54] is
1587 mS/m, and that of the Kanaaldok[55] 1320 mS/m.

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[54] Measuring point VMM 157000, see Appendix 5
[55] Measuring point VMM 80400, see Appendix 5

Table 9-8: Relationship between salinity (TDS) and conductivity (EC) for different salinity classes on the North Sea coast (De Moor & De Breuck, 1969)

Kwaliteitsklasse (De Moor & De Breuck, 1969)	TDS (mg/l) (De Moor & De Breuck, 1969)	Geleidbaarheid ot (mS/m)
VF : zeer zoet	<200	> 5
F : zoet	200 - 400	5 - 10
MF : matig zoet	400 - 800	10 - 20
WF : zwak zoet	800 - 1600	20 - 40
MB : matig brak	1600 - 3200	40 - 80
B : brak	3200 - 6400	80 - 160
VB : zeer brak	6400 - 12800	160 - 320
MS : matig zout	12800 - 25600	320 - 640
S : zout	>25600	> 640

In summary, it can be stated that, based on the groundwater vulnerability map, the groundwater in the project area is designated as highly vulnerable to contamination. Any extraction of fresh water could result in the intrusion of brackish to salty groundwater from the Scheldt or from a salty sublayer in the groundwater reservoir above the Boom clay.

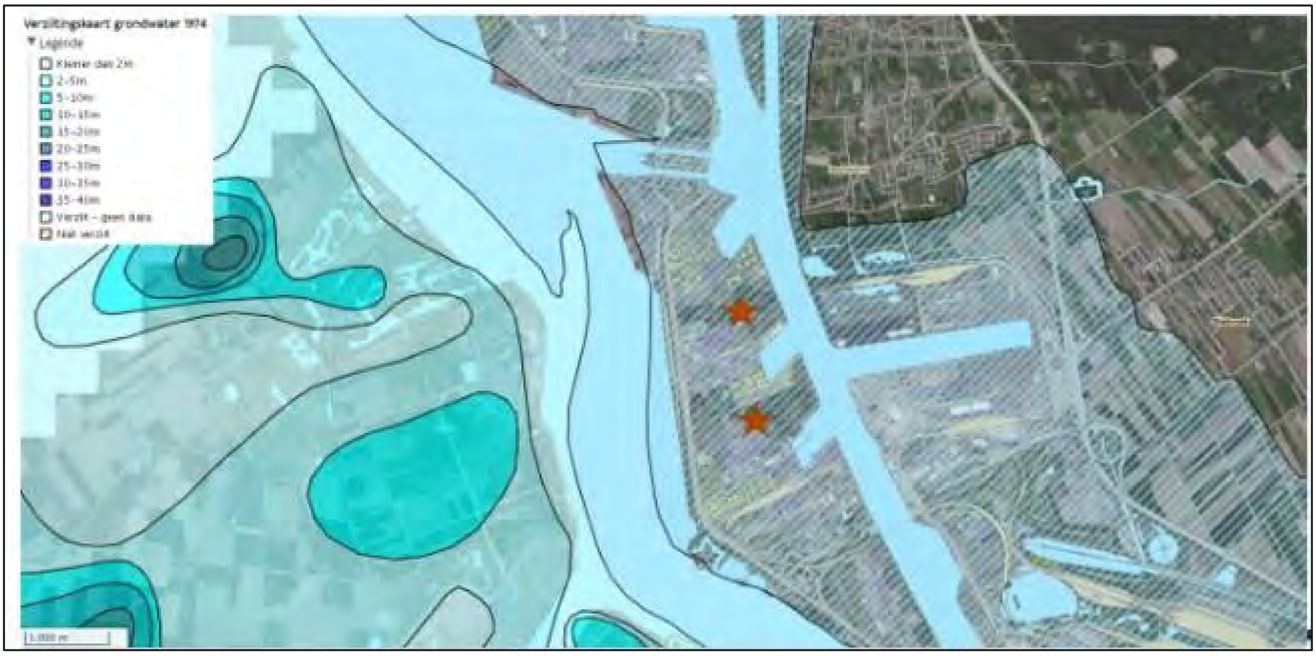


Figure 9-7: Groundwater salinisation map 1974 with indication of northern and southern parts of the project area (orange stars) (Source: DOV)

Figure 9-8: Location of the deep monitoring wells for salinity measurements

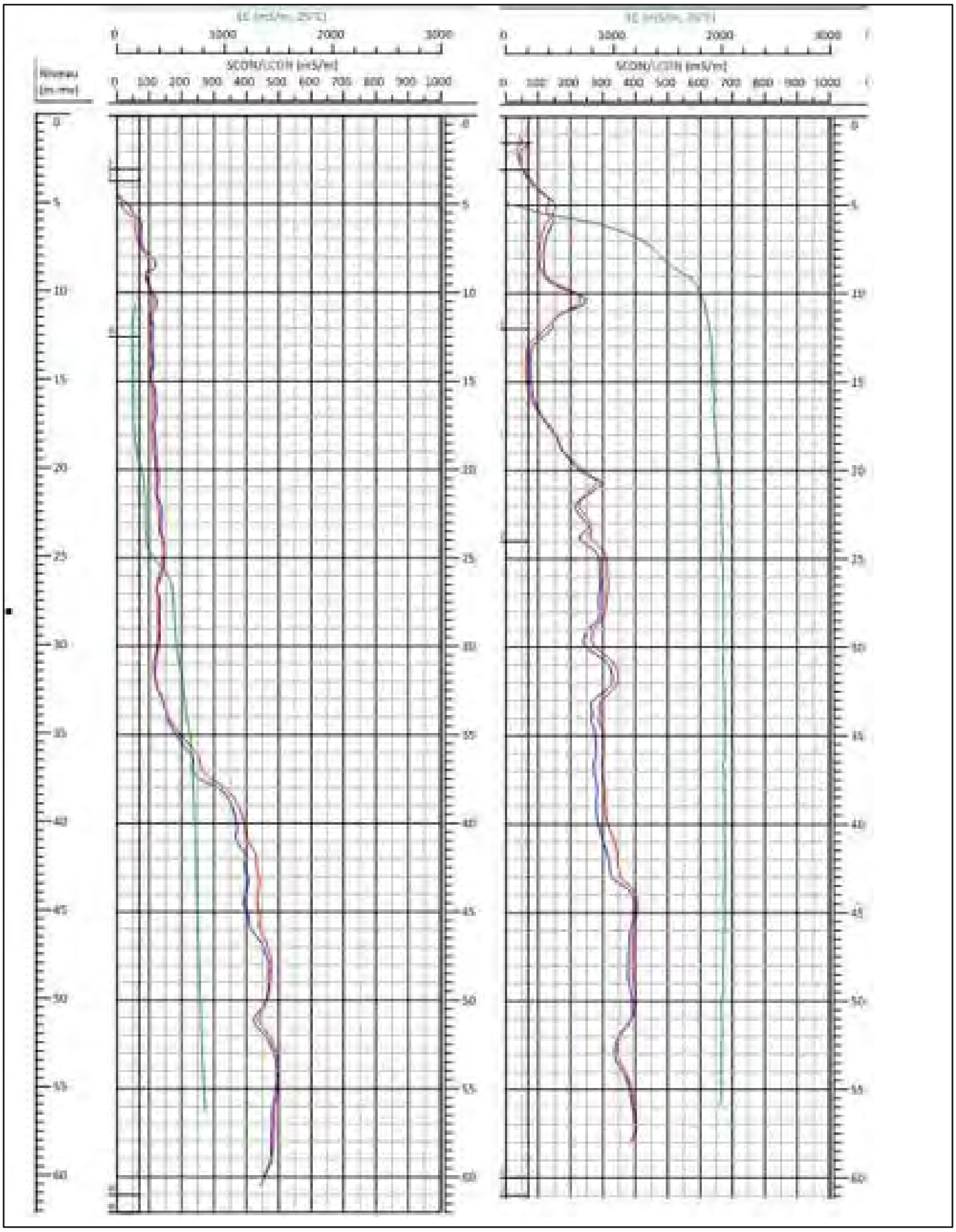


Figure 9-9: EM-39 - Measurement profiles (left: BH55A; right: BH55B) dated 07/08/2020 - Blue line: apparent electrical conductivity at short range (SCON); red line: apparent electrical conductivity at long range (LCON); green line: measured conductivity in the PB (not relevant)

9.1.2.4 Groundwater quality

For a discussion of groundwater quality in the reference situation, please refer to Chapter 8 Soil.

9.1.3 Effect description and effect assessment – construction phase

9.1.3.1 Change in infiltration and groundwater quantity

Site preparation, including the removal of vegetation, has resulted in changes to evapotranspiration and infiltration in the project area. Vegetation influences groundwater management through evapotranspiration, which is the sum of evaporation and transpiration.

Evaporation is the process whereby precipitation intercepted by the canopy evaporates again, as does the water that falls on the ground. The interception of precipitation is determined by the size and density of the canopy. In addition, there are differences between deciduous and coniferous species, with interception being greater in conifers than in deciduous trees.

Transpiration is the process whereby water absorbed by tree roots evaporates through the stomata of the leaves. There are slight differences in transpiration between different tree species, but greater differences between conifers and deciduous trees.

When trees and vegetation are removed, the transpiration component is partially lost. This can increase infiltration, provided that the soil is not completely compacted as a result of structural deterioration and compaction. The runoff regime has changed partially because more rainwater reaches the soil and the surface storage fills up more quickly, as the retention by the canopy has disappeared. However, after removing the vegetation, paved surfaces are constructed, which reduces the positive effect on infiltration and even greatly reduces it compared to the terrain with vegetation.

After site preparation, further development of the project area with **the construction of** (temporary or permanent) **paved surfaces** for roads, construction zones and site huts will result in a local drying effect, which will translate into a lower groundwater level. The pavements constructed during the construction phase will (largely) remain in place for the operational phase. The effects of the permanent pavement on groundwater quantity were included in the groundwater model and discussed in § 9.1.4.1. During the construction of the new permanent road network, the contractor village and the car parks, the provisions of the urban development regulations regarding rainwater wells, infiltration facilities and buffer facilities must be taken into account.

In addition to the (permanent) roads and planned car parks during the construction phase, infiltration channels will be provided. These are trenches that are dug out and filled with crushed stone so that water can be buffered and infiltrate into the subsoil. The car park will be constructed using water-permeable asphalt.

The impact of the construction of paved surfaces is assessed as having a limited negative impact (-1) due to the local drying effect. In the planned situation, the project area will be fully developed as an industrial site, which means that the drying of the project area will not have any significant secondary effects.

9.1.3.2 Drainage

During the construction phase of Project One, temporary drainage will be necessary for various works below ground level (foundations, underground pipes, collection pits, basins, etc.). Some of this work has already been carried out (see schedule in sections 3.1 and 3.2). During the preparatory works, a number of test trenches were dug (carried out in 2022-2023). No drainage was required for this. The description of the various scenarios, the necessary drainage depth and zones, and the drainage flow rate and volume are described below. As part of the EIA, groundwater modelling was carried out to assess the effects of drainage on the environment (see description in § 9.1.1.3).

9.1.3.2.1 Drainage scenarios

a) Scenario without preventive measures

In the scenario without preventive measures, groundwater is extracted and discharged into Canal Dock B2. No preventive measures are planned to limit the impact radius of the drainage, which may result in negative effects in terms of soil settlement, groundwater-dependent vegetation, existing groundwater contamination, etc. This scenario will not be implemented, but is only presented in the EIA as a basis for comparison in order to assess the planned preventive measures.

The modelled total volumes of water (over 24 months) for this scenario are shown in Table 9-11.

b) Dam wall scenario

The sheet piling scenario involves installing sheet piling or equivalent technology into the polder clay surrounding the construction site, as shown in Figure 9-10. This creates a closed construction pit. The groundwater extracted from this closed construction pit is purified, if necessary, and discharged into Canal Dock B2. For this scenario, the risk of subsidence and the impact on the movement of contaminants is virtually negligible. The calculations show a temporary groundwater rise at the Bayer site of approximately 0.20 m at the level of the existing installation. The impact of this groundwater rise is virtually negligible.

The temporary sheet piling ensures that groundwater outside the protected volume is not extracted (with the exception of leakage flows under and through the sheet piling), which means that no settlement will occur outside these sheet piles.

The modelled total volumes of water (over 24 months) for this scenario are shown in Table 9-11.

Figure 9-10: Location of the sheet piling during the construction phase

9.1.3.2.2 Drainage specifications

Groundwater lowering

The groundwater level must be lowered to 0.5 m below the required excavation depth. This was defined per zone (see Table 9-9 and Table 9-10), the location of the zones is shown in Figure 9-11. The excavation depth and drainage schedule differ depending on whether the excavation is for buildings/equipment/structures or for underground facilities. This was taken into account in the groundwater model. Construction pits are planned. Rainwater falling on these construction pits will be drained by means of horizontal drains. This rainwater constitutes a significant part of the drainage flow that will be discharged into the Kanaaldok. Where horizontal drains are provided, the reduction will be per zone. Figure 9-11 below shows these zones as assumed in the groundwater model.

Figure 9-11: Drainage zones (with zone number indicated)

Figure 9-12: Drainage zones with horizontal drains

Table 9-9: Maximum excavation depth (m) for the different zones

Zone no.	Excavation depth during construction phase (m below ground level)	
	Buildings/equipment/structures	Underground support infrastructure
01 - Northern zone (Contractor, Power & Telecom)	1.0	1.5
0014	N/A	2
0015	2	3
0016	2	3
0017	3	2.5
0018	2.85	2
0019	1.5	2
0020	2	3.5
0021	2	3.5
0022	2	3
0023	2	2.5
0024	2	2
0026	2	2
ECR	2.5	3
Deep excavation plot 21	Pumps: 5* Basin: 5*	4*
Deep excavation ECR	4.3	N/A

*: these excavations will be carried out in a closed construction pit; no drainage outside the construction pit is planned for this purpose.

Table 9-10: excavation depth of construction pits

Construction pit	Excavation depth (mTAW)
G-bathtub	7.4
Jb bathtub	8.40
Jd_1 bathtub	8.40
Jc-bathtub	7.40
Jd_2-bathtub	7.90
Jd_3 bathtub	8.40
K1bc-bathtub	6.55
K1a bathtub	7.25
K1d bathtub	8.25
K2d bathtub	7.30
K2abc bathtub	6.78
L1b_2 bathtub	7.15
L1b_1 bathtub	7.80

Drainage schedule

The total construction phase requiring drainage is expected to take 24 months. The first phase of drainage was carried out in 2023 (see Figure 9-13) until July 2023. The works were then paused for several months. The next phase was continued in January 2024 (see Figure 9-14). The various drainage operations follow each other or overlap during these periods. For some areas, drainage is short-term, while other areas are drained for a longer period of time. The relevant duration was included in the groundwater model for each area.

		Start	Stop	1	2	3	4	5	6	7	8	9	10	11	12
Buildings/Equipment/Structures	7650-8230-01-800-0014	1 January 24	1 July 24												
	7650-8230-01-800-0015	01-Jul-23	23 July 23												
	7650-8230-01-800-0016	01-Jul-23	23 July 23												
	7650-8230-01-800-0017	01-Jul-23	23 July 23												
	7650-8230-01-800-0018														
	7650-8230-01-800-0019	/ 01-Jul-23	/ 23 July 23												
	7650-8230-01-800-0020	1 July 23	23 July 23												
	7650-8230-01-800-0021														
	7650-8230-01-800-0022	/ 01-Jan-23	/ 23 July												
	7650-8230-01-800-0023	1 March 23	1 July												
	7650-8230-01-800-0024														
	7650-8230-01-800-0026	/ 01-Jan-23	/ 23 July												
	7650-8230-01-ECR	01-Mar-23	23 July												
	7650-8230-01-150-0001	01-Jan-23	23 July												
	7650-8230-01-800-0014	1 May 23	23 July 23												
	7650-8230-01-800-0015	1 July 23	23 July 23												
Sub-period for deep underground services	7650-8230-01-800-0016	01-Jul-23	23 July 23												
	7650-8230-01-800-0017	/	/												
	7650-8230-01-800-0018	01 May 23	23 July 23												
	7650-8230-01-800-0019	01 July 23	23 July 23												
	7650-8230-01-800-0020	01-Jul-23	23 July												
	7650-8230-01-800-0021	/	/												
	7650-8230-01-800-0022	01 May 23	23 July												
	7650-8230-01-800-0023	/	/												
	7650-8230-01-800-0024	01 May 23	23 July												
	7650-8230-01-800-0026	01 May 23	23 July												
	7650-8230-01-ECR	01-Mar-23	23 July												
	7650-8230-01-150-0001	01-Jan-23	23 July												
			23 July												
	Sub-period for deep excavations														
	7650-8230-01-800-0021	1 February 2024	28 February 2025												
	7650-8230-01-800-0021		31 December 24												
	7650-8230-01-800-0021	1 April 24	15 February 25												
		15 February 2024													
	7650-8230-01-ECR	01- Mar-23	23 July 23												
	G-bathtub	06-Mar-23	23 July 23												
	Jb-bathtub	17-Apr-23	23 July 23												
Construction pit	Jd_1-bathtub Jc-	17-Apr-23	23 July 23												
	bathtub Jd_2-	17-Apr-23	23 July 23												
	bathtub Jd_3-	17-Apr-23	23 July 23												
	bathtub K1bc-	17 April 23	23 July												
	bathtub K1a-	17 April 23	23 July												
	bathtub K1d-	17 April 23	23 July												
	bathtub K2d-	17 April 23	23 July												
	bathtub K2abc-	02- Feb	23 July												
	bathtub L1b_2-	12 January 2023	23 July												
	bathtub L1b_1-		23 July												
	bathtub	12 January 23	23 July 23												
		12 January 23													

Figure 9-13: Drainage schedule 2023

Figure 9-14: Drainage schedule 2024

Drainage flow rate and volume

Figure 9-15 shows the pumped flow rates at Project One for both the scenario without measures and the sheet pile scenario.

Figure 9-16 shows the pumped flow rates in the second aquifer.

The maximum extraction rate of 22,166 m³/day is a theoretical calculation based on the groundwater model and will not occur in reality. In practice, all pumped groundwater will be directed to the water treatment plant. The discharge rate is therefore limited to the capacity of the water treatment plant, which is
5.00 m³/day.

It is important to note that the vast majority of the drainage water consists of rainwater that ends up inside the sheet piling during the construction/drainage activities. Approximately 68% of the drainage water is rainwater that ends up inside the construction pits, while the remaining 32% is groundwater.

The dewatering water will be discharged into Canal Dock B2. If necessary, the dewatering water will be purified prior to discharge in order to comply with the discharge conditions.

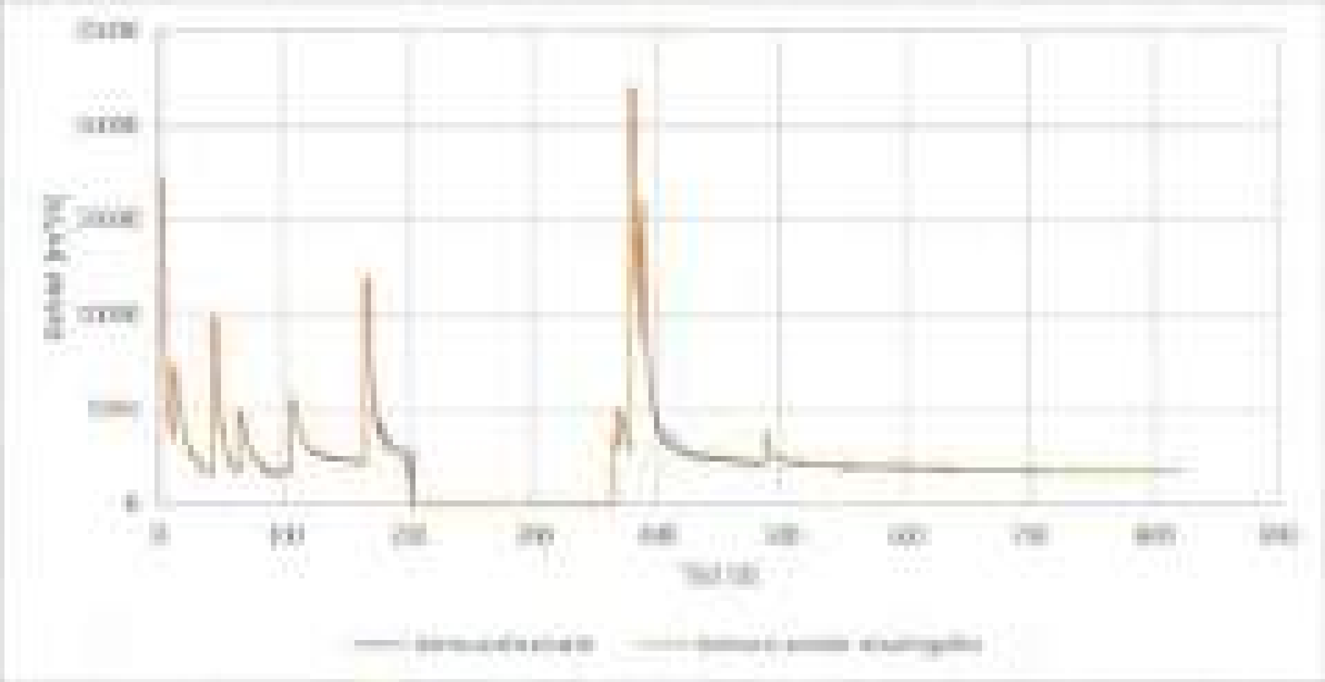


Figure 9-15: Total pumped flow rates (m³/day) in the scenario without measures and the dam wall scenario

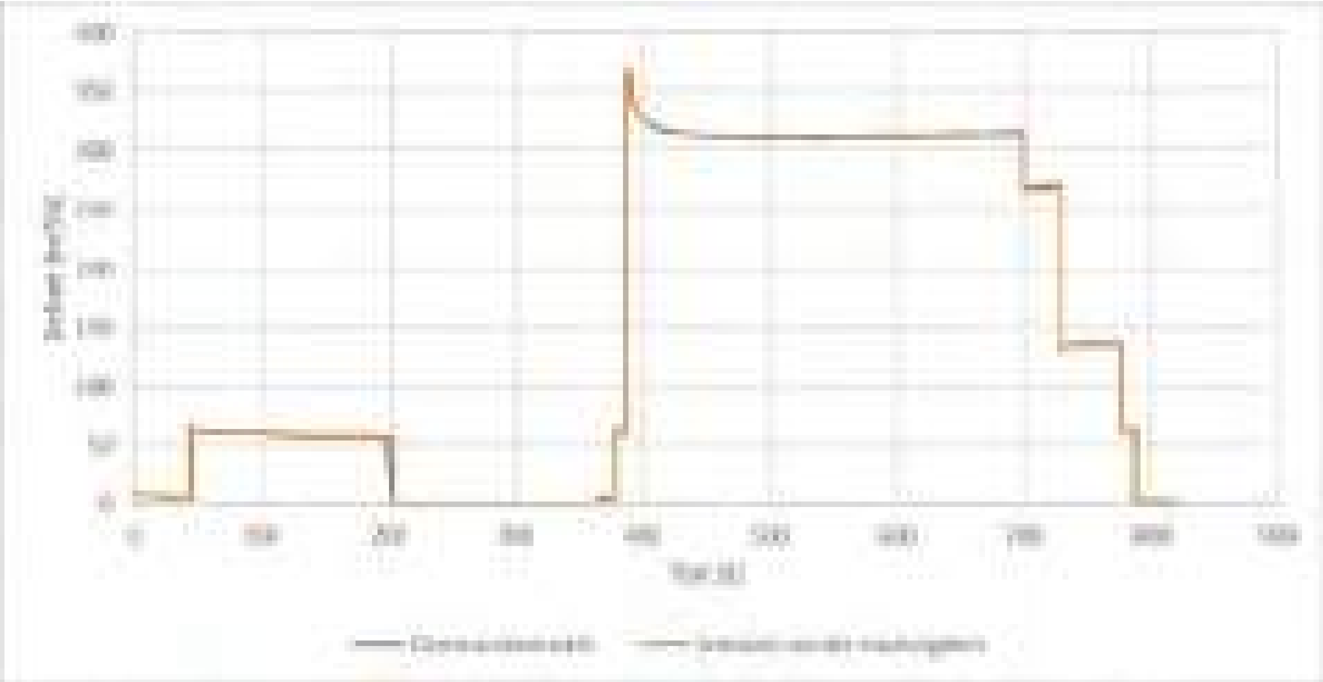


Figure 9-16: Pumped flow rates (m³/day) from the second aquifer in the scenario without measures and the sheet piling scenario.

Table 9-11: Overview of volumes (m³) of pumped and discharged drainage water in the various scenarios for the total drainage period (24 months)

	Scenariowithout measures	Sheet piling scenario
Total volume pumped (m³)	2,036,564	1,980,004
Phreatic aquifer	1,913,204	1,856,016
Confined aquifer	123,359	123,989
Volume discharged (m³)	2,036,564	1,980,004

9.1.3.2.3 Impact assessment

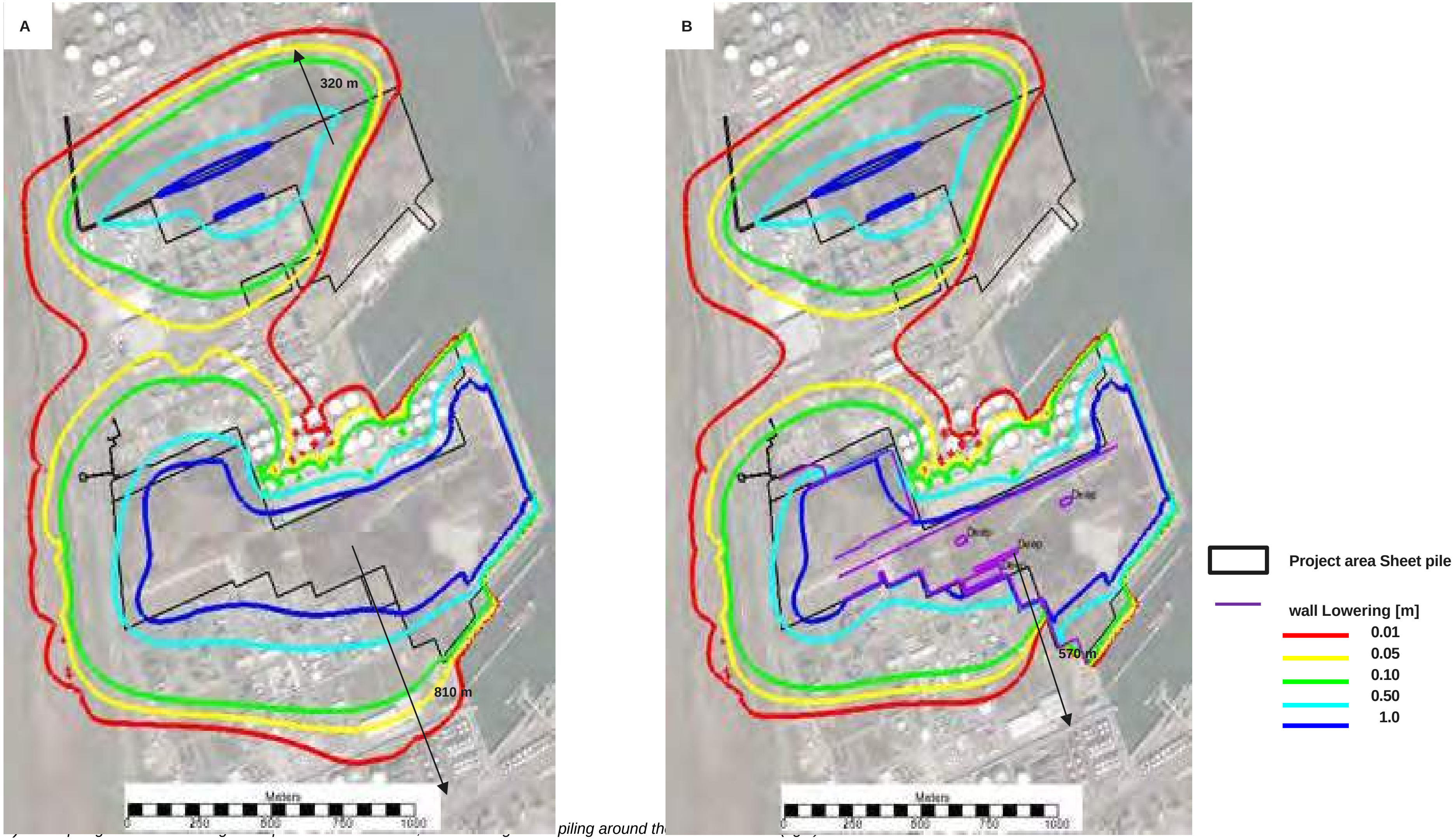
Drainage may have an impact on the following receptors:

- Soil subsidence;
- Existing groundwater contamination;
- Salinisation;
- Groundwater extraction in the surrounding area;
- Groundwater-dependent vegetation.

To mitigate the impact on these receptors, preventive measures are provided, in particular sheet piling (or equivalent technology). Figure 9-17 shows the groundwater lowering as a result of the drainage: the lowering without taking preventive measures (scenario without measures) and the lowering with preventive measures, i.e. the provision of sheet piling. The drainage water will be discharged (after possible purification) into the Kanaaldok B2.

Figure 9-18 shows the groundwater level reduction resulting from drainage in the second aquifer for the various scenarios. The reduction in groundwater pressure in the confined aquifer is located in the south of the project area.

The extent of the radius of influence of the groundwater lowering as a result of the drainage is described in Table 9-12. In both the phreatic and confined aquifers, the lowering is limited to the zone between the Scheldt and the Canal Dock.



piling around th

Figure 9-18: Maximum calculated groundwater reduction (m) in the second aquifer for
a) maximum scenario (drainage without measures) (left),
b) sheet piling scenario: drainage with preventive measures, i.e. installing sheet piling around the construction zone

Table 9-12: Extent of the radius of influence of the groundwater lowering as a result of the drainage

Aquifer	Scenario without measures	Sheet pile scenario
Phreatic aquifer	• 320 m to the north • 810mtothesouth(relative totheVesta Road) • • Towardsthewesttouchesthesphere of influencethe (Scheldt).	• 320 m to the north 570 m to the south (relative to Vesta Road) • To the west, the radius of influence touches the Scheldt.
Tense aquifer	• north-south length of 2,400 m.	• north-south length of 2,350 m

During the construction phase, the sheet piling will cause a temporary rise in the water level along the boundary with the Bayer site (Figure 9-19). The elevation is calculated at the start of the simulation and disappears when drainage begins in the project area. At the temporary construction site on the border with Bayer, the elevation is a maximum of 0.40 m. At the existing Bayer installations, the elevation is 0.20 m. At the maximum elevation (0.40 m), the groundwater table is approximately 1.5 m below ground level. There is no indication that the groundwater table would rise to ground level. This elevation is a worst-case scenario because the model does not take into account the construction time of the sheet piling. The impact is virtually negligible (0).

Impact on soil settlement

In general, three values apply to settlement; these values are listed in Table 9-13 below:

1. As a rule, 20 mm is used as the limit value for the total settlement of a structure. If greater settlements occur, damage to buildings may be caused, and this is considered negative. These 20 mm settlements also apply to tanks.
2. For information purposes, the value of 15 mm settlement is also shown. This value is for information only and is not an official limit value.
3. The permitted settlements at the level of rail traffic, located to the west of the site, are 8 mm (INFRABEL, 2013).

Table 9-13: Proposed limit values for settlements

	Location	Limit value for settlement [mm]
1.	**Buildings**	20
2.	**Buildings**	15
3.	**Railway track**	8

With regard to settlement, a clear distinction is made between the northern and southern parts of the project area; the latter is the most sensitive site in terms of settlement. As no settlement problems are expected in the northern part of the project area, the following paragraphs focus mainly on the southern part of the project area.

Northern part of the project area

As Figure 9-17 clearly shows, the groundwater level reduction at Vopak and Nippon Gases is less than 1.0 m. With a groundwater level reduction of 1.00 m, maximum settlements of 2 mm occur. In general, it can therefore be concluded that these remain below the limit values of 20 mm and 15 mm. Groundwater table reductions of 0.15 m occur near the railway; no settlement occurs because the groundwater level has never been lower than this limit value. This means that the settlement remains below the limit value of 8 mm for rail traffic at all times.

No settlement problems are expected in the northern part of the project area.

Southern part of the project area

For this zone, a distinction is made between the different scenarios, namely a. the scenario without measures and b. the sheet pile scenario. The isocontour lines of the groundwater lowering (m) in the construction phase for the project area are plotted and shown in Figure 9-19. This figure shows two isocontour lines: the blue isocontour line, which shows a lowering of 1.1 m, and the red isocontour line, which shows a lowering of 1.2 m. With these reductions, maximum settlements of 15 mm (1) and 20 mm (2) are expected, respectively. In the groundwater modelling, groundwater reductions are shown where settlements of 15 mm and 20 mm are expected, based on the most adverse sounding currently known. These contours are therefore drawn as a worst-case approach. Smaller settlements are expected for other soundings.

At the level of the railway line, a maximum reduction of 0.55 m can be expected in each of the scenarios, which means that there will be virtually no settlement at the level of the railway line (3).

Sc**enario without preventive measures (a):** In this scenario, it is clear that several tanks at the Vesta site are located in the zone where the groundwater table is falling by 1.1 m to 1.2 m. For the easternmost tanks, this does not pose an immediate problem, as the soundings (CPTU092 and CPTU043) indicate settlements of 5 mm and 6 mm respectively for a 1.2 m lowering of the groundwater table. For the westernmost tanks, the calculations associated with sounding CPTU014 show settlements of 15 mm and 20 mm for a lowering of the groundwater table by 1.1 m and 1.2 m, respectively. In the scenario without measures, the settlements would have to be monitored. To mitigate these calculated settlements, Project One will take preventive measures, as shown below in the sheet pile scenario. The scenario without preventive measures will therefore not be implemented due to the calculated settlements.

On the Bayer side (south), there are several buildings and warehouses in the zone where a groundwater table reduction of 1.1 m to 1.7 m is expected. The corresponding CPTU075, CPTU083 and CPTU084 soundings show settlements of 32 mm, 22 mm and 20 mm respectively (in the calculations for a groundwater table lowering of 1.7 m). Settlement is therefore expected at the Bayer site, as the settlements remain above the specified limit values set out in Table 9-13.

Sheet pile scenario (b): In this scenario, there is no groundwater level reduction of more than 1.2 m outside the project area.

A temporary rise in the groundwater level is calculated at the Bayer site due to the construction of the sheet piling. The maximum rise is 40 cm. However, this rise causes a negligible swelling of the subsoil of 0.13 mm.

It can therefore be concluded that no settlement problems are expected in this scenario.

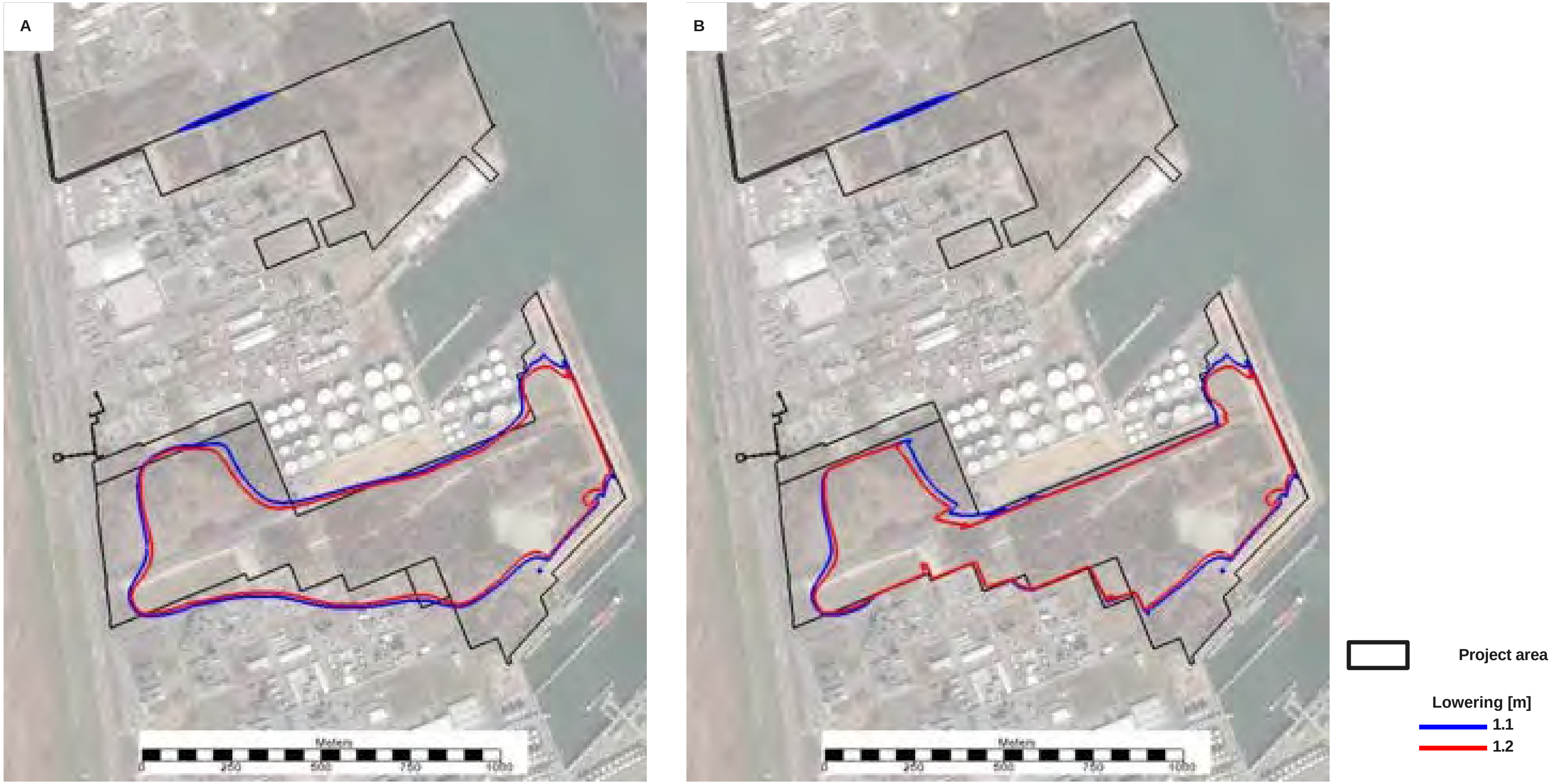


Figure 9-20: Isocontour lines of groundwater lowering (m) during the construction phase for the project area
a) in the scenario without preventive measures (left)
b) in the sheet piling scenario (right)

Project area Reduction [m]
0.10
0.05

cati ... *measures*

Cumulative settlement at Vesta:

A pump and treat installation is already in operation at Vesta as part of a groundwater remediation project. This installation will lower the groundwater at the Vesta site to a maximum reduction of 1.5 m. During the construction phase of Project One, a temporary sheet pile wall will be installed. This sheet pile wall will reduce the groundwater inflow from the Project One site, meaning that less pumping will be required at Vesta to achieve the same reduction.

The sheet piling almost completely protects the Vesta site from the impact of Project One's drainage. Conversely, this reduces the inflow of groundwater to the Vesta site. As a result, if Vesta continues to extract groundwater, the groundwater level on the Vesta site may drop too low. If the drainage for groundwater remediation at Vesta is not adjusted, it is possible that the installation of sheet piling and drainage at Project One could cause additional subsidence at Vesta. At two locations (at the entrance and at the tanks indicated in Figure 9-22 with the red rectangle), the additional settlement could amount to approximately 27 mm. It is advisable to control the drainage of the groundwater remediation at the Vesta site on the basis of effective groundwater levels in order to prevent any such settlement. Control should also be considered in relation to the available flow rate for the groundwater remediation of Vesta in their treatment plant (to be adjusted to precipitation). This may result in a temporarily lower extraction flow rate for groundwater remediation. As the risk has been assessed conservatively, it is advisable to monitor the settlement at these locations (monitoring of the groundwater level and monitoring of the actual settlement). The monitoring will be discussed in the hydrogeological study/drainage report that will be attached to the permit application.

Figure 9-22: Locations of soundings

Impact on groundwater contamination – displacement of contaminants:

The Soil discipline (Chapter 8) shows that there is groundwater contamination in the project area and surrounding areas. The contamination present was inventoried on the basis of the soil investigations available at OVAM. These reports were partly consulted digitally on the web portal, and partly requested and consulted in PDF format. The main soil investigations used for the impact assessment are listed in Table 9-14.

Table 9-14: Soil investigations in connection with groundwater contamination included in the groundwater model

OVAM file	Company	Report
8996 **96,738**	Vopak	OBO 2013 BBO 2017 BBO 2020 OBO 2021 BSP 2022 EEO claim 2022
94190	Project One	OBO 2021
11361	IMB	OBO 2019
4798	IMB	EEO 2013 BBO 2014 BBO 2016 EEO 2016 OBO 2016 OBO 2019 OBO 2020 BSP 2021 BBO 2022 EEO claim 2023
10682	Vesta	BBO 2005 BBO 2017 OBO 2019 OBO 2020 OBO 2021 BSP 2021 EEO claim 2021
4014	Bayer	BBO 2016 BBO 2019 EEO 2019 OBO 2020 EEO 2020 BBO 2021 BSP 2021 EEO 2022 EEO claim 2023 BBO 2023 BSP 2024
5149	ASA	OBO 2019

The movement of groundwater contamination as a result of drainage was modelled using MT3DMS. MT3DMS is a multispecies transport model that uses the output from ModFlow (flow calculation).

The possible movement of the contamination was modelled according to different scenarios:

- a natural situation without drainage,
- drainage scenario where the zone of influence is limited by sheet piling (sheet piling scenario).

The groundwater model takes into account the groundwater contamination that was known at the time the groundwater model was drawn up, based on the contamination situation described in the available public soil investigations. The concentrations and retardation factors used for the relevant parameters and the results of the groundwater modelling are given in the hydrogeological study/drainage report attached to the permit application. For more details, please refer to this hydrogeological study/drainage report. The following conclusions were reached in this report.

Taking into account the calculations based on the sheet pile scenario, for most groundwater contaminants present within the sphere of influence of the drainage system, a displacement of less than 5 m is calculated. For some contaminants, a greater displacement is calculated at certain points on the contour (up to a maximum of 13 m).

It may be decided that no relevant adverse impact is expected for the sheet piling scenario, taking into account the industrial nature of the site, in relation to the current extent of the contamination and given that no receptor is threatened as a result of any displacement. However, it is advisable to monitor any displacement of the existing groundwater contamination during the dewatering works. The monitoring will be discussed in the hydrogeological study/dewatering report attached to the permit application.

The sheet piling near Vesta will affect the influx of groundwater to the Vesta site. This will influence the groundwater level on the site, especially cumulatively due to the lowering of the groundwater level on the Vesta site itself as a result of their ongoing remediation. It is advisable to inform Vesta of this and to agree on appropriate measures in mutual consultation.

This monitoring plan, including measurements prior to commencement of the works and any agreements regarding communication, must be discussed further with the managers responsible for the contamination.

Based on the evaluation carried out, contamination at the drainage wells cannot be ruled out. Consequently, the quality of the drainage water must be monitored (see below).

Taking into account the proposed mitigation measures and monitoring, the impact on the spread of groundwater contamination is assessed as negligible (0) in the sheet piling scenario.

Impact on groundwater contamination – quality of drainage water

Based on the evaluation carried out, the presence of contamination in the groundwater cannot be ruled out. Consequently, the quality of the extracted groundwater must be monitored. The exact composition, and therefore the parameters to be monitored, will vary from subzone to subzone. The water to be discharged will be sampled at each discharge point.

The quality of the drainage water must be monitored and will therefore be periodically monitored and sampled. Based on these analyses, a decision will be made as to whether it needs to be purified. The following procedure will be used:

- The locations where there is potential interaction with contaminated groundwater are identified, allowing the extraction scenario to be determined in advance. Separate extraction and purification strategies are considered for the various zones where potential contamination is expected in the drainage water, tailored to the expected contaminants.
- In the event of possible interaction with contaminated groundwater, an analysis of the contaminant parameters is carried out in addition to a general screening.
- The deployment of mobile water treatment units will be determined based on the contaminant parameters present and the discharge standards to be achieved. Given the size of the site and the various contaminants, it is likely that several mobile water treatment units will be deployed. A differentiated approach will be taken to the treatment of the drainage water.
- Monitoring and periodic analyses of the drainage water and effluent will be provided, in each case related to the expected contaminants. This will be specified in the drainage note. Periodic follow-up analyses will be carried out on the extracted groundwater and effluent in order to monitor its composition and to verify the proper functioning of the water treatment plant.

- Furthermore, the existing monitoring wells will be monitored. Initially, groundwater levels will be monitored, preferably with continuous measurements using *various methods*. If, during drainage, it is determined that the flow direction at the known groundwater contamination sites changes significantly, the concentration of the potentially affected pollutants will be analysed.

Table 9-15 below shows the discharge standards for discharge into **surface water** for the parameters expected in the drainage water at Project One. The proposed discharge standards are based on the guidelines of VMM (10x IC (classification criterion) or 1x IC), the standard procedure of OVAM, and for the specific parameters on the discharge standards from the Bayer soil remediation project (Arcadis, 2018) and the project EIA New quay wall Canal Dock B2 (Antea Group, 2020). The OVAM standard procedure specifies standard discharge standards for the common contamination parameters; these were determined by the OVAM on the basis of 'best available techniques'. The motivation for these standards is given below and in Table 9-15.

- A discharge standard of 10*IC is proposed for chlorobenzene.
- For triallate, trichloropropane, mercaptobenzothiazole and benzothiazole, the discharge standard was taken from Bayer's soil remediation project.
- No discharge standard was proposed for triethylamine in the Bayer BSP; for TEA, the discharge standard is equated with the detection limit.
- No discharge standard was proposed for diallate in the BSP; no PNEC value is available for this parameter, but it was derived on the basis of an ecotoxicity model; a safety margin (factor 10,000) was taken into account, resulting in a very low estimated derived PNEC value; for diallate, the discharge standard is equated here with the discharge standard requested for the construction of the quay wall, i.e. 1.1 µg/l. The calculated increase in concentration due to this discharge into the Kanaaldok is 2.75%.
- No discharge standard was proposed for benzothiazolol in the BSP. The expected concentrations are of the same order of magnitude as those for benzothiazol. The discharge standard is set at the same level as that for benzothiazol.
- For aniline and alachlor, the discharge standard is set at the same level as the discharge standard requested for the construction of the quay wall.
- For PFAS, the reporting limit is proposed in accordance with Annex 4.2.5.2 of Title II of the VLAREM.

Table 9-15: Proposed discharge standards for the discharge of drainage water from Project One into the Kanaaldok

Parameter	Unit	Discharge standard	Classification criteria / PNEC	Motivation
Arsenic	µg/l	25	5	Based on the Wezertool, the standard of 50 µg/l (10 x IC) was adjusted to 25 µg/l
Chromium	µg/L	500	50	10 x IC
Benzene	µg/l	10		Standard discharge standard in accordance with standard procedure Soil remediation project of the OVAM
Toluene	µg/l	10		
Ethylbenzene	µg/l	10		
Xylenes	µg/l	10		
Mineral oil	µg/l	500		
MTBE	µg/L	100		
1,2-cis-dichloroethene	µg/L	50	10	Soil remediation standard, in accordance with the OVAM Standard Procedure and Vlarebo, Annex IV
Vinyl chloride	µg/L	1	100	Soil remediation standard, in accordance with the OVAM Standard Procedure and the Vlarebo, Annex IV
Trichloromethane,	µg/L	25	2.5 (PS)	Standard discharge standard in accordance with

Parameter	Unit	Discharge standard	Classification criteria / PNEC	Justification
				Standard procedure Soil remediation project of the OVAM
Dichloromethane	µg/L	20	20 (PS)	1 x IC
1,1,2-trichloroethane	µg/L	20	20	discharge standard in accordance with standard procedure Soil remediation project of the OVAM (in procedure OVAM limited up to 12 µg/l, but the classification criterion is 20 µg/l)
1,2-dichloroethane	µg/L	10	10 (PS)	1 x IC
Cyanide (total)	µg/l	100	50	Based on the Wezertool, the discharge standard of 500 µg/l (10 x IC) was adjusted to 100 µg/l
1,2,3-trichloropropane	µg/l	20	8.8	In accordance with soil remediation project for file 4014 (Arcadis, 04.12.2018)
Aniline	µg/L	15		Discharge standard equivalent to the requested discharge standard for construction of the quay wall
Alachlor	µg/l	1.6	0.3	
Diallate	µg/l	1.1	0.0186	No PNEC value is available for this parameter, but it was derived on the basis of an ecotoxicity model; a safety margin (factor 10,000) was taken into account, resulting in a very low estimated derived PNEC value; for diallate, the discharge standard is equated here with the discharge standard requested for the construction of the quay wall, i.e. 1.1 µg/l.
Benzothiazole (BT)	µg/l	30	3	In accordance with the soil remediation project for file 4014 (Arcadis, 04.12.2018)
Benzothiazole (BT-OH)	µg/l	30	1.6	
2-Mercaptobenzothiazole (MBT)	µg/l	20	0.4	No discharge standard was proposed for benzothiazolol in the BSP. The expected concentrations are of the same order of magnitude as those for benzothiazole. The discharge standard is set at the same level as that for benzothiazole.
Triallaate	µg/l	1	0.041	In accordance with the soil remediation project for file 4014
Triethylamine (TEA)	µg/l	100	11	Detection limit
Monochlorobenzene	µg/l	60	6 (MKN)	10 x IC
AMPA	µg/l	1000	830	The PNECaquatic is derived from to apply an assessment factor of 10 to the lowest chronic NOEC or EC10. This results in: 8.3 mg/l (lowest 72-h ErC10 algae) / 10 = 0.83 mg/l

Parameter	Unit	Discharge standard	Classification criteria / PNEC	Justification
				According to https://substances.ineris.fr/ https://substances.ineris.fr/[56]The discharge standard was determined on the basis of the Wesertool
Nickel	µg/l	90	30	Based on the Wesertool, the discharge standard was adjusted to 90 µg/l
Uranium	µg/l	5	1	Based on the Wesertool, the discharge standard was adjusted to 5 µg/l
Glyphosate	µg/l	100	86.7	86.7 µg/l is the proposal for the AA-EQS[57] (for fresh water not used for drinking water production) according to https://circabc.europa.eu/[58] The discharge standard was determined on the basis of the Wesertool.
PFAS individually	ng/l	20 (quantitative PFAS) 50 (indicative PFAS)		Reporting limit for quantitative PFAS and the indicative PFAS, see Annex 4.2.5.2 of Title II of the VLAREM

Impact on salinisation

The impact on salinisation was modelled using SEAWAT. The following scenarios were modelled:

- Evolution without drainage at Project One
- Construction phase: scenario without preventive measures
- Construction phase: sheet piling scenario

The salt concentrations after the construction phase are compared with the salt concentrations in the situation without drainage at Project One. The results are therefore difference maps of the salt concentrations in different model layers. The salt concentrations in the scenario without preventive measures and in the sheet piling scenario are shown in Figure 9-23.

[56] https://substances.ineris.fr/substance/1066-51-9
[57] AA-EQS = Annual Average Environmental Quality Standard
[58] https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/140d52e3-b95a-488a-95da-9bcdd2a60de4/details

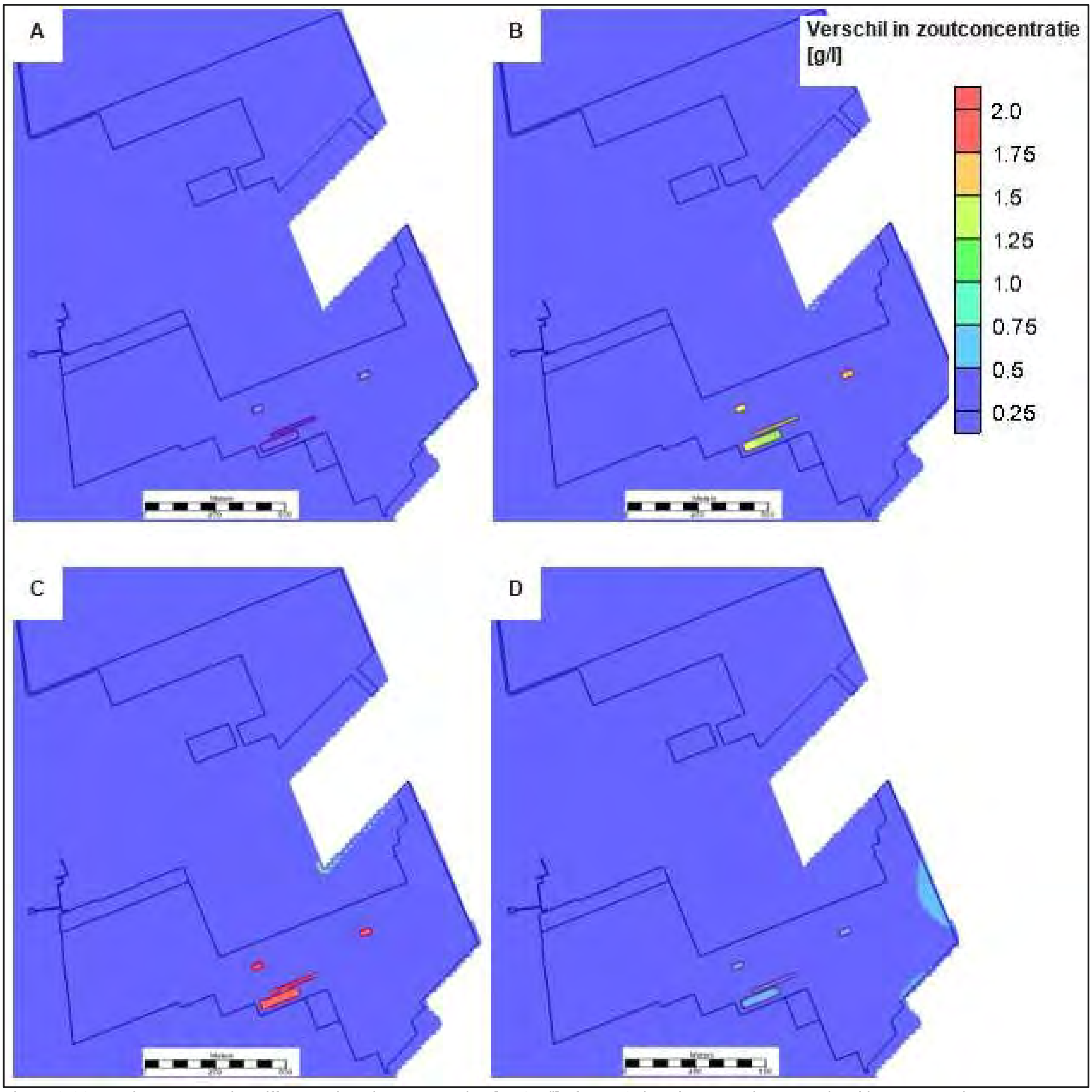


Figure 9-23: Maximum scenario: Difference in salt concentration [TDS g/l] after 776 days between the scenario without preventive measures and the calculated evolution without drainage for the Project One project area (A: Model layer 3, B: Model layer 4, C: Model layer 5, D: Model layer 6)

Figure 9-23 shows the differences in the **scenario without measures** compared to the simulation without drainage at Project One, for model layers 3 to 6.

The effects occur at the level of deep drainage, in the second aquifer, which takes place within closed construction pits. There are no differences in the northern part of the project area.

Model layer 3 (Quaternary sand): In the southern part of the project area, the differences amount to a maximum of 0.32 g/l in the closed construction pits. Outside the closed construction pits, there is no difference.

Model layer 4 (Sand from Merksplas): In model layer 4, the difference is a maximum of 1.6 g/l in the southern part of the project area, in the deep construction pit on the ECR plot.

Model layer 5 (Sand from Zandvliet and Merksplas): In model layer 5, the differences amount to a maximum of 2.0 g/l.

Model layer 6 (Clay from Kruisschans): In model layer 6, the differences are up to almost 0.5 g/l.

Figure 9-24 shows the difference in the **sheet pile scenario** compared to the simulation without drainage at Project One, for model layers 3 to 7. The results are similar to the scenario without preventive measures.

The upwelling of salt water remains limited to the deep closed construction pits.

For both scenarios, the drainage does not result in any change in the quality classes according to De Moor & De Breuck (1969), not even at the deep closed construction pits. The quality classes of the groundwater are not affected by the drainage.

Figure 9-25 shows the evolution of salt concentrations after the construction phase of Project One, over a simulation period of 20 years, in model layers 3, 4 and 5, at the location of the deep construction pits. Only the evolution at the locations of the deep construction pits is shown because only at those locations is an impact on salt concentration noticeable. Despite the negligible increase in salt concentrations, we still see very long recovery times to the original concentrations. This emphasises the high vulnerability of a fresh/saltwater system to external factors such as drainage. Since there is no change in quality class, the impact on salinisation is assessed as negligible (0). At the request of VMM, monitoring will be provided. The monitoring plan is presented in the hydrogeological study/drainage note that is attached to the environmental permit application.

Impact on groundwater abstraction in the surrounding area

Figure 9-21 shows the groundwater level reduction in the second aquifer (below the polder clay), where the groundwater abstraction points are located. In both scenarios, the groundwater level reduction at the abstraction points is less than 15 cm. This is a temporary impact and is within the natural seasonal fluctuations. The impact on groundwater abstraction in the second aquifer is negligible.

In the first aquifer at the groundwater extraction site '2020-093238', a temporary maximum reduction of 0.45 m is expected during the construction of the telecom cable along the access road. At the Vesta pump and treat installation, an additional reduction of up to 0.50 m is expected.

A negligible effect (0) is expected from the drainage on the existing groundwater extraction sites in the second aquifer and a limited negative effect (-1) on the existing groundwater extraction sites in the first aquifer.

Impact on groundwater-sensitive vegetation

The impact of drainage on the Galgenschoor nature reserve is discussed in Chapter 11 Biodiversity.

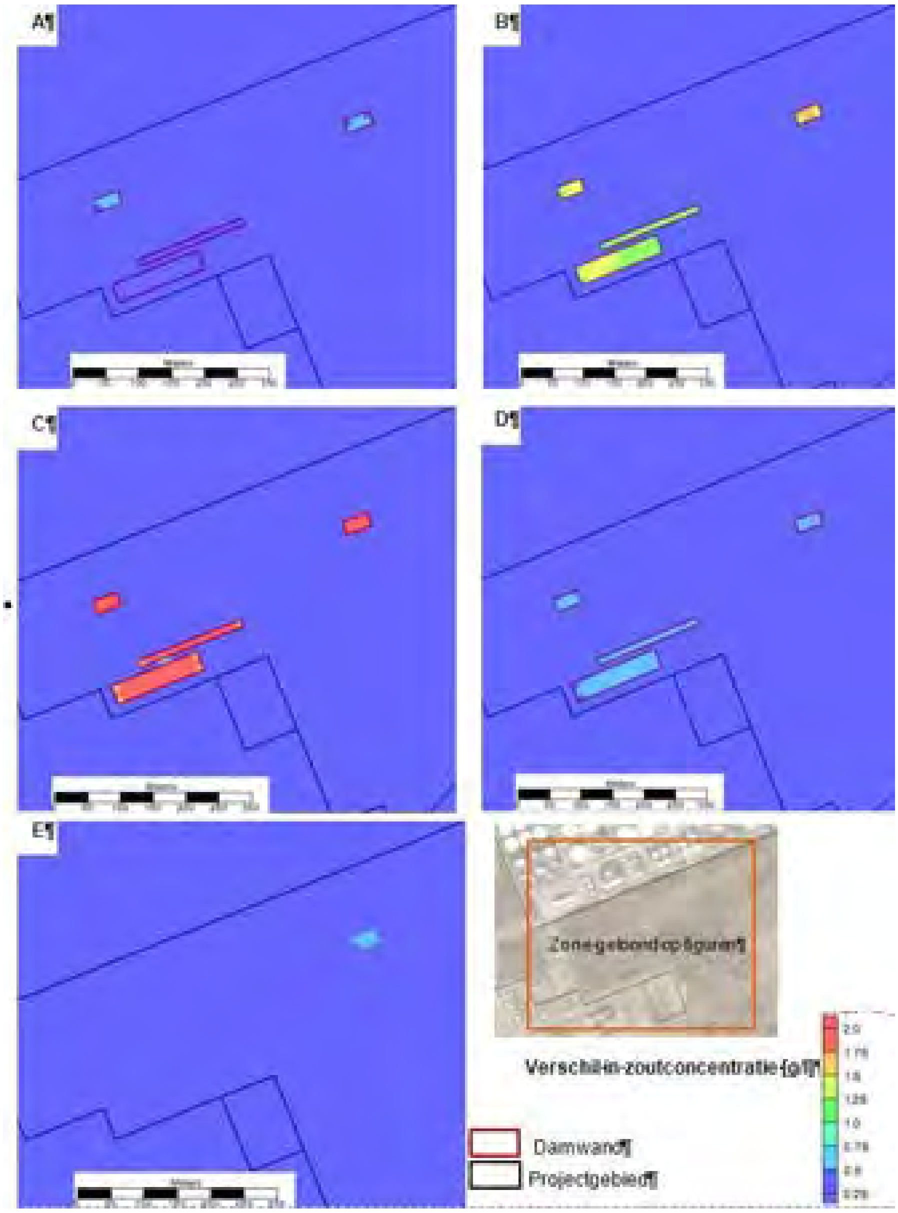


Figure 9-24: Sheet piling scenario: Difference in salt concentration [TDS g/l] after 776 days between the sheet piling scenario and the calculated evolution without drainage at the deep construction pits in the southern zone of the project area (A: Model layer 3, B: Model layer 4, C: Model layer 5, D: Model layer 6, E: Model layer 7)

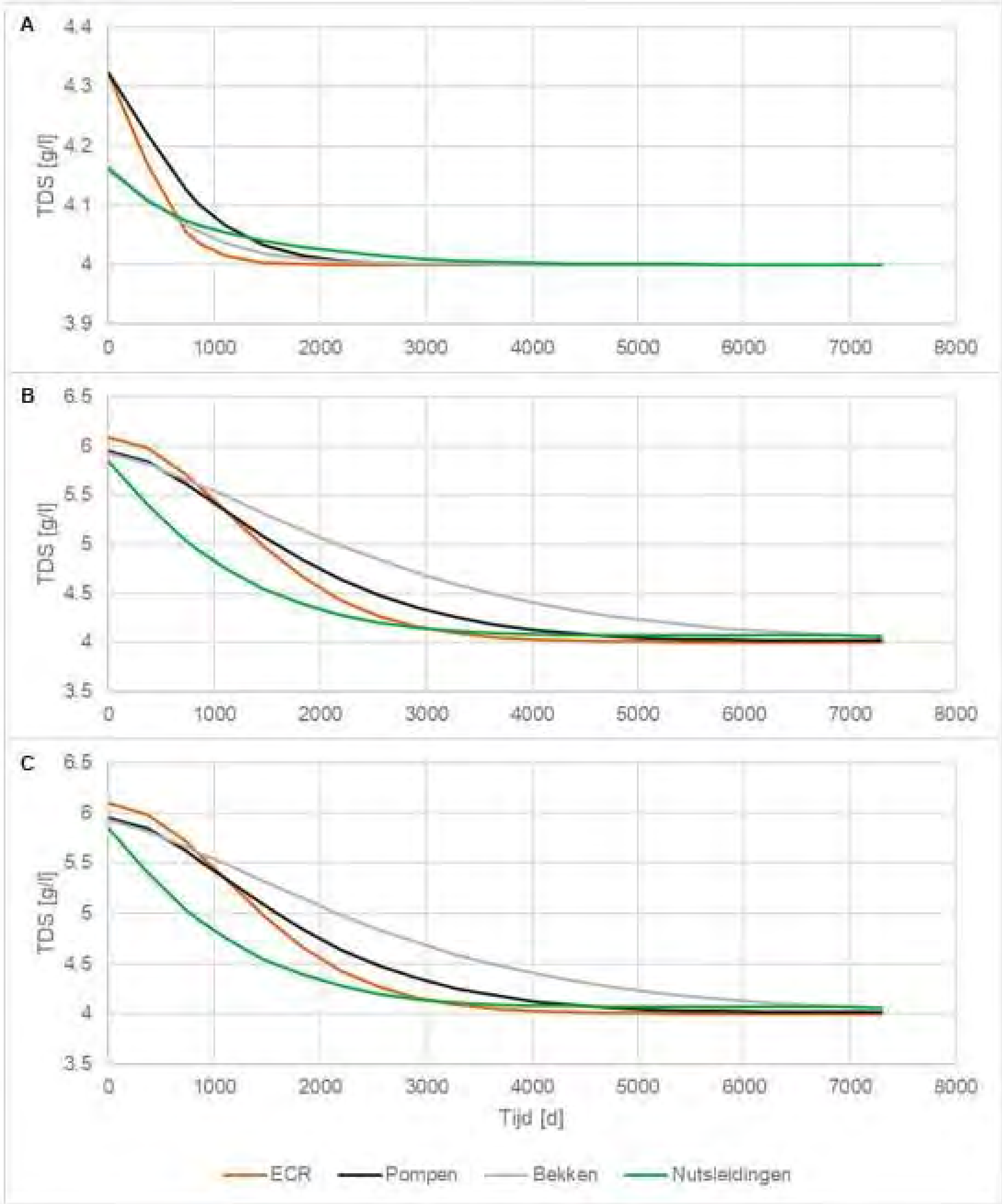


Figure 9-25: Evolution of salt concentration [TDS g/l] at the deep construction pits ***after*** *the construction phase of Project One (A: model layer 3, B: model layer 4, C: model layer 5). Time d = 0 shows the final concentration at the end of the construction phase.*

9.1.3.2.4 Conclusion regarding the influence of drainage:

The comparison between the preventive measures envisaged by Project One and the scenario without measures shows that the negative effects of drainage (subsidence and migration of existing contaminants) are sufficiently mitigated. The preventive measures in the sheet piling scenario include temporary water-retarding screens extending into the polder clay, whereby the drainage water (after any purification) is discharged in its entirety to the Kanaaldok B2. Since the sheet piling forms a hydrological barrier that creates a 'bathtub' situation, as it were, the drainage activities mainly involve the extraction of rainwater that has accumulated within this 'bathtub'. The amount of groundwater that is drained has been significantly reduced by the installation of the sheet piling, which explains the mitigating effect of these planned measures.

The groundwater level will recover after the works.

The planned preventive measures mitigate the potential secondary effects of soil subsidence, salinisation and the attraction of groundwater contamination from neighbouring plots. The Galgenschoor nature reserve will also be protected from any significant impact. As a result of these planned measures, no negative effects are expected in terms of soil subsidence, salinisation, the attraction of groundwater contamination from neighbouring plots or the Galgenschoor nature reserve. The effect on neighbouring groundwater extraction in the first aquifer is limited negative (-1); the effect on groundwater extraction in the second aquifer is negligible (0).

The impact on the change in groundwater quantity is therefore assessed as limited negative (-1).

The impact of the discharge of drainage water on surface water quality is discussed in the section on Surface Water, see § 9.2.3.2.

9.1.3.3 Change in groundwater quality

The effect on groundwater quality as a result of the works (other than drainage) is discussed in Chapter 8 Soil.

9.1.4 Impact description and impact assessment – operational phase

9.1.4.1 Impact on groundwater quantity

During the construction of the site, the ground levels within Project One will be altered. High groundwater levels are currently being measured in some zones during the winter. To prevent parts of the site from flooding in winter, a drainage system will be installed in zones K1, K2 and L1. This is shown in Figure 9-26. The purpose of a drainage system is to reduce groundwater levels to 1 m below the finished ground level. Groundwater from K1 and K2 is collected in the service water tank for reuse. Groundwater from L1 is discharged into the slipway.

At the new quay wall on the Canal Dock, a drainage system has also been installed along Insteekdok 1, just above the water level of the Canal Dock. This drainage system along Insteekdok 1 of the new quay wall is included in the reference situation of the groundwater model.

The construction of paved surfaces can also have an impact on groundwater quantity. The increasing hardening of the ground surface can result in a local drying effect, which translates into a lower groundwater level. The hard surfaces that are being constructed are shown in Figure 9-27 and Figure 9-28. The construction of the hard surfaces has been included in the calculations using the groundwater model.

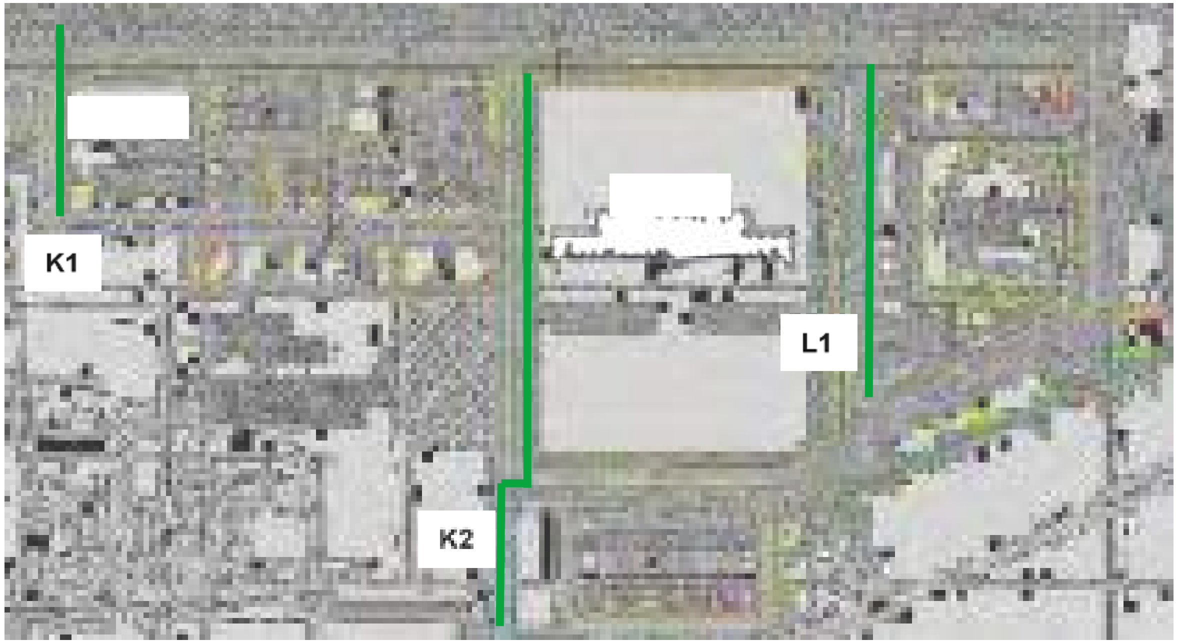


Figure 9-26: Indication of the drainage system (green lines) in the southern part of the project area

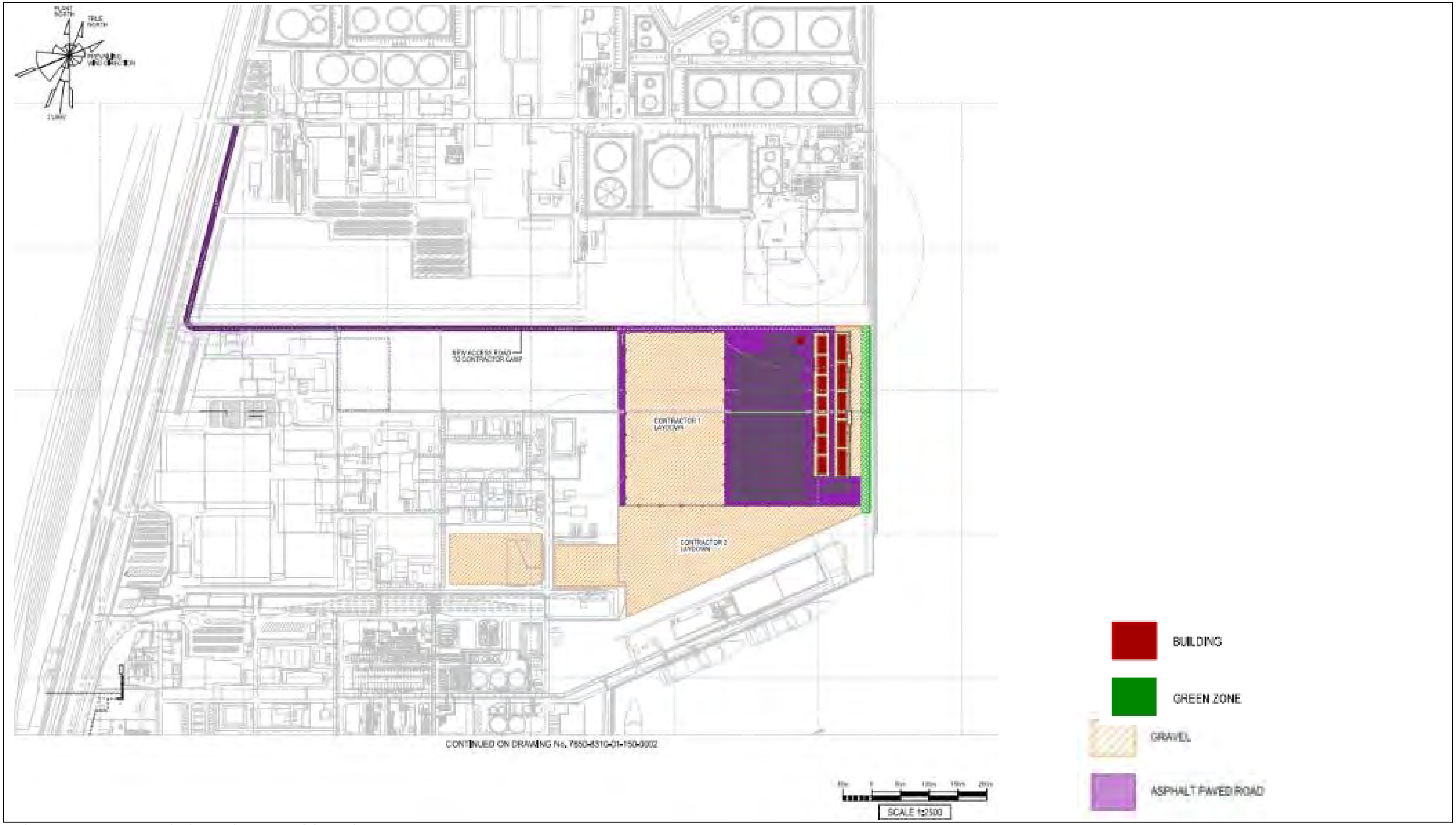


Figure 9-27: Pavements in the northern part of the project area

Figure 9-28: Pavements in the southern part of the project area

For the situation in the operational phase of Project One (with modified ground level, drainage systems, changes in the degree of paving of the site), the groundwater levels were modelled using the groundwater model.

The results are shown in Figure 9-29.

No change is expected in the overall groundwater flow pattern as a result of the development of Project One. Vesta's pump and treat installation continues to cause a local depression in the groundwater level.

Since no impact on the groundwater flow pattern is expected during the operational phase, the existing groundwater contamination will not be affected. Given that the water table (1st aquifer) will not be lowered below the groundwater level in the 2nd aquifer, the risk of increasing salinisation is also negligible.

In the confined aquifer beneath the polder clay, the model calculates a maximum lowering of 2 cm beneath the southern part of the project area. No impact is expected on the groundwater flow pattern during the operational phase in the confined aquifer.

The groundwater lowering resulting from Project One is shown in Figure 9-30. The realisation of Project One will result in a groundwater level reduction in the project area and the surrounding plots, mainly due to reduced groundwater recharge. The groundwater level reduction is localised in the southern part of the project area. The zone with a reduction greater than 5 cm has a north-south length of approx. 1,020 m. In terms of width, the lowering is limited by the Kanaaldok and the Scheldt. However, the lowering of the groundwater level remains limited and does not result in any secondary effects. The direction of groundwater flow towards the Galgenschoor is not affected. The impact is assessed in the Biodiversity discipline.

In order to estimate the quantities of groundwater drained via the drainage systems, the groundwater model was run with winter groundwater recharge. The model calculates a flow rate of 26 m^3/d from the drainage system. The results are worst case because the simulations were performed with a stationary model. The drainage water from drains K1 and K2 is used as cooling water; if it is contaminated, it is treated first. The uncontaminated drainage water from the lower zone L1 is discharged to the Kanaaldok (or treated if it is contaminated). The drainage system has no impact on groundwater levels. This is because the drainage system only comes into operation when groundwater levels are higher than 1 m below ground level. The groundwater level calculated in the model with average precipitation is lower than 1 m below sea level. The drainage system is only provided to drain groundwater during extreme precipitation events and to avoid the risk of flooding due to high groundwater levels. This only has a local and temporary impact on the groundwater level. The resulting impact is negligible.

The impact on groundwater quantity during the operational phase is assessed as limited negative (-1), as there will be less freshwatering of the groundwater lens, the unsaturated zone above the water table will become permanently thicker and certain substances in the soil matrix will oxidise more quickly. These secondary effects are minimal, but it cannot be ruled out that they will become measurable. For this reason, permanent groundwater lowering is assessed as limited negative and cannot be mitigated.

For the effects on groundwater quality, please refer to Chapter 8 Soil.

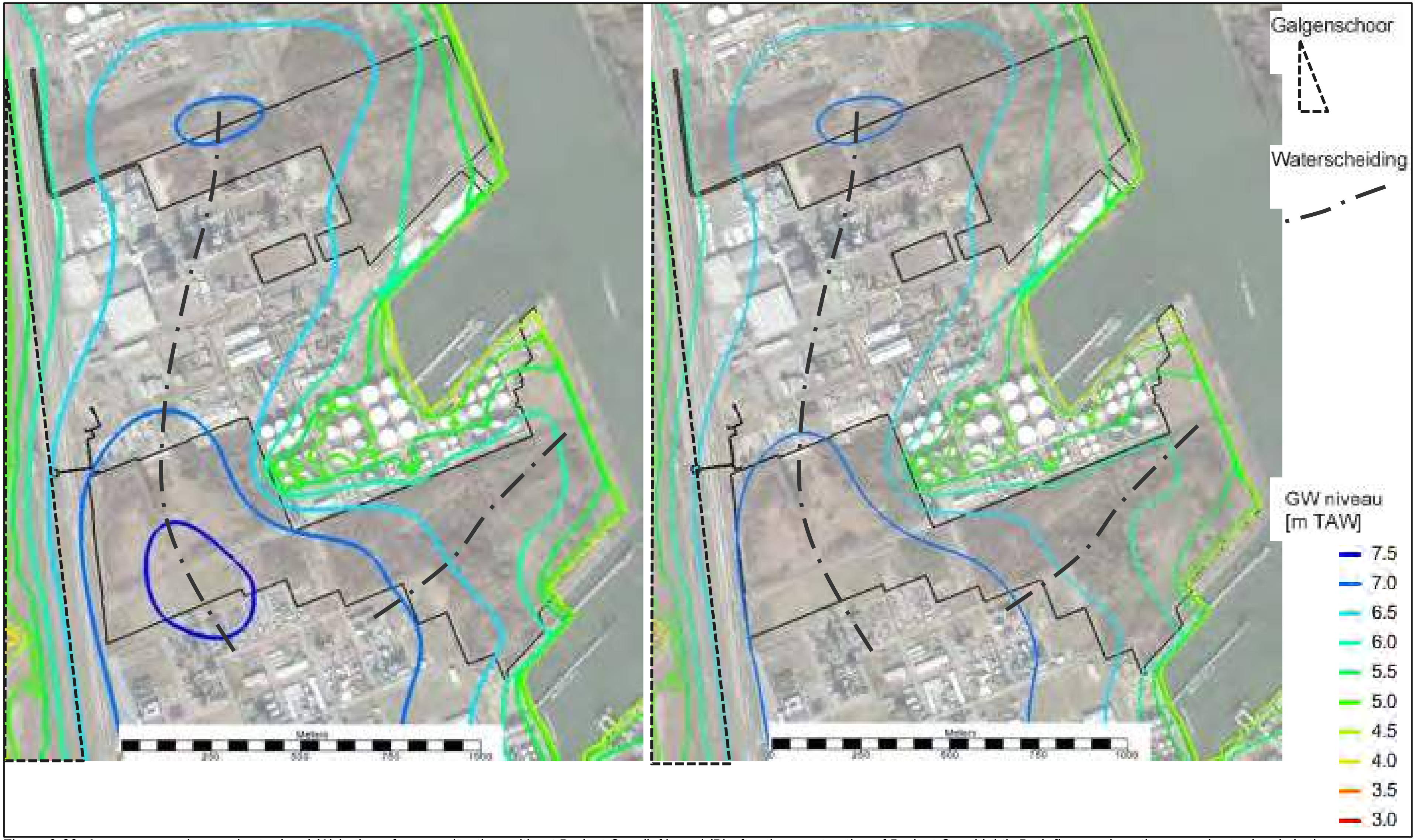


Figure 9-29: Average annual groundwater level (A) in the reference situation, without Project One (left), and (B) after the construction of Project One (right). Both figures show the groundwater levels in the 1e aquifer.

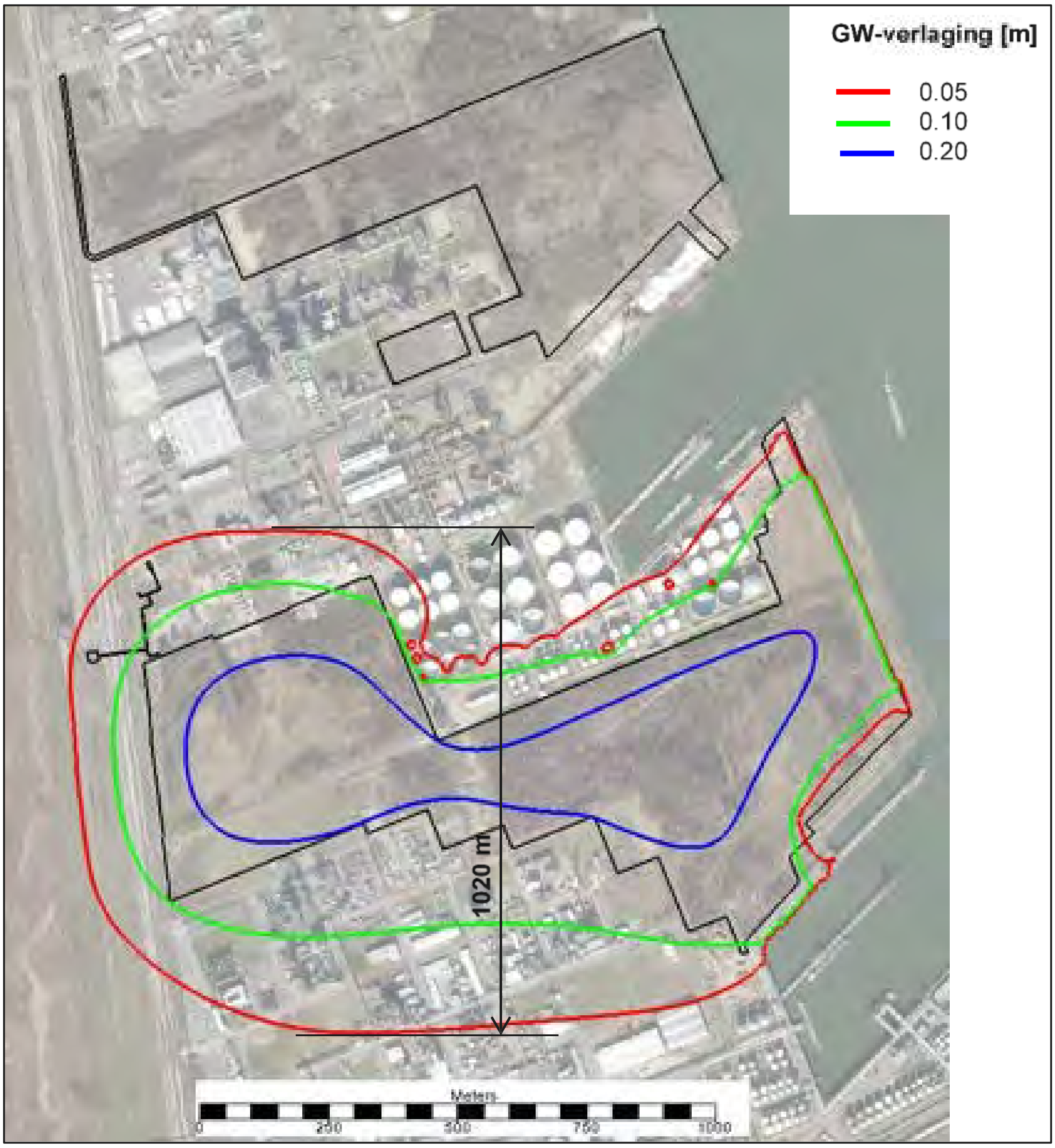


Figure 9-30: Groundwater level reduction after the development of Project One compared to the reference situation (i.e. the difference between A and B in Figure 9-34) in the 1[e] aquifer

9.2 Surface water

9.2.1 Methodology

The effects that will be discussed within the Surface water sub-discipline are:

During the construction phase:

- Discussion of emissions:
  - As a result of the drainage, drainage water will be released. This drainage water will be discharged into Canal Dock B2. The contaminated drainage water will be purified in advance by means of a (mobile) purification system(s) and its quality will be monitored.
    - The effect of the discharge of drainage water on the quality of Canal Dock B2 is assessed quantitatively. For the assessment, an impact calculation was performed in accordance with the methodology set out in the revised Water Guidelines (MER Water Fact Sheet, Impact of Industrial Wastewater Discharge dated 1 December 2023) (see § 9.2.1.1). In the Groundwater section, § 9.1.3.2.3 describes the relationship between the groundwater contaminants present and the quality of the drainage water. Based on this, the discharge standards for drainage water were proposed in § 9.1.3.2.3.
    - The impact of the temporary discharge of drainage water on the waterbed quality of the Canal Dock is not considered relevant, as no effect on water quality is expected. If necessary, purification will take place. Furthermore, this discharge is not permanent (only during the construction phase for approximately 24 months).
    - Furthermore, the expected discharge flow rate is minimal compared to the flow rate in the Kanaaldok (the discharge flow rate will amount to no more than 0.8% of the flow rate of the Kanaaldok), and this impact is considered negligible.
  - A description is provided of the (waste) water flows and the reuse of uncontaminated rainwater.

During the operational phase:

Water management: discussion of the water balance of Project One during the operational phase (use of city water, demineralised water, rainwater, reuse).

- Discussion of planned emissions and (preliminary) treatment of waste water:
  A description is provided of the wastewater streams and the planned water treatment. Pre-treatment is also planned for the removal of specific contaminants (spent caustic wastewater stream) before they are further treated in the central water treatment plant. Less polluted wastewater streams are sent directly to the central water treatment plant. All treated wastewater is discharged into the Scheldt via the existing Inovyn discharge point.
- Effect on the surface water quality of the Scheldt as a result of the discharge of treated waste water: Project One will discharge the described (waste) water flows after treatment into the Scheldt, via the same pipe through which Inovyn's waste water is also discharged (see § 9.2.4.2.7). This means that no new discharge pipe needs to be laid through the Galgenschoor, but the existing discharge of treated water can be used. The treatment and monitoring of the wastewater will be carried out by Project One prior to its confluence with Inovyn's wastewater.
  The effect of the discharge is assessed for all relevant pollutants in accordance with the methodology set out in the amended Water Guidelines Manual (MER Water Fact Sheet, Impact of Industrial Wastewater Discharge dated 1/12/2023) (see § 9.2.1.1). This assesses the effects of the discharge of treated waste water into the Scheldt on the condition of the water body (within the framework of the Wezer judgment).
  An impact assessment of the *thermal discharge* (cooling water discharge) into the Scheldt is not considered necessary, as the heat to be cooled will be dissipated through evaporation in the cooling towers and not into the surface water. The cooling water discharge goes to the water treatment plant and is discharged into the Scheldt together with the other treated waste water. The effluent will comply with the standard for wastewater of 30°C (VLAREM II Art. 4.2.4.1). In addition, the average discharge flow rate of the effluent is only 0.07% of the average flow rate of the Scheldt. The impact of the temperature of the effluent on the Scheldt will be negligible.

- Effect on *surface water quantity* in the Scheldt as a result of the effluent discharge rate. At Canal Dock B2, overflows are only provided for uncontaminated rainwater from Project One. The effects on the water quantity of the Scheldt and the Canal Dock are assessed (see § 9.2.1.2).
- Impact on *waterbed quality*: a qualitative discussion of the possible influence of the discharge of the effluent on the waterbed of the Scheldt is provided.
  The discharge of uncontaminated rainwater during the operational phase has no impact on the quality of the waterbed.

9.2.1.1 Change in surface water quality as a result of the discharge of waste water

The Water Framework Directive (WFD) sets quality objectives for surface water, further tightened by the Wezer judgment (C-461/13). An existing or new discharge from a company must not cause a deterioration in the status of the water body or jeopardise the achievement of the objectives for a water body. This must be demonstrated by the discharge conditions imposed (concentrations, flow rates, loads). The Wezer judgment and the Water Framework Directive therefore have an impact on all pollutants (both physicochemical parameters and hazardous substances). The VMM translated this into practice and developed a methodology to determine which discharges could potentially lead to a deterioration of the water body into which they are discharged.

The assessment must be carried out at the level of the water body on the one hand and for the various components of the status assessment on the other. The status of a water body is determined by its ecological status and chemical status. Neither of these may deteriorate in terms of class, or if the water body is already in the lowest class, its status may not deteriorate further. The ecological status is influenced by various components, namely the quality elements as described in Annex V of the Water Framework Directive, which must not deteriorate to such an extent that they have to be classified in a lower class. As soon as a quality element is classified in a lower class, this automatically means a deterioration of the water body, regardless of whether the water body itself also has to be classified in a lower class as a result. A quality element or water body that is already in the lowest class may not deteriorate any further.

The VMM has developed a step-by-step plan for assessing whether a discharge leads to a 'deterioration in the condition of a water body'. This step-by-step plan serves as a manual for assessing the impact group 'change in surface water quality as a result of wastewater discharge' in the EIA (VMM, 2023). The step-by-step approach provides concrete guidance for assessing the risk of deterioration and failure to achieve the objective due to point source discharges. The step-by-step plan (see Figure 9-31) is structured as a preliminary assessment followed by an increasingly thorough assessment, with the aim of filtering out discharges with a minor impact and retaining only the most relevant ones for which the final assessment may be that they could cause deterioration or failure to achieve the objectives. The translation of the results of the step-by-step plan into the assessment framework for the EIA is shown in Table 9-16.

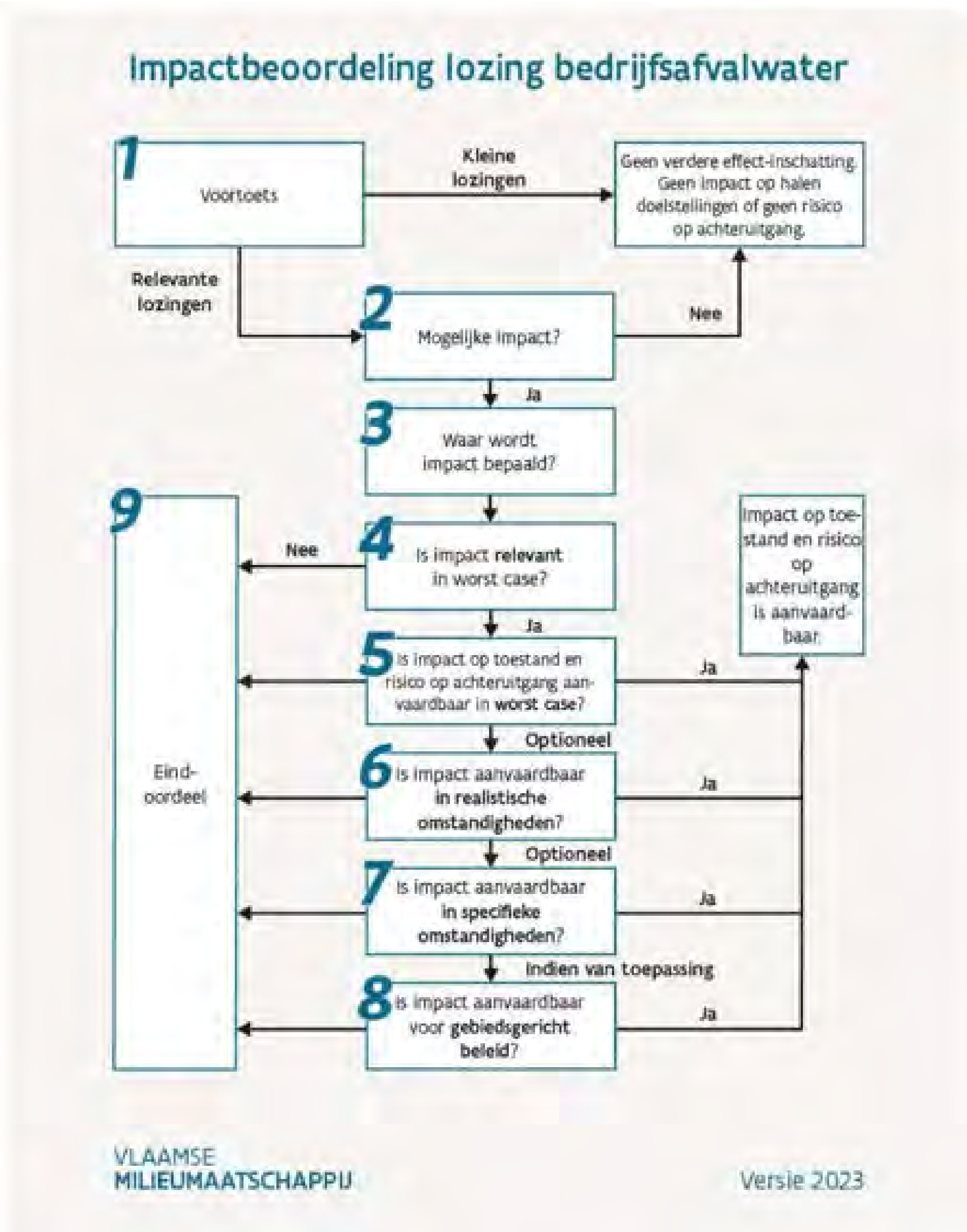


Figure 9-31: Step-by-step plan for impact assessment of industrial wastewater discharge into surface water in the context of the Weser judgment and the Water Framework Directive (Source: EIA fact sheet Water: impact of industrial wastewater discharge; Department of the Environment; 2023)

For the discharge of drainage water into the Kanaaldok, the emission situation for the relevant parameters, as indicated in § 9.1.3.2.3, is assessed.

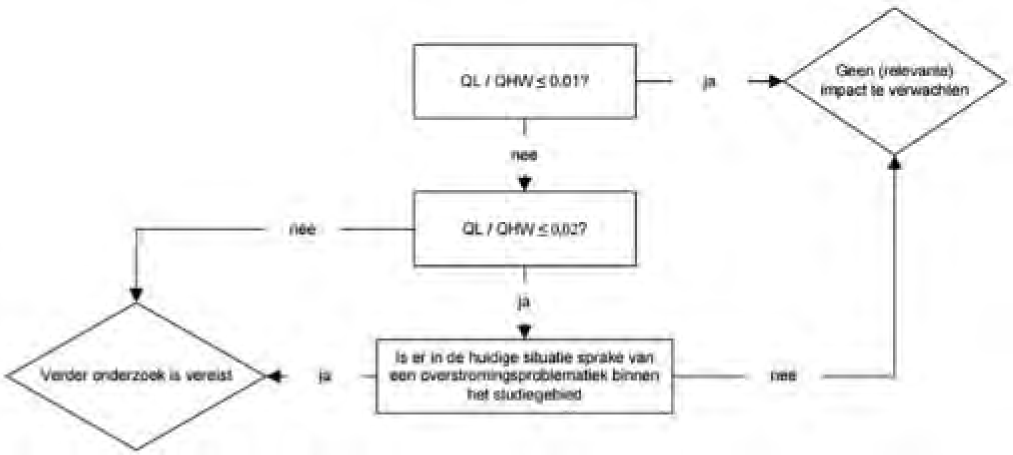
For discharge into the Scheldt, the emission situation for all relevant parameters is mapped out. These are the parameters for which Project One expects the concentration after treatment to exceed the classification criterion. An estimate is made of the expected discharged pollutant loads for which a discharge standard is requested. Since this is a new installation, no analysis results for the effluent are available yet. There are no quality objectives for chlorides, sulphate and conductivity due to the brackish nature of the transitional water in the Scheldt estuary (in accordance with the MKN VLAREM II); these parameters are therefore not evaluated in the EIA.

Table 9-16: Summary table of significance framework for surface water quality (Source: EIA fact sheet Water: impact of industrial wastewater discharge; Department of the Environment; 01/12/2023)

Significance level	Assessment criteria	Mitigating measures
Surface water quality		
Significant negative effect (-3)	Clear deterioration	Mitigatingmeasures (should)be proposed be proposed
Negativeimpact(-2)	Objectives are not OK, but no clear deterioration.	An investigation must be conducted to propose mitigating measures
Limitednegativeeffect(-1)	Objectives are OK, there is no clear decline	Given that the objectives are being achieved in accordance with the principles of the roadmap, the environmental quality in the reference situation is sufficient and there is no need to seek mitigating measures N/A
Negligibleeffect(0)	No or negligible contribution from the discharge	

9.2.1.2 Hydraulic impact

The hydraulic impact is assessed on the basis of the discharge rate of the wastewater and the high-water discharge rate of the receiving surface water, using the following assessment framework:



With

QL: discharge flow rate

QHW: high water flow rate of the receiving surface water Source: Water Guidelines

Manual (2011)

9.2.1.3 Mitigating measures

If the project has negative effects, mitigating measures will be proposed (see § 5.3 for more information).

9.2.2 Reference situation

9.2.2.1 Hydrographic characteristics and surface water quality

9.2.2.1.1 Hydrography

To the west of the project area, with Scheldelaan in between, lies the Scheldt. To the east of the project area is Kanaaldok B2 (Havendok) (see Appendix 1, Map 7). Insteekdokken 1 and 2 connect to Kanaaldok.

Scheldt

The Scheldt is a lowland river, which is approximately 355 km long from its source at Saint Quentin (northern France) to its mouth at Vlissingen (the Netherlands). The Scheldt river basin and its tributaries cover almost the whole of southern Belgium, part of northern France and half of Zeeland. The river basin is bordered to the west by the Yser basin and to the north, east and south by the Meuse basin.

The Scheldt roughly consists of two parts. The actual upper river section (Upper Scheldt) begins at Saint Quentin and ends at the weirs in Ghent. Downstream from Ghent to the mouth at Vlissingen (Sea Scheldt and Western Scheldt), the Scheldt forms an estuary in which the tide from the North Sea has a significant influence on the direction of flow, discharge, water levels and salinity. In the Zeeschelde, salty seawater and fresh river water mix. This creates a unique transition zone between river and sea. The fresh water gradually turns into brackish water downstream and further into the Netherlands, the water becomes salty. The salinity fluctuates constantly, depending on the tide and the upstream catchment areas.

At the project site, the Scheldt belongs to the Sea Scheldt. Due to the regular inflow of seawater, the Scheldt water here is brackish. Administratively, the project site is located in the Lower Scheldt basin.

As part of the Sigma Plan, higher and wider dykes were constructed in combination with controlled flood areas along the tidal rivers and local depoldering. These provide protection against flooding from those tidal rivers during storm surges. In addition, the natural bends or meanders of the rivers are being restored in certain places. These form a natural buffer during periods of heavy rainfall. In the summer, they also prevent desiccation, just like thresholds in the riverbed.

In the Scheldt estuary near Vlissingen, the difference between high and low tide is around four metres. Further inland, the tidal difference increases. The further upstream, the narrower the riverbed and the more the incoming flood water is pushed up. Near the project area, the tidal difference is approximately 5 metres.
m. Near Hamme, where the Durme flows into the Scheldt, the river reaches its highest water level at high tide. After that, the backwater effect subsides. Due to the locks in the vicinity of Ghent, the river further upstream is no longer influenced by the sea.

The transition from salt to fresh water, together with the steady rhythm of the tides, creates a wide variety of tidal nature. Mud flats and salt marshes purify the river water (biofilter principle) and regulate the balance in the food chain. At the same time, they temper the waves, reducing the pressure on the dykes.

Canal dock

The Canal Dock was constructed in the 1960s and is a shipping route for vessels passing through, which need to reach the slip docks or continue their journey from the port of Antwerp. The construction of the Canal Dock was part of the Ten-Year Plan (1956-1965), under which the Belgian government invested heavily in the expansion of the port.

Canal Dock B2 in the port of Antwerp begins downstream of the Lillo Bridge. Canal Dock B1 is located upstream. Canal Dock B2 then runs alongside Insteekdokken 1 (Bayer), 2 (Inovyn) and 3 (Vopak) on the left bank and Bevrijdingsdok on the right bank. Canal Dock B2 ends at the junction and connection with the lock complexes of the Berendrecht and Zandvliet locks, Canal Dock B3 (loading and unloading dock, dead end at the BASF concern) and the Scheldt-Rhine Canal.

9.2.2.1.2 Surface water quality

9.2.2.1.2.1 Physico-chemical quality

Scheldt

In order to assess the quality of the Scheldt water, the EIA relies on the database of the Flemish Environment Agency (VMM) concerning surface water quality in the Flemish Region. Every year, the VMM carries out measurements to determine the quality of the watercourses. The VMM's 'upstream concentration database' provides the average and maximum concentrations for the measuring points over the past six years. In the context of the EIA, various measuring points are important for determining the quality of the Scheldt upstream and downstream of the project area. These measuring points are:

- 159000: upstream, in the Scheldt navigation channel, Scheldt bend near Kallosluis;
- 157000: upstream, Lillo, the channel near Fort Liefkenshoek and Fort Lillo (relevant for individual PAKs);
- 154100: downstream, Zandvliet, Doel border, the shipping channel in the middle of the Scheldt.
- If no measurements are known for a particular parameter for a measuring point, the 90th percentile value of the catchment area or the Lower Scheldt basin should be used in determining the impact. The results for the catchment area or the Lower Scheldt basin are calculated as the 90th percentile values of both all annual maximums and all annual averages of all measured measuring points in the basin.

The results (average and maximum over the last 6 years) are shown in Table 9-17. The location of the measuring points is indicated on Map 7 in Appendix 1.

Upstream and downstream of Project One, the **Scheldt** must meet the objectives for 'Transitional water – brackish macrotidal lowland estuary (O1b)' (VLAREM II Annex 2.3.1, River Basin Management Plan 2012-2027). There are no quality objectives for chlorides, sulphate and conductivity due to the brackish nature of the water in the Scheldt estuary.

Table 9-17 shows that the environmental quality objectives (EQS) for **Scheldt water** at the selected measuring points can be met, with the exception of the following parameters:

- chemical oxygen demand (COD),
- nitrogen: more specifically, the average sum of nitrite, nitrate and ammonium,
- orthophosphate,
- dissolved boron,
- arsenic, cobalt, total vanadium,
- maximum concentration of cadmium at the downstream measuring point,
- benzo(a)pyrene.

Overall, the MKN is exceeded in the catchment area for arsenic, boron, benzo(a)pyrene, cobalt, vanadium and nitrogen (nitrite+nitrate+ammonium). In the Lower Scheldt basin, the MKN is also exceeded for the parameters biochemical oxygen demand (BOD), total cadmium and nitrite.

In general, there are no significant systematic differences between the upstream and downstream measuring points, except for the maximum concentration of cadmium, where an exceedance of the EQS was only observed downstream, and for benzo(a)pyrene and cobalt, where the upstream concentration is significantly higher than the downstream concentration. Exceedances of the environmental quality standards for some pollutants are observed both upstream and downstream. The parameters boron and arsenic are partly due to natural increases. Seawater naturally contains approximately 5 mg/l boron and 2 to 4 µg/l arsenic. The Scheldt consists partly of seawater and therefore naturally contains a higher boron concentration than the EQS and an arsenic concentration of the same order of magnitude as the EQS.

The VMM measures PFAS (usually 43 compounds are analysed) at a number of measuring points. Currently, PFOS is the only PFAS compound designated as a Priority Hazardous Substance for which an EQS has been set. The average concentrations of the available analysis results for PFOS in the Scheldt are shown in Table 9-17 below. This shows that the annual average concentration is higher than the MKN.

Table 9-17: Water quality of the Scheldt and assessment against the environmental quality standard (EQS) at the measuring points upstream and downstream of the Project One site for the last 6 years (VMM database report on upstream quality dated 16/01/2024) (exceedances of the EQS are indicated in orange)

					159000- upstream		157000 - upstream		154100 - downstream		Runoff zone VL17_43		Lower Scheldt basin	
Symbol	Parameter	Unit	MKN max	MKN gem	Maximum	Average	Maximum	Average	Maximum	Average	90th percentile Max	90th percentile Mean	90th percentile Max	90th percentile Avg
As o	Arsenic, dissolved	µg/L	-	3	5.4	**3.56**	4.8	**3.59**	5	**3.55**	**4.76**	**3.51**	4.90	**3.20**
Ash t	Arsenic, total	µg/L	-	5	15.6	**7.45**	14.1	**7.33**	7.9	**5.07**	**14.56**	**7.58**	17.64	**8.07**
B o	Boron, dissolved	µg/L	-	700	2,110	**1,193**	2,250	**1,432**	2,430	**1,695**	**2,210**	**1,508**	1,451	**985**
B t	Bore, total	µg/L	-	700	2,110	**1,188**	2,170	**1,458**	2,370	**1,687**	**2,290**	**1,547**	1,822	**722**
B(a)P	Benzo(a)pyrene (b)	ng/L	27	0.17			**126**	**63.33**	**31**	**12.83**	**85.00**	**40.17**	**102.20**	**50.03**
Benzene	Benzene	µg/l	50	8					0	0.00	0.00	0.00	0.00	0.00
BOD5	Biochemical oxygen demand after 5 days.	mgO2/L	6	-	4.1	1.80	2.4	1.53	2.3	1.45	3.18	1.65	**14.58**	5.73
Cd o	Cadmium, dissolved	µg/L	0.45	0.2	0.26	0.09	0.3	0.13	**0.6**	0.12	0.27	0.09	0.24	0.11
Cd t	Cadmium, total	µg/L	-	0.8	1.37	0.48	1.07	0.41	0.687	0.25	1.11	0.47	1.66	0.63
Co o	Cobalt, dissolved	µg/L	-	0.5	1.26	**0.57**	0.92	0.47	0.69	0.35	1.00	0.46	1.98	**0.96**
Co t	Cobalt, total	µg/L	-	0.6	8.8	**2.94**	7.6	**2.68**	2.84	**1.26**	**7.36**	**3.19**	10.20	**4.68**
Cr o	Chromium, dissolved	µg/L	-	5	3	0.28	0.	0.00	0	0.00	0.28	0.08	0.96	0.25
Cr t	Chromium, total	µg/L	-	50	32	12.73	27.6	12.44	18.6	5.76	31.66	14.38	49.00	17.33
Cu o	Copper, dissolved	µg/L	-	7	6	3.21	8.9	3.66	26.	4.53	8.66	2.71	6.10	4.57
Cu t	Copper, total	µg/L	-	50	32.1	11.84	31	11.43	30.6	8.77	30.92	11.78	32.74	14.93
CZV	Chemical oxygen demand	mgO2/L	30	-	**78**	45.23	**86**	51.13	**130**	77.14	96.20	51.13	**110.00**	38.15
EyBz	Ethylbenzene	µg/L	50	5					0	0.00	0.00	0.00	0.00	0.00
iPyBz	Isopropylbenzene	µg/L	10	1							0.00	0.00	0.00	0
KjN	Kjeldahl nitrogen	mgN/L	-	-	2.3	1.21	3	1.40	2.3	1.19	5.25	2.61	16.02	6.32
N t	Nitrogen, total	mgN/L	-	-	6.6	4.46	5.8	3.88	6.	3.51	12.30	8.74	18.60	10.04
Naphthalene	Naphthalene	ng/L	130000	2000			0	0.00	270	30	135.00	15	70.60	16.18
NH4+	Ammonium	mgN/L	-	-	0.63	0.25	0.76	0.40	0.8	0.48	4.33	2.42	13.00	2.69
Ni o	Nickel, dissolved	µg/L	34	8.6	7.5	3.32	7.4	3.55	6.9	2.68	7.02	2.80	6.98	4.98
Ni t	Nickel, total	µg/L	-	51	18.4	8.50	17	8.63	11	6.00	16.70	9.04	21.05	9.81
NO2-	Nitrite	mgN/L	0.6	0.2	0.096	0.03	0.094	0.03	0.091	0.03	0.43	0.15	0.43	**0.20**
NO3-	Nitrate	mgN/L	-	-	5.5	4.04	5.1	3.53	5.1	3.28	12.64	3.97	10.10	5.90
ompXyl	Xylenes (o+m+p)	µg/L	40	4							0.00	0.00	0.00	0.00
oPO4	Orthophosphate	mgP/L	-	0.07									3.70	**2.59**
oPO4 f	Orthophosphate, filtered	mgP/L	-	0.07	0.2	**0.15**	0.209	**0.14**			0.19	0.14	1.93	**1.00**
P t	Phosphorus, total	mgP/L	-	-	1.47	0.50	1.34	0.46	0.63	0.29	1.10	0.58	3.40	0.89
Pb o	Lead, dissolved	µg/L	14	1.3	5.1	0.43	0	0.00	0.	0.	0.	0.	1.04	0.25
Pb t	Lead, total	µg/L	-	97.22	40.7	11.28	32.8	9.89	16	4.37	32.72	12.79	58.69	19.84
Se o	Selenium, dissolved	µg/L	-	2	1.34	0.23	1.64	0.41	1	0.37	1.22	0.32	1.36	0.21
Se t	Selenium, total	µg/L	-	3	2	1.09	2.12	0.61	1.95	0.53	2.40	0.79	3.81	1.37
Ti o	Titanium, dissolved	µg/L	-	20	13	1.05	0	0.00	0.	0.00	0.00	0.	0.	0.
Titanium	Titanium, total	µg/L	-	100	195	72.67	192	63.57	104	28.78	191.20	76.42	252.40	72.65
Toluene	Toluene	µg/L	700	90					0	0.00	0.00	0.00	0.00	0
V o	Vanadium, dissolved	µg/L	-	4	6.5	3.17	4.3	2.83	3.9	2.69	4.40	2.90	4.30	2.69
V t	Vanadium, total	µg/L	-	5	31	**15.15**	27.	**14.14**	18.5	**8.27**	**30.88**	**16.22**	40.80	**16.70**
Zn o	Zinc, dissolved	µg/L	-	20	26	2.17	0	0.00	21.7	3.13	3.80	1.23	29.00	12.55
Zn t	Zinc, total	µg/L	-	200	194	63.25	155	56.62	85	30.02	169.40	71.77	248.80	100.74
ZS	Suspended solids	mg/L	-	-	1,060	206	340	126	218	64	373	135	290	82
	Nitrite + nitrate + ammonium	mg/L	winter gem	0.49		**8.53**		**8.66**		**36.03**		**24.18**		**26.20**
	PFOS	ng/l	7200	0.13			20	**12.10**	36.5	**13.40**				

Canal dock

The following measuring points are important for reflecting the quality of the Canal Dock in the project area:

- 804000: upstream, Quay 601, Waste Park, Lillopark, sideways Evonik;
- 803800: downstream, Zandvliet; near the Berendrecht lock turning basin.

If no measurements are known for a particular parameter at a measuring point, the 90th percentile value for the catchment area or the Lower Scheldt basin should be used. The results for the catchment area or the Lower Scheldt basin are calculated as the 90th percentile values of both all annual maximums and all annual averages of all measured measuring points in the basin. The results (average and maximum over the last 6 years) are shown in Table 9-18. The location of the measuring points is indicated on Map 7 in Appendix 1.

The **Canal Dock** must meet the objectives for 'very, slightly brackish lake (Bzl)' upstream and downstream of Project One (VLAREM II Appendix 2.3.1, River Basin Management Plan 2022-2027).

Table 9-18 shows that the environmental quality objectives (MKN) for the **dock water** at measuring points 804000 and 80 can be met, with the exception of the following parameters:

- chemical oxygen demand (COD),
- total nitrogen,
- total phosphorus,
- sulphate,
- chloride,
- dissolved cadmium, boron, cobalt, nickel and arsenic.

In general, the environmental quality standards for benzo(a)pyrene, biochemical oxygen demand (BOD), total cadmium, nitrite and vanadium are also exceeded in the Lower Scheldt basin.

In general, there are no significant systematic differences between the upstream and downstream measuring points. Exceedances of the environmental quality standards for some pollutants are observed both upstream and downstream.

The VMM measures PFAS (usually 43 compounds are analysed) at a number of measuring points. Currently, PFOS is the only PFAS compound designated as a Priority Hazardous Substance for which an MKN has been established. The average concentrations of the available analysis results for PFOS in the Kanaaldok are shown in Table 9-18 below. This shows that the annual average concentration is higher than the MKN.

Table 9-18: Water quality in the Kanaaldok and assessment against the environmental quality standard (MKN) at the measuring points upstream and downstream of the Project One site for the last 6 years (VMM database report on upstream quality dated 16/01/2024) (exceedances of the MKN are indicated in orange)

					804000- upstream		803800 - downstream		Runoff zone VL17_187		Lower Scheldt basin	
Symbol	Parameter	Unit	MKN max	MKN gem	Maximum	Average	Maximum	Average	90th percentile Max	90th percentile Mean	90th percentile Max	90th percentile Avg
As o	Arsenic, dissolved	µg/L	-	3	4.4	3.02	4.6	4.03	4.48	3.12	4.90	3.20
As t	Arsenic, total	µg/L	-	5	4.8	3.44	4.7	4.17	5.03	3.81	17.64	8.07
B o	Boron, dissolved	µg/L	-	700	1,820	1,320	1,700	1,090	1,776	1,205	1,451	985
B t	Bore, total	µg/L	-	700	1,700	1,248	1,800	1,363	1,812	1,344	1,822	722
B(a)P	Benzo(a)pyrene (b)	ng/L	27	0.17	11	0.92	20.0	6.0	17.9	2.5	102.20	50.03
Benzene	Benzene	µg/l	50	8	0	0.00			0.00	0.00	0.00	0.00
BOD5	Biochemical oxygen demand after 5 days.	mgO2/L	6	-	3.4	1.63	1.7	0.43	3.18	1.26	14.58	5.73
Cd o	Cadmium, dissolved	µg/L	0.45	0.2	0.3	0.16	0.25	0.19	0.31	0.14	0.24	0.11
Cd t	Cadmium, total	µg/L	-	0.8	0.34	0.23	0.269	0.15	0.33	0.16	1.66	0.63
Co o	Cobalt, dissolved	µg/L	-	0.5	1.49	0.56	0.55	0.43	0.76	0.46	1.98	0.96
Co t	Cobalt, total	µg/L	-	0.6	1.63	0.67	1.26	0.68	1.34	0.63	10.20	4.68
Cr o	Chromium, dissolved	µg/L	-	5	0	0.00	1.1	0.18	0.83	0.13	0.96	0.25
Cr t	Chromium, total	µg/L	-	50	5.1	0.43	14.	2.8	5.128	0.4632	49.00	17.33
Cu o	Copper, dissolved	µg/L	-	7	7.4	5.06	5.6	4.33	6.70	5.24	6.10	4.57
Cu t	Copper, total	µg/L	-	50	13.	6.49	11.	6.72	11.07	6.74	32.74	14.93
CZV	Chemical oxygen demand	mgO2/L	30	-	66	32.40	60	53.67	60.80	43.00	110.00	38.15
EyBz	Ethylbenzene	µg/L	50	5	0	0.00			0.00	0.00	0.00	0.00
iPyBz	Isopropylbenzene	µg/L	10	1	0	0.00			0.00	0.00	0.00	0.00
KjN	Kjeldahl nitrogen	mgN/L	-	-	1.3	0.56	1.69	0.53	1.49	0.51	16.02	6.32
N t	Nitrogen, total	mgN/L	-	1.8	4.3	3.21	4.4	3.07	4.93	3.10	18.60	10.04
Naphthalene	Naphthalene	ng/L	130000	2000	0.	0.00	40	8.00	41.80	7.36	70.60	16.18
NH4+	Ammonium	mgN/L	-	-	0.64	0.32	0.63	0.30	0.64	0.31	13.00	2.69
Ni o	Nickel, dissolved	µg/L	34	8.6	63	8.81	42	10.28	8.54	3.51	6.98	4.98
Ni t	Nickel, total	µg/L	-	51	68.	9.77	43.	9.83	35.80	7.32	21.05	9.81
NO2-	Nitrite	mgN/L	0.6	0.2	0.36	0.08	0.19	0.07	0.26	0.08	0.43	0.20
NO3-	Nitrate	mgN/L	-	-	4.1	3.09	3.96	2.55	4.53	3.02	10.10	5.90
ompXyl	Xylenes (o+m+p)	µg/L	40	4	0.	0.			0.	0.	0.	0.
oPO4	Orthophosphate	mgP/L	-	-							3.70	2.59
oPO4 f	Orthophosphate, filtered	mgP/L	-	-	0.161	0.11	0.15	0.11	0.20	0.11	1.93	1.00
P t	Phosphorus, total	mgP/L	-	0.11	0.251	0.17	0.23	0.17	0.29	0.23	3.40	0.89
Pb o	Lead, dissolved	µg/L	14	1.3	0	0.00	2.2	0.26	2.20	0.38	1.04	0.25
Pb t	Lead, total	µg/L	-	97.22	3.12	0.92	3.2	0.86	4.70	1.53	58.69	19.84
Se o	Selenium, dissolved	µg/L	-	2	0.	0.00	1.50	0.46	1.10	0.41	1.36	0.21
Se t	Selenium, total	µg/L	-	3	0	0.00	1.7	0.28	1.20	0.20	3.81	1.37
Ti o	Titanium, dissolved	µg/L	-	20	0	0.00	0.	0.00	0.	0.	0.	0.
Titanium	Titanium, total	µg/L	-	100	9	2.64	42	14.98	36.80	13.30	252.40	72.65
Toluene	Toluene	µg/L	700	90	0	0.00			0.00	0.00	0.00	0
V o	Vanadium, dissolved	µg/L	-	4	3.3	2.30	3.7	2.56	3.34	2.29	4.30	2.69
V t	Vanadium, total	µg/L	-	5	6	4.14	6.3	4.92	7.08	4.77	40.80	16.70
Zn o	Zinc, dissolved	µg/L	-	20	22	3.17	15.	4.33	19.40	5.36	29.00	12.55
Zn t	Zinc, total	µg/L	-	200	49	17.82	27	13.00	35.32	7.10	248.80	100.74
ZS	Suspended solids	mg/L	-	-	23	14	46	16.98	49.00	15.98	290	82
Cl-	chloride	mg/L	3000	-	8,000	5,594	7,900	5,217	8,010	4,598	3,003	1,020
SO4=	sulphate	mg/L	-	400	1200	801.67	1100	843	1,182	1,106	582	415
	PFOS	ng/l	36,000	0.65	15	11,00						

9.2.2.1.2.2 Prati index for dissolved oxygen

The Prati index is an additional parameter that indicates water quality. Transformation formulas are used to assign a score between 0.1 and > 16 to the physicochemical parameters. The scores obtained are then classified into classes from 1 to 6, which assess the quality of the water from unpolluted (class 1) to very heavily polluted (class 6) (Table 9-19:).

At the relevant measuring points in the **Scheldt**, a gradual improvement in water quality has been observed over time. At the upstream measuring points 159000 and 157000, the quality has improved from polluted to acceptable, and at measuring point 154100 from polluted to unpolluted. Water quality is therefore improving in a downstream direction.

At the relevant measuring points in the **Kanaaldok**, an improvement in water quality has been observed over time. The quality of the water is evolving from acceptable to unpolluted. No significant difference has been observed between the upstream and downstream quality.

Table 9-19: Prati index according to oxygen: classification into classes

Class	Index	Description
1	0.1 – 1	Not contaminated
2	1 – 2	Acceptable
3	2 – 4	Moderately polluted
4	4 – 8	Contaminated
5	8 – 16	Heavily contaminated
6	> 16	Heavily contaminated

Table 9-20: Prati index - dissolved oxygen for measuring points 159000, 157000, 154100, 804000 and 803800

159000	4.7	5.5	4.6	3.8	4.0	4.5	4.8	3.3	3.1	2.4	2.4	2.0	2.0	2.2	2.0	1.7	2.1	1.7	1.7	1.3	1.5	2.1	1.5	1.7
157,000	4.5	4.7	3.5	2.8	3.0	3.0	3.2	2.5	2.5	2.0	1.8	1.5	1.5	1.5	1.6	1.3	1.6	1.3	1.3	1.0	1.1	1.5	1.3	1.3
154,100	3.6	4.4	3.0	2.3	2.7	2.0	1.5	1.4	1.5	1.4	1.3	0.9	0.9	0.9	1.0	0.9	1.1	0.9	0.7	0.8	0.9	1.1	0.9	0.9
804,000	2	2.8	1.4	1.1	1.8	1	0.9	1	0.8	0.6	0.9	0.7	0.8	0.9	0.9	0.6	0.8	0.4	0.5	0.4	0.6	0.9	0.6	
803800																	0.5		0.5	0.5	0.5	0.9	0.6	

9.2.2.1.2.3 Biological quality

The VMM also determines the biological quality of surface water. The biological study evaluates the watercourse as a biotope, rather than simply examining the quality of the water column. The Belgian Biotic Index (BBI) method is used to determine the biological water quality.

To determine the BBI, macroinvertebrates are collected from the bottom and from the water using a scoop net. The presence or absence of certain macroinvertebrates determines the BBI. The biotic index is based on the relative sensitivity of certain indicator species to pollution on the one hand and diversity on the other. Unlike chemical analyses, which reflect the moment at which the water sample is taken, the biological assessment evaluates pollution effects that have occurred over a longer period of time. For the assessment, a value between 10 (very good quality) and 0 (extremely poor quality) is assigned.

Table 9-21: Index values Belgian Biotic Index

BBI	Quality class
10 – 9	Very good quality
8 - 7	Good quality
6 – 5	Moderate quality
4 – 3	Poor quality
2 – 1	Very poor quality
0	Extremely poor quality

No BBI values are available for measuring points 159000, 157000 and 154100 in the **Scheldt**. The BBI is a measuring instrument developed for the evaluation of fresh surface water and does not provide usable results for brackish and salt water.

The BBI for measuring points 803800 and 80400 in the Kanaaldok is shown in the table below.

Table 9-22: Belgian Biotic Index (BBI) for measuring points 803800 and 804000

Measuring point	2006	2011	2014	2018
804,000	4	4	5	5
803800		4		

The biological quality of the **Kanaaldok** in the upstream section was poor in 2006 and 2011. In recent years, moderate quality has been measured. In the downstream section, poor quality was measured in 2011.

9.2.2.1.2.4 Water quality decision

In general, based on all the above data from the VMM monitoring network, it can be concluded that the **Scheldt**, both upstream and downstream of Project One, does not currently meet the quality objectives. The most critical parameters are nitrogen (nitrite + nitrate + ammonium), COD, orthophosphate, dissolved boron, arsenic, cobalt, vanadium, cadmium (at one measuring point), benzo(a)pyrene and PFOS. Based on the Prati index, a gradual improvement in water quality is observed at all measuring points over time. Water quality is acceptable to unpolluted according to the Prati index and is also improving downstream.

The **Canal Dock**, both upstream and downstream of Project One, does not meet the quality objectives. The most critical parameters are COD, total nitrogen, total phosphorus, sulphate, chloride, dissolved cadmium, cobalt, nickel, arsenic, boron and PFOS. Based on the Prati index and the Belgian Biotic Index, an improvement in water quality at the relevant measuring points has been observed over time.

9.2.2.1.2.5 Description of the status of the water body

Under the Water Framework Directive (WFD), a significant proportion of surface waters in Belgium have been designated as water bodies. The aim of this framework directive is to safeguard the quality of surface water and groundwater. Any deterioration in the condition of a water body must be prevented. Deterioration occurs as soon as the status of at least one of the quality elements declines by one class, even if this deterioration does not result in the surface water body being classified in a lower class overall. If the quality element in question is already in the lowest class, any deterioration of that element constitutes a 'deterioration of status'..

‘Good surface water quality’ means that both the ecological status or ecological potential and the chemical status of the surface water are at least ‘good’ (see Figure 9-32). The ecological status of heavily modified or artificial water bodies is assessed on the basis of four quality classes: good, moderate, poor and bad. The biological quality elements phytoplankton, macrophytes, phytobenthos, macroinvertebrates and fish, as well as a number of hydromorphological, chemical and physico-chemical parameters, determine the ecological status. A good chemical status of surface water implies that the environmental quality standards, as included in VLAREM, are respected for a number of specific pollutants, which can be divided into pesticides, industrial pollutants and heavy metals.

The project area belongs to the following water bodies (cf. River Basin Management Plans 2022-2027) (see Table 9-23):

1. Zeeschelde IV (VL17_43)
2. Antwerp Port Docks + Scheldt-Rhine connection (VL05_187)

The water body 'Zeeschelde IV' is a Flemish water body in the 'Transitional water' category, of the 'brackish macrotidal lowland estuary' type (cf. River Basin Management Plans 2022-2027). The quality assessment for the Zeeschelde IV water body is carried out in the River Basin Management Plan (RBMP) and is shown in Table 9-24:. The most recent assessment available on the geoloket of the River Basin Management Plans 2022-2027 (at https://www.integraalwaterbeleid.be/nl/geoloket/geoloket-stroomgebiedbeheerplannen/) dates from 2018. The water body is currently in an inadequate ecological status due to the inadequate status of the macrophytes and the poor status of the underlying physico-chemical elements (nitrate+nitrite+ammonium) and specific pollutants (arsenic, boron, uranium). Compared to the previous assessment in the context of the river basin management plans (in 2015), the ecological and chemical status has not changed in terms of class. However, there has been an improvement in the underlying parameters for fish (from inadequate to good).

The water body 'Antwerp Port Docks and Scheldt-Rhine Connection' is a Flemish water body in the 'lake' category, classified as a 'very slightly brackish artificial lake' (cf. River Basin Management Plans 2022-2027). The Antwerp Port Docks are connected to the Scheldt via locks. The quality assessment for the water body Antwerp Port Docks and Scheldt-Rhine connection is carried out in the River Basin Management Plan (RBMP) and is shown in Table 9-25. The most recent assessment available on the geoloket of the River Basin Management Plans 2022-2027 (on Geoloket river basin management plans — nl (integraalwaterbeleid.be)) dates from 2018. The water body is currently in an inadequate ecological condition. Compared to the previous assessment under the river basin management plans, the ecological and chemical status has not changed in terms of class. However, there has been a slight shift in the underlying parameters for phytoplankton, nitrogen and specific pollutants.

The drainage areas of the water bodies 'Zeeschelde IV' and 'Antwerp Port Docks and Scheldt-Rhine connection' are designated as a class 5 area of concern (good ecological status after 2033, but potential for significant improvement, provided that the actions included in SGBP3 and SGBP4 are implemented) on the geoloket of the River Basin Management Plans 2022-2027.

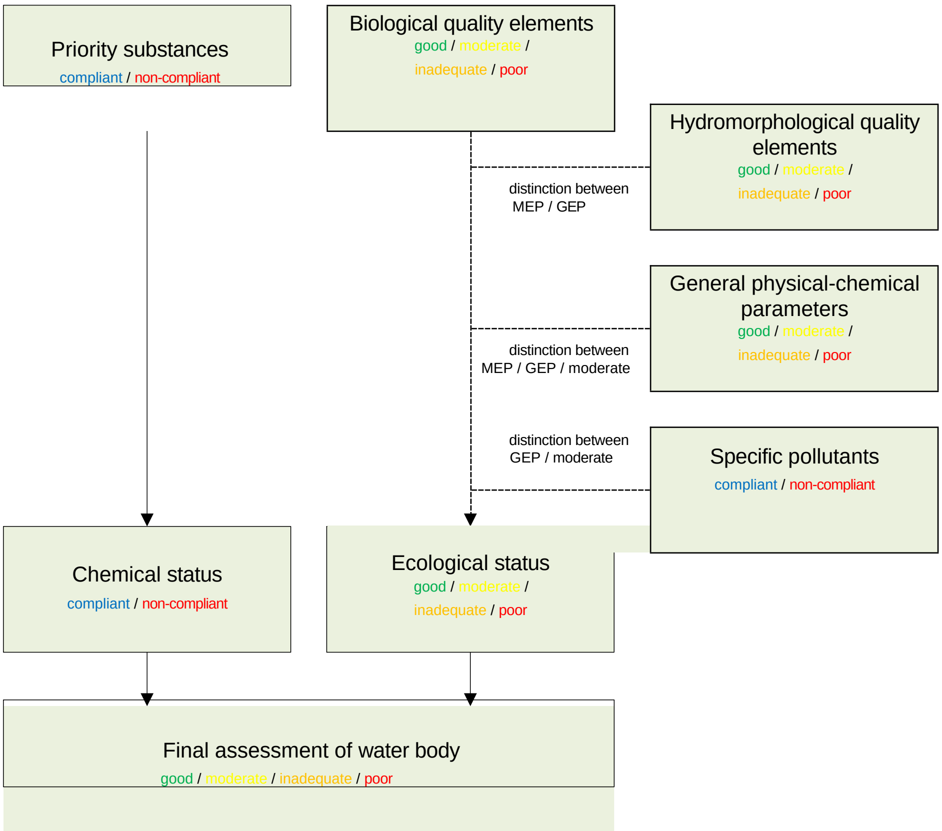


Figure 9-32: Assessment of quality elements and determination of chemical and ecological status and final assessment for heavily modified and artificial water bodies

Table 9-23: Code, type and status of water bodies in the vicinity of the project area

Water body	Code	Type	Status
ZeescheldeIV	VL17_43	O1 brackish (brackish macrotidal lowland estuary)	Natural – significantly altered
Antwerp harbour docks + Scheldt-Rhine connection	VL05_187	Very slightly brackish artificial lake	artificial

Table 9-24: Overview of quality assessment for the Zeeschelde IV water body in accordance with the River Basin Management Plans (RBMP)

Component	Quality element	Target	Assessment 2015 (2e RBMP)	Explanation	2018 assessment (3e SGBP)	Explanation
Ecological status			Inadequate		Inadequate	
	Biological elements:		Inadequate		Inadequate	
	Phytobenthos	0.6 (MEP)	Not relevant		Notof application	
	Phytoplankton	Not relevant	Not relevant		Not relevant	
	Macrophytes	0.6	Insufficient		Insufficient	
	Macroinvertebrates/macrobenthos	0.75	Moderate		Moderate	
	Fish	0.75	Insufficient		Good	
	Biologically supportive physical-chemical elements:		Poor		Poor	
	Nitrate + nitrite + ammonium	0.49 mg/L (winter average)	poor	>2 mgN/L	poor	>2 mgN/L

Component	Quality element	Objective	Assessment 2015 (2e SGBP)	Explanation	2018 assessment (3e SGBP)	Explanation
	Oxygen, dissolved	>= 6 mg/L (10th percentile)	Good	≥6 mg/L	Good	≥6 mg/L
	PH	≥7.5, ≤9	Good	≥7.5, ≤9	Good	≥7.5, ≤9
	Specific pollutants		Poor	Exceedance of uranium (dissolved), boron (dissolved) and arsenic (dissolved)	Non-compliant	Exceedance of arsenic (dissolved), boron (dissolved), uranium (dissolved)
	Hydromorphology				Inadequate	
Chemical status	**Hazardous substances**		Poor	Exceedance of mercury (total), PAH benzo (g,h,i)perylene + indeno (1,2,3-cd)pyrene	Does not comply	Exceedance of mercury (total), benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, fluoranthene, heptachlor + epoxide, perfluorooctane sulfonic acid, polybrominated diphenyl ether, tributyltin

Table 9-25: Overview of quality assessment for the Antwerp Port Docks and Scheldt-Rhine connection water body

Component	Quality element	Target	Assessment 2014 (2e SGBP)	Explanation	2018 assessment (3e SGBP)	
Ecological status			Insufficient		Inadequate	
	Biological elements:		Inadequate		Inadequate	
	Phytobenthos	0.6	Good		Good	
	Phytoplankton	0.6	Very good		Good	
	Macrophytes	0.6	Not relevant		Not relevant	
	Macroinvertebrates/macrobenthos	0.6	Insufficient		Insufficient	
	Fish	0.6	Moderate		Not available	
	Biologically supportive physical-chemical elements:		Insufficient		Moderate	
	Nitrogen, total	1.8 mg N/l (MKN) (summer average)	Insufficient	>2.9, <= 4.1 mg N/l	Moderate	>1.8, <= 2.9 mg N/l

Component	Quality element	Objective	Assessment 2014 (2e SGBP)	Explanation	2018 assessment (3e SGBP)	
	Conductivity	18,000 µS/cm (MKN) (90th percentile)	Good	<= 18,000 µS/cm	Good	<= 18,000 µS/cm
	pH (min and max)	6 - 9 (MKN)	Good	≥ 6, ≤ 9	Good	≥ 6, ≤ 9
	Phosphorus, total	0.11 mg P/l (MKN)	Moderate	>0.11, ≤0.22 mg P/l	Moderate	>0.11, ≤0.22 mg P/l
	Oxygen, dissolved	>=6 mg/l (MKN)	Good	≥6 mg/l	Good	≥6 mg/l
	Specific pollutants		Compliant		Does not comply	Arsenic (dissolved), boron (dissolved), uranium (dissolved)
Chemical state	**Hazardous substances**		Does not comply	Exceeding standards for mercury, benzo(ghi)perylene, indeno (123-cd)pyrene	Does not comply	The chemical status is considered poor even if no exceedances have been measured. This is because the ubiquitous substances heptachlor epoxide and mercury in biota exceed the standard at all locations in Flanders where they have been measured.

9.2.2.1.3 Quality of the waterbed

In order to assess the quality of the waterbed, the analysis data from the Flemish Environment Agency (VMM) concerning the quality of the waterbeds in the Flemish Region is used. The VMM carries out regular measurements to determine the quality of watercourses. In the context of this environmental impact report, Table 9-26 shows the measuring points that are relevant for determining the quality of the waterbed of the Scheldt and Kanaaldok upstream and downstream of the Project One project area. These measuring points are indicated on Map 7 in Appendix 1. In the Scheldt, arsenic enrichment in the waterbed was only detected at MT-42 and 154100. In the Canal Dock, cadmium, lead and chromium were detected in the waterbed.

Table 9-26: Waterbed quality in the vicinity of the project area

Measuring location	X/Y coordinates (m)	Date of analysis	Exceedance Appendix V value
MT41 (upstream) - Lillo threshold - green side	145 231 / 220 468	27/02/2019	No exceedance
MT42 (upward) - Lillo threshold - red side	145 178 / 220 665	26/02/2019	Arsenic
MT36 (downward) - Frederik threshold - green side	143 168 / 223 620	25/02/2019	No exceedance
MT37 (downward) – Frederik's threshold – red side	143 304 / 223 462	25/02/2019	No violation
MT28 (downstream) – Edge Plate of Doel	142,767 / 225,842	13/02/2019	No exceedance
E004420 (upstream) – Harbour Dock – Canal Dock B1 – Canal Dock B2	146 283 / 222 931	22/09/2010	Cadmium, chromium
E004425 (upstream) – Insertion dock	145 631 / 222 863	13/07/2010	Cadmium, chromium, lead
E004424 (downward)	145 535 / 224 612	14/07/2010	Cadmium, chromium
E004344 (downstream) Harbour dock – Canal dock B1 – Canal dock B2	145 488 / 225 223	14/07/2010	Cadmium, chromium
157000 – Zeeschelde - Lillo; navigation channel near Fort Liefkenshoek and Fort van Lillo	144400/ 221001	13/01/2022	No exceedance
154100 – Zeeschelde - Zandvliet, border Doel; central channel Scheldt at P buoy	141077 / 227033	01/02/2022	Arsenic
804000 – Canal dock B2 - Quay 601, Lillopark waste park, sideways Evonik	146492/ 221980	02/02/2022	chrome

9.2.2.1.4 Hydraulic characteristics

The flow rate of the Scheldt is derived from the Pegase flow rates, available at https://www.vmm.be/water/afvalwater/impact-assessment-industrial-wastewater/geoloket-impact-assessment-industrial-wastewater; dated 24/01/2024, see Figure 9-33). The average flow rate for water body 'Zeeschelde IV' (VL17_43) at the project site is 96.7 m³/s, and the low water discharge rate Q10 is 46.6 m³/s.

For the flow rate of the Kanaaldok, the Pegase database indicates that this area is subject to control, divisions and tidal effects from the Zeeschelde and that, moreover, there is no usable flow measurement station available in the vicinity of the harbour docks. As a result, the modelled Pegase flow rates deviate from reality and it is best to take the PoAB data into account. In 2021, KULeuven carried out a water balance study on behalf of the Antwerp Port Authority, which provided validated water flows into and out of the port area for the years 2017, 2018 and 2019. For the Kanaaldok, an average flow rate of 7.2 m³/s and a low water discharge rate (Q10) of 2 m³/s were derived.

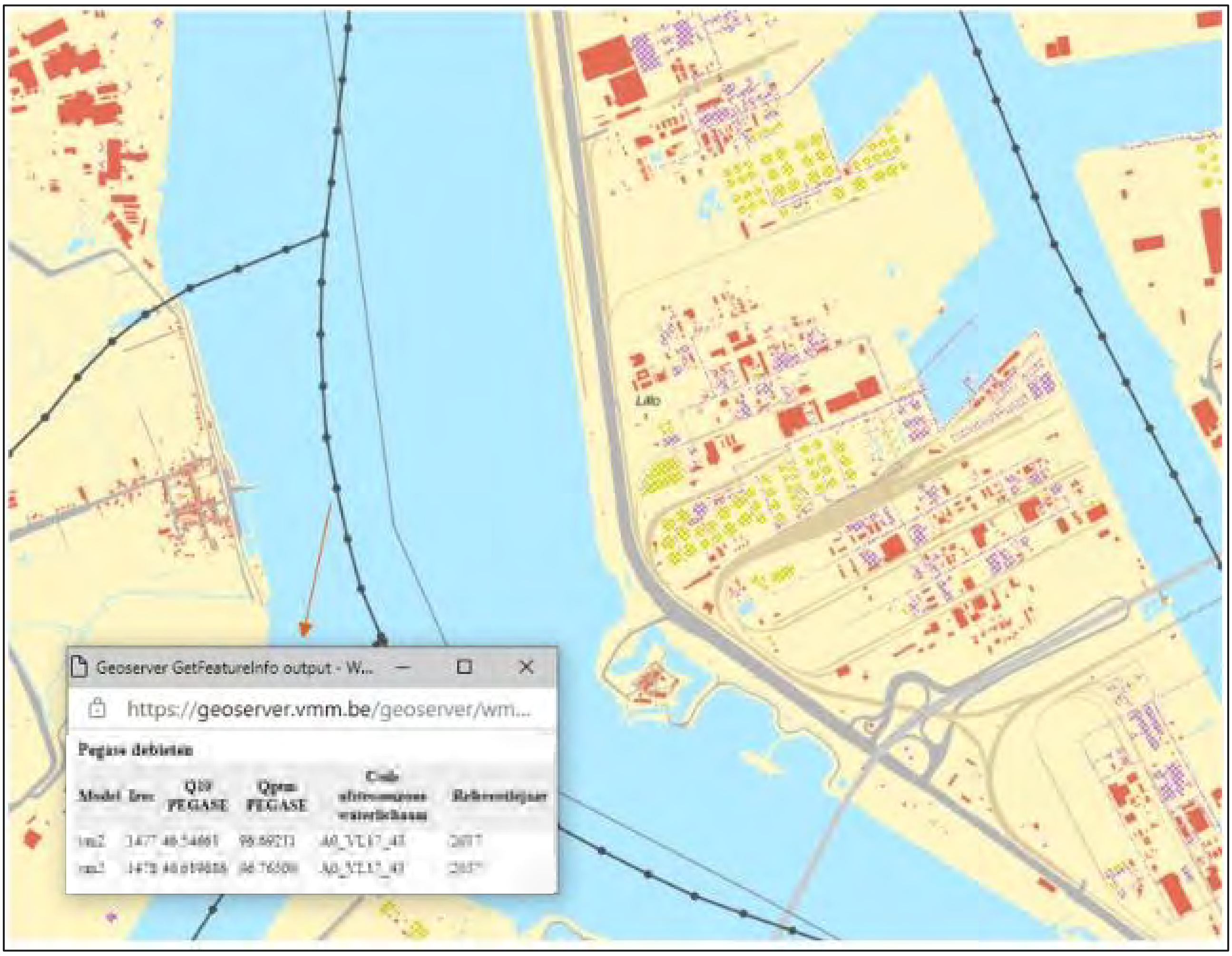


Figure 9-33: Pegase flow rate of the Zeeschelde at the project site (Source: https://www.vmm.be/water/afvalwater/impactbeoordeling-bedrijfsafvalwater/geoloket-impactbeoordeling-bedrijfsafvalwater; dated 23/01/2024)

The following information can be found in the Lower Scheldt Basin Management Plan (2022-2027) (River Basin Management Plan for the Scheldt 2022-2027 – Basin-specific section Lower Scheldt Basin; available at https://www.integraalwaterbeleid.be/nl/stroomgebiedbeheerplannen).

The part of the Scheldt that runs from Ghent via Antwerp to the Dutch border is called the Zeeschelde. In the Zeeschelde, salty seawater and fresh river water mix.

This creates a unique transitional area between river and sea. The fresh water gradually turns into brackish water downstream, and further into the Netherlands, the water becomes salty. The salinity fluctuates constantly, depending on the tide and the upper waters.

At the mouth of the Scheldt near Vlissingen, the difference between high and low tide is about four metres. Further inland, the tidal difference increases. The further upstream, the narrower the riverbed and the more the incoming flood water is pushed up. Near Hamme, where the Durme flows into the Scheldt, the river reaches its highest water level. After that, the backwater effect decreases again. Due to the locks in the vicinity of Ghent, the river further upstream is no longer influenced by the sea.

The transition from salt to fresh water, together with the steady rhythm of the tides, creates a wide variety of tidal nature. Mudflats and salt marshes purify the river water and restore balance to the food chain. At the same time, they temper the waves, reducing the pressure on the dykes.

The Lower Scheldt basin is where the drainage from a significant part of the Scheldt estuary converges. This includes the drainage from the Nete, the Dijle (and Demer), part of the Leie, the Upper Sea Scheldt and the Lower Scheldt basin itself. Beyond Antwerp, the Sea Scheldt flows into the Netherlands and is called the Western Scheldt. Further downstream, the Scheldt flows into the North Sea. The Zeeschelde, the Westerschelde and the Scheldt estuary together form the Scheldt estuary.

When storms rage over the North Sea in combination with spring tides, storm surges occur. When such a surge rolls into the Scheldt and its tributaries, the water level rises and there is an increased risk of flooding.

9.2.2.2 Location of the project area in relation to flood-prone areas

Large parts of the Lower Scheldt basin are susceptible to peak flows for a variety of reasons, either due to its topographical and geological characteristics or due to storm surges from the North Sea. Added to this is the impact of human intervention on the water system (encroachment of valley areas by buildings, straightening and embanking of watercourses, accelerated drainage, increase in paved surfaces, etc.). All this means that the Lower Scheldt basin regularly experiences serious flooding problems during periods of heavy rainfall.

Before the land was raised as part of the construction of the port in the 1960s, the project area was naturally prone to flooding from the Zeeschelde. The site is not located in a recently flooded area. On the pluvial flood map, a few small areas in the project area are marked as flood-prone in a future climate. These areas can serve as water storage areas during heavy rainfall. This map is based on the current ground level. The project provides for adjustments to the ground levels, which will be higher, so that the flood map will look different in the future and the flood sensitivity will be negligible. The fluvial flood maps (Figure 9-35) and coastal flood maps (Figure 9-36) are also shown below, both for the current and future climate. These maps show no flood risk for the project area.

Figure 9-34: Pluvial flood map – flood-prone area under current climate conditions (left) and future climate conditions (right) (source:www.waterinfo.be/overstromingsrichtlijn , dated 01/2024)

Figure 9-35: Fluvial flood map – flood-prone area under current climate (left) and future climate (right) (source:www.waterinfo.be/overstromingsrichtlijn , dated 03/2024)

Figure 9-36: Coastal flood map – flood-prone area under current climate (left) and future climate (right) (source:www.waterinfo.be/overstromingsrichtlijn , dated 03/2024)

9.2.3 Impact description and impact assessment – construction phase

9.2.3.1 (Waste) water

Sanitary wastewater

Approximately 2,500 construction workers and site personnel will be on site during the construction phase, generating up to approximately 65 litres/day of sanitary waste water from toilets, showers, canteens, etc.; this can amount to up to 195 m³/day of sanitary waste water.

All sanitary waste water will be collected in septic/collection tanks, which will be emptied by a vacuum tanker and transported to an external location for treatment.

This option was chosen after evaluating alternatives such as a mobile installation or local processing in a treatment plant on neighbouring land, connecting to the public sewerage system, or using the water treatment facilities provided for the operational phase.

Water reuse

Rainwater from the contractor village is collected in various rainwater tanks, with an overflow to the Canal Dock. The rainwater is used for sanitary applications and cleaning. The surface areas of the roofs, the volume of the rainwater wells and the reuse of rainwater are coordinated in such a way that there is almost no overflow of rainwater.

Test water

It is essential that tanks and pipelines are pressure tested after construction to demonstrate the mechanical integrity of the welded joints and to ensure leak tightness prior to commissioning. The test requires large quantities of test water. To limit corrosion during the test, the following measures are taken:

- the duration of a test is limited (<30 days);
- temporary protective coatings are applied to stainless steel;

- rapid drainage and drying;
- inspections.

The decision has been made to use municipal water, which does not require the addition of chemicals, unlike dock water. The test water can then be discharged into the Canal Dock without further purification. Due to the corrosion that dock water can cause, it cannot be used on its own; municipal water offers better guarantees in this respect. The use of dock water alone would require the use of additional chemicals to condition the test water, which would result in a large amount of waste water. This can be avoided by using municipal water.

In order to reduce water consumption, the hydro test water will – where possible – be reused in succession in various tanks, vessels and pipelines that require a similar test. After completion of the activities, the test water will be discharged into the Canal Dock. Since no chemicals are added to the test water, the impact on the water quality of the Canal Dock is negligible (0).

9.2.3.2 Change in surface water quality

The removal of vegetation has no significant impact on the quality of runoff and infiltrating rainwater, except for a possible initial increase in sediment content. Other contaminants will be absent or present in negligible quantities. The significance of this effect is negligible (0).

All sanitary waste water and industrial waste water (including potentially contaminated rainwater) produced during the construction phase will be collected and transported to an external treatment facility. This option was chosen after evaluating alternatives such as a mobile installation or local treatment in a purification plant on a neighbouring site. This means that no industrial or domestic wastewater will be discharged into the Canal Dock. Only drainage water will be discharged into the Canal Dock. The impact of this discharge on the water quality of the Canal Dock is explained below, based on the methodology set out in the revised Water Guidelines (EIA Water Fact Sheet, Impact of Industrial Wastewater Discharge dated 01/12/2023).

Impact assessment of drainage water:

The maximum discharge rate of drainage water to the Canal Dock is 5,000 m^3/d.

Initially, the low water discharge rate Q10 of the Kanaaldok is used, which is 2 m^3/s.

In order to assess the effect of the discharge on the receiving surface water, we calculate the change in concentration based on the required discharge standards for the drainage water from Project One (as given in § 9.1.3.2.3).

The impact assessment for discharge into the Canal Dock is carried out for the parameters that may be present in the drainage water: arsenic, chromium, BTEX, mineral oil, MTBE, 1,2-cis-dichloroethene, vinyl chloride, trichloromethane, dichloromethane, 1,1,2-trichloroethane, 1,2-dichloroethane, cyanide, 1,2,3-trichloropropane, aniline, alachlor, diallate, benzothiazole, benzothiazolol, 2-mercaptobenzothiazole, triallate, triethylamine, monochlorobenzene, AMPA, glyphosate, nickel and uranium.

No environmental quality standards are available for the following parameters:
- MTBE, 1,2,3-trichloropropane, aniline, diallate, benzothiazole, benzothiazolol, 2-mercaptobenzothiazole, triallate, triethylamine, AMPA, glyphosate. These parameters were tested against the PNEC values.
- Mineral oil. For this parameter, testing was carried out against the groundwater quality standard.

The annual average MKN is translated in the Vlarem legislation into a classification criterion, namely the concentration in waste water above which companies are required to apply for a permit. Because there are currently no analysis techniques available for PFOS to measure such low concentrations, the classification criterion was equated with the reporting limit. Currently, the reporting threshold is 20 ng/l (or 50 ng/l for a number of components) per individual component.

When assessing the impact of PFAS-contaminated wastewater, the combined pressure of all PFAS compounds must be taken into account.

Since any additional discharge of PFAS will lead to a pressure that exceeds the carrying capacity of the aquatic ecosystem, all these substances must be purified as far as possible. The reporting limit serves as a guideline in this regard.

Ineos provides for extensive purification of the drainage water using activated carbon filters in order to achieve this reporting limit. Sufficient samples of the effluent will be taken to ensure that the discharge standard is always met.

Given the thorough purification of PFAS in the wastewater from the construction phase, whereby the reporting limit of 20 ng/l (or 50 ng/l for a number of components) per individual component will be achieved, and the temporary nature of the discharge, the impact on the water quality of the Canal Dock is considered negligible.

The total construction phase requiring drainage is expected to take 24 months. The first phase of drainage was carried out in 2023 until July 2023. The works were then paused for several months. The next phase was resumed in January 2024.

For the assessment of Project One's discharge on the quality of the water body 'Antwerp Port Docks'
+ Scheldt-Rhine connection" (VL17_187) follows the VMM roadmap (VMM 2023), which can be found at https://www.vmm.be/water/wastewater/impact assessment-industrial wastewater), which assesses whether or not there will be a 'deterioration in the status of a water body' as a result of the discharge of drainage water from Project One. Deterioration occurs as soon as the status of at least one of the quality elements referred to in Annex V to that Directive deteriorates by one class, even if that deterioration does not result in the surface water body being classified in a lower class overall. However, if the quality element referred to in this Annex is already in the lowest class, any deterioration of that element constitutes a 'deterioration of the status' of a surface water body.
A summary of the calculation tool is provided in Appendix 5.2.

1. Step 1: Preliminary assessment
   The Class 1 company discharges drainage water into surface water with a permitted flow rate >20 m³/day and a measuring device. This is a temporary discharge with a maximum (worst case) flow rate of 5,000 m³/day. This discharge is further investigated in step 2.

2. Step 2: Is there a potential impact?
   The company discharges hazardous substances listed in Annex 2C of VLAREM II at concentrations exceeding the classification criterion (IC) or PNEC (in the absence of an IC). A comprehensive study of the effects on the water body must be carried out.

3. Step 3: Where is the impact determined?
   The company discharges drainage water into the Flemish surface water body Antwerp Port Docks + Scheldt-Rhine Connection (VL17_187).

4. Step 4: Is the impact on the condition in worst-case circumstances relevant?
   This step assesses the extent of the discharge's contribution relative to the test value under worst-case conditions (maximum discharged pollutant load combined with low water flow in the receiving watercourse). In reality, the actual contribution will therefore always be less.
   The percentage contribution of the discharge is calculated for the relevant parameters in relation to the test value after complete dilution in the receiving surface water. The results of this calculation are shown in Table 9-35. If the percentage contribution is less than 10%, the calculation tool's recommendation is favourable, provided that step 9 is completed, which involves investigating whether there is any problem with achieving the objectives at the end of the water body. If the percentage contribution is >10%, proceed to step 5.

   Table 9-27 shows the percentage contribution for the relevant parameters of the discharge of drainage water into the Kanaaldok. A summary of the 'industrial waste water impact assessment' calculation tool is provided in Appendix XX.

   For the following parameters, the percentage contribution is <10%: BTEX, MTBE, dichloromethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2,3-trichloropropane, cyanides, benzothiazole, benzothiazolol, triallaate, triethylamine, AMPA, glyphosate and nickel. For these, additional step 9 must be completed.

   For the parameters arsenic, chromium, mineral oil, 1,2-dichloroethene, vinyl chloride, trichloromethane, aniline, alachlor, diallate, 2-mercaptobenzothiazole, chlorobenzene and uranium, the percentage contribution is >10% and step 5 should be taken.

5. Step 5: Is the impact on the condition and the risk of deterioration acceptable in worst-case circumstances?
The aim of this step is to identify those discharges where the risk of not achieving the objectives and the risk of deterioration are clearly acceptable or unacceptable in worst-case circumstances. To investigate the risk of not achieving the objectives, it is examined whether the relevant test values are achieved downstream after complete dilution. In addition, it is checked whether the mixing zone is not too large in relation to the dimensions of the receiving water body. The test value does not have to be met within the mixing zone. If the risk is unacceptable in worst-case circumstances, the impact can be determined in more realistic circumstances (steps 6 and 7). If the risk is acceptable, a further assessment must be carried out in the light of area-specific policy (step 8).

   Table 9-28 shows the evaluation of step 5 for the parameters arsenic, chromium, mineral oil, 1,2-dichloroethene, vinyl chloride, trichloromethane, aniline, alachlor, diallate, 2-mercaptobenzothiazole and chlorobenzene. For these parameters, the test values upstream and downstream after complete dilution are achieved if the chronic mixing zone remains limited. Table 9-28 shows that the calculated mixing zone is within the limits for the maximum mixing zone for all parameters. The impact is acceptable.

   For Uranium, the Weser tool concludes that the test value has not been achieved upstream, but that there is no clear deterioration downstream. The discharge does contribute to the target not being met. According to the Excel tool, the application of technically feasible BAT+ measures is necessary. For uranium, an initial assessment was carried out with a discharge standard of 200 µg/l. Based on the initial assessment, this standard has already been adjusted to 5 µg/l. A further reduction of the discharge standard is no longer possible. Given that uranium (and nickel) are present in the granulate of the activated carbon filter, they are inextricably linked to the necessary purification of the drainage water for PFAS. Ineos already takes maximum account of the technically feasible measures.

6. Step 8: Is the impact on the situation acceptable in light of the area-specific policy?
For discharges in priority areas for an area-specific source protection policy for drinking water, special protection zones and priority areas, an additional area-specific assessment must be carried out. The water body into which the discharge is made, namely the Kanaaldok, is not designated as an area intended for drinking water abstraction, is not located in an SBZ area and is not designated as a priority area. This step is therefore not applicable.
7. Step 9: Deterioration of the situation or achievement of the objectives: final assessment and actions in permits
In step 9, VMM gives a final assessment, taking the following points into consideration:

   The water body 'Antwerp Port Docks and Scheldt-Rhine Connection' is currently in an inadequate ecological condition due to the inadequate condition of the macroinvertebrates. Compared to the previous assessment in the context of the river basin management plans, the ecological and chemical status has not changed in terms of class. However, there has been an improvement in the underlying parameters for phytoplankton, nitrogen and specific pollutants.

   Based on the River Basin Management Plans for the Scheldt and Meuse 2022-2027, a positive trend was observed for nitrogen parameters at more locations than locations with a negative trend. No specific reduction targets were set for the parameters for the Antwerp Port Docks water body.

   Ineos provides for extensive purification of drainage water in accordance with BAT and monitoring of drainage effluent.

   The Wezertool provides an acceptable evaluation for the requested discharge standards.

   This is also a worst-case estimate. The tool assumes that the maximum permitted concentration will be discharged at the maximum permitted flow rate. What's more, this will be into a watercourse that has low water flow throughout the entire year. The tool also does not take into account the self-purifying capacity of the watercourse.

   The drainage water will comply with the proposed discharge standards, and these discharge standards will not cause any deterioration in the quality objective for the water body.

The discharge will therefore not cause any deterioration in the status of the quality elements referred to in Annex V of the Water Framework Directive, nor in the status of the surface water body. Based on the above assessment, it can be concluded that the discharge will not compromise the achievement of good chemical and/or ecological status. The effect of the discharge on surface water quality is therefore negligible (0).

Table 9-27: Worst-case impact of the discharge of drainage water from Project One (based on requested discharge standards) on the Kanaaldok (worst-case discharge rate of 5,000 m³/d)

Parameter ID	Parameter [illegible]	[illegible]	Eenheid	[illegible]	Debiet lozing (m³/d)	[illegible]	Jaargemiddelde / Maximum	[illegible]	[illegible]	Gem. waterdebiet [illegible]	Absolute bijdrage	Procentuele bijdrage	Advies
121	As-t	Arseen, totaal	µg/L	25.00	5,000.00	3.00	jaargemiddelde	4.80	5.44	2,000	3.47	12.2	Ga naar stap 5-7 aanvaardbaar
110	Cr-t	Chroom, totaal	µg/L	100.00	5,000.00	50.00	jaargemiddelde	1.15	1.42	2,000	14.09	28.1	Ga naar stap 5-7 aanvaardbaar
252	Benzeen	Benzeen	µg/L	75.00	5,000.00	10.00	jaargemiddelde	0.00	0.00	2,000	[illegible]	2.3	Gunstig mits doorlopen van stap 6
221	Tolueen	Tolueen	µg/L	10.00	5,000.00	95.00	jaargemiddelde	0.00	0.00	2,000	[illegible]	3.3	Gunstig mits doorlopen van stap 6
[illegible]	EtBz	Ethylbenzeen	µg/L	10.00	5,000.00	3.00	jaargemiddelde	0.00	0.00	2,000	[illegible]	8.8	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	Xylenen (som o,m,p)	µg/L	10.00	5,000.00	4.00	jaargemiddelde	0.00	0.00	2,000	[illegible]	7.5	Gunstig mits doorlopen van stap 6
1	0	Minerale olie	µg/L	100.00	5,000.00	50.00	jaargemiddelde	0.00	0.00	2,000	14.05	28.1	Ga naar stap 5-7 aanvaardbaar
2	0	MTBE	µg/L	100.00	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	2.87	0.1	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	1,2-Dichloorethaan	µg/L	10.00	5,000.00	10.00	jaargemiddelde	0.00	0.00	2,000	1.41	14.1	Ga naar stap 5-7 aanvaardbaar
[illegible]	VinCl	Vinylchloride	µg/L	1.00	5,000.00	0.05	jaargemiddelde	0.00	0.00	2,000	[illegible]	[illegible]	Ga naar stap 5-7 aanvaardbaar
[illegible]	TCMe	Trichloormethaan	µg/L	25.00	5,000.00	2.50	jaargemiddelde	0.00	0.00	2,000	[illegible]	[illegible]	Ga naar stap 5-7 aanvaardbaar
[illegible]	DCMe	Dichloormethaan	µg/L	20.00	5,000.00	20.00	jaargemiddelde	7.25	[illegible]	2,000	2.58	2.6	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	1,1,2-Trichloorethaan	µg/L	20.00	5,000.00	20.00	jaargemiddelde	0.00	0.00	2,000	0.58	2.8	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	1,2-Dichloorethaan	µg/L	10.00	5,000.00	10.00	jaargemiddelde	[illegible]	[illegible]	2,000	0.25	[illegible]	Gunstig mits doorlopen van stap 6
0	0	1,2,3-Trichloorpropaan	µg/L	20.00	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	8.8	Gunstig mits doorlopen van stap 6
[illegible]	CN-t	Cyaniden, totaal	µg/L	100.00	5,000.00	50.00	jaargemiddelde	0.00	0.00	2,000	2.87	5.6	Gunstig mits doorlopen van stap 6
0	0	Aniline	µg/L	15.00	5,000.00	1.00	jaargemiddelde	0.00	0.00	2,000	0.42	42.5	Ga naar stap 5-7 aanvaardbaar
[illegible]	[illegible]	[illegible]	µg/L	1,000.00	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	44.05	19.8	Ga naar stap 5-7 aanvaardbaar
0	0	[illegible]	µg/L	[illegible]	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	18.1	Ga naar stap 5-7 aanvaardbaar
0	0	[illegible]	µg/L	[illegible]	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	[illegible]	Gunstig mits doorlopen van stap 6
0	0	[illegible]	µg/L	[illegible]	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	[illegible]	Gunstig mits doorlopen van stap 6
0	0	[illegible]	µg/L	[illegible]	5,000.00	4.00	jaargemiddelde	0.00	0.00	2,000	[illegible]	14.6	Ga naar stap 5-7 aanvaardbaar
0	0	[illegible]	µg/L	1.00	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	7.1	Gunstig mits doorlopen van stap 6
0	0	[illegible]	µg/L	[illegible]	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	[illegible]	2.6	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	Chloorbenzeen	µg/L	50.00	5,000.00	[illegible]	jaargemiddelde	0.00	0.00	2,000	1.69	25.3	Ga naar stap 5-7 aanvaardbaar
0	0	[illegible]	µg/L	1,000.00	5,000.00	[illegible]	jaargemiddelde	0.00	[illegible]	2,000	28.1	3.4	Gunstig mits doorlopen van stap 6
[illegible]	Ni-t	Nikkel, totaal	µg/L	80.00	5,000.00	70.00	jaargemiddelde	[illegible]	[illegible]	2,000	2.38	7.5	Gunstig mits doorlopen van stap 6
[illegible]	[illegible]	Vanadium, totaal	µg/L	5.00	5,000.00	1.00	jaargemiddelde	1.74	[illegible]	2,000	6.1	15.9	Ga naar stap 5-7 aanvaardbaar
0	0	[illegible]	µg/L	100.00	5,000.00	[illegible]	jaargemiddelde	[illegible]	[illegible]	2,000	2.81	3.2	Gunstig mits doorlopen van stap 6

Table 9-28: Calculation of mixing zone (step 5)

Parameter naam	Eenheid	Concentratie lozing	Chronische mengzones (CMZ)					
			JG Toetswaarde	JG / SOW	Lengte CMZ (m)	Breedte CMZ (m)	Lengte maximaal (m)	Breedte maximaal (m)
Arseen totaal	µg/L	25.00	5.00	1.48	363.57	48.[illegible]	1,000.00	120
Chroom totaal	µg/L	100.00	10.00	[illegible]	138.24	35.[illegible]	1,000.00	120
Minerale olie	µg/L	500.00	50.00	1.00	110.14	[illegible]	1,000.00	120
1,2-Dichloorethaan	µg/L	50.00	10.00	1.00	[illegible]	14.[illegible]	1,000.00	120
[illegible]	µg/L	1.50	[illegible]	1.00	411.[illegible]	51.[illegible]	1,000.00	120
Trichloormethaan	µg/L	25.00	2.50	1.00	153.[illegible]	[illegible]	1,000.00	120
[illegible]	µg/L	15.00	1.00	1.00	149.[illegible]	41.[illegible]	1,000.00	120
[illegible]	mg/L	1,000.00	[illegible]	2.00	94.76	11.[illegible]	1,000.00	120
[illegible]	µg/L	1.[illegible]	[illegible]	5.00	111.[illegible]	11.[illegible]	1,000.00	120
[illegible]	µg/L	20.00	4.00	5.00	83.28	14.56	1,000.00	120
[illegible]	µg/L	50.00	[illegible]	[illegible]	202.[illegible]	[illegible]	1,000.00	120

Parameter naam	Eenheid	Concentratie lozing	Acute mengzones (AMZ)					
			MAX Toetswaarde	MAX / SOW	Lengte AMZ (m)	Breedte AMZ (m)	Lengte maximaal (m)	Breedte maximaal (m)
1,2-Dichloorethaan	µg/L	50.00	[illegible]	[illegible]	[illegible]	[illegible]	100.00	120.00
[illegible]	mg/L	1,600.00	[illegible]	[illegible]	[illegible]	[illegible]	100.00	[illegible]
[illegible]	µg/L	60.00	[illegible]	[illegible]	[illegible]	[illegible]	100.00	[illegible]

9.2.4 Effect description and effect assessment – operational phase

The water treatment plant will be built in the southern part of the project area and will treat the wastewater from the processes. Sanitary wastewater from the northern part of the project area will be collected separately and transported for external treatment. This option was chosen after an evaluation of alternatives, such as a mobile installation or local treatment in a treatment plant on a neighbouring site.

The main wastewater flow is located in the southern part of the project area and is described and assessed below.

9.2.4.1 Water balance

An overview of the main incoming and outgoing water flows is provided in Table 9-29 and Table 9-30. The water balance is shown for the normal situation that will occur 95% of the time. In 5% of the time, a maximum (worst case) situation may occur (exceptional wastewater flow). In the normal situation, approximately 74 m³/h of treated wastewater will be discharged into the Scheldt. In the worst-case situation, a higher discharge rate of 246 m³/h may occur. The worst-case discharge rate is a combination of an increased water flow from the process and an increased discharge flow from the cooling water circuit. The increased contaminated water flow from the process (occasionally contaminated sewage, DOC) can be caused by periodic maintenance work in the ECR. This wastewater is first collected and stored, but must be processed within a reasonable period of time in order to free up the buffer capacity. High concentrations of dissolved substances (e.g. high chloride concentrations) or a disruption of the cooling water system (e.g. due to a hydrocarbon leak) lead to an increased discharge flow. Figure 9-37 shows a schematic representation of the water balance for the normal situation.

The following sections provide more information about the various water flows.

Table 9-29: Incoming water flows at Project One

Incoming water flows		Flow
Municipal water	Most of it is used as cooling water. The rest municipal water is used in the offices, showers, fire water tank, etc. .	367 m³/h
Demineralised water	Demineralised water is supplied externally. Demineralised water is used in the process installations and in the cooling towers.	333 m³/h
Rainwater	Uncontaminated rainwater is used for sanitary applications in the administrative building and as cooling water. Rainwater from the sewer system, which collects potentially contaminated water, is used to supplement the cooling water after analysis.	Approx. 19 m³/h
Drainage water	The groundwater collected in winter will be used in part as cooling water; if it is contaminated, it will be treated first.	Approx. 1 m³/h
Total IN		720 m³/h

Table 9-30: Outgoing water flows at Project One

Outgoing water flows		Flow rate
Discharge of treated waste water into the Scheldt	The treated wastewater is discharged into the Inovyn discharge pipe, which empties into the Scheldt.	74 m³/h
Losses due to evaporation	Most of the water consumed evaporates via the cooling systems and ends up in the atmosphere.	619 m³/h
	Steam losses, steam used in processes that escapes via chimneys and vent valves (e.g. decoking in the ECR)	27 m³/h
Total OUT		720 m³/h

The above incoming and outgoing flows do not include the smaller and less easily estimable quantities of water that may be present in limited amounts in certain chemicals supplied and discharged or in waste materials.

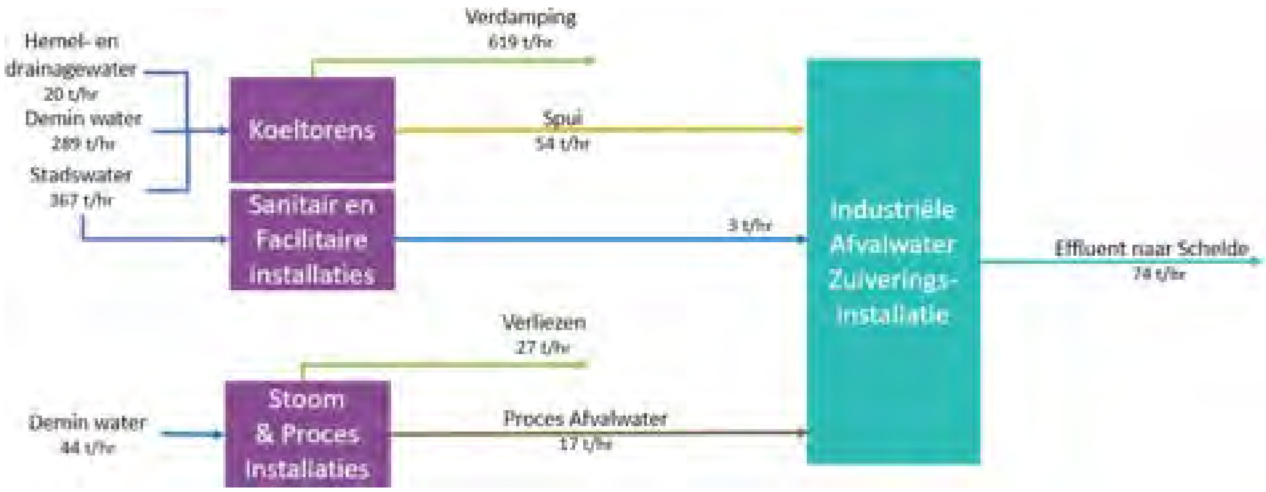


Figure 9-37: Diagram of water consumption in normal circumstances

9.2.4.1.1 Incoming water flows

Municipal water

The municipal water is taken from the local network and stored in the service water tank. The use of municipal water (in combination with demineralised water) as supplementary water for the cooling water systems is explained in the following section 9.2.4.1.2.

In addition to its use as cooling water, municipal water is also used in the offices spread across the Project One site.

The service water tank has a total capacity of 32,000 m³, of which the lower 8,200 m³ is reserved for firefighting water. The firefighting water supply tank consists mainly of municipal water and is supplemented with rainwater, if available. The supply is filled once to be available in case of incidents and exercises and is only replenished later if necessary. The water is changed occasionally to prevent contamination; this water is then used as cooling water.

To limit urban water consumption in Project One, two options were investigated, namely:

- Use of 100% municipal water in combination with a Reverse Osmosis (RO) installation for the treatment of cooling tower discharge and rainwater. The reverse osmosis installation would produce purified water that would be used as supplementary water for the cooling circuit (to replace municipal water). This option results in a limited reduction in municipal water consumption. The cooling water discharge (when using 100% municipal water) is approximately 100 m3/h, of which about half can be recovered, resulting in a reduction in municipal water consumption of approximately 50 m3/h. This represents a percentage decrease in municipal water consumption of approximately 8%. The amount of waste water is halved, but the concentration of minerals in this stream is doubled.
- The use of a mixture of demineralised water and municipal water as supplementary water for cooling systems. Demineralised water is produced externally on a large scale by a third party in a more energy-efficient manner (scale effect). Chapter Climate (§ 14.4.3.2.2) explains that demineralised water production does not compete with drinking water production for fresh water. The demineralised water for Project One is purchased from this third party. The use of a mixture of demineralised water and municipal water results in a 46% reduction in municipal water consumption and a halving of the discharge from the cooling towers, without further concentration of this discharge.

This shows that the second option results in a much higher reduction in urban water consumption than the first option (46% compared to 8%).

Demineralised water

The demineralised water is also supplied via an external network. The demineralised water is mainly used as cooling water. By using demineralised water in the cooling circuits instead of just municipal water, water consumption and wastewater discharge are significantly reduced. When demineralised water is used as cooling water, the concentration of micro-pollutants is much slower, greatly reducing the need for discharge and thus also significantly reducing water consumption.

In addition, demineralised water is also used in the process installations, mainly as boiler feed water for steam production in the steam circuits of the various installations (ECR and steam boilers).

Rainwater

Rainwater that falls on paved surfaces is collected via various drainage systems. From here, the water can be used as cooling water or sanitary water (see Figure 9-38). The following collection systems are distinguished:

- **Uncontaminated rainwater** is collected in a separate drainage system:
    - The pure rainwater from the area "north of Vesta Road" is drained directly into the Service Water tank, so that it can be used immediately as cooling water in the production process.
  - All collected rainwater, both pure rainwater and potentially contaminated rainwater, south of Vesta Road, is collected in the collection basins (see description below regarding first flush, second flush and final discharge basin).
  - The uncontaminated rainwater from the impermeable surfaces east of the ECR (ethane tank, quay area, C5+ tank) is discharged to the Canal Dock via several KWS separators. For this part of the site, it is not possible to drain rainwater by gravity to the service water tank due to the lower elevation of this part of the site. Furthermore, the presence of a shallow drainage system around the C5+ tank and behind the quay wall makes local infiltration inefficient (i.e. first infiltrating above ground and then draining towards the dock is considered to be of little use).
  - Rainwater falling on the roof surfaces of the administrative building, reception building, maintenance building, workshop and warehouses is collected in rainwater tanks and used as sanitary water. The overflow from these rainwater tanks is connected to the wadis. When the wadis are full, there is an overflow to the retention basins: 'first flush' and 'second flush' retention basins. From here, the collected water is reused as cooling water (via the Service Water tank). In the event of such excessive rainfall that both retention basins are completely filled, the excess rainwater overflows to the Canal Dock (via the 'final discharge' basin). The administrative building has a green roof. The overflow from the green roofs is connected to wadis.

- In the northern part of the project area, almost 100% of the rainwater that falls on roofs is reused as sanitary water.
- Rainwater that falls on permeable paving (the car park, the inner area, gravel zones) can infiltrate the soil; in the East zone next to the Canal Dock, most of the paving is gravel, allowing rainwater to infiltrate naturally.
- Rainwater falling on impermeable surfaces in the Admin Campus zone is connected to swales. The narrow footpaths drain into the adjacent unpaved zone, where the rainwater can infiltrate naturally on site.

- **Potentially (oil) contaminated drainage system** (DOC): This system collects water (rainwater, process water, firefighting water) that ends up on surfaces that may be contaminated with process fluids (e.g. tank farms, refuelling areas, etc.). The potentially contaminated rainwater is collected in three steps:

10. **First flush collection basin**: The first flush collection basin collects and treats the initial rainwater that falls on areas of the site that may be contaminated by accidental leaks (e.g. during maintenance work). The first flush basin collects rainwater from the first 10 minutes of a (heavy) rainfall, which may contain residual concentrations of hydrocarbons. The capacity of this first flush basin is 1,653 m³, suitable for a 1/10 year rainfall. When this basin is full, the remaining water will be collected in the second flush collection basin. At the end of the rain shower, the water collected in the 'first flush collection basin' is analysed. If this water meets the quality requirements, it will be directed via the second flush basin to the service water tank, from where it will be used as cooling water. If it does not meet the quality requirements, the water will be sent to the water treatment plant.
11.
12. **Second flush collection basin**: Rainwater ends up in this collection basin once the first flush basin is full. The capacity of this 'second flush' basin is 1,650 m³. This water is less polluted or unpolluted compared to the first rainwater that is collected. At the end of the rain shower, the water in the 'second flush collection basin' is analysed. If this water is satisfactory, it is used as cooling water. If this is not the case, the water is sent to the water treatment plant.
13.
14. **Final discharge basin**: the final discharge basin is designed as a last resort oil separation point, in case both the 'first flush collection basin' and 'second flush collection basin' are full. The excess rainwater will be discharged into the Canal Dock via the final discharge basin. The capacity is dimensioned based on the predicted flow rate for a 1/10 j downpour. The final discharge basin is designed to function as a KWS separator. A skimmer removes the floating oil, which is then directed to the recovered oil tank at the water treatment plant and ultimately discharged externally.

The first flush and second flush basins are continuously emptied, as the demand for cooling water is always high and rainwater can therefore be used quickly as cooling water. The capacity of the rainwater basins will then be available again to collect the next rainfall.

Strict compliance with the rules of good housekeeping will be enforced on the Project One site in order to avoid contamination of rainwater as much as possible (primary measure) and to enable reuse.

The tank basins are always sealed to isolate any possible contamination. Visual inspections are carried out, and if there is any indication of contamination, the rainwater is sampled and analysed. If the rainwater collected in the containment is contaminated, it is sent to the water treatment plant for treatment. The uncontaminated water is used as cooling water.

Drainage water

A drainage system will be installed in some areas (see § 9.1.4.1). The groundwater collected in winter can be used in part as cooling water; if it is contaminated, it will be treated first. The remaining drainage water, originating from the lower-lying area L1, will be discharged to the Canal Dock.

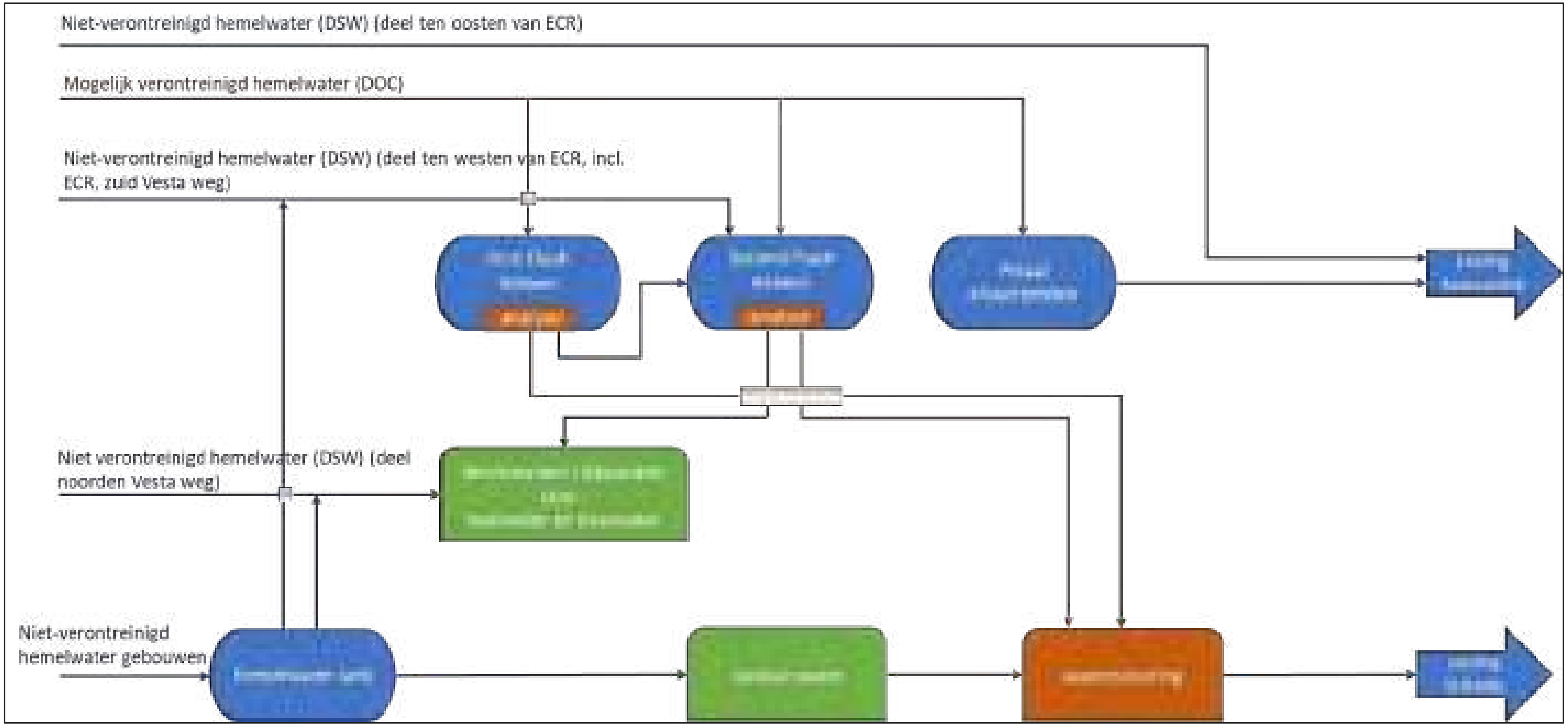


Figure 9-38: Rainwater drainage and use diagram

9.2.4.1.2 Water consumers

Process water - Steam boiler feed water

Deionised water is mainly used in the processes for steam production (both ECR installation and steam boilers). The steam condensate is reused as much as possible. In addition, water is also used directly in the processes. Direct water and steam use mainly concerns:

- Water used in the 'water quench section'. The dilution steam that is fed together with ethane to the cracking furnaces comes into direct contact with the cracked gas. The resulting condensate is therefore contaminated with hydrocarbons. In order to minimise the amount of water that comes into direct contact with hydrocarbons, the condensed dilution steam is re-evaporated and reused as dilution steam. This is therefore a circular system. In order to keep the concentration of contamination in this circulation flow below an acceptable level, it is necessary to provide a 'drain' on this system. The drained water must be replenished, for which demineralised water is used. The drain from the quench water system is directed to the water treatment plant.
- Steam used during the decoking of the furnaces. This steam is treated via the waste gas cleaning system.

Steam stripping is used in the ECR to separate hydrocarbons. This can be regarded as a pre-treatment of the process water that is sent to the water treatment plant.

Make-up water for cooling water systems

Independent cooling systems are provided for the ECR and the utilities.

Each cooling system is a forced airflow system (multi-cell cooling towers equipped with fans, in which the water is cooled by contact with ambient air). The cooling water is circulated through the following steps:

- Pumping the cold cooling water to process heat exchangers.
- Heating the cooling water in the process heat exchangers, where it absorbs residual heat from the processes.
- The warm cooling water is returned to the cooling towers. The downward-flowing cooling water is brought into contact with an upward, forced air flow. This causes part of the cooling water to evaporate and be carried away with the air flow. The evaporation cools the cooling water that has not evaporated.

The cooling water therefore remains in a cycle. To prevent an excessive increase in impurities in the water, a discharge rate must be set. The discharge rate is determined by:

- The thermal load of the cooling system: the amount of evaporated cooling water is directly proportional to the thermal load of the cooling system.
- The quality (concentration of minerals, especially chlorides) of the make-up water used.
- The permissible concentration of minerals (especially chlorides) in the circulating cooling water.

In order to keep the discharge (wastewater flow) and municipal water consumption as low as possible, it was decided to use a mixture of municipal water and demineralised water as make-up water for the cooling towers. The ratio between municipal water and demineralised water was determined as follows:

- The maximum permissible concentration of chlorides in the circulating cooling water is 400 mg/l. This concentration is low enough to prevent corrosion at the heat exchangers. The average concentration of chlorides in municipal water is 59 mg/l.
- For practical reasons, the cycle of concentration (COC) is limited to 12.5. The COC is the ratio of the amount of make-up water to the amount of discharge. This COC is limited because, in addition to minerals, other substances are also concentrated in the cooling water (substances washed out of the air, concentration of 'spent' additives for conditioning the cooling water).

A maximum COC of 12.5 in combination with a maximum chloride content of 400 mg/l means that the maximum concentration of chlorides in the replenishment water may be 32 mg/litre. This requires dilution of municipal water with demineralised water in a ratio of 54% municipal water and 46% demineralised water. If rainwater is available, part of the demineralised water can be replaced by rainwater (rainwater contains little to no minerals). For a total amount of supplementary water of 673 m³/h, this corresponds to an amount of municipal water of 363 m³/h and an amount of rainwater/demineralised water of 310 m³/h (289 m³/h demineralised water and 20 m³/h rainwater). See also the water balance in Figure 9-37.

The discharge water from the cooling circuits is directed to the water treatment plant, where it is treated before being discharged into the Scheldt.

To make the process water suitable for use in the cooling tower, it is conditioned with chemicals. The chemicals used mainly serve to protect the system against:

- Corrosion;
- Precipitation of the substances present;
- Microbiological growth.

The use of NaOCl as a biocide for cooling water applications is not recommended. ClO_2 has been researched for use as a biocide and has been approved for use. ClO_2 is a superior biocide compared to NaOCl and does not produce chlorinated by-products (AOX parameter in waste water). No other alternatives to ClO_2 are currently being considered.

Efforts are being made to use organic/biodegradable additives (‘green’ anti-scalants) to a significant extent. In doing so, care is taken to ensure that there will be no negative impact on the biological water treatment plant. Specific attention will be paid to the concentrations of zinc and phosphorus.

Firefighting water

In order to ensure that sufficient firefighting water is always available, a firefighting water supply of 8,200 m³ is provided; this is generally filled with municipal water.

In addition to the rainwater collection basins, there is a separate collection basin for contaminated firefighting water. The quality of this collected firefighting water will be checked. Based on the analysis results, the destination of this firefighting water will be determined: to the water treatment plant, to an external processor or, if it is not contaminated, it will be reused as cooling water.

9.2.4.1.3 Water reuse

In the processes, water is reused in:

- the 'water quench section' (see previous § 9.2.4.1.1);
- steam condensation (see previous section 9.2.4.1.1);
- the cooling circuit.

Rainwater falling on the roof surfaces of the administrative building, the reception building and the maintenance building is collected in the central rainwater tanks and reused for sanitary applications. Rainwater falling on the roofs of the other buildings is collected in the Service Water tank and used as cooling water.

Rainwater tanks with a total volume of 230,000 litres will be installed. The overflow from these rainwater tanks will be connected to the wadis. When the wadis are full, there is an overflow to the retention basins: 'first flush' and 'second flush' retention basins. From here, the collected water is reused as cooling water (via the Service Water tank).

In the southern part of the project area, uncontaminated rainwater that falls on paved surfaces located west of the ECR, including the ECR plot, will be collected and used as cooling water. Uncontaminated rainwater from the first flush and second flush basins will also be reused as cooling water. There are also plans to partially reuse the drainage water from the drainage system as cooling water.

Higher groundwater levels are expected during the winter months. The drainage system aims to keep groundwater levels at least 25 cm below ground level. Drainage water (from zones K1 and K2) can be used as cooling water if it is not contaminated; if it is contaminated, it is directed to the water treatment plant. Due to the difference in height, the drainage water from the lower zone L cannot be diverted to the service water tank and is therefore discharged to the Canal Dock. The quality of the drainage water discharged to the Canal Dock must be monitored during the first year (preferably once every quarter) to ensure that it is not contaminated.

The clean rainwater ends up in the **Service Water Tank**. This Service Water Tank has a total capacity of 32,000 m³, of which the lower 8,200 m³ is reserved for firefighting water. The upper part (23,800 m³) of the Service Water Tank serves as a supply for the cooling water circuit.
This buffer is continuously replenished with collected rainwater from the collection basins for reuse as cooling water. Taking into account the fluctuation in rainwater supply and the fact that the supply of municipal water reaches its maximum at a certain point, the buffer in the Service Water Tank is limited to half of its maximum capacity. In concrete terms, this means that a minimum continuous storage of 50% for cooling water is provided in the Service Water Tank to compensate for any loss of supply. Of the 23,800 m³, half (11,900 m³) is always kept in stock and the other half is available for replenishment with rainwater. Because this latter part of the storage will also always be replenished with municipal water or demineralised water, 5,950 m³ is included in the calculation. In concrete terms, this means that a quarter of the total storage capacity for service water is replenished by reusing rainwater. This results in a buffer capacity for rainwater in the Service Water Tank of 5,950 m³. Together with the collection basin (second flush) of 1,650 m³, this means a total buffer capacity of 7,600 m³.

In total, therefore, 7,600 m³ (service water tank and second flush collection basin) + 230 m³ (rainwater wells) = 7,830 m³ of rainwater collection capacity is provided. This is more capacity than required by the rainwater regulation. This larger collection capacity can be justified by the high daily consumption of water.

In order to limit water consumption, it was decided to use a mixture of municipal water and demineralised water, as described in § 9.2.4.1.1.

The reuse of effluent from the water treatment plant is not currently planned. Given that the wastewater from Project One consists mainly of discharge from the cooling water system and therefore contains high concentrations of minerals, it is not energy-efficient to treat this stream in an RO plant. Reusing the effluent from the water treatment plant would also result in a limited further reduction in water consumption (approx. 5%). This is also not practised at other INEOS Group sites. The measures already planned in Project One will minimise water consumption at source.

9.2.4.1.4 Outgoing water flows

Description of wastewater flows

Rainwater and wastewater flows will be separated at source based on the characteristics of the flow. The separated flows will be directed via separate pipes to the appropriate treatment system (e.g. pre-treatment, secondary treatment or reuse).

The main contaminants found in the wastewater are mainly hydrocarbons, supplemented with nutrients, minerals and organic components (sulphates, nitrates, phosphates, etc.).

The various process wastewater streams, which are treated in the company's own water treatment plant via primary, secondary and tertiary treatment, are examined in more detail below. A schematic overview is provided in Figure 9-39, and an estimate of the sub-streams is given in Table 9-31.

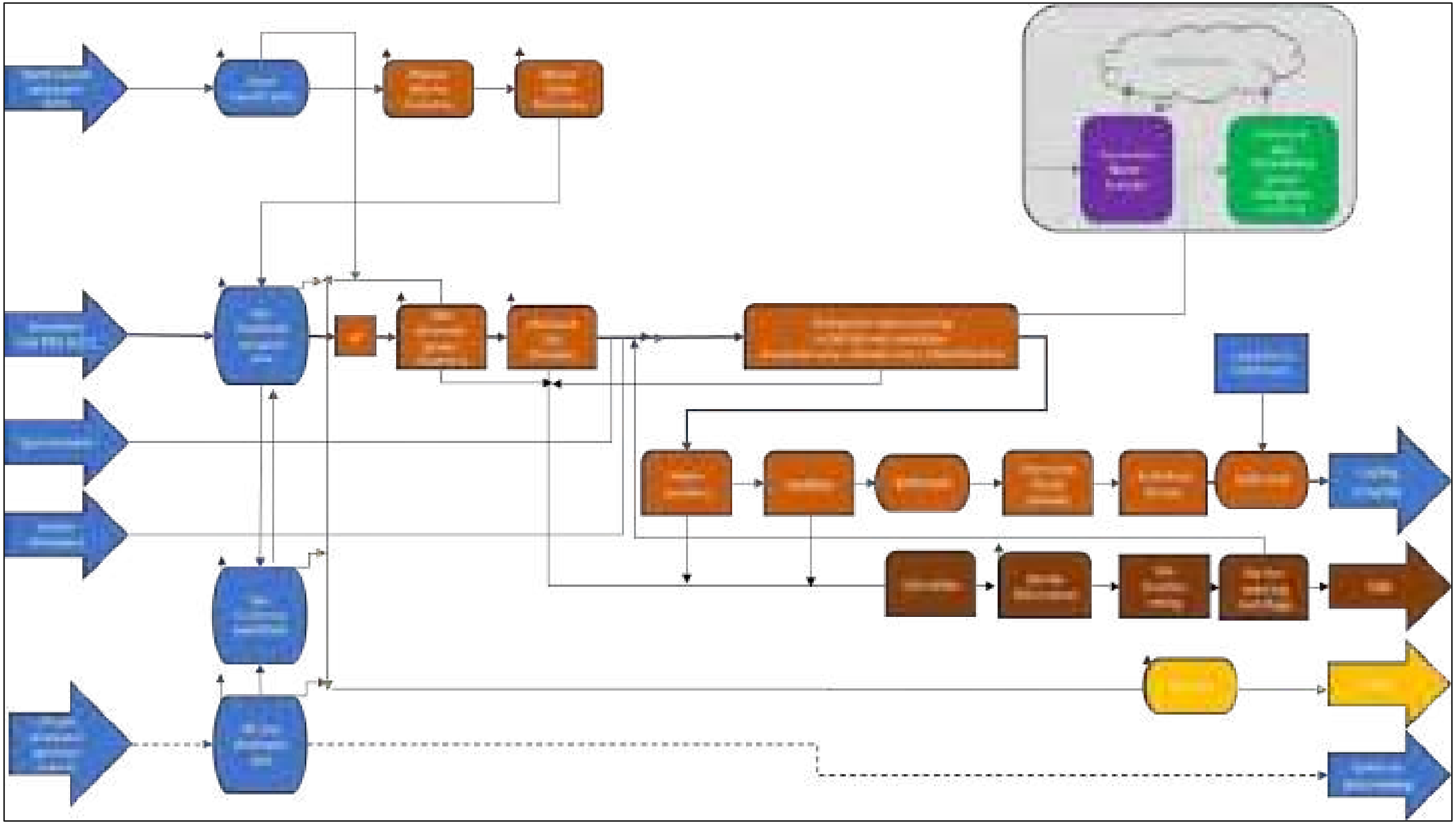


Figure 9-39: Schematic overview of process wastewater flow

Table 9-31: Estimate of the various waste streams (m³/h)

Wastewater flows		Flow rate (range)		Comment
	Origin	*Normal situation (in m³/h)*	*Worst case (in m³/h)*	
Normal operation				
Process water	ECR	17	130	
Sanitary waste water	Sanitary	3	3	
Off-spec wastewater	Supporting infrastructure	-	-	Dosed further processing
Cooling water discharge		54	113	
Total		**74**	**246**	

The following drainage systems will be provided:

- **Process wastewater drainage system**

The continuously contaminated waste water from the process installations is separated according to effluent type and pumped to the waste water treatment plant for treatment tailored to the type of contamination. The following effluent types are distinguished:

1. Wastewater contaminated with hydrocarbons is sent to the DCC [59](continuous oil-containing drainage system). This system collects waste water from installations where oil contamination is likely. Examples include pump drip trays, leaks at sampling points, etc. and dry weather drainage: this stream is always contaminated and comes from installations and washdowns. The stream is sent to the oil-containing waste water treatment section of the waste water treatment plant.
2. Spent caustic wastewater from ECR.
3. Cooling water discharge may contain low levels of various pollutants due to concentration in the cooling water and the additives used in the cooling system.

- **Closed drainage system**

This closed system is provided for process units. This system is designed for discharges that are high temperature, flammable or otherwise highly hazardous. The collected liquid remains separate from the water effluent system. The liquid flow is either returned to the process or discharged in a suitable manner via the 'off-spec tank' and disposal by an approved processor.

- **Rainwater drainage system:**
  - See § 9.2.4.1.1

- **Sanitary waste water**

This system collects domestic wastewater from buildings (including office buildings) in the southern part of the project area. Domestic wastewater will be treated and purified together with industrial wastewater in the water treatment plant. The synergy between the two streams will bring operational benefits, not only in terms of the composition of the wastewater, but also in terms of the design of the plant. The sanitary wastewater adds a valuable nutrient load to the industrial wastewater.

[59] Continuously Oil Contaminated Drain

- **Firefighting water**

The runoff from firefighting will be collected in the potentially contaminated drainage system (DOC). A diversion valve, activated by an operator of the installation, will be provided to divert the discharge to a separate firefighting water collection basin. The water collected in this basin will be sampled and tested. Depending on the type and concentrations of the contaminants, the waste water will either be treated in the on-site water treatment plant, discharged by an external contractor, or reused as cooling water (after treatment, if applicable).

- **Drainage water during the operational phase**

A drainage system will be provided (see § 9.1.4.1). The groundwater collected in winter will be used in part as cooling water, or if it is contaminated, it will first be treated. The remaining drainage water from the lower zone L will be discharged to the Canal Dock. Drainage water is expected to be mainly used in winter. This involves a flow rate of approximately 26 m³/d.

Evaporation

Most of the water consumed is used as cooling water in the cooling towers, where an average of approx. 646 m³/h (619 m³/h via the cooling towers and 27 m³/h in the processes) evaporates into the atmosphere.

Infiltration

Figure 9-27 and Figure 9-28 (see § 9.1.4.1) show the paved and unpaved areas. An overview of the distribution of paved and unpaved areas is given in Table 9-32.

Rainwater that falls on unpaved surfaces (green areas and gravel areas) can infiltrate on site. This water is not collected.

Rainwater that falls on paved surfaces is either:

- collected and reused, e.g. uncontaminated rainwater that falls on paved surfaces located west of the ECR, including the ECR plot; rainwater from the roof surfaces of the administrative building.
- either discharged to the Canal Dock, e.g. uncontaminated rainwater from the areas east of the ECR (ethane tank, quay area, C5+ tank), the overflow from the final drainage basin;
- or it concerns contaminated rainwater, which is purified in the WZI.

In the northern part of the project area, water from unpaved areas will infiltrate on site. Rainwater that falls on roofs in the northern part will be 100% reused as sanitary water. The surface areas of the roofs, the volume of the rainwater tanks and the reuse of rainwater are coordinated in such a way that there is almost no overflow of rainwater. In the very exceptional cases where the tanks do become full, this clean rainwater will be discharged into the Kanaaldok. Infiltration pipes will be provided for rainwater from paved surfaces (asphalt and concrete). The Rainwater Motivation Memorandum demonstrates that the infiltration facilities for the buildings can be reduced to 4% of the roof surface area, as the remaining 96% of the water is reused immediately. It also demonstrates that underground infiltration is possible.

In the southern part, near the Admin Campus, water-permeable paving will be installed and grass swales will be created to allow rainwater to infiltrate on site. Rainwater from the roofs will be fully reused. The remaining rainwater from green roofs and paved surfaces, among other sources, will be collected and infiltrated on site, using nearby green areas and wadis.

No specific infiltration systems have been installed in the rest of the southern part of the project area (ECR and supporting facilities), but rainwater is drained to collection basins. This makes it possible to buffer the collected water in the collection basins, where it is then pumped to the service tank and reused in the production process as cooling water. The open spaces between the technical installations, constructed with water-permeable gravel paving, are not included in the infiltration and buffering calculations, but do contribute to the positive effects thereof.

Rainwater wells will be provided, the volumes of which exceed the minimum requirements (prescribed by the Rainwater Regulation) for the entire project. This means that more water will be available for reuse than required by the regulation.

Table 9-32: Overview of pavements Project One (m²)

Paving	Project area in the north (m²)	Project area in the south (m²)	Total (m²)
Asphalt or concrete pavements	3,256	113,987	117,243
Buildings	6,120	23,947	30,067
Unpaved areas	256,624	446,066	702,690
Total	266,000	584,000	850,000

9.2.4.1.5 Measures to optimise water use

Where possible, Project One has provided for the following:

- by using demineralised water in the cooling circuits instead of just municipal water, water consumption and wastewater discharge flow are significantly reduced;
- maximum separation and treatment of the various effluent sources, with uncontaminated flows separated from contaminated flows as much as possible. This is an important factor for the optimal design and operation of the wastewater treatment plant;
- implementing water usage management systems to prevent or reduce excessive water usage, accidental discharges and leaks. Measures are also taken to contain and collect any possible discharges or leaks on site, rather than immediately discharging them into the drainage system;
- the possibilities for modifying or adapting wastewater-producing processes were investigated, in particular those that occasionally cause 'peaks' with high pollution concentrations and that can hinder treatment (these flows undergo pre-treatment, see § 9.2.4.2.1);
- the evaluation of additional possibilities for recycling and reusing water where possible (see above).

9.2.4.2 Water treatment

The wastewater treatment for Project One consists of the following components:

- pre-treatment removal of specific contaminants, so that the pre-treated wastewater can be processed more effectively together with the other flows in the general water treatment process;
- the central water treatment plant consists of:
  - primary treatment:
    - collection tanks (buffer) to prevent fluctuations in flow and composition in the water treatment plant;
    - removal of insoluble contaminants by means of mechanical separation using an oil separator and dissolved gas flotation;
  - secondary treatment: removal of dissolved contaminants by means of biological activated sludge treatment;
  - tertiary treatment: to achieve an even better quality of the discharged effluent. The various treatments

are discussed in the sections below.

9.2.4.2.1 Pre-treatment

The wastewater streams from the ECR are pre-treated. Pre-treating these effluent streams has the following advantages:

- The pre-treatment unit is designed to remove the specific contaminants from a particular wastewater stream. This allows the wastewater to be treated more effectively and efficiently in the subsequent stages of wastewater treatment.
- Treating a concentrated flow prior to general water treatment avoids dilution problems in the larger and more complex central water treatment plant; this results in higher treatment efficiency in the pre-treatment unit.

- This increases the overall efficiency of the wastewater treatment process.

9.2.4.2.1.1 Spent caustic

The ECR uses sodium hydroxide (caustic) to remove hydrogen sulphide and mercaptans from the process gases of the cracker. After use, a waste water stream is obtained which is called 'spent caustic'. This has a high pH and contains sulphur components. For this reason, this waste water stream is difficult to treat in a traditional waste water treatment plant and specific pre-treatment is required.

The wastewater stream is first sent to a spent caustic tank. This wastewater stream is then treated in a 'Wet Air Oxidation Unit (medium pressure/temperature)'. Here, the effluent is brought into contact with oxygen at an elevated temperature and pressure. This results in the chemical oxidation of sulphide components into sulphates and biodegradable organic components. Volatile organic components produced during the process are removed in a KO drum, then in a gas stripping tower and destroyed in the thermal oxidiser. The thermal oxidiser is discussed in Chapter 7 Air. The treated effluent is neutralised with sulphuric acid and then sent to the oil-containing collection tank.

9.2.4.2.2 Central wastewater treatment

The central wastewater treatment plant is designed to achieve optimal mixing of the individual flows. This maximises the biodegradability of nutrients and organic-rich flows in the biological treatment stage. Sanitary wastewater is also combined with industrial wastewater that enters the secondary treatment stage. This creates a mix between a high organic load (from sanitary wastewater) and a nutrient-rich stream (from industrial wastewater). The various stages of the central wastewater treatment plant (WWTP) are described in the following sections.

9.2.4.2.2.1 Wastewater contaminated with hydrocarbons (DCC[60])

This wastewater stream contains contaminated rainwater, oily wastewater and process wastewater contaminated with hydrocarbons. This wastewater is collected in the oily collection tank and sent to primary treatment.

An off-spec tank is provided for collecting and buffering sudden large quantities of waste water resulting from process malfunctions or maintenance activities, with control provided via TOC measurement to divert this largest waste water flow to this off-spec tank. The off-spec water will be gradually returned to the WWTP by mixing it in the collection tank. Only if the off-spec water is so contaminated that it cannot be processed in the WWTP will it be discharged.

There is also a third tank that serves as a replacement tank for the oil-containing collection tank and off-spec tank.

9.2.4.2.2.2 Cooling water discharge

As a result of the evaporation of the process water in the cooling towers, the substances present in the process water become concentrated, making it necessary to discharge the water. This may result in increased levels of dissolved substances, traces of chemicals, phosphates and dissolved hydrocarbons in this stream, originating from possible process leaks in heat exchangers. As regards additives (biocides, anti-corrosion agents, etc.) for water treatment, mainly rapidly (bio)degradable substances will be used to ensure smooth processing in the biological water treatment plant. The use of approximately 50% demineralised water for the production of cooling water significantly reduces discharge.

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[60] Continuous oily waste water drainage system

9.2.4.2.2.3 Primary treatment

Wastewater that does not undergo pre-treatment is collected in the oil-containing collection tank. There is also an exchange tank that can serve as a backup for the collection tank.

From these tanks, the wastewater is sent at a controlled flow rate to the next stage in the wastewater treatment process. This reduces fluctuations in the flow rate and composition of the wastewater. The storage capacity of the collection tanks is dimensioned for a total of approximately 16 hours of average outgoing wastewater flow; in addition, 6 hours of average outgoing flow has been added to the capacity in order to accommodate peak flows in supply. This also provides a delay time for resolving any operational problems.

The **pH** can be adjusted in the collection tank if necessary. This can be done in the collection tank itself or can be provided at the outlet of the discharge pumps that transport the waste water to the next treatment step. The ideal pH is between 6 and 9.

Due to the long retention time, an oil layer may separate in the collection tank, which is not the intended effect. Oil skimmers will be installed to remove this floating layer.

In addition, solids can also settle in this collection tank. For this reason, jet mix pumps will be installed at the bottom of the tanks to ensure that the solid particles do not settle.

Oil separator
The water from the collection tank is pumped to the oil separator, which is a corrugated plate interceptor (CPI) type. The corrugated plates in this installation are positioned against the flow, ensuring efficient removal. In this step, coarser particles and oil are removed.

Dissolved gas flotation (DGF)
The wastewater is then sent to the DGF unit for further oil removal. In this step, the finer oil droplets and particles with a lower density are removed by injecting a gas at the bottom of the water column. To avoid potential explosion hazards due to the presence of hydrocarbon vapours, nitrogen will be used as the gas. The oil particles and finer particles will attach themselves to the gas bubbles, causing them to float to the surface. Appropriate additives will be used to break down emulsions and chemical coagulation and flocculation will be applied.

The oil separated from the oil separator (CPI) and the DGF is collected separately and collected by an external contractor. The separated sludge is pumped to the sludge conditioning unit. Exhaust gases from the tanks, CPI and DGF unit will be discharged to a thermal oxidiser.

The partially treated wastewater is sent on to secondary treatment.

9.2.4.2.2.4 Secondary treatment

All pre-treated water flows converge just before the secondary biological treatment unit. In this step, dissolved organic carbon-containing pollutants are removed, as well as excess nitrogen and phosphate nutrients.

For the secondary treatment of industrial petrochemical wastewater, the conventional technique of activated sludge with secondary clarifier(s) is used.

Here, the biomass uses the dissolved organic matter in the influent as a substrate to generate new biomass and produce CO_2. The oxygen required for the aerobic process is supplied by fine air bubble diffusers installed in the reactor tank. Nitrification plays an important role in the biological reactor for removing nitrogen from the wastewater, followed by denitrification, in which nitrate and nitrite are converted into gaseous N_2.

9.2.4.2.2.5 Tertiary treatment

In order to comply with the emission limits, the wastewater stream will be further treated in the tertiary treatment unit after the secondary treatment unit, for:

- further removal of dissolved particles, COD, BOD, TOC, total phosphorus;
- removal of traces of organic contaminants.

The technology used for this will consist of:

- plate settler;
- sand filter;
- buffer tank;
- chemical oxidation (ozone) unit;
- activated carbon filtration.

In this configuration, the effluent from the secondary treatment unit is first treated in a plate settler and a sand filter to remove solids from the biological treatment and reduce the load on the downstream process. Floating solids and sludge from this installation are sent to the sludge conditioning unit. The water flow is then buffered in a collection tank. This is an additional safety measure to compensate for possible effluent malfunctions. The buffer tank allows the wastewater to be returned to the start of the water treatment process for re-treatment. After the buffer tank, the wastewater is brought into contact with ozone to partially oxidise the remaining organic substances and produce shorter, more biodegradable compounds. After the ozone treatment, the effluent is further purified in an activated carbon filter. These last two steps generate a thorough purification process, as the 'long' residence time on the activated carbon filters allows any residual contaminants to be further processed by the bacteria in the biofilm of the activated carbon. Activated carbon filtration is the best available technique (BAT) for achieving very low organic concentrations.

The purified water from the tertiary treatment unit is collected in a buffer tank and ultimately discharged into the Scheldt.

The buffer tank also collects a very low-load residual water stream that does not require further purification
. This stream consists of the regeneration stream from the polisher (ion exchange resins).

9.2.4.2.2.6 Sludge treatment

Sludge is produced in the various stages of wastewater treatment. Its quantity and composition depend on the technology used. Sludge is usually liquid or semi-liquid, with a solid content of between 0.25 and 12% by weight.

Mechanical techniques will be used to limit the amount of sludge on the one hand and to reduce the water content of the sludge as much as possible on the other.

The sludge produced during the various stages of wastewater treatment is collected in a sludge thickener. The thickened sludge is then pumped to an aerobic digestion tank to reduce the total biomass. Afterwards, an organic polymer is added to aid dewatering, after which the conditioned sludge is pumped to the sludge dewatering (centrifuge). Centrifugal force separates the solid sludge from the water fraction. The dewatered sludge has a dry matter content of approximately 20%, is stable and suitable for further external processing (e.g. incineration or drying in a rotary kiln).
The dewatered sludge is removed and transported to an external location for treatment.

9.2.4.2.3 Oil disposal

Oil is captured at various stages of the water treatment process and transferred to a separate oil collection tank. This oil is collected and transported away by an external processor.

9.2.4.2.4 Removal efficiency of the water treatment process

Table 9-33 shows the expected concentrations for the various stages of water treatment, which provide an indication of the treatment efficiencies in the various phases of water treatment. The locations where these indications are expected are indicated on the water treatment diagram shown in Figure 9-40.

The water treatment plant provides tertiary treatment in which poorly biodegradable components will be removed. The biological removability of the various wastewater streams will primarily be monitored on the basis of the BOD/COD ratio. If this reveals that there may be problems with biodegradability due to the water treatment plant, further tests will be carried out. This monitoring will form part of the environmental management system.

Table 9-33: Expected concentrations in the various stages of water treatment

Parameter	Step 1	Step 2	Step 3	Step 4	Step 5
BOD (mg O2/l)	n.a.	n.a.	<25	<25	<25
CZV (mg O2/l)	1,500	750	<100	<100	<100
Free oil and Fats (mg/l) (mg/l)	100	<10	<5	<1.5	<0.5
Suspended matter	1000	150	3,250	<35	<35
pH	6 - 9	6 - 9	6 - 9	6 - 9	6 - 9
Total N (mg/l)	n.a.	n.a.	<15	<15	<15
Total P (mg/l)	n.a.	n.a.	<2	<2	<2

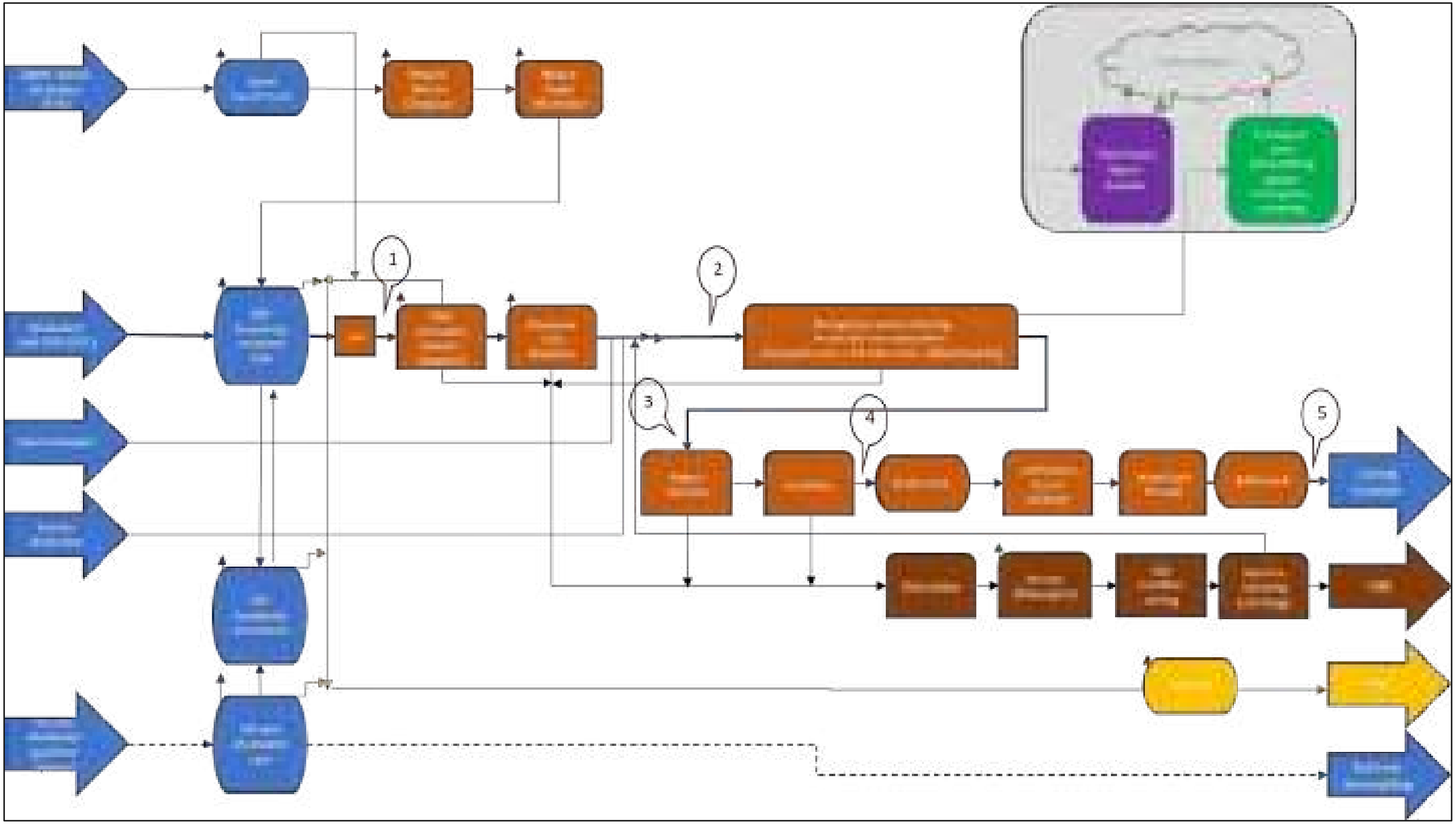


Figure 9-40: Indication of the various steps in water treatment

9.2.4.2.5 Buffer margin

The water treatment plant has various buffer tanks (including an off-spec collection tank, oil-containing collection tank, oil-containing exchange tank, spent caustic tank, effluent buffer tank; see also the description of the various components and Figure 9-39) to compensate for fluctuations in flow rate. The following volumes are provided:

- Oil-containing collection tank: 1,000 m³
- Off-spec waste water tank: 2,000 m³
- Oil-containing exchange tank: 2,000 m³
- Buffer tank: 180 m³
- Purified water buffer tank: 400 m³
- Spent caustic tank: 2,000 m³

Several scenarios were also calculated for possible process failures and periodic maintenance work on the installations. These showed that the WWTP (including the collection/buffer tank and operational control) had sufficient capacity. In addition, the first/second flush basins could potentially be used as temporary collection basins.

Wastewater streams that do not meet the specifications for processing in the WZI can be collected in the off-spec tanks. An off-spec tank is provided for the largest wastewater stream (oil-containing wastewater).

9.2.4.2.6 Monitoring

The operation of the water treatment plant will be continuously checked and monitored. Checks are carried out with a view to steering the process towards optimum efficiency, identifying and preventing disruptive situations that could affect the biological treatment process, and achieving the discharge standards.

The efficient operation of the water treatment plant requires the monitoring and control of various process parameters at the level of the different influent streams and at the appropriate stages of the water treatment plant. Primary monitoring of critical parameters (e.g. turbidity, pH, flow rate, TOC, MAKs, PAHs) is carried out in the pre-treatment units (ECR) in order to control the influent in the central wastewater treatment unit. A set of internal "acceptance criteria" will be established, based on flow rate, turbidity and the concentration of potential contaminants. Online measurements of specific indicator parameters (e.g. turbidity, pH, TOC, suspended solids, O2 consumption) will enable rapid intervention, e.g. buffering, adding additives, etc.

- A set of 'internal' threshold values is determined for each incoming wastewater stream. These internal threshold values are agreed between the entity producing the wastewater and the operational management of the WWTP, based on production processes, expected fluctuations for the various parameters, any buffer capacity, the removal efficiency of the WWTP, etc. These threshold values are expected to include flow rate, temperature, pH, TOC, turbidity as an indicator for suspended solids; which also means that the necessary online measurements (flow rate, turbidity, pH, TOC, total P) will be available for the individual flows (taking into account the relevance, after an operational/risk analysis).
- Based on this online information about the various incoming wastewater flows, and taking into account the possible buffer effect, WWTP operators can manage the incoming wastewater flows in a predictive/anticipatory manner through their control and monitoring systems.
- An important aspect of this working method is the 'live feedback' from the online measurements to the relevant responsible persons at the WW-producing entities. A web-based dashboard (a highly visual platform), accessible to all relevant 'partners' (including management), is very useful for generating commitment and a responsive, proactive attitude among those involved. This is especially true when compliance with internal standards is visually indicated by a 'traffic light' visualisation: green = everything OK; orange = close to standard (action to be taken) and red = exceeding standard (shut off supply to WWTP to protect the treatment process).

- Furthermore, a system of 'scenario response' cards with specific instructions will be developed for WWTP operators. A high-performance system of 'lessons learned' management (covering both the identification of opportunities for improvement and implementation and follow-up) should support this approach. A similar approach must be provided at the source of the wastewater streams, in order to be able to provide feedback at the source (process approach).
- The web-based, visually appealing dashboard should also display the online results of the effluent from the WWTP. This again helps to build the necessary commitment, as the (potential) consequences of exceeding internal standards can be reflected in an exceedance of effluent standards (or reduced efficiency/performance or even serious disruption to the WWTP system).
- As part of the organisation of the WWTP, regular meetings will also be arranged (initial frequency = high, to be reduced once the necessary knowledge has been fully developed) between the operators/management of the WWTP on the one hand and the representatives of AW dischargers on the other. During these meetings, the operation of the WWTP will be discussed on the basis of monitoring data, identified problems and implemented solutions, and further opportunities for improvement will be sought.

Monitoring of the effluent discharged into the Inovyn discharge pipe is also planned. The analysis results for the effluent (pH, temperature, suspended solids, TOC, total N, total P, supplemented with parameters imposed in the permit decision) will further assist in the management and operational control of the water treatment plant. The discharge of effluent that does not meet the permit conditions will be avoided at all times.

In addition to the parameters that are monitored online (e.g. flow rate, turbidity, pH, TOC, total N, total P, temperature), sampling facilities will be provided to enable routine and non-routine sampling of a larger number of parameters. The sampling frequency is determined in accordance with legal requirements (VLAREM, permit).

9.2.4.2.7 Discharge point

The treated wastewater from Project One will be discharged into the Scheldt via the discharge pipe also used by Inovyn. Prior to the merging of the two wastewater streams, a separate flow measurement and sampling facility will be provided to monitor Project One's effluent separately. This means that no new discharge pipe needs to be constructed through Galgenschoor for Project One.

The location where the discharged water enters the Scheldt is shown in Figure 9-41. A discharge permit has been granted to Inovyn for a discharge flow rate of 210 m^3/h. This also includes the discharge from IMB. Project One is applying for a separate discharge permit to discharge the treated waste water into the Scheldt via the same existing pipeline.

In future, this pipeline will carry the treated wastewater flows from Inovyn (average approx. 116 m^3/h), IMB (average approx. 40 m^3/h) and Project One (normal situation 74 m^3/h, worst case approx. 246 m^3/h) into the Scheldt.

Figure 9-41: Location of discharge point in the Scheldt (see red circle)

9.2.4.3 Impact assessment of discharge into the Scheldt

Since the Project One installations and the water treatment plant are new, no analysis results are yet available regarding possible concentrations of pollutants in the effluent. This EIA proposes discharge standards that the effluent will meet according to the design data of the water treatment plant. The relevant parameters are COD, BOD, suspended solids, N_{tot}, P_{tot}, BTEX, PAHs, phenols and metals. The requested discharge standards are shown in Table 9-34. It is proposed that, after the installation and commissioning of the water treatment plant, a monitoring programme be set up and the effluent be analysed for the possible parameters. The following assumptions are made for the establishment of the **discharge standards**:

- For macro-pollutants (oxygen-binding factors + nutrients), we initially base our calculations on the values commonly imposed by VMM on industrial wastewater discharges.
- For micro-pollutants, VMM distinguishes between hazardous substances and the most hazardous substances (VLAREM II, Art. 2.3.6.1). The concentration at which wastewater must be considered 'industrial wastewater containing hazardous substances' is referred to as the classification criterion (IC):
  - for hazardous substances: maximum 10*the classification criterion (IC). If no IC has been set, then 10*MKN is set. For some parameters, based on the estimated water purification efficiency, a lower discharge standard than 10*IC is achievable; this is indicated in Table 9-34;
  - for priority hazardous substances (PHS): maximum 1*the classification criterion;
- For some parameters, the BREF study "Treatment and management of waste water and waste gas in the chemical sector (CWW)" applies stricter standards. The discharge standards requested by Project One are in line with these stricter CWW standards.
- The requested discharge standards are instantaneous standards. Some discharge standards are based on annual average standards from BREF reports; this "annual average" value is requested as an instantaneous standard;
- Table 9-34 indicates the basis on which the discharge standards were proposed for the parameters that are expected to exceed the classification criterion;

- For parameters in concentrations lower than the classification criterion, no discharge standard needs to be applied for and the impact on the water quality of the Scheldt does not need to be determined. After all, discharges in concentrations below the applicable test values in the receiving water body will not have a negative impact on the achievement of these standards and will not result in a deterioration of the status (cf. Step 2 of the step-by-step plan for assessing the impact of industrial waste water discharges).

It should be noted that the reuse of cooling water leads to a concentration of the parameters that are taken in via the municipal water supply. This mainly concerns the parameters metals (Cr, Cu, Ni), P and N.

Table 9-34: Required discharge standards for the discharge of treated waste water into the Scheldt

Parameter	Unit	Required discharge standard	Basic
CZV	mg/l	100	CWW : CZV: 100 mg/l (rolling annual average)
BOD	mg/l	25	VMM
Suspended Substance	mg/l	35	CWW
Nitrite	mgN/l	1	Fluctuations in N degradation are expected during the start-up of the WWTP, resulting in increased nitrite concentrations. Therefore, 1 mg/l is requested instead of 0.2 mg/l.
Nitrite+Nitrate +Ammonia	mg/l	4.9	10*MKN
Total N	mgN/l	15	VMM
Total P	mgP/l	2	VMM
Orthophosphate	mg/l	0.7	10*MKN
Total metals			
Ash	mg/l	0.05	10*IC
Cu	mg/l	0.05	CWW
Zn	mg/l	0.3	CWW
B	mg/l	1.4	2*IC
Mo	mg/l	0.7	2*IC
Ti	mg/l	0.04	2*IC
Cr	mg/l	0.025	CWW
Ni	mg/l	0.05	CWW
Co	mg/l	0.003	5*IC
V	mg/l	0.025	5*IC
Se	mg/l	0.006	2*IC
PAHs			
Naphthalene	µg/l	20	10*IC
BTEX			

Parameter	Unit	Requested discharge standard	Basic
Benzene	µg/l	100	10*IC
Ethylbenzene	µg/l	50	10*IC
Toluene	µg/l	900	10*IC
Xylene	µg/l	40	10*IC
Isopropylbenzeen	e (µg/l)	10	10*IC
Other			
Diethylamine e	e (µg/l)	300	10*IC
Dimethylamine ne	µg/l	60	10*IC
Phenols sum	µg/l	400	VMM
AOX	µg/l	400	10*IC

Impact assessment

Under normal circumstances, the discharge rate will be 74 m³/h. In 5% of cases, a higher discharge rate of 246 m³/h may occur in the event of an upset scenario, which is the worst-case situation.

Initially, the low water discharge rate Q10 of the Scheldt is used in the calculations, which amounts to 46.47 m³/s.

According to the guidelines manual and the VMM calculation tool, a good mixture between the water from the Scheldt and the effluent is assumed. The degradation, conversion or adsorption of the discharged pollutants is not taken into account.

In order to assess the effect of the discharge on the receiving surface water, we calculate the change in concentration based on the requested discharge standards for Project One, as no analysis results for the effluent are available yet.

The impact assessment for discharge into the Scheldt is carried out for all relevant parameters: COD, BOD, nitrite+nitrate+ammonium, orthophosphate, BTEX, PAHs, AOX, phenols and metals. The objectives for chlorides, sulphate and conductivity are not applicable due to the brackish nature of the water in the Scheldt estuary and are not evaluated in the EIA. There is also no environmental quality standard for suspended solids for the Zeeschelde IV water body; transparency has been included as an environmental quality standard for this water body.
This parameter cannot be evaluated using the VMM calculation tool.

No environmental quality standard is available for the following parameters:

- Phenols (total): this is assessed against the PNEC: 8 µg/l.
- Total metals: the environmental quality standard for dissolved metals is used for the impact calculation (cf. the VMM calculation tool). The discharge standard is requested for total metal.
- No environmental quality standards are available for total N and total P in transitional waters. Standards are available for ammonium+nitrite+nitrate and orthophosphate in transitional waters. A calculation is performed for total N and total P based on the available standards for ammonium+nitrite+nitrate and orthophosphate; this is a worst-case assumption.

To assess the impact of Project One's discharge on the quality of the Zeeschelde IV water body (VL17_43), the VMM's step-by-step plan (VMM 2023) can be found at https://www.vmm.be/water/wastewater/impact assessment-industrial wastewater), which assesses whether or not there will be a 'deterioration in the status of a water body' as a result of the discharge of treated industrial wastewater from Project One. Deterioration occurs as soon as the status of at least one of the quality elements referred to in Annex V to that Directive deteriorates by one class, even if that deterioration does not result in the surface water body being classified in a lower class overall. However, if the relevant quality element referred to in this Annex is already in the lowest class, any deterioration of that element constitutes a 'deterioration of the status' of a surface water body. The summary of the calculation tool is given in Annex 5.2.

1. Step 1: Preliminary assessment

   The Class 1 company discharges industrial waste water into surface water with a permitted flow rate >20 m³/day and a measuring flume. This is a new discharge with a maximum (worst case) flow rate of 246 m³/h or 5,904 m³/day and a normal flow rate of 74 m³/h or 1,776 m³/day. This relevant discharge needs to be investigated further in step 2.

2. Step 2: Is there a potential impact?

   The company discharges hazardous substances listed in Annex 2C of VLAREM II at concentrations exceeding the classification criterion (IC) or PNEC (in the absence of an IC). The company generally discharges physicochemical parameters above the test values (i.e. the type-specific basic environmental quality standards listed in Annex 2.3.1 of VLAREM II). A comprehensive investigation into the effects on the water body is required.

3. Step 3: Where is the impact determined?

   The company discharges directly into the Flemish surface water body Zeeschelde IV (VL17_43).

4. Step 4: Is the impact on the condition relevant in worst-case circumstances?

   This step examines the extent of the discharge's contribution in relation to the test value under worst-case conditions (maximum discharged pollutant load combined with low water flow in the receiving watercourse). In reality, the actual contribution will therefore always be less.
   The percentage contribution of the discharge is calculated for the relevant parameters in relation to the test value after complete dilution in the receiving surface water. The results of this calculation are shown in Table 9-35. If the percentage contribution is less than 10%, the calculation tool's recommendation is favourable, provided that step 9 is completed, which involves investigating whether there is any problem with achieving the objectives at the end of the water body. If the percentage contribution is >10%, proceed to step 5 (Is the impact on the status and the risk of deterioration acceptable in worst-case circumstances?).

Table 9-35 shows the percentage contribution for the relevant parameters of Project One's discharge into the Scheldt. For all parameters, the percentage contribution is <10%. The calculation tool's recommendation is 'favourable, provided that step 9 is completed'.

5. Step 9: Deterioration of the situation or achievement of the objectives: final assessment and actions in permits

The Zeeschelde IV water body (VL17_43) is currently in poor ecological condition due to the poor condition of the macrophytes and the poor condition of the underlying physical-chemical elements (nitrate+nitrite+ammonium) and specific pollutants (arsenic, boron, uranium). Compared to the previous assessment in the context of the river basin management plans (in 2015), the ecological and chemical status has not changed in terms of class. However, there has been an improvement in the underlying parameters for fish (from inadequate to good).

Based on the River Basin Management Plans for the Scheldt and Meuse 2022-2027, a positive trend was observed for nitrogen parameters at more locations than locations with a negative trend. No specific reduction targets were set for the parameters for the Zeeschelde IV water body. The water body is located in a Class 5 area of concern (good ecological status after 2033, but potential for significant progress, provided that actions included in SGBP3 and SGBP4 are implemented).

The future outlook (shown in the 2022-2027 river basin management plans) indicates a slight improvement for this water body in terms of dissolved oxygen (this parameter is already in good condition) and total nitrogen (no status assessment). The discharge of treated waste water does not hinder this improvement.

Ineos provides for extensive treatment of the wastewater in accordance with BAT and monitoring of the effluent.

The Wezertool calculates the percentage contribution for all parameters, which is less than 10% for all parameters. The discharge will therefore not cause any deterioration in the status of the quality elements as referred to in Annex V of the Water Framework Directive, nor in the status of the surface water body.

Based on the above assessment, it can be concluded that the discharge does not compromise the achievement of good chemical and/or ecological status. The effect of the discharge on surface water quality is therefore negligible (0).

Table 9-35: Worst-case impact of the discharge from Project One (based on requested discharge standards) on the Scheldt (worst-case discharge flow rate of 246 m³/h)

[illegible]

9.2.4.4 Impact on waterbed quality

Any enrichment of the Scheldt's underwater bed caused by Project One's discharge is mainly relevant for pollutants that are insoluble, attach themselves to suspended solids and/or are highly persistent substances. Since Project One's water treatment will involve a combination of treatment steps using the latest technology, it is expected that suspended solids will be removed as much as possible and that no substances that could have a relevant impact on the underwater bed will be discharged.
Furthermore, the impact of Project One's discharge on the surface water quality of the Scheldt is negligible; consequently, it will not lead to an enrichment of the underwater sediment.

With regard to PAHs, no exceedances are currently being observed in the subaquatic sediment; in the surface water of the Scheldt, the environmental quality standard for several PAHs (benzo(a)pyrene, fluoranthene, benzo(b)fluoranthene, benzo(ghi)perylene and benzo(k)fluoranthene) is being exceeded. However, the existing balance between surface water and the underwater sediment does not lead to exceedances of the standards in the water sediment, from which it can be concluded that the existing concentrations in the surface water do not cause enrichment of the water sediment. These parameters are not expected in the effluent from Project One. The discharge from Project One will not give rise to a relevant contribution to the concentrations in the waterbed.

No pollutants are expected to have a significant effect on the underwater sediment. The effect is negligible (0).

9.2.4.5 Effects on water quantity to Kanaaldok/Scheldt

No water will be extracted from the Scheldt. Based on estimates, in normal situations approximately 74 m³/h and a maximum of approximately 246 m³/h of treated industrial waste water from Project One will be discharged into the Scheldt.
be discharged. Compared to the average discharge of the Scheldt of 97 m³/s (350,000 m³/h) at Antwerp, the hydraulic impact is max. 0.07%. The hydraulic impact of the discharge on the receiving watercourse is therefore considered negligible (0).

Rainwater from Project One will be reused as much as possible as cooling water and sanitary water. There will be an overflow to the Canal Dock. The impact on the water quantity of the Canal Dock is negligible (0).

9.2.4.6 Assessment of effects on the status of water bodies - Test against WFD Annex V

In its judgment of 1 July 2015, the European Court of Justice ruled on the interpretation of the Water Framework Directive (Case C-461/13, the so-called Weser judgment), stating that attention must be paid to the effects on water and the various elements that determine its status. This is addressed in the following. The assessment was carried out on the basis of the interim guidelines for assessing effects on the status of water bodies (Coordination Committee for Integrated Water Policy, 2019). This approach is based on the risk that a project or activity, plan or programme poses to the status of surface water or groundwater. The greater the likelihood of significant adverse effects, the more extensive the investigation and the more aspects of the water system that need to be discussed. Only if there is a possibility that the current or future status of one or more water bodies will be affected should this be investigated further. This is the case for discharges, hydromorphological changes and changes to groundwater.

9.2.4.6.1 Assessment of the likelihood of effect – test for further investigation

In accordance with the interim guidelines for assessing impacts on the status of water bodies (Coordination Committee for Integrated Water Policy, 2019), a number of criteria are used to determine whether further investigation is necessary. The purpose of this step is to retain only those projects that could potentially cause a deterioration in the status of water bodies or jeopardise the achievement of the objectives for the status of water bodies.

The criteria are:

- Hydromorphological changes:
  The project does not involve any hydromorphological changes to the water body: no further investigation is necessary.
- Discharges:
  The project involves a class 1 discharge of industrial waste water: further investigation is recommended. This was carried out in § 9.2.4.3.
- Changes to groundwater:
  The project involves the extraction of groundwater:
  - Drainage will be carried out during the construction phase. Further research into the drainage water was carried out and is presented in §9.2.3.2.
  - During the operational phase, groundwater is drained in winter: however, this is limited to approx. 25 m³/day: no further investigation is necessary, as this is a 'Class 3 classification' (according to Appendix 1 of Vlarem II). These activities do not need to be considered further, as they have a negligible impact.

Further research into the effects of the discharge is necessary. This was carried out in § 9.2.4.3. Based on the VMM calculation tool, it was decided that the discharge from Project One does not cause any deterioration in the status of the water body.

9.2.4.6.2 Groundwater

During the operational phase, the impact of the project on groundwater quantity is assessed as limited negative (-1), while the impact on groundwater quality is limited negative (-1) to negligible (0).

Consequently, the project is not expected to result in a downgrade, thereby jeopardising the achievement of the desired outcome.

9.3 Cumulative effects

9.3.1 Quay wall

The environmental permit application (with project EIA) for the construction of the quay wall by the Antwerp Port Authority has been approved.

9.3.1.1 During the construction phase

The construction phase of the quay wall at canal dock B2, between docks 1 and 2, overlaps with the construction phase of Project One. During the construction phase of both projects, cumulative effects may occur as a result of the drainage work to be carried out. As part of the quay wall project, a drainage study was carried out by SBE (02/06/2020). The construction of the cofferdam for quay walls of type 1 and type 2 requires an excavation depth of 3.4 m TAW for the land side and 2.8 m TAW for the water side. The drainage is divided into three zones, depending on whether or not contaminated groundwater is likely to be found within an area of approximately 30 m next to the future construction pit. Within this distance, a sheet pile wall or a return circuit can be provided. Due to the phased execution of the works, it is unlikely that the drainage systems in the three drainage zones will be active simultaneously for a longer period of time.

The radius of influence of the drainage of aquifer 1 on the landward side is almost identical to the distance to the sheet pile wall.

Measures are already being taken during the construction of the quay wall to limit any possible effects on the surrounding area. The drainage for the quay wall will be isolated by means of sheet piling or return drainage will be used, so no effects are expected outside this wall. Consequently, no cumulative effects are to be expected with the drainage for the construction of Project One.

9.3.1.2 During the operational phase

Once construction of the quay wall has been completed, it will be put into use for the further construction work on Project One. No cumulative effects are expected at that time, as there will be no discharge of waste water as a result of the operation of the quay wall.

The impact of the presence of this new quay wall was included in the reference situation in the present EIA for Project One. The groundwater model already took into account the presence of this quay wall and the planned drainage at Insteekdok 1. The effects on the groundwater system were included in the reference situation. Cumulative effects were therefore already assessed in the model.

9.4 Mitigating measures

During the **construction phase**:

- Installation of sheet piling or equivalent technology.
- Purification of contaminated pumped drainage water in accordance with the specified discharge standards before discharge.
- Carrying out the planned monitoring and control of water purification and drainage at the drainage zones. The monitoring plan is provided in the hydrogeological study, including the drainage note, with the environmental permit application.
- Monitor the effective impact during drainage works by monitoring the reduction in groundwater levels and monitoring subsidence, groundwater contamination and salinisation. The monitoring will be discussed in the hydrogeological study, including the drainage report, which will be attached to the permit application.

During the operational phase - surface water:

Within Project One, the following preventive measures, among others, are already planned to limit the impact on the receiving water bodies:

- the use of demineralised water in the cooling circuits instead of just municipal water, which significantly reduces water consumption and wastewater discharge;
- reusing rainwater as cooling water and for sanitary applications;
- separating and pre-treating specific wastewater streams at source and treating different types of wastewater appropriately (see § 9.2.4.2);
- potentially contaminated rainwater is collected separately in the first flush and second flush basins, so that it can then be used as cooling water if the quality is satisfactory;
- strictly monitor the application of good housekeeping:
  - keeping production facilities and surrounding areas clean
  - Wastewater streams are separated at source and directed to the appropriate drainage system for proper disposal and treatment.
- the use of ClO_2 to replace NaOCl, thereby avoiding the contaminant AOX in the effluent;
- the use of appropriate additives (anti-corrosion, anti-fouling agents) in the cooling water systems;
- installing pre-treatment, primary, secondary and tertiary treatment, with secondary treatment being a biological treatment process (see § 9.2.4.2);
- providing sufficient buffer capacity in the water treatment system;
- Wastewater vapours that do not meet the specifications for processing in the wastewater treatment plant are collected in the off-spec tank.
- equipped with a monitoring system for the wastewater treatment plant from both the local and central control rooms:
  - on the incoming wastewater streams (online: pH, temperature, flow rate, TOC, suspended solids, oxygen consumption);
  - on the effluent from the wastewater streams (online: pH, temperature, TOC, suspended solids, flow rate; on a daily basis: total N);
  - with clear agreements on internal threshold values (e.g. flow rate, temperature, pH, TOC, turbidity as an indicator for suspended solids) for each of the incoming wastewater streams to the wastewater treatment plant;

- web-based dashboard (highly visual platform), accessible to all relevant "partners" for communication of online information on the various incoming wastewater streams, the efficiency of the WWTP and the concentrations of the outgoing effluent; designed to support a responsive, proactive attitude;
- Furthermore, a system of 'scenario response' cards with specific instructions will be developed for WZI managers. A high-performance system of 'lessons learned' management (covering both the identification of opportunities for improvement and implementation and follow-up) should support this approach. A similar approach should be provided at the source of the wastewater streams, in order to also be able to provide feedback at the 'source side' (process approach);
- improvement of the performance of the separators and reduction of the water load by:
  - maintaining a continuous and balanced hydraulic flow through the installation, e.g. by providing a sufficiently large collection tank, combined with the necessary process control to ensure sufficient buffer capacity at all times;
  - take measures (by means of additional dosing) to adjust the nutrient concentration where necessary in order to maintain optimal conditions in the biological treatment plants;
- providing monitoring and control measures to prevent the cooling water from becoming contaminated in the process heat exchangers. Appropriate measures include:
  - high-quality cooling pipes/sheet materials to prevent corrosion;
  - quality assurance and inspection of heat exchangers during construction;
  - adequate preventive maintenance, and;
  - online monitoring (of TOC) for the presence of contaminants in the cooling water; with immediate action if these are detected;
- minimising VOC emissions to the vapours released at the successive treatment stages in the wastewater system by:
  - covering as much as possible of the physico-chemical parts of the wastewater treatment plant, whereby the volatile components are collected for processing in an afterburner;
  - sending the vapours from the biological water treatment stages to a biogas scrubber to remove the odorous compounds and any remaining VOCs. This is discussed in Chapter 7 Air;
- Installation of online process monitoring equipment throughout the plant to record product flows and the risk of significant contamination in a timely manner and report them to the authorities (in the event of an incident). These online systems are equipped with alarms to warn operators if certain operational parameters rise above a certain range.

During the operational phase - groundwater:

- leak detection systems will be installed on the tanks;
- The areas where the risk of spillage is greatest are bundled or covered; a liquid-tight surface is provided. Spilled liquids within these areas are collected and removed by third parties.
- tanks containing environmentally hazardous liquids are provided with bunds with liquid-tight floors and walls. Systems are provided to check the seals;
- Tanks are designed to prevent hydrocarbons from entering the groundwater. In addition to design, operational management and performance, the maintenance, inspection and repair of tanks will be crucial to meeting this requirement.
- the containment will have sufficient capacity to collect any leaks of flammable/hazardous liquids and, where applicable, firefighting and cooling water, a layer of foam, rainwater and wind waves. The capacity for collecting firefighting water, cooling water and foam will be determined in accordance with a code of good practice;
- Loading and unloading areas for hazardous products will be equipped with liquid-tight paving and drainage to a collection pit or to the sewer system for oily waste water (to WZI).

9.5 Decision

9.5.1 Groundwater

9.5.1.1 Construction phase

Various interventions may give rise to changes in infiltration and **groundwater quantity:**

- Vegetation removal: when trees and vegetation are removed, the transpiration component will partially disappear. This will increase infiltration, provided that the soil is not completely compacted as a result of structural deterioration and compaction, or built on/paved over. After site preparation, the further development of the project area with the construction of (temporary or permanent) paved surfaces for roads, construction sites and site huts will result in a local drying effect, which will translate into a lower groundwater level. The impact is assessed as limited negative (-1).
- During construction, temporary drainage is necessary for various works below ground level (foundations, underground pipes, collection pits, basins, etc.). The groundwater must be lowered to 0.5 m below the required excavation depth. The dewatering scenario without preventive measures has negative effects on the displacement of groundwater contaminants and possible soil settlement. Therefore, preventive measures are provided, namely the provision of sheet piling or equivalent technology. Since the sheet piling forms a hydrological barrier that creates a 'bathtub' situation, the drainage activities mainly involve the extraction of rainwater that accumulates
  has accumulated within this 'bathtub'. These planned preventive measures will reduce the secondary effects that may occur as a result of drainage. As a result of these measures, no negative effects are expected in terms of soil settlement, salinisation, the attraction of groundwater contamination from neighbouring plots or the Galgenschoor nature reserve.
  The effect on neighbouring groundwater extraction in the first aquifer is limited negative (-1), while the effect on groundwater extraction in the second aquifer is negligible (0). It is also expected that the groundwater level will recover after the drainage works. The impact on the change in groundwater quantity is assessed as limited negative (-1).

Groundwater quality

During the work, accidental soil and groundwater contamination may occur as a result of leaks in (fuel) pipes or spillage of mainly oil and/or fuels during the use and maintenance of the machinery on site. This is discussed in Chapter 8 Soil. Please refer to this chapter for more information.

9.5.1.2 Operational phase

During the construction of the site, the ground levels within Project One will be altered. In some areas, high groundwater levels are currently being measured in winter. To prevent parts of the site from flooding in winter, some areas will be raised to 25 cm above the maximum groundwater level. Drainage systems will also be installed in some areas. At the new quay wall on the Canal Dock, a drainage system has also been included along Insteekdok 1, just above the water level of the Canal Dock; this drainage system has been included in the reference situation. The construction of pavements may also have an impact on groundwater quantity. The increasing paving of the ground surface may result in a local drying effect, which translates into a lower groundwater level.

For the operational phase of Project One (with modified ground level, drainage system, and changes in the degree of hardening of the terrain), groundwater levels were modelled using the groundwater model. No change in the overall groundwater flow pattern is expected as a result of the development of Project One. Vesta's pump and treat installation still causes a local depression in the groundwater level.
As no impact on the groundwater flow pattern is expected during the operational phase, the existing groundwater contamination will not be affected. The implementation of Project One will result in a groundwater level reduction in the southern part of the project area (the zone with a reduction greater than 5 cm has a north-south length of approximately 1,020 m); this is mainly due to reduced groundwater recharge. However, the groundwater level reduction will be limited and will not result in any secondary effects. The impact is assessed as limited negative (-1).

9.5.2 Surface water

9.5.2.1 Construction phase

- Rainwater from the roofs of the office containers will be collected and used as sanitary water. Rainwater tanks will be provided for reuse in sanitary facilities. All sanitary waste water and potentially contaminated rainwater during the construction phase will be collected in septic tanks; these will be emptied by a vacuum tanker and transported to an external location for treatment.
- After construction, the tanks and pipelines will be pressure tested to demonstrate the mechanical integrity of the welded joints and to guarantee leak tightness before commissioning. The test requires large quantities of hydro test water. Municipal water will be used for this purpose. This water will not be chemically treated, so that it can be discharged into the Canal Dock.
- The drainage water will be discharged (after treatment) into the Kanaaldok. The worst-case impact of the discharge of drainage water based on the discharge standards is negligible (0).

9.5.2.2 Operational phase

The water supply for Project One is mainly provided via municipal water (average consumption approx. 367 m³/h), demineralised water (average approx. 333 m³/h) and rainwater and drainage water (20 m³/h). The use of demineralised water in the cooling circuits instead of municipal water significantly reduces water consumption. Most of the water consumed evaporates and enters the atmosphere (average approx. 646 m³/h). Potentially contaminated rainwater is checked and then either recovered as uncontaminated rainwater or, if contaminated, sent to the water treatment plant. The uncontaminated rainwater is reused as cooling water and for sanitary applications. In the southern part of the project area, 52% of the rainwater will be reused, 34% will infiltrate and 14% will be discharged to the Kanaaldok. No flood risks are expected as a result of the additional paving.

The wastewater will be treated in the industrial water treatment plant that will be built on the Project One site. The industrial water treatment plant will process process wastewater, cooling water discharge, sanitary wastewater and contaminated rainwater.

The Project One wastewater treatment plant consists of the following components:

- the pre-treatment of spent caustic wastewater steam, whereby specific contaminants will be removed so that the pre-treated wastewater can be processed more effectively, together with the other flows, in the general water treatment process;
- the central water treatment consists of: primary treatment (buffer tanks, oil separator and dissolved gas flotation), secondary biological treatment, and tertiary treatment to achieve an (even) better quality of the discharged effluent.

The treated wastewater is discharged into the Scheldt at a normal flow rate of 74 m³/h. In worst-case circumstances, the discharge flow rate can rise to 246 m³/h, but this occurs in no more than 5% of cases. The worst-case impact of Project One's discharge based on discharge standards is negligible (0).

The hydraulic impact of the discharge into the Scheldt is considered negligible. At the Kanaaldok, the hydraulic impact resulting from the discharge of uncontaminated rainwater is also negligible (0).

No pollutants are expected to have a significant effect on the underwater sediment. The effect is negligible (0).

10 Mobility

10.1 Methodology

The following chapter elaborates on the mobility aspect within the framework of the EIA. This chapter consists of three main parts, in which the impact during both the construction and operational phases is examined. In addition, the cumulative effects of the construction of the quay wall, the works in the context of the Oosterweel connection and the utility works of Elia and Waterlink under Scheldelaan are also examined. Finally, the impact of the complex ECA project is studied as development scenarios.

The following section describes the approach that will be taken to study and assess the effects of Project One.

10.1.1 Reference situation

First, the existing situation is described. This serves as a reference situation. The accessibility profile describes the road infrastructure, the existing networks (public transport, road categorisation, cycle network) and current traffic intensities. In addition, the current mobility profile and parking availability are discussed for the companies whose connection to Scheldelaan will be affected by Project One (Vopak, IMB, Inovyn and Vesta). Although no additional traffic will use the entrance to Inovyn or IMB in the context of Project One (both during the construction and operational phases), these companies and their current traffic flows are nevertheless included in the analysis. This is because traffic to and from the Vopak site (in the context of construction traffic) and to and from the Project One site will affect the intermediate intersections as through traffic.

10.1.2 Construction phase

Next, the mobility profile for the construction phase is drawn up. An estimate is made of the increase in traffic and any infrastructural adjustments. Data obtained from IOB is used for this purpose. This includes the following data (not exhaustive):

- Number of expected workers (construction phase);
- Attendance rate;
- Choice of transport mode for these workers (by car, public transport, bicycle, etc.);
- Distribution of departing and arriving traffic throughout the day (time of departure/arrival);
- Number of lorries per day and per hour;
- Distribution of traffic flows.

For the rest, reference is made to key figures or assumptions. These are clearly indicated in each case. Based on the mobility profile, the various effects on road traffic are described and assessed. The following effect groups are discussed for the construction phase:

Traffic generation;
Road safety;
Motorised traffic – road segment and network flow; Motorised traffic – intersection flow; Motorised traffic – passenger car parking; Motorised traffic – lorry parking.

The final section concludes with a summary and proposes (desirable) recommendations, mitigating and accompanying measures. These can be used to limit or prevent the possible negative effects of the construction phase.

In each case, the measure is proposed for a specific negative effect, indicating whether it is necessary or merely desirable and who is responsible for implementing/organising the measure. A distinction is made between organisational measures and infrastructural measures.

Accompanying measures include possible interventions to the road network that could primarily improve traffic safety and traffic flow on and around Scheldelaan in general. These measures are highly dependent on the ambitions of the road authority, which Project One cannot realise on its own. Project One is already in consultation with the road authority about this.

10.1.3 Operational phase

Finally, the mobility profile for the operational phase of Project One will be drawn up. An estimate will be made of the increase in traffic due to Project One and any infrastructural adjustments. Data obtained from IOB will be used for this purpose. This includes the following data (not exhaustive):

- Number of expected employees (operational phase);
- Attendance rate;
- Choice of transport mode for these employees (by car, public transport, bicycle, etc.);
- Car occupancy rate;
- Distribution of departing and arriving traffic throughout the day (hour of departure/arrival);
- Number of visitors, choice of transport mode, time of arrival/departure;
- Number of lorries per day and per hour;
- Distribution of traffic flows.

For the rest, reference is made to key figures or assumptions. These are clearly indicated in each case. Based on the mobility profile, the various effects on road traffic are described and assessed again. The following effect groups are discussed for the operational phase:

Traffic generation;
Road safety;
Motorised traffic – intersection management; Motorised traffic – passenger
car parking; Motorised traffic – lorry parking.

The impact group 'Motorised traffic – road segment flow' will not be studied in this phase. This is because the increase in traffic will not have an impact on the flow of road segments, but it will have an impact on the flow at intersections.

Finally, a conclusion will be drawn and (desirable) recommendations, mitigating and accompanying measures will be proposed. This will limit or prevent the possible negative effects of the operational phase.

In each case, the negative effect for which the measure is proposed is indicated, whether it is necessary or rather desirable, and who is responsible for implementing/organising the measure. A distinction is made between organisational measures and infrastructural measures.

Accompanying measures include possible interventions to the road network that could primarily improve traffic safety and traffic flow on and around Scheldelaan in general. These measures are highly dependent on the ambitions of the road authority and cannot be realised by Project One on its own.
Project One has already entered into consultation with the road authority on this matter.

10.1.4 Assessment framework

The significance framework below will be applied to assess the impact of the project (construction and operational phase) in terms of mobility. The final negative scores will be linked to mitigating measures.

Table 10-1: Significance analysis and assessment framework

Significance level	Representation	Assessment framework
Significantly negative Effect	-3	Mitigating measures linked to the short term must necessarily be sought. If these are not available, this must be justified.
Negative effect	-2	Mitigating measures must be sought, linked to the longer term. If these are not available, this must be justified.
Limited negative effect	-1	Research into mitigating measures is less compelling, but if the legal and policy conditions indicate that a problem may arise, the expert should proceed to propose mitigating measures. If these are not proposed, this should be justified.
Negligible effect	0	Negligible
Limited positive effect	+1	Positive
Positive effect	+2	Very positive
Significant positive effect	+3	Pronounced positive

For a description of the 7-point scale used in the above significance frameworks and the negative scores linked to the mitigating measures, please refer to § 5.3.

10.2 Reference situation

The description of the reference situation includes a description of the current situation. The accessibility profile describes the road infrastructure, existing networks (public transport, road categorisation, cycle network) and current traffic intensities. It also discusses the current mobility profile of surrounding businesses and the current parking availability. Finally, specific assumptions relating to mobility-determining developments are explained.

10.2.1 Accessibility profile: Traffic and transport structure – existing situation

10.2.1.1 Slow transport network

Planning background current situation

There is a cycle route along Scheldelaan that is included in the regional functional cycle route network (BFF). This cycling infrastructure is designated as compliant.

The nearest cycle highway is the F12, between Antwerp and Bergen-op-Zoom. It is approximately 2.5 km from the site. A cycle path, also included in the BFF, over the Lillo Bridge connects the cycle infrastructure along Scheldelaan with cycle highway F12. However, the Lillo Bridge is currently undergoing restoration and is therefore closed to all traffic. No information is currently available about a possible reopening of the Lillo Bridge. Cyclists can use the Cycle Bus as an alternative to cross the Kanaaldok. In the longer term, a new cycle path is also being considered as part of the Tijsman Tunnel project.

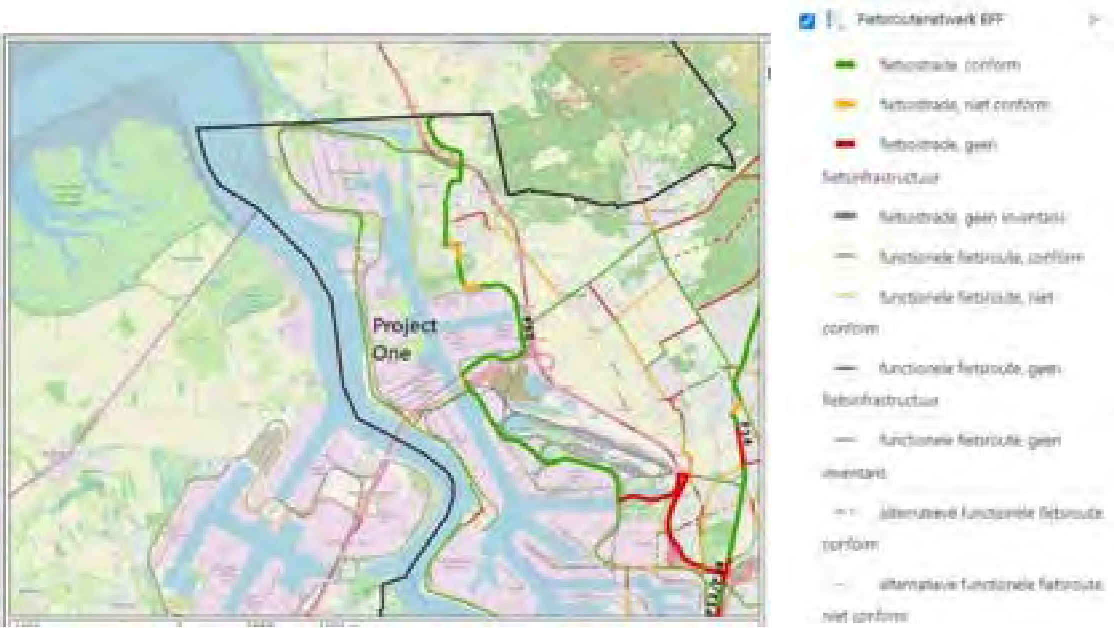


Figure 10-1: BFF Province of Antwerp (Source: https://www.provincieantwerpen.be/aanbod/dict/gis/digitale-kaarten.html,, 2024)

The cycling infrastructure along Scheldelaan is also included in the cycle junction network (junctions 92-95).

Figure 10-2: Cycle junction network (www.fietsnet.be, 2024)

For the time being, there are no public bicycle sharing systems available in the port area. However, there are plans to extend the Vélo sharing system to the port area. No concrete decisions have been made yet.

<u>Infrastructure condition: current situation</u>

There are no footpaths along Scheldelaan near the project area.

Between the Tijsmans complex and the Inovyn site, there is a separate two-way cycle path on the western side of Scheldelaan. At Inovyn, there is a traffic light-controlled cycle crossing (traffic control system (VRI) on demand). From there, the two-way cycle path on the eastern side of Scheldelaan continues northwards.

Between the Vesta and ASA sites, there is also a two-way cycle path on the eastern side of Scheldelaan, providing access to the Vesta, Bayer and ASA sites. At three locations, there are crossings between this cycle path on the eastern side and the cycle path on the western side (see locations 2, 3 and 4 marked on the map). The crossing at the ASA site is secured by traffic lights. At the other two crossings (between Bayer and Vesta and between I-hub and Havencentrum), Scheldelaan is reduced locally from 2x2 lanes to 2x1 lanes, making it easier for cyclists to cross.

Figure 10-3: Overview map showing cycle paths, cycle crossings and intersections (Google map)

The cycle path on the west side of Scheldelaan is largely conflict-free, as there are no business entrances on this side. The local cycle path on the east side conflicts with several business entrances.

Figure 10-4: Lane reduction with cycle crossing on Scheldelaan – between Vesta and Bayer

Lillobrug (over the Kanaaldok) is primarily a railway bridge, which cyclists can also use. However, shipping has priority here, which means that the bridge is usually open and is only closed for rail traffic. Lillobrug has been undergoing restoration for some time and is therefore permanently open to shipping (and therefore unusable for train traffic and cyclists). The Port Authority is therefore deploying the free Cycle Bus.

For an overview of combined transport systems such as I-bus, Waterbus and Fietsbus, please refer to § 10.2.1.3.

Finally, there are no Vélo stations or other sharing systems in the wider vicinity of the project area. There are plans to extend this network to the Port of Antwerp, but no concrete information, locations or timing are available.

10.2.1.2 Public transport network

Public transport services and stop infrastructure: current situation

There are no public transport stops in the vicinity of Scheldelaan. The nearest bus stop (Antwerpen kaai 602) is located on the east side of the Kanaaldok on the N180-Noorderlaan. This stop is served by bus line 760 (Antwerp – Noorderlaan – Bevrijdingsdok) and is accessible by bicycle bus.

There are no train stations in the immediate vicinity of the site. The existing rail infrastructure is reserved for freight transport.

Figure 10-5: De Lijn network plan (De Lijn, 2021)

10.2.1.3 Alternative modes of public transport

In recent years, a number of alternative forms of public transport have been introduced in the context of the Port of Antwerp. The Fietsbus (Bicycle Bus) and the Waterbus are the best-known initiatives in this regard. In addition, the I-bus has also been in service for some time. These are explained in more detail below, along with their usefulness for Project One.

10.2.1.3.1 I-bus

The I-bus or Industry bus is an initiative of several large companies in the Port of Antwerp. Through an independent non-profit organisation, they organise daily, free shuttle services for thousands of employees. In 2024, they offer 39 routes (as shown on the map below), serving a wide area around the Port of Antwerp. Each bus makes a limited number of stops within a few municipalities before taking the fastest route to the HUB.

The HUB is a central transfer point located on the right bank north of Tijsmanstunnel West, approximately 3.5 km from the Project One site. There, employees can transfer to shuttle buses to their respective workplaces. Arrival and departure times are arranged in advance. Employees who wish to use the system must register in advance. Each participating company has a representative responsible for organising everything and supporting employees where necessary. Only employees of participating companies can use this system. In 2024, the I-bus is already being used by employees of various companies, including those along Scheldelaan (such as Bayer, Invoyn, IMB, etc.).

Figure 10-6: I-bus routes (http://www.i-bus.be/show_text/show-network, 2024)

10.2.1.3.2 Bicycle bus

The Bicycle Bus is an initiative of the Port Authority that offers free transport to port workers and recreational cyclists. This bus travels through the Tijsman Tunnel and Liefkenshoek Tunnel, making it much easier to cross the Scheldt and the Canal Dock by bicycle. It has four stops:

- Waaslandhaven-Noord (Oudedijk)
- Tolplein
- Scheldelaan (about 3.6 km from the Project One site)
- Noorderlaan

The Bike Bus runs daily, four times per hour during peak hours and once per hour during off-peak hours. An additional advantage over the I-bus is that passengers can take their bicycles on board.

Figure 10-7: Bicycle bus stops (Google Maps, 2024)

10.2.1.3.3 Waterbus

The Waterbus is an initiative of the Port Authority. For a fee, passengers can travel along the Scheldt and get on or off at various locations. As this form of transport is recognised as public transport, employers can contribute to part of the cost of employees' season tickets for commuting. Passengers can take their bicycles on the Waterbus.

The closest stop for Project One employees is Lillo, about 2.8 km from the site, north of Complex Lillo. Between 5 a.m. and 11 p.m., a Waterbus departs every half hour for Antwerp. It takes 60 minutes to reach Steenplein in the centre of Antwerp.

Figure 10-8: Waterbus stops (https://www.dewaterbus.be/nl/schelde, 2024)

10.2.1.4 Motorised transport network – qualitative assessment

The Project One site is accessed via the 2x2 N101-Scheldelaan. To the south of the site, this connects to the Tijsman Tunnel (R2) via the 12-Lillo slip road complex in an easterly direction, and then to the A12, the E19 and the Antwerp ring road (R1). The same complex connects westwards to the Liefkenshoek Tunnel (R2), the E34 and the E17. North of the site, the N101-Scheldelaan connects to the A12 via the 11-Zandvliet slip road complex.

Scheldelaan runs through Antwerp's port area and has no intersections with residential areas or schools. The figure below shows Project One's location in relation to the surrounding motorways and Scheldelaan.

Figure 10-9: Location of Project One, macro level

In the 2019-2024 Coalition Agreement, the Flemish Government decided to renew the road categorisation. In 2022, a proposal for provisional adoption was submitted to the Flemish Government.

The following roads are selected as main roads:

- R1: European Main Road
- R2: European Main Road
- E17: European Main Road
- E19: European Main Road
- E34: European Main Road
- A12: European Main Road
- Tijsman Tunnel: European Main Road
- Liefkenshoek Tunnel (toll road): European Main Road

The Antwerp Transport Region decides on the lower levels of road categorisation. Relevant to the present case is the selection of the N101-Scheldelaan as a regional road.

Figure 10-10: Selection of road categorisation (source: https://assets.vlaanderen.be/image/upload/v1697461566/6_231011_VRA_Wegencategorisering_v6_003_k172g3.pdf, 2024)

10.2.1.4.1 Accessibility on a macro scale

There are two crucial traffic complexes in the vicinity of Project One:

- Junction 12 – Lillo on the R2 with connection to the N101-Scheldelaan via:
  - Priority-controlled T-junction (1): This junction does not connect directly to the R2, but provides access to the I-bus hub, several business parks and the Lillo ferry.
  - Traffic light-controlled T-junction (2).
  - Traffic light-controlled T-junction (3).

Figure 10-11: Junction 12 – Lillo (Google Earth, 2024)

- Entrance and exit complex 11 – Zandvliet on the A12; junction complex (junctions 4-7) on the N101-Scheldelaan.

Figure 10-12: Junction 11 – Zandvliet (Google Earth, 2024)

It is assumed that traffic from the southern and eastern parts of the country will mainly use junction 12-Lillo. This traffic will arrive via junction (2) and depart via junction (3). Traffic from Antwerp itself will either travel via Scheldelaan or via junction 12.
This complex will also be used by traffic from East and West Flanders and Waaslandhaven. This traffic will arrive via junction (3) and depart via junction (2).

Traffic from the north of the country and from the Netherlands can use complex 11-Zandvliet. This traffic then leaves the A12 via exit (4) and rejoins it via slip road (7). Complex 12 can also be used by following the A12 further south. This route is mainly of interest to traffic from Berendrecht, Zandvliet and the Netherlands.
Traffic from the southern and eastern parts of the country can also use complex 11 by following the A12 further north and exiting at junction (6). The exit is via slip road (5).

A more detailed estimate of the distribution of traffic will be provided in later chapters.

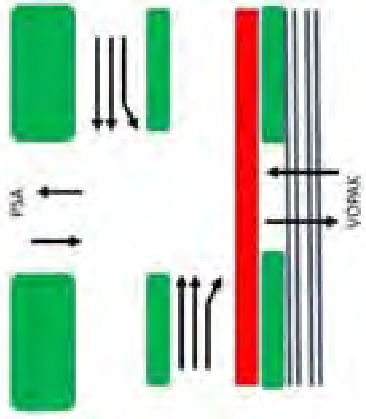
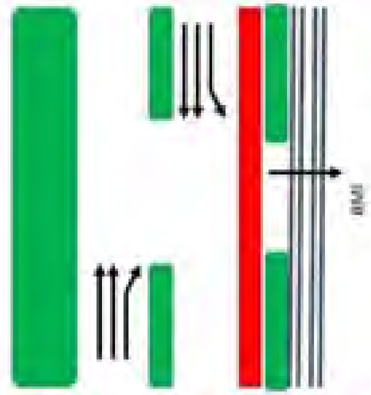
10.2.1.4.2 Accessibility at meso-micro scale

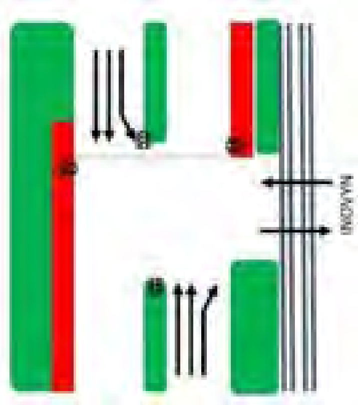
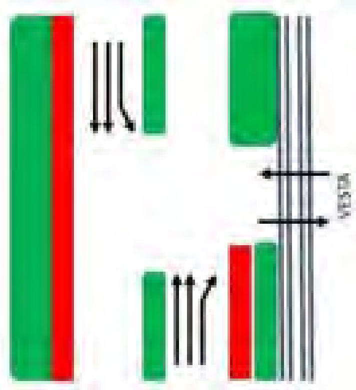
The new Project One site will be accessed via the existing entrance to Vesta. This entrance is not controlled by traffic lights. Traffic coming from the north has two through lanes and one left-turn lane at the intersection. Traffic coming from the south has two through lanes and one lane for right-turning traffic. The next chapter discusses traffic intensities on Scheldelaan.

10.2.1.4.3 Scheldelaan intersections

The Scheldelaan zone, with the Vopak site to the north (this access will be used intensively by construction traffic during the construction of Project One) and the Tijsmans complex to the south, is being considered. Between these two zones are several intersections that provide access to the companies. The intersections with the entrances to Inovyn, ASA and connections to the R2 (see locations on Figure) are traffic light-controlled intersections. The other intersections are not traffic light-controlled. In general, Scheldelaan consists of 2x2 lanes. At two locations, the carriageway is reduced to 2x1 lanes by means of road markings. At these locations, crossings for cyclists are provided (see locations 2 and 4 on Figure).

The intersections are discussed individually in the overview below.

Points of attention	Layout	Situational photo
Access Vopak/PSA • **Traffic light: absent.** • **Incoming and outgoing traffic crosses cycle path – unprotected.** • **Incoming and outgoing traffic crosses railway - unprotected, but with warning lights.** • **Exit lanes are short (+/-50m).** • **Visibility is good.**		
Access IMB • **Traffic lights: absent.** • **Only entrance to site.** • **Entering traffic crosses cycle path - unprotected.** • **Incoming traffic crosses railway - unprotected.** • **Exit lanes are short (+/-50m).** • **Visibility is good.**		

Points of attention	Layout	Situational photo
Access to Inovyn (and exit to IMB) • Traffic lights: present. • Cyclists cross safely with on-demand traffic lights. Waiting times are limited. • Traffic entering and leaving crosses the railway line without safety • Exit lanes are short (+/-50m). • Visibility is good.		
Access to Vesta • Traffic light: absent. • Cyclists travelling to Vesta can cross Scheldelaan at the crossing between Vesta and Bayer (unprotected, 2x1 carriageway). • Traffic entering and exiting crosses the railway - unprotected. • Visibility is good.		

ARCADIS

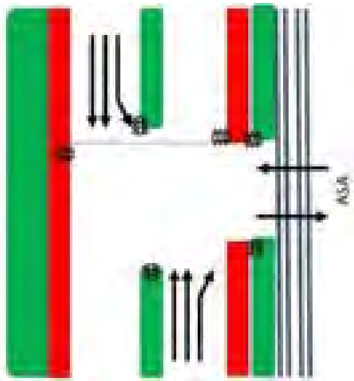
Points of attention	Layout	Situational photo

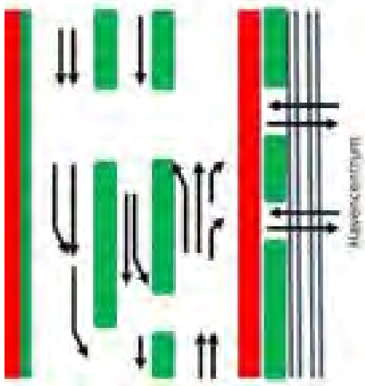
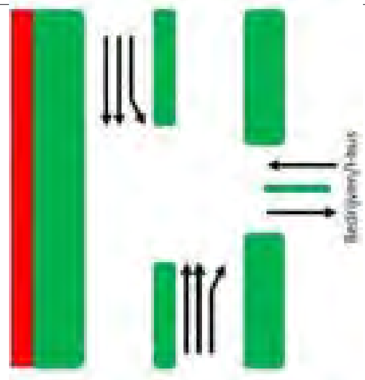
Access to Bayer

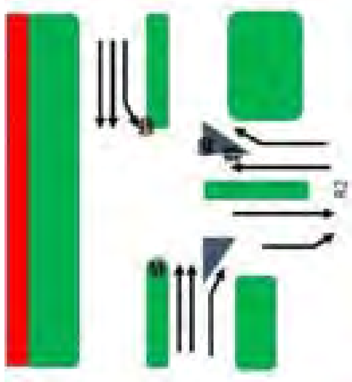
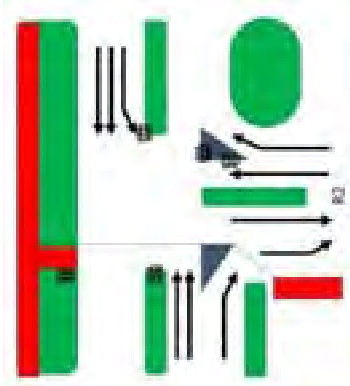
- Traffic lights: absent.
- Cyclists travelling to Bayer can cross Scheldelaan between Vesta and Bayer (unprotected, 2x1 carriageway) and at Bayer (traffic lights).
- The cycle path across the access road is not marked.
- Traffic entering and exiting crosses the railway line - unprotected.
- Visibility is good.

Access ASA

- Traffic lights: present.
- Cyclists cross safely with traffic lights on demand. Waiting times are limited.
- Incoming and outgoing traffic crosses railway - unprotected.
- <u>Visibility is not optimal.</u>



Points of attention	Layout	Situational photo
Access Port Centre • **Traffic lights: absent.** • **Cyclists travelling to Havencentrum can cross Scheldelaan between ASA and I-hub (unprotected, 2x1 carriageway) and at Bayer (traffic lights).** • **Traffic entering and exiting crosses the railway line - unprotected.** • **<u>Visibility is not optimal.</u>**		
Access to I-hub • **Traffic lights: absent.** • **Cyclists travelling to these companies take the more southerly cycle path towards Lilloveer/Lillobrug. This allows them to reach the companies separately from motorised traffic.** • **No cycle path on the east side of Scheldelaan.** • **<u>Visibility is not optimal.</u>**		

Points of attention	Layout	Situational photo
R2 – West • **Traffic lights: present.** • **No cycle path on the east side of Scheldelaan.** • **Visibility is good.**		
R2 – East • **Traffic lights: present.** • **No cycle path on the east side of Scheldelaan.** • **Cyclists cross Scheldelaan safely using traffic lights on demand. Waiting times are limited.** • **Visibility is good.** • **This is where the cycle path departs towards Lillobrug, Lilloveer and the Scheldelaan bicycle bus stop.**		

10.2.1.5 Motorised transport network – quantitative assessment

The following sections analyse the current traffic load on the road network and intersections. This analysis is based on the roads and segments mentioned in the previous chapter (Scheldelaan, complexes 11 and 12, parts of the R2 and parts of the A12). The map below provides an overview.

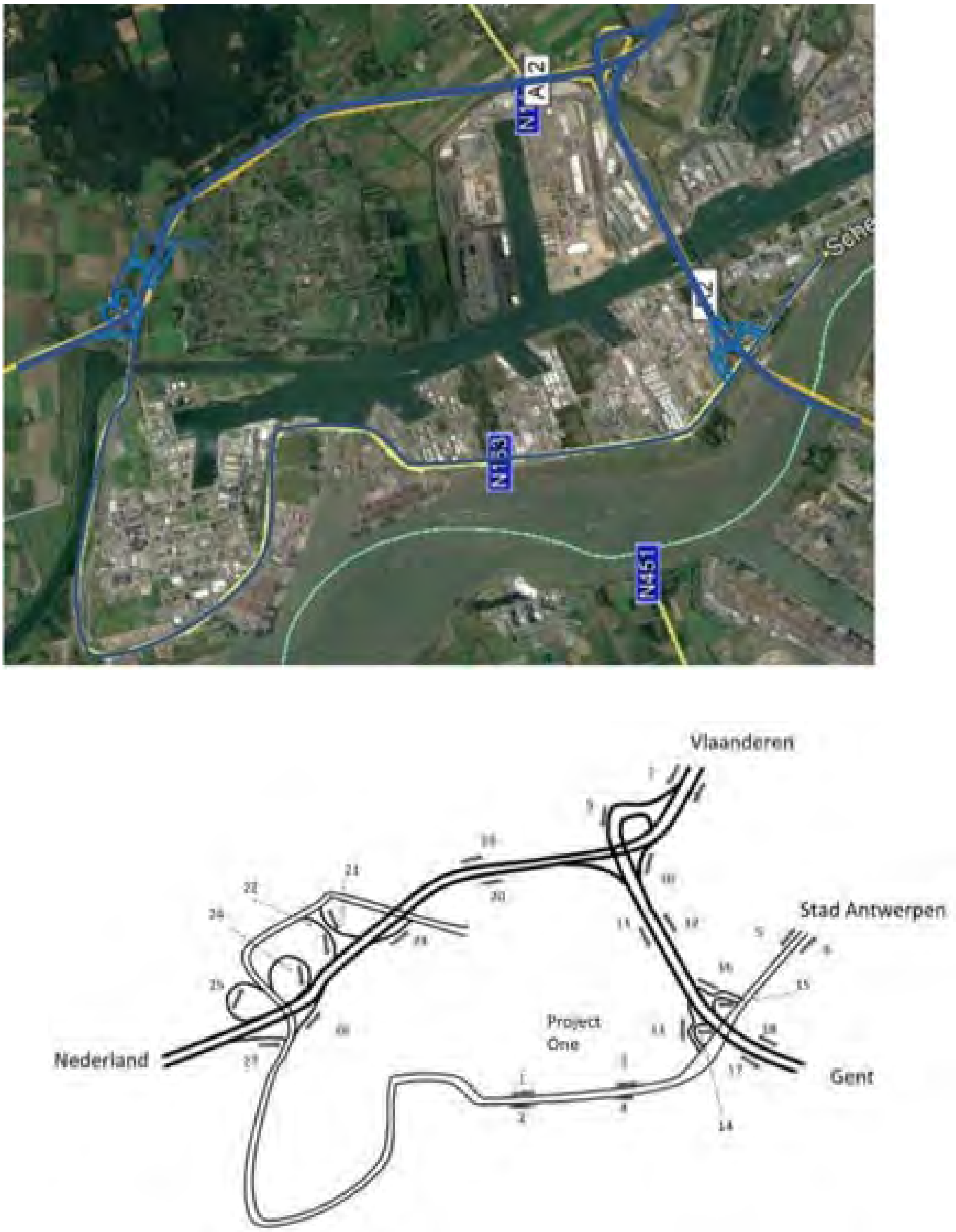


Figure 10-13: Overview of segments of the road network studied (the numbers correspond to the numbers in the table below)

Figure 10-14: Overview of segments studied on Scheldelaan (the numbers correspond to the numbers in the table below)

Table 10-2: Names of segments studied

Segment name	Number
Scheldelaan north towards Bergen-op-Zoom (NL)	1
Scheldelaan north towards IMB	2
Scheldelaan centre towards IMB	3
Scheldelaan middle towards complex 12	4
Scheldelaan south towards complex 12	5
Scheldelaan south towards Antwerp	6
From Poldervliet to Antwerpse-Haven towards Bergen-op-Zoom (NL)	7
From Antwerp Harbour to Poldervliet towards Antwerp	8
connection from the A12 from Antwerp to the R2	9
connection from the R2 to the A12 towards Antwerp	10
from Kanaaldok B1-B2 to Lillo towards Beveren (Tijsman Tunnel)	11
from Lillo to Canal Dock B1-B2 towards Antwerp-Port (Tijsman Tunnel)	12
Lillo exit towards Beveren	13
Lillo entrance towards Beveren	14
Lillo exit towards Antwerp-Port	15
Lillo slip road towards Antwerp-Port	16
from Lillo to Waaslandhaven-Noord towards Beveren (Liefkenshoek Tunnel)	17
From Waaslandhaven-Noord to Lillo towards Antwerp-Port (Liefkenshoek Tunnel)	18
From Antwerp-Port to Stabroek towards Bergen-op-Zoom (NL)	19
from the Stabroek exit to Antwerp Port towards Antwerp	20
Zandvliet exit to Ossendrecht towards Bergen-op-Zoom (NL)	21
Zandvliet entrance from Ossendrecht towards Bergen-op-Zoom (NL)	22
Zandvliet exit to Ossendrecht towards Antwerp	23
Zandvliet slip road from the harbour towards Bergen-op-Zoom (NL)	24

Segment name	Number
Zandvliet exit to port towards Bergen-op-Zoom (NL)	25
Zandvliet slipway from port towards Antwerp	26
Zandvliet exit to port towards Antwerp	27
Vopak In	28
Vopak Out	29
IMB In	30
IMB Out	31
Inovyn In	32
Inovyn Out	33
Vesta In	34
Vesta Out	35
North to Vopak	36
Vopak to IMB	37
IMB to Inovyn	38
Inovyn to Vesta	39
Vesta to I-hub	40
I-hub to R2 towards Beveren	41
R2 towards Beveren to R2 towards Antwerp	42
R2 towards Antwerp southbound	43
South towards R2 towards Antwerp	44
R2 towards Antwerp to R2 towards Beveren	45
R2 towards Beveren to I-hub	46
I-hub to Vesta	47
Vesta to Inovyn	48
Inovyn to IMB	49
IMB to Vopak	50
Vopak to the north	51

The data used has been obtained from various sources:

- Results from the Antwerp Provincial Traffic Model (2017 and 2030) (for more information, see Appendix 4.1);
- Results from traffic counters on Scheldelaan provided by AWV (Agency for Roads and Traffic);
- Data from the IMB /Inovyn/Vesta/Vopak sites;
- Traffic indicators for Flemish main roads (http://indicatoren.verkeerscentrum.be/, March 2024).

Due to work on utility lines on Scheldelaan, it was not practical to carry out counts at the relevant intersections (Vopak, IMB, Inovyn, Vesta, VRI complex 12) or on the various road sections. Therefore, figures from the traffic model (2017 and 2030, for more information see Appendix 4.1) and data on the number of vehicles visiting the various sites in the existing situation (2024) are used.

10.2.1.5.1 Traffic intensities and flow – road segments – current situation

10.2.1.5.1.1 Traffic model

As indicated above, figures from the traffic model (reference years 2017 and 2030; for more information, see Appendix 4.1) and data on the number of vehicles visiting the various sites in the current situation (2024) are used.

Since the previous permit application, a new version of the regional traffic models (RTMs) has been released, which includes a number of changes to the network. After analysing the previously used version (version 4.2.1) and the new version (4.2.2), we have decided that it makes sense to continue working with the figures from the previously used model (4.2.1). The changes in the traffic model (4.2.2) result in a decrease in traffic in the Tijsman tunnel and at the associated 12-Lillo complex and an increase in traffic at the 11-Zandvliet complex. Since most of the traffic during the construction phase of Project One will pass complex 12-Lillo, it is safer to continue using the older figures as a worst-case scenario.

The use of the Strategic Traffic Model provides insight into traffic intensities on the road network for the years 2017 and 2030.

The traffic model initially uses input data for the base year 2017 to construct and calibrate the 2017 Base Scenario. This scenario represents the current situation and serves as a point of comparison for the derived (future) scenarios.

Based on this, a reference scenario for 2030 is then derived. This takes into account interim spatial developments (e.g. development of new residential areas or business parks) and socio-economic developments (e.g. autonomous growth, port development, etc.) as well as changes in infrastructure provision (e.g. road projects, but also public transport timetables). The most relevant infrastructure interventions for the Antwerp region are shown in the figure below. These include the following projects:

- Radical Port Route: includes optimisation of the A12-R2 as an east-west thoroughfare, 2nd Tijsman Tunnel;
- Modifications to complex 12 Tijsman Tunnel;
- Work on the R1: includes the Oosterweel link, among other things.

For more information about the use of these figures and the differences between 2017 and 2030, please refer to Appendix 4.1.

Figure 10-15: Overview of infrastructure projects included in Reference Scenario 2030 (source: Strategic traffic models v4.2.1 – input future scenario 2030 (version June 2021)

The intensities used are those of the (extended) rush hours (5 a.m. to 8 a.m. and 3 p.m. to 6 p.m.). These hours correspond to the expected arrival and departure times for the majority of Project One employees (both during the construction and operational phases). In addition to total PAE (Passenger Car Equivalents) intensities, the model provides insight into the proportion of passenger cars and lorries. For lorries, the model uses a conversion of 1 lorry = 2.5 PAE. This conversion will therefore be used for lorries in the following analyses.

For the existing situation and construction phase, figures from the reference year 2017 are used. For the operational phase, figures from the reference year 2030 are used. Appendix 4.2 contains the relevant figures for the various segments studied for 2017, while Appendix 4.3 contains those for 2030. These figures show intensities in PAE for the relevant rush hours, as well as the proportion of lorries (%), with 1 lorry equalling 2.5 PAE. The table also provides immediate insight into the capacity and saturation level per road section. More on this in § 10.2.1.5.1.4.

10.2.1.5.1.2 Traffic indicators

In addition to figures from the Traffic Model, figures from the Flemish Traffic Indicators are also used.

> *"Traffic indicators are statistics that describe traffic in quantitative terms. These figures can be used to compare traffic situations (e.g. the Brussels region versus the Antwerp region) and to chart developments over time."* (Source: http://indicatoren.verkeerscentrum.be/vc.indicators.web.gui/frontpage/index?page=%2Ffrontpage%2Findex.html)

A comparison was made between the traffic indicators for 2019 (used in the previous EIA, as the measures taken to reduce Covid-19 had no impact on them) and those for 2023.
This shows that by 2023, the number of vehicles will be back to pre-coronavirus pandemic levels. Some road sections will have more traffic, others less. The traffic composition (proportion of freight) will also be very similar in most places. Overall, the traffic indicators used at the time are still representative.

The average traffic volumes and traffic composition for the various slip roads are discussed below. The figures and graphs can be found in Appendices 4.4 and 4.5. Initially, daily averages for weekdays, 00:00-24:00, are examined, as statements about traffic composition can only be made for that time interval. An overview is provided for all months of the year 2019. In this traffic composition, a lorry is registered as 1 vehicle (= 1 PAE). These figures cannot therefore be compared one-to-one with those of the Traffic Model. In concrete terms, this means that the Traffic Indicators give lower intensities than the Traffic Model.

Secondly, rush hours are examined. For the morning rush hour, this is from 6 a.m. to 8 a.m. and for the evening rush hour from 4 p.m. to 6 p.m.

10.2.1.5.1.2.1 Daily averages

Complex 12: R2-Lillo (Appendix 4.4)

The Lillo complex has two entrances and exits. These are numbered in the attached figure, in accordance with the graphs in Appendix 4.4.

A first observation is that the link with Antwerp is particularly strong at this complex. On average, there are around 4,000 to 5,000 vehicles on the slip road to Antwerp (3) and on the slip road from Antwerp (2). The link with Beveren/Ghent (1 and 4) is considerably smaller, with around 2,500 to 3,000 vehicles per day.

On the other hand, it can be noted that the share of freight traffic to Antwerp is smaller (18-21%) than to Beveren (23-25%). In absolute numbers, there are still more lorries travelling to and from Antwerp than to Beveren, but the share of non-lorries to and from Antwerp is much greater than to Beveren.

Complex 11: A12-Zandvliet (Appendix 4.5)

The Zandvliet complex actually consists of two complexes. On the one hand, there is a northern junction, which connects directly to Scheldelaan, with an entrance and exit in each direction (1, 2, 3, 4). On the other hand, there is a southern junction, which connects to Noorderlaan (5, 6, 7). The latter complex has two exits and one entrance for traffic heading towards Bergen-op-Zoom. Traffic heading towards Antwerp cannot enter the A12 at this complex.
It is likely that the slip road towards Antwerp at the northern complex will therefore be subject to heavier traffic. Similar observations can be made as for the Lillo complex. Once again, the link with Antwerp is particularly strong in this complex, with an average of around 2,000 to 5,000 vehicles on the slip road to Antwerp (3) and both slip roads (2, 6) coming from Antwerp. The connection with Bergen-op-Zoom/the Netherlands is considerably smaller, with around 200 to 600 vehicles on each of the four slip roads in that direction (1, 4, 5, 7).

In terms of traffic composition, we see a significant difference between the northern and southern complexes. In the latter, freight accounts for between 8% and 14% of traffic. In the northern complex, this figure is closer to 25% to 48%.

The relationship with driving directions is less pronounced. We will only look at the northern complex for this. The share of freight traffic to and from Bergen-op-Zoom/the Netherlands varies between 25 and 31% there. The exit for traffic coming from Antwerp (2) handles around 49% of freight traffic. Meanwhile, the entrance to Antwerp (3) handles only around 32% of freight traffic. It is possible that freight traffic heading for Antwerp tends to use a different route, for example complex 12-Lillo.

Finally, it can be concluded that the Lillo complex (+/- 7,000 vehicles) is used by significantly more vehicles than both Zandvliet complexes combined (+/- 3,500 vehicles).

10.2.1.5.1.2.2 Hourly averages

Based on the graphs in Appendix 4.4 and Appendix 4.5, it can be established that the highest traffic volumes were almost always recorded in the month of October. These figures can be used to extrapolate the figures from the traffic model to 24-hour intensities. These intensities are important for the Air and Noise disciplines. The calculation method and figures used can be found in Appendix 4.6.

10.2.1.5.1.3 Snake counts

Due to utility works carried out by Elia on Scheldelaan, which reduced the capacity to 2x1 instead of 2x2, it did not make sense to carry out traffic counts on Scheldelaan. Therefore, the previously used counts from 2017 (AWV) will be used. Counts in the meantime were also not appropriate due to the measures taken to combat the coronavirus pandemic. Therefore, already available counts are being used, supplemented with data from the Strategic Traffic Model (for more information, see Appendix 4.1).

Hose counts have been carried out on Scheldelaan in the past. These took place from 13/02/2017 to 23/02/2017. The counting lanes were located between the entrances to the former Gunvor (now Vopak) and IMB sites, at kilometre marker 11.8. The counts show that during the morning rush hour, traffic mainly travels in a northerly direction, presumably largely originating from complex 12: R2-Lillo. During the evening rush hour, the situation is reversed, with the main traffic flow heading towards complex 12. It is also noticeable that there are significant traffic flows in both directions around midday. These can probably be explained by shift changes in companies. An important point to note is that the counting tubes do not provide any insight into the proportion of passenger cars and lorries.

In the further course of the study, the figures from the traffic model will therefore be used, as they provide results for the various segments of Scheldelaan and also provide insight into the traffic composition (such as the number of lorries). The results of the counting tubes are used for the extrapolation to 24-hour intensities for Scheldelaan. The Traffic Indicators do not provide figures for this.

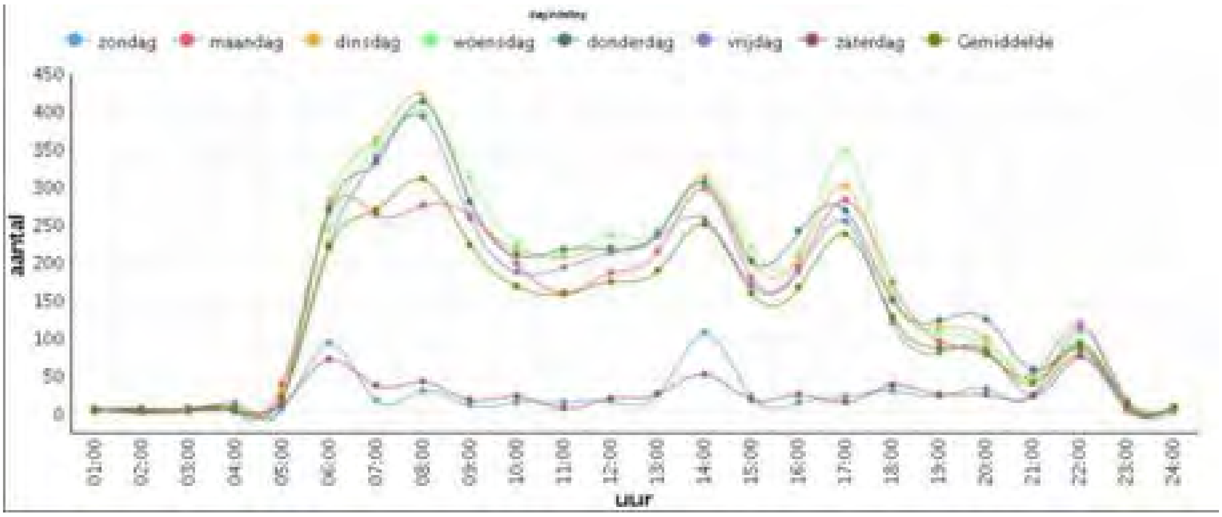


Figure 10-16: Traffic on Scheldelaan heading north

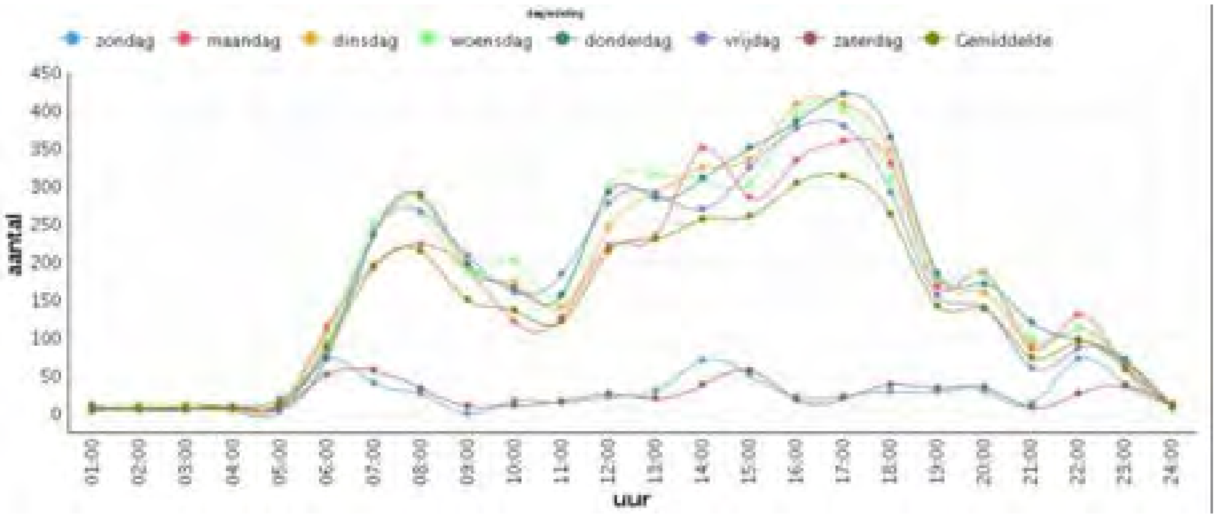


Figure 10-17: Traffic on Scheldelaan heading south

10.2.1.5.1.4 Assessment of traffic flow on road sections

The Traffic Model (4.2.1) is also used to assess the capacity of road sections. This model provides an indication of the capacity per segment, taking into account factors such as the number of lanes, road conditions, bends and buildings. This allows for a better analysis than when working with a theoretical capacity per road section. Appendices 4.2 (2017) and 4.3 (2030) show the capacity used and the saturation in the existing situation for each segment.

This data shows that virtually all segments still have more than sufficient capacity in the current situation, both for 2017 and 2030. The most critical segment is segment 19, north of the junction between the R2 and A12 motorways. Saturation levels of around 95% and above are recorded for this segment. In 2030, saturation of 106% is even expected between 5 p.m. and 6 p.m.

Furthermore, the 2030 model already assumes an additional lane and thus an increase in capacity on some segments:

- Segment 7: A12 south of the junction with R2, northbound;
- Segment 8: A12 south of the junction with R2, southbound;
- Segment 11: Tijsman Tunnel westbound;
- Segment 12: Tijsman Tunnel eastbound.

There is also another important point to note. Between the Vesta and Bayer entrances and between the Havencentrum and I-hub entrances, the number of lanes on Scheldelaan has recently been reduced in both directions. Locally, traffic there has to use 2x1 lanes. This narrowing of the road makes it safer for cyclists to cross locally, as they only have to cross one lane. However, this also reduces the capacity of Scheldelaan. In the current situation, this is not a problem. This reduction in capacity was not included in the Traffic Model. However, the capacity indicated by the Traffic Model is sufficiently high that even with a 50% reduction due to the lane reduction, there is still sufficient capacity in the current situation.

Figure 10-18: Local reduction in the number of lanes on Scheldelaan

10.2.1.5.2 Traffic intensities and flow – intersections – current situation

Traffic flow on road segments is largely determined by the capacity of intersections. The entrances to businesses on Scheldelaan, as well as the traffic light-controlled intersections near the Lillo complex, will be decisive for smooth traffic flow.

Due to utility works carried out by Elia on Scheldelaan in the spring of 2024, it was not feasible to conduct traffic counts at the relevant intersections (Vopak, IMB, Inovyn, Vesta, VRI complex 12). Therefore, figures from the traffic model (2017 and 2030, for more information see Appendix 4.1) and data on the number of vehicles visiting the various sites in the current situation (2024, obtained via Project One) are used. This allows the following estimates to be made for the intersections. Section 10.2.2 discusses the traffic intensities at the various company entrances in detail. These serve as input for the assessment below.

Intersections complex 12-Lillo

No intersection counts are available for the Lillo complex, but the Traffic Model does allow flow diagrams to be drawn up for the intersections. These are included in Appendix 4.7 (2017) and Appendix 4.8 (2030). For more information about the assessment of the intersections, please refer to § 10.2.1.5.2.2.

10.2.1.5.2.1 Intersections at the entrances to Vopak, IMB, Inovyn and Vesta – current situation

No specific traffic counts are available for the intersections on Scheldelaan with access to the Vopak, IMB, Inovyn and Vesta sites.

However, IMB did provide data on how many vehicles will reach these sites from Scheldelaan in 2024 (see § 10.2.2). In addition, the figures from the Traffic Model can also be used. This allows an estimate to be made of the intersection flow.

Assumptions are made when allocating traffic on the road network. These are based on estimates made by Project One.

For passenger cars, the following applies:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%;
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 25%;
- South (City and agglomeration of Antwerp), via Scheldelaan to Antwerp: 5%;
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

For lorries:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%;
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 30%;
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 0%;
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

Based on these assumptions and the figures for the Vopak, IMB, Inovyn and Vesta sites, flow diagrams can be obtained in Appendix 4.9 (2017) and Appendix 4.10 (2030).

10.2.1.5.2.2 Assessment of intersection clearance – current situation

Various methods are used to estimate the saturation level. An explanation of these different methods is available in Appendix 4.11. The ICU method is used for traffic light-controlled intersections.

For priority-controlled intersections, it is determined whether traffic lights are desirable from a capacity perspective. For this purpose, reference is made to service order A266 of 1 October 1991 (AWV) or to the Vademecum Veilige Wegen en Kruispunten (AWV) (Handbook for Safe Roads and Intersections). If traffic lights are not desirable, the Harders method is used for priority-controlled intersections.

10.2.1.5.2.2.1 Intersection complex 12-Lillo

The ICU method is used to assess these light-controlled intersections. Cells with a red background indicate saturation, while cells with an orange background indicate that saturation is approaching.

In the current situation, this results in the following clearance levels. These figures clearly show that the north-western junction has a higher saturation level than the south-eastern junction. However, both intersections generally flow smoothly in the current situation (2017). This smooth flow is partly due to the bypasses for right-turning traffic (from the R2 towards Scheldelaan-Noord and from Scheldelaan-Zuid towards the R2). Between 5 p.m. and 6 p.m., traffic flow at the eastern intersection is not smooth and a saturation level of 100% is reached. This is due to the large flow of left-turning traffic from the north towards Antwerp.

In 2030, we see a slight increase in the number of vehicles at both intersections and therefore also in the saturation level. For the north-western intersection, this even means that the 82% limit will be reached at certain times. A slight decrease in the saturation level can be observed for R2 – East at 5 p.m.

According to the traffic model, a slight decrease in left-turning vehicles can be expected during this rush hour. Although the 2030 model does include an extra lane in the Tijsman Tunnel, no changes will be made to the intersections with Scheldelaan.

In 2024, it is still too early to make any statements about the impact of modified intersections. In the Tijsman Tunnel project, various scenarios are still on the table.

Table 10-3: Assessment of intersections R2 – current situation (2017 and 2030)

	R2 – West				**R2 – East**			
	LoS (2017)	I/C (2017)	LoS (2030)	I/C (2030)	LoS (2017)	I/C (2017)	LoS (2030)	I/C (2030)
5-6	A	54	D	77	A	51	A	47
6am-7am	B	62	E	84	B	59	B	59
7am-8am	D	78	E	83	A	54	B	60
3pm-4pm	D	80	E	83%	E	83	D	79
4pm-5pm	D	81	D	80	E	82%	E	87
5pm-6pm	C	68	B	58	G	100%	F	98%

LoS = Level of Service, I/C = Intensity over Capacity ratio; A(<55%) to D(<82%) indicates acceptable saturation levels, E(82%-91%) to F(91%-100%) indicates critical saturation levels, and G(100%-109%) to H(>109%) indicates oversaturation.

10.2.1.5.2.2.2 Intersections at Vopak, IMB and Vesta entrances

Given that these junctions currently operate according to a traditional right-of-way system, whereby traffic on Scheldelaan has right of way, the first step is to assess whether traffic lights are desirable from a traffic management perspective (in accordance with service order 266, explanation in Appendix 4.11). The assessment below applies to both 2017 and 2030.

Table 10-4: Assessment of intersections at Vopak, IMB and Vesta entrances – current situation (2017 and 2030)

	Scheldelaan x Vopak	Scheldelaan x IMB	Scheldelaan x Vesta
5 a.m.-6 a.m.	No traffic light required	No traffic lights required	No traffic lights required
6 a.m.-7 a.m.	No traffic lights required	No traffic lights required	No traffic lights required
7am-8am	No traffic light required	No traffic lights required	No traffic lights required
3pm-4pm	No traffic light required	No traffic lights required	No traffic light required
4pm-5pm	**Traffic lights are desirable**	No traffic lights required	No traffic lights required
5pm-6pm	**Traffic lights are desirable**	No traffic lights required	No traffic lights required

When the Vopak intersection is assessed using Harders' method, it appears that waiting times are indeed high and even becoming unacceptable. Harders determines the gap time required to allow Vopak traffic to clear and compares this with the available gap time on Scheldelaan. Due to the high speed on Scheldelaan, the 2x2 through lanes and the high traffic volumes on Scheldelaan, the available gap time is limited. This means that traffic from Vopak has to wait a long time (>20 seconds) to leave the site. No problems are expected on Scheldelaan itself.

10.2.1.5.2.2.3 Inovyn entrance junction

The intersection at Inovyn is controlled by traffic lights and is therefore assessed using the ICU method. We would like to remind you that the entrance to IMB is an entrance only and that traffic from IMB leaves via the exit from Inovyn. Here too, a slight increase is recorded between 2017 and 2030, but traffic continues to flow very smoothly.

Table 10-5: Assessment of the Inovyn entrance intersection – current situation (2017 and 2030)

	Scheldelaan intersection x Inovyn entrance			
	LoS (2017)	I/C (2017)	LoS (2030)	I/C (2030)
5 a.m.-6 a.m.	A	32	A	33
6am-7am	A	38	A	43
7am-8am	A	47	A	45
3pm-4pm	A	47	A	49
4pm-5pm	A	49	A	54
5pm-6pm	A	46	A	48%

LoS = Level of Service, I/C = Intensity over Capacity ratio; A(<55%) to D(<82%) indicates acceptable saturation levels, E(82%-91%) to F(91%-100%) indicates critical saturation levels, and G(100%-109%) to H(>109%) indicates oversaturation.

10.2.1.6 Freight transport

The freight route network that was to be established at the Flemish level is not yet in force. Nor does Antwerp's mobility plan provide much information about the freight route network in the vicinity of IMB.

> *"The intention is for freight traffic to use the main road network (A12, R1, E34 and R2) and the Singel (up to 4.50 m) for as long as possible to reach the various parts of the port. (Antwerp Active and Accessible, Mobility Plan 2020-2025-2030, p.13)"*

The 2030 route plan, drawn up by the Antwerp Transport Region, sets out the following ambition:

> *Rat-running caused by traffic jams on the main road network is a persistent problem today. In order to control the pressure of freight transport on the environment, the routing of freight traffic on the secondary road network must be more clearly controlled. We want to get freight transport onto the main road network as quickly as possible (via the comb structure). This should improve the quality of life and safety in urban centres, but can also be an opportunity to increase the efficiency of freight transport. (Route Plan 2030, Draft version 2020)*

The Antwerp Transport Region also established a freight route network. In this network, Scheldelaan is selected as a regional freight route. The R2 is a main freight route.

Figure 10-19: Proposal for a freight route network for the Antwerp Transport Region (Freight Transport Memorandum, 28/09/2022)

All roads in the port are used by exceptional transport (UV), both the roads managed by the port and the regional roads N101-Scheldelaan and N180-Noorderlaan, as well as the motorways R2 (over its entire length, including the tunnels) and A12 (between the Zandvliet border and the junction with the R2). The A12 further towards Antwerp is also used by UV, but for 'less heavy' transport (only exceptional in length and/or width).

The restrictions in the tunnels, but also on other roads, are infrastructure restrictions (tunnel gauge, overhead structures such as porticos and wind bracing on bridges, load-bearing capacity of underbridges,
...). The following conditions apply specifically to the tunnels in the vicinity of the project area:

- Tijsman Tunnel:
  - maximum permitted height: 4.80 m

    - maximum permitted width: 7.50 m
- Liefkenshoek Tunnel:
    - maximum permitted height: 5.10 m
    - maximum permitted width: 7.50 m

It is relevant to add the regulations concerning ADR transport (=*"Accord européen relatif au transport international des marchandises Dangereuses par* Route"). There are no restrictions in this regard on the roads in the port, nor in the Liefkenshoek Tunnel, nor in the Tijsman Tunnel. However, since 1 October 2020, a restriction has been in place in the Beveren Tunnel. Since then, it has been classified as category D: *"Restriction on the transport of dangerous goods that could cause a very large explosion, a large explosion, the release of a significant amount of toxic substances or a major fire."* (Source: https://wegenenverkeer.be/wegen/wegennet/verlaging-adr-categorisering-beverentunnel).

In addition to the road network, the IMB site is also accessible via the rail network and the water network. On the east side of the site, Project One borders the Kanaaldok, along which a connection to the Scheldt can be made.

To the west, two railway tracks run alongside the IMB site. The maximum permitted speed is 40 km/h. These are used by Inovyn for the delivery of certain goods and, more sporadically, by IMB.

The following information regarding the use of the tracks has been provided by the Port of Antwerp Authority:

> *On average, there are 10 to 12 trains per working day in the zone (6 arrivals and 6 departures). These trains currently arrive from the north, via the locks, to stop at the Kanaaldok bundle (located south of the Europaterminal). From there, the various companies in the zone between the Berendrecht and Boudewijn locks are served. However, sometimes the wagons are transferred in parts to the various companies (trains often consist of different parts destined for or coming from different companies), which means that the actual number of train movements on the section of track in front of the IMB will be higher in practice. Exact data is not available here, as Infrabel does not record train movements on site.*

10.2.1.7 Road works

Parallel to the planned construction of Project One, numerous other infrastructure projects will continue. In particular, the major projects within the framework of the Future Alliance will have a significant impact on mobility in and around Antwerp (e.g. Oosterweel connection, 2nd Scheldt crossing, new Tijsman tunnel), but various other projects will also cause additional disruption. The effects of these works may include reduced capacity on certain road sections, but may also lead to an increase in traffic intensity on surrounding roads that serve as diversion routes, whether desired or not.

The nature and scope of the upcoming works will likely result in a highly dynamic sequence of construction sites starting up and winding down. The exact timing, sequence, and possible interaction and overlap between certain works cannot be estimated at this time and will require continuous planning and coordination between the various initiatives.

It is crucial to avoid interference between different projects. The most direct way to do this is to avoid conflicts where work is carried out on roads that already serve as diversion routes for other works. However, indirect conflicts must also be monitored when different construction sites cause an increase in traffic on the same alternative route. This can happen when a road is explicitly used as a diversion route (and, for example, communicated or signposted as such), but also in the form of (undesirable) detour (rat-running) traffic.

Since the traffic impact of the construction of Project One mainly affects Scheldelaan, the R2 and the A12, work on these roads is a particular focus of attention. In addition, work that causes an increase in traffic on these roads will also have an impact on access to the Project One site. One example is the construction of the Oosterweel junction, which will affect the accessibility of the southern port, potentially leading to more traffic using the Scheldelaan junction on the R2.

Capacity restrictions on the R1 (Oosterweel junction, Merksem viaduct area) or on the E19 (construction of the A102) may also lead to increased use of the R2-Liefkenshoek Tunnel and the A12 respectively.

Lantis was contacted to discuss the issue of road works in more detail. The planned works for Project One partly coincide with a number of planned road works in the wider area (such as the Oosterweel link). The following points for attention will be included:

- Traffic problems are to be expected in the vicinity of the works on the Antwerp ring road, which are scheduled to start in 2022 and will take approximately eight years to complete. Long-distance traffic between Linkeroever and the Netherlands will be diverted via the Liefkeshoek Tunnel (current route via the Kennedy Tunnel) to relieve pressure on the Antwerp ring road. This will result in more traffic using the Liefkenshoek Tunnel. In addition, the capacity of the Antwerp ring road will be significantly reduced during the works (expected loss of capacity of 1,500 PAE/hour per direction). These works and disruptions will last until 2030. The 2030 traffic model already takes into account an additional lane in both directions.
- Construction of the Scheldt Tunnel began in 2021 and will continue until 2030. Measures are being taken to ensure that traffic can continue to flow in all directions on Scheldelaan, so that the port remains accessible from that side. Traffic lights will be adjusted in some places to improve safety and maintain traffic flow.
- The timing for the construction of the second Tijsman tunnel is a point of attention (no details regarding timing are currently known). The 2030 Traffic Model already takes into account an additional lane in both directions.
- The Oosterweel junction works are planned for 2026-2027.

Lantis' advice is to focus as much as possible on shared transport for site traffic. The reduced disruption programme drawn up by Lantis could possibly be used for Project One. In addition, this study will map out the available capacity of the relevant main roads during the construction phase. This is done in § 10.5.3.

10.2.1.8 Other construction sites in the vicinity

10.2.1.8.1 Construction of new quay wall

The construction of the new quay wall is a project of the Antwerp Port Authority. Work started in March 2021 and, according to current plans, will continue until the end of 2024. In terms of mobility, the greatest impact would result from the removal of dredged material (which was mainly transported by water) and the delivery of concrete. These works do not therefore overlap with the peak period of the Project One site (which is scheduled for early 2025). This aspect is discussed further in § 10.5.1.

10.2.1.9 Parking facilities – current situation

The existing car parks will not be affected during the construction and operational phases. A new separate car park will be provided for the construction phase, accessible via the Vopak entrance. During the operational phase, a new separate car park will be provided for Project One employees. It is therefore not necessary to assess and map the existing parking situation.

10.2.2 Mobility profile: Estimated traffic generation – current situation

Figures obtained from IMB, Inovyn, Vesta and Vopak are used to estimate current traffic generation. These figures were also used to draw up the flow diagrams (§ 10.2.1.5.2.1) and to assess the handling of intersections with entrances (§ 10.2.1.5.2.2.2 and § 10.2.1.5.2.2.3).

10.2.2.1 Number of employees at IMB, Inovyn, Vesta and Vopak sites – current situation

The tables below provide an overview of the number of employees at the various sites in the current situation. Although the sites of Vopak, Vesta, Inovyn and IMB are not part of this EIA, their mobility profile provides an insight into the current use of these entrances and exits.

During the construction phase, site traffic will also affect the intersections with entrances to Inovyn and IMB (as straight-ahead traffic). The intersections with entrances to Vopak and Vesta are effectively used by site traffic. In order to estimate the impact, it is necessary to have insight into the traffic flow in the existing situation.

Table 10-6: Overview of IMB employees – current situation

IMB – Employees	Number	Interpretation
Employees – non-shift	90	Clerical staff, etc.
Employees– shift	66	Working in 4 shifts, so ¼ are present on site at any given time, except during shift changes (6 a.m. and 6 p.m.)
Total number of own employees	**156**	
Contractors	62	Come in at different times throughout the day. Do not have fixed working hours. Some contractors carpool to the site.
Katoen Natie	15	
Visitors	15	Estimate, are not usually present on site all day.
Total external visitors	**92**	

Table 10-7: Overview of Inovyn employees – current situation

Inovyn – Employees	Number	Interpretation
Employees – not shift	41	Clerks, etc.
Employees – shift	47	Working in 4 shifts, so ¼ are always present on site, except during shift changes (6 a.m., 2 p.m. and 10 p.m.)
Lab & Maintenance	48	
Total number of own employees	**136**	
Contractors	100	Arrive throughout the day. Do not have fixed working hours. Some contractors carpool to the site.
Air Liquide	3	
Visitors	17	
Total external visitors	**120**	

Table 10-8: Overview of Vesta employees – current situation

Vesta – Employees	Number	Interpretation
Employees – non-shift	25	Clerks, etc.
Employees – shift	21	Working in 4 shifts, so ¼ are present on site at any given time, except during shift changes (6 a.m., 2 p.m. and 10 p.m.)
Total number of own employees	46	
Contractors	100	Come in spread throughout the day, do not follow fixed working hours. Some contractors carpool to the site.
Total external staff	100	

*Table 10-9: Overview of Vopak employees – current situation**

Vopak – Employees	Number	Interpretation
Employees – non-shift	90	Office staff, etc., parking spread across car parks P1 and P2.
Employees– shift	160	Working in 4 shifts, so ¼ are present on site at any given time, except during shift changes (6 a.m., 2 p.m. and 10 p.m.), parking spread across car parks P1 and P2.
Total number of own employees	250	
Contractors	31	80% via the sandy road towards contractor parking (P3), 20% spread across parking P1 and P2. Arrive spread throughout the day. Do not have fixed working hours. Some contractors already carpool to the site.
Total external staff	315	

* ***Vopak took over the Gunvor site in 2023. The exact activities and mobility generation of Vopak are not yet known. Therefore, Gunvor's data is being used for the time being.***

10.2.2.2 Modal split – current situation

To determine the *modal split* of employees, figures provided by IMB are used as a reference.

Table 10-10: Modal split – current situation

Vehicle choice	Model split
Public transport I-bus	4
Bicycle	8
Motorcycle	5
Carpool	4

Vehicle choice	Model split
Car	79

The modal split above will be applied throughout the rest of this study, including for the other sites. The table below shows the *modal split* used for cars per user.

Table 10-11: Modal split by type of user – current situation

User	Modal split car	Interpretation
Employees – non-shift	79	Applies to Vopak, IMB, Inovyn, Vesta.
Employees – shift	100	They arrive at times when use of the I-bus, bicycle bus, etc. is not feasible. This is a worst-case estimate and is assumed for employees of the four companies.
Visitors	100%	It is estimated that they will all come individually by car .
Contractors	79%	Contractors are expected to arrive by car/minibus (bringing their work equipment), but to carpool.
Katoen Natie, Air Liquide, Nippon Gases	100	

10.2.2.3 Number of lorries at IMB, Inovyn, Vesta and Vopak sites – current situation

The tables below provide an overview of the number of freight movements per day at the various sites in the current situation. For these freight movements, a PAE (passenger car equivalent) of 2.5 is used (i.e. 1 lorry is counted as 2.5 passenger cars).

Table 10-12: Overview of lorries IMB – current situation

IMB – Freight	Number of lorries/day	Interpretation
IMBlorries	100	Entering from the north. Various types of lorries (bulk, crates or containers).
NipponGasestrucks	50	Entering from the north. Mostly lorries carrying liquid gas.
Contractor and delivery	10	
Train	<1	

Table 10-13: Overview of Inovyn lorries – current situation

Inovyn – Freight	Number	Explanation
Inovyn	40	Bulk lorries carrying liquids. Usually loaded at loading bays with integrated weighing cells. Less traffic at weekends.
Air Liquide	40	Bulk trucks carrying liquids. Less traffic at weekends.
Contractor and delivery	10	
Train	<1	Approximately 20 wagons per week. However, these are handled in batches. Two individual (chlorine) and two groups of nine (corrosive).

Table 10-14: Overview of Vesta lorries – current situation

Vesta – Freight	Number	Designation
Transport of hazardous products	<1	1-2 lorries per week carrying propane.
Total freight vehicles	1	Average of 1 lorry per day
Train	None	

*Table 10-15: Overview of Vopak lorries – current situation**

Vopak – Freight	Number	Designation
Total freight vehicles	50	ARCADIS estimate based on previous permit.
Train	<1	Few trainsets.

* ***Vopak acquired the Gunvor site in 2023. The exact activities and mobility generation of Vopak are not yet known. Therefore, Gunvor's data will be used for the time being.***

10.2.2.4 Distribution of traffic throughout the day for the various users (employees and freight) – current situation

Based on the information obtained, the distribution throughout the day can be determined as shown below. This applies to the current situation, as well as to the situation during the construction phase and future operation. The same distribution pattern is expected for most users of the site. The exception to this are workers who work in shifts.

- Shift workers – IMB (2 shifts – 4 teams)
  - Arrival between 5 a.m. and 6 a.m. and between 5 p.m. and 6 p.m.
  - Departure between 6 a.m. and 7 a.m. and between 6 p.m. and 7 p.m.
- Employees shift – Inovyn, Vesta, Vopak (3 shifts – 4 teams)
  - Arrival between 5 a.m. and 6 a.m., between 1 p.m. and 2 p.m. and between 9 p.m. and 10 p.m.
  - Departure between 6 a.m. and 7 a.m., between 2 p.m. and 3 p.m. and between 10 p.m. and 11 p.m.
- Employees – non-shift (office staff, etc.)
  - Arrival between 7 a.m. and 8 a.m. and 8 a.m. and 9 a.m., 50/50 in each case (= worst case).
  - Departure between 3 p.m. and 6 p.m., divided 25/50/25 (= worst case).

- External contractors
  - Some of the contractors are present on site for the entire day, while others are only there temporarily (1 hour, 2 hours, 4 hours, etc.).
    - Visitors
  - Spread throughout the day between 9 a.m. and 6 p.m.
- Freight
  - Mainly between 6 a.m. and 6 p.m. The following percentages are assumed during peak times, for both arriving and departing lorries:
    - 6 a.m.-7 a.m.: 5%
    - 7 a.m.-8 a.m.: 10%
    - 4 p.m.-5 p.m.: 10%
      5 p.m.-6 p.m.: 5%

The tables below summarise the distribution of traffic throughout the day for the various sites. The coloured cells indicate which movements are relevant to the mobility aspect of this EIA. These are movements during the morning and evening rush hours by those target groups that have an impact on mobility during the construction phase.

Table 10-16: Distribution of traffic throughout the day, 00:00 to 12:00

	0	1 a.m.	2	3	4	5	6 hours	7 hours	8	9	10 a.m.	11 a.m.
Employees No shift, Arrival	0	0	0	0	0	0	0	50	50	0	0	0
Employees Not on shift, Departure	0	0	0	0	0	0	0	0	0	0	0	0
Shift IMB Arrival	0	0	0	0	0	25	0	0	0	0	0	0
Shift IMB, Departure	0	0	0	0	0	0	25	0	0	0	0	0
Shift others, Arrival	0	0	0	0	0	25	0	0	0	0	0	0
Shift others, Departure	0	0	0	0	0	0	25	0	0	0	0	0
Contractors, Arrival	0	0	0	0	0	0	0%	30	30	5	5	10
Contractors, Departure	0	0	0	0	0	0	0	0	0	0	5	5
Shift freight, Arrival	0	0	0	0	0	0	5	10	10	10	10	5
Shift freight, Departure	0	0	0	0	0	0	3	10	10	10	10	5
Visit, Arrival	0	0	0	0	0	0	0	0	0	5	5	10
Arrival, Departure	0	0	0	0	0	0	0	0	0	0	5	5

Table 10-17: Distribution of traffic throughout the day, 12 noon to midnight

	12 noon	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.
Employees No shift, Arrival	0	0	0	0	0	0	0	0	0	0	0	0
Employees Not on shift, Departure	0	0	0	25	50	25	0	0	0	0	0	0
Shift IMB, Arrival	0	0	0	0	0	25	0	0	0	0	0	0
ShiftIMB,Departure	0	0	0	0	0	0	25%		0	0	0	0
Shift others, Arrival	0	25	0	0	0	0	0	0	0	25	0	0
Shift others, Departure	0	0	25	0	0	0	0	0	0	0	25	0
Contractors, Arrival	10	5	5	0	0	0%	0%	0	0	0	0	0
Contractors, Departure	10	10	5	5	30	30	0	0	0	0	0	0
Shift freight, Arrival	10	5	10	10	10	5	0	0	0	0	0	0

	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.
Shift freight, Departure	10	5	10	10	10	5	2	0	0	0	0	0
Visit, Arrival	10	20	20	20	10	0	0	0	0	0	0	0
Visits, Departures	10	10	20	20	20	10	0	0	0	0	0	0

The tables below provide an overview of the number of vehicles (in PAE) arriving and departing from the sites per hour in the current situation, taking into account the number of employees, the modal split, the distribution throughout the day and the use of the various entrances and exits.

Table 10-18: Overview of traffic flows at company sites – current situation

	Vopak entrance and exit		IMB entrance and exit		Entrance and exit Inovyn		Entrance and exit Vesta	
	Future	Departing	Arriving	Departing*	Arriving	Departing	Incoming	Departing
5am-6am	40	0	17	0	12	0	5	0
6am-7am	6	44	20	0	11	47	0	5
7am-8am	172	13	108	0	99	63	50	0
3pm-4pm	13	92	43	0	26	141	0	25
4pm-5pm	13	172	42	0	24	213	0	50
5pm-6pm	6	86	37	0	11	106	0	25

*Traffic arriving via the IMB entrance departs via the Inovyn exit.

10.2.2.5 Traffic distribution across the road network for the IMB, Inovyn, Vesta and Vopak sites (employees and freight) – current situation

As explained in § 10.2.1.5.2.1, the following distribution of traffic across the network is assumed for the various sites.

For passenger cars:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%;
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 25%;
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 5%;
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

For lorries:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%;
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 30%;
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 0%;
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

This means that the 12-Lillo complex will be subject to the heaviest load. In the context of a worst-case scenario calculation, this is a good starting point, as this is already the busiest junction in the vicinity of IMB.

10.2.2.6 Parking occupancy – current situation

The existing car parks will not be affected during the construction and operational phases. A new separate car park will be provided for the construction phase, accessible via the Vopak entrance. During the operational phase, a new separate car park will be provided for Project One employees. It is therefore not necessary to assess the existing parking situation.

10.2.3 Decision on current accessibility and mobility profile

The Project One site is easily accessible to cyclists via a well-developed network of cycling infrastructure (BFF, cycle highways, etc.). There are sufficient wide cycle paths on Scheldelaan. Cyclists can cross Scheldelaan safely at the entrance to Inovyn. However, the local two-way cycle path on the eastern side of Scheldelaan does pose potential conflicts with traffic entering and leaving the company sites.

The site is not accessible by traditional public transport (De Lijn). The nearest stop is beyond walking distance. However, within the context of the Port of Antwerp, various initiatives are being taken to improve comfort for cyclists (Bicycle Bus, Water Bus). Employees can also use the I-bus and can commute to work by combining cycling with the bus or water bus.

The site is easily accessible for motorised passenger traffic. With two junction complexes connecting to the higher-level road network within a radius of 5 km, there is no need to drive through residential areas or traffic-sensitive areas. The various road segments (complexes, junctions and road sections) still have sufficient theoretical capacity to allow traffic to flow smoothly. Capacity problems may arise at entry lanes, exit lanes and weaving lanes.

Traffic from the Netherlands and the north of Antwerp can avoid the frequent structural traffic jams around Antwerp by using the A12 and complex 11-Zandvliet.

Traffic from East Flanders enjoys a similar advantage. They drive through the Liefkenshoek Tunnel, which generally allows for smooth traffic flow (but is subject to a toll), and can leave the R2 before encountering traffic jams heading towards Antwerp. Traffic from Flanders/Limburg/Antwerp drives in the opposite direction of the structural traffic jams towards Antwerp in the morning. A similar situation can be observed during the evening rush hour.

On Scheldelaan itself, there is sufficient reserve capacity to handle traffic smoothly. The intersections with the business entrances (both those with traffic lights and those with priority control) also handle traffic smoothly and still have plenty of reserve capacity. Traffic volumes are considerably higher at the intersections with the R2 slip roads. However, there is still sufficient spare capacity there for the time being. The exception to this is the eastern intersection, where a saturation level of 100% was recorded at 5 p.m.

This easy accessibility also applies to heavy traffic and exceptional transport. In addition, the site offers a number of options for water and rail transport. However, in 2024, only limited use is being made of these options.

Parallel construction sites (Oosterweel connection, complex ECA project, construction of the quay wall) are important points of attention in the further organisation of site traffic for the construction of the Project One site. The most important starting point must be to remove as many individual vehicles as possible from the road network.

10.3 Impact description and impact assessment – construction phase

This chapter focuses primarily on the periods with the highest traffic pressure during the construction phase of Project One. A number of preparatory works (excavation of topsoil, levelling, etc.) and the construction of the quay wall fall outside this peak period. The peak of the actual construction is the most burdensome from a mobility perspective, and the effects will be most pronounced here. Proposed measures do, however, relate to the entire construction phase.

The effects on mobility are described and assessed according to the following impact groups:

- Road safety (for the various modes of transport);
- Motorised traffic – road network management;
- Motorised traffic – intersection management;
- Motorised traffic – passenger car parking;
- Motorised traffic – lorry parking.

Before these aspects can be assessed, an estimate is made of the increase in traffic and any infrastructural adjustments. This estimate is made in § 10.3.2. Below is an overview of measures already taken in advance by Project One to limit the impact of the construction site.

10.3.1 Measures taken by Project One – construction phase

Project One is aware of the mobility impact that the construction phase will have. That is why a number of measures are being planned to limit this impact. An overview of these measures is provided below. Afterwards, the traffic impact that can still be expected despite these measures will be explained. The impact of this forms the subject of the mobility section of this EIA.

10.3.1.1 Reducing transport

10.3.1.1.1 Working with modules

An important measure is to carry out as much preparatory work as possible outside the actual construction site. This allows large modules to be assembled, which can then be delivered directly by ship as far as possible.

This means a significant reduction in the amount of manpower required on site and the associated transport to the site. Fragmented transport with smaller parts is thus avoided.

Modules weighing up to 9,000 tonnes will be delivered as complete units. Smaller modules and pre-assemblies will also be delivered. Project One estimates that around 40% of the total number of man-hours will be carried out off-site. The following transports are currently planned:

- 21 very large modules (>1,000 tonnes);
- 155 modules;
- 50 heavy/large components.

The modules and large equipment are delivered directly to the construction unloading quays at the shipyard site. The number of such deliveries is currently estimated at between 60 and 90 (i.e. several modules per transport).

This significantly reduces freight traffic and exceptional transport on the roads and minimises the risk of disruption to normal traffic.

10.3.1.1.2 Bulk material by ship

In addition to the use of modules, there is also a strong focus on the transport of bulk material by ship. In this way, a large part of the soil to be removed and supplied will be transported. Every effort will be made to combine transport for removal and supply. However, this depends on the type and quality of the soil and the timing. Chapter 7 Air provides an overview of the quantities and transport operations.

Based on the schedule provided, there will be little or no overlap between the various ship transports. The removal of topsoil and delivery of soil took place consecutively during the first year of construction (Q4 2022 – Q2 2023 and Q1 2024).

10.3.1.1.3 Use of transhipment sites

In addition, efforts are being made to transport materials as efficiently as possible by road. Smaller quantities are taken to external transhipment sites (marshalling yards) and stored there before being transported by lorry to the construction site. This greatly reduces the number of movements on Scheldelaan. Project One plans to establish two of these locations in less congestion-prone areas in the Antwerp region. By using two sites, they can be deployed flexibly, taking into account congestion on the routes to and from Project One and work carried out as part of the Oosterweel project. It is therefore possible that a particular transhipment site will not be used, or will be used to a lesser extent, during certain peak periods in order to avoid additional congestion on the road network.

Both transhipment sites are also accessible by rail, which means that materials can also be transported to the transhipment sites by train. However, it is not possible to organise transport by train from the transhipment sites to Project One. The railway line to Vesta is not in use, and the railway line to Inovyn is not suitable for bulk transport.

10.3.1.2 Shifting transport

Reducing the number of transports and journeys is possible to a certain extent. In any case, there will also be employees at the project site itself. That is why efforts are also being made to shift transport. Efforts will be made to shift both in terms of time and modes of transport.

10.3.1.2.1 Shift in time

<u>Working with shifts and delivery windows for freight traffic</u>

For freight traffic that does come to the site, every effort will be made to ensure that these transports take place outside rush hour:

- During peak times (morning and evening rush hour) at the site, no freight traffic will be permitted (unless a continuous supply of materials is crucial, such as concrete, for example).

- Deliveries of bulk materials are organised outside normal working hours.

Working with shifts and working windows for employees

During peak periods with a risk of congestion, the arrival and departure times of groups of employees are adjusted to smooth out the peaks. This makes the peaks broader but less intense.

10.3.1.2.2 Shift in modes of transport

Working with collective transport

During the construction phase, the transport of workers is bundled as much as possible in buses and minibuses:

- Foreign workers staying in shared accommodation are picked up by buses and minibuses;
- For workers living outside Antwerp, a number of pick-up points will be designated from which (mini)buses will depart for the site.
- For workers within the Antwerp region, coordination will be sought with the existing public transport services. If this proves insufficient, a shuttle bus will be provided between the construction site and the centre of Antwerp during peak periods.

Focus on sustainable modes of transport

Employees in the project area will be encouraged to cycle to the site. To this end, the following will be provided:

- Secure bicycle access (separate infrastructure so that cyclists do not mix with motorised traffic);
- Sheltered bicycle parking facilities;
- Showers;
- Encouragement through the launch of cycling and walking groups via social media.

Promoting carpooling
In addition, carpooling will be encouraged. Use of the car park will be limited by the provision of parking permits. These will mainly be made available to people who, due to their job, are dependent on the use of a car or for those for whom other modes of transport are not realistic, such as site managers and project managers of subcontractors. Priority will also be given to employees who carpool. By monitoring parking, Project One will ensure that there is no shift towards the use of parking spaces on public land.

10.3.1.3 Internal organisation

Finally, during the construction phase, internal transport will also be required between the contractor village and the Project One construction sites. Shuttles will be provided for this purpose.

10.3.2 Traffic generation – construction phase

This chapter builds a mobility profile of the construction sites, which can be used to estimate how much traffic is expected and how it would be distributed, both in terms of transport mode and distribution across the network. This chapter specifically discusses and assesses the 'distribution across modes' in relation to general policy objectives and/or usual achievable shares of certain modes.

Specifically, the site consists of two parts:

- A northern section, between Vopak and IMB, accessible via the Vopak entrance. It is mainly this entrance that will be heavily used, as this is where most of the parking facilities for the construction phase will be located.
- A southern section, south of Vesta, accessible via the Vesta entrance.

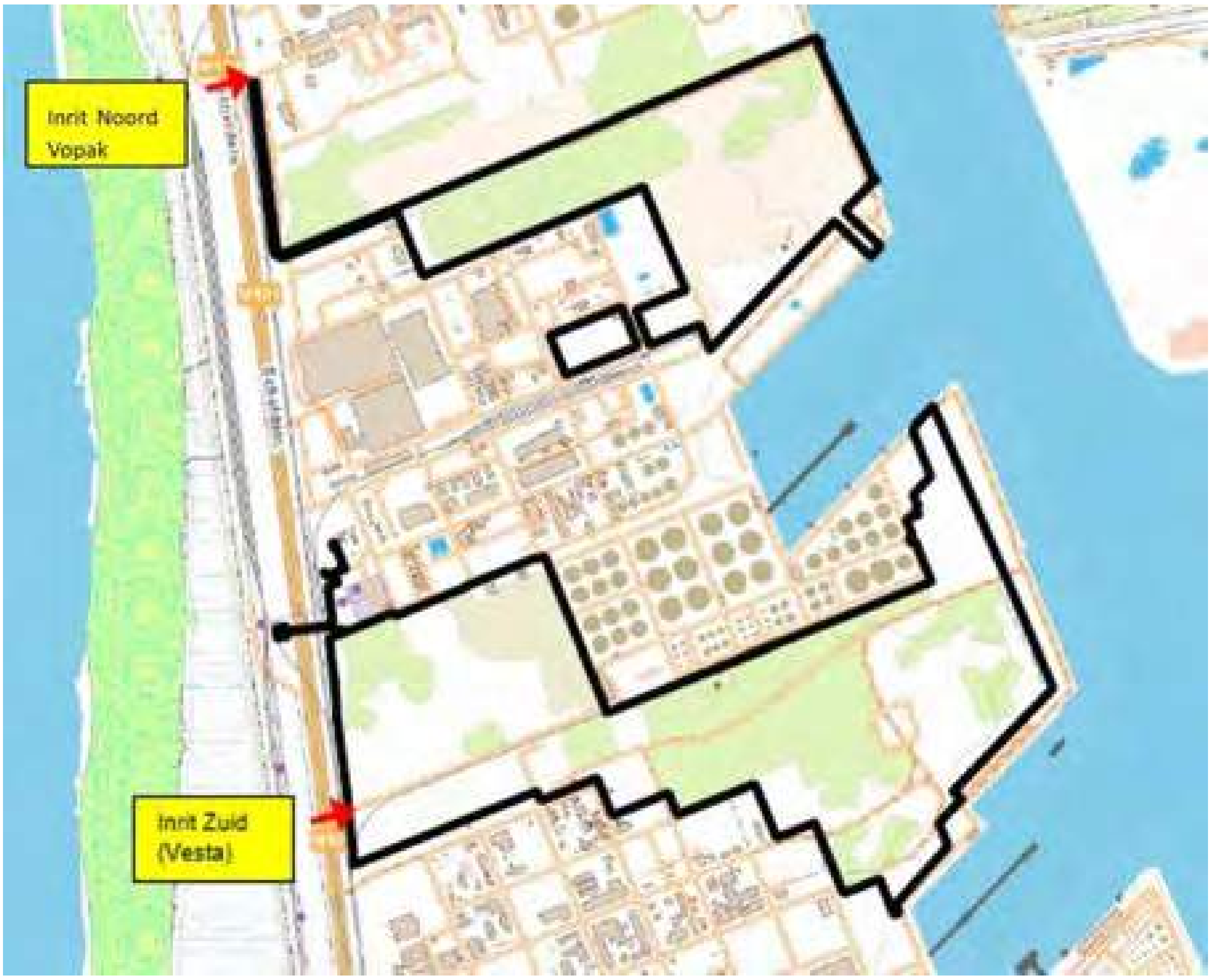


Figure 10-20: Overview of project areas at the site

10.3.2.1 Mobility profile – construction phase

Figures obtained via Project One are used to estimate traffic generation during the construction phase. The overview below excludes employees and freight transport that will already be present on the sites in 2024. Naturally, these existing traffic flows are included in the various calculations.

10.3.2.1.1 Number of employees – construction phase

Throughout the construction phase, the number of employees on site will vary considerably. Appendix 4.12 provides an overview of this. The construction phase will last approximately 3 years and 8 months and will commence in August 2022.

The table below is an extract from Appendix 4.12 and shows the busiest months (peak period August 2025 – March 2025) in terms of the number of employees on the construction sites. For the assessment of parking, a peak of 2,535 employees (October 2025) will be used. The impact assessment of the handling of intersections and road segments will be based on a different peak, which also takes into account the number of freight movements (June 2024). This will be discussed in more detail later.

Table 10-19: Number of employees during peak period – construction phase

Month	67 June 2024	68	69 Aug 2024	81 Aug 2025	82	83	84	85	86	87 March 2025
Indirect/Management	395	392	378	661	676	678	670	639	587	507
Labourers	1,083	1,075	1,035	1,812	1,852	1,857	1,835	1,751	1,608	1,388
Total	1,478	1,467	1,413	2,473	2,528	2,535	2,505	2,390	2,195	1,895

10.3.2.1.2 Modal split employees – construction phase

Project One provides the following figures regarding the expected *modal split* for employees during the construction phase. For employees working in the companies, the same modal split is used as in the existing situation.

Other forms of public transport (such as the Waterbus) may further improve this modal split. However, at this stage, traditional public transport is not considered to be a suitable means of transport due to the specific working hours of the employees.

Table 10-20: Modal split for site personnel – construction phase

Vehicle choice	Modal split construction phase
Bicycle, motorbike and public transport	2
Buses (45 passengers)	50
Minibuses (10 passengers)	15
Cars (1.15 passengers)	33

10.3.2.1.3 Freight movements – construction phase

Throughout the construction phase, the number of freight transports to the sites will vary greatly. The figure in Appendix 4.13 provides an overview of this. The peak period for freight is expected to be in months 67 to 69. The peak period for site personnel is also taken into account, as this may lead to a higher number of vehicle movements. The table below therefore also shows the number of freight movements during the peak period for freight and passenger traffic (months 81 to 87). As indicated in the chapter on measures already taken, two external transhipment sites (marshalling yards) are planned, which are also included in the overview below.

Table 10-21: Number of freight transports per day during peak period – construction phase

Month	67 June 2024	68	69 Aug 2024	81 Aug 2025	82	83	84	85	86	87 March 2025
Concrete mixers	53	50	52	27	20	21	20	17	14	9
Freight between north and south zones	32	32	33	23	22	17	15	15	12	6
Freight directly to zone north	11	11	11	4	3	2	2	1	1	1

Month	67 June 2024	68	69 Aug 2024	81 Aug 2025	82	83	84	85	86	87 March 2025
Freight directly to zone South	24	24	24	10	9	7	6	6	5	3
Freight from transhipment sites to zone south	17	17	17	12	11	8	7	7	6	3
Total freight to zone South	136	133	137	76	65	55	50	46	38	22
Freight to transhipment sites	10	11	11	4	3	2	2	1	1	1

The previous chapter already indicated that a large part of the transport of materials will be carried out by ship and in bulk. This is in line with the general policy objective of the Port of Antwerp. However, it is not possible at this stage of the works to make a quantitative estimate of the exact ratio.

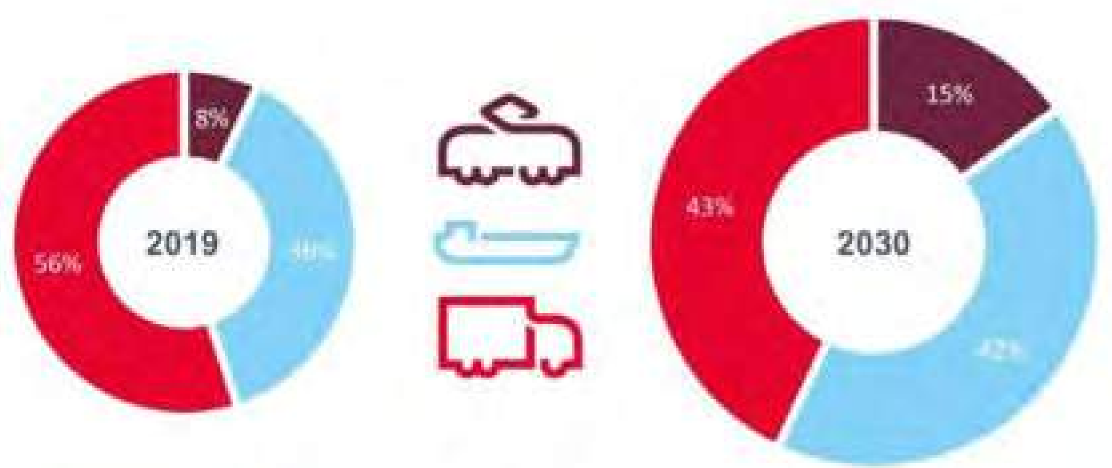


Figure 10-21: Policy objective regarding freight transport Port of Antwerp (source: https://www.portofantwerp.com/nl/transport-van-en-naar-de-haven)

In order to limit the number of concrete mixers, the feasibility of working with a temporary, local concrete plant on a pontoon on the water was investigated. Ultimately, this option could not be pursued for two main reasons:

- The capacity of such a temporary concrete plant is too small compared to the large amount of concrete required for Project One;
- There is only one such temporary concrete plant (Bonton), which means that it is not certain that the availability of that plant will be in line with the timing of the construction phase. Furthermore, it is risky to be dependent on a single source of raw materials.

10.3.2.1.4 Total vehicles – construction phase

The combination of both types of traffic flows means that month 67 (June 2024) is the busiest month (in absolute PAE). The relevant figures are therefore used to assess traffic flow. The table below summarises which figures are used for which assessment. To assess parking, the month in which the largest number of passenger vehicles will reach the sites is used, i.e. month 83 (October 2025).

Table 10-22: Overview of number of vehicles used – construction phase

	Assessment of traffic flow at intersections	Assessment of parking
Month	67 (June 2024)	83 (October 2025)
Cars	686	727
Buses	10	29
Minibuses	29	38
Freight	136	50

10.3.2.1.5 Distribution of traffic throughout the day (employees and freight) – construction phase

Based on the information obtained, the distribution throughout the day can be determined as follows. This applies to transport related to the construction site.

- Site personnel (car, minibus and bus):
  - arrival between 5 a.m. and 6 a.m. (40%) and between 6 a.m. and 7 a.m. (60%);
  - departure between 4 p.m. and 5 p.m. (40%) and between 5 p.m. and 6 p.m. (60%).
- Freight:
  - Mainly driving between 6 a.m. and 6 p.m. The following share is assumed during rush hour, both for arriving and departing lorries:
    - 6 a.m.-7 a.m.: 5%
    - 7 a.m.-8 a.m.: 10%
    - 4 p.m.-5 p.m.: 10%
    - 5 p.m.-6 p.m.: 5%

10.3.2.1.6 Measures for freight traffic – construction phase

Where delivery by lorry is unavoidable, the general strategy will be to minimise deliveries during peak hours (avoiding congestion during morning and evening rush hour) and to have goods delivered in batches as much as possible. This strategy includes the following principles:

- During the peak construction period, no deliveries are permitted during the morning and evening rush hours when most of the workers arrive at or leave the site. Exceptions will be made for critical deliveries (e.g. for continuous concrete pouring), but this will only be in exceptional cases.
- Truck deliveries to an offsite marshalling facility will be maximised. The offsite facility will be located in a less congested area of Antwerp, and general/partial deliveries will be stored or grouped into full loads for delivery on site with a minimum number of truckloads.
- During the peak construction period, shift work will be implemented so that some deliveries can take place outside normal working hours (e.g. night shifts) or during weekends.

This strategy minimises freight traffic and avoids peak loads on the road network and the site by spreading freight traffic. This also eliminates the need to provide large numbers of waiting bays on the site to accommodate freight traffic.

10.3.2.1.7 Spreading traffic across the road network (employees and freight) – construction phase

Due to the large number of employees who will be working on site every day during the peak period, possibilities for collectively organising accommodation for (some of) these employees were explored at an early stage. Various avenues were investigated, but the options studied ultimately proved unfeasible:

- Allowing a cruise ship to moor in the harbour for an extended period of time. This is not permitted because residential use is not allowed in the harbour area.
- A temporary village on the former Churchill site.
- A bungalow park in the north of the province of Antwerp or in the Netherlands. Such a park is not available in Belgium, and temporarily housing workers in the Netherlands is not feasible for tax reasons. Moreover, this would mean that Flanders would lose out on the income that this housing would generate.

Therefore, this EIA assumes that there will be no collective accommodation for the workers. This is a worst-case scenario. The figure below shows the expected distribution of site traffic for **employees** (by car, bus or minibus) who drive directly to the site:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%.
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 25%.
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 5%.
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

This means that the 12-Lillo complex will be particularly affected. In the context of a worst-case scenario, this is a good starting point, as this is already the busiest junction in the vicinity of Project One.

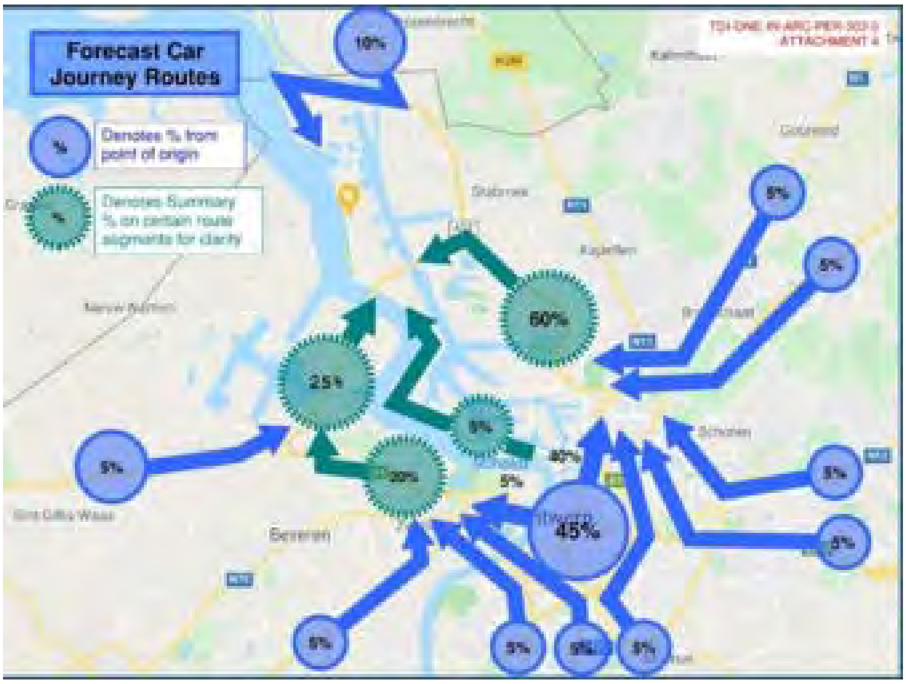


Figure 10-22: Distribution of passenger traffic across the road network (Project One) – construction phase

For **freight** traffic travelling directly to the construction site, a similar distribution across the road network is expected:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%.
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 30%.
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 0%
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

This means that the 12-Lillo complex will once again bear the brunt of the load. In the context of a worst-case scenario calculation, this is a good starting point, as this is already the busiest junction in the vicinity of Project One.

These forecasts also anticipate traffic travelling via Scheldelaan. Work is expected to be carried out on Scheldelaan south of the R2 motorway over the coming years as part of the Oosterweel link and a second Scheldt tunnel.

No further timing for work on and around Scheldelaan has been set yet. However, a diversion route via Kastelweg is possible. The calculations and impact assessments below are therefore based on the assumption that a route via Scheldelaan will always be possible.

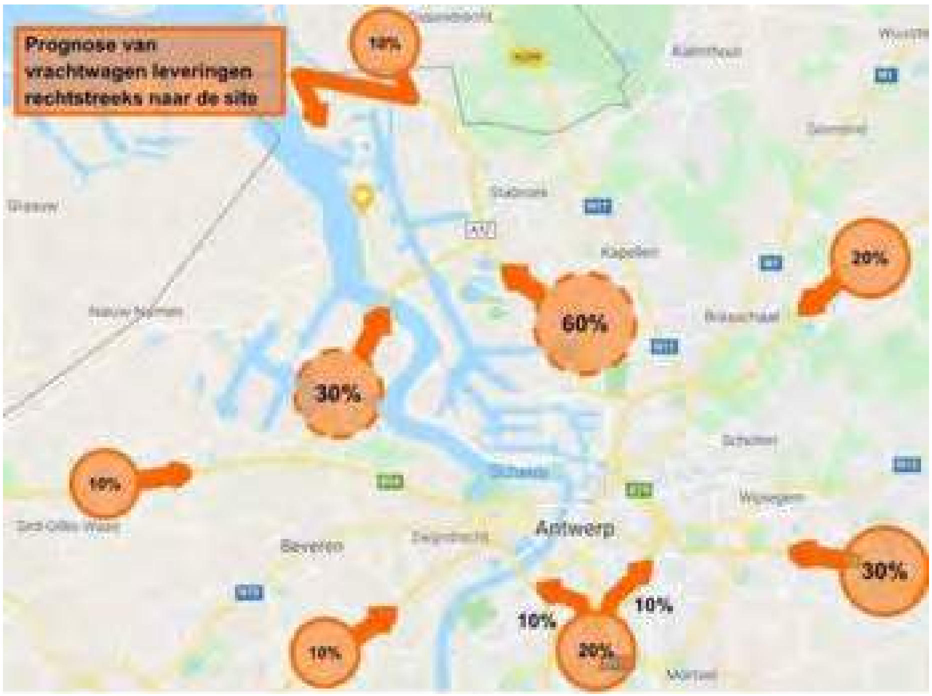


Figure 10-23: Distribution of freight traffic across the road network (Project One) – construction phase

In addition, the following distribution is assumed for freight transport from both external transhipment sites. The following distribution of the use of both transhipment sites applies:

- Marshalling yard 1: 60%
- Marshalling yard 2: 40%

Figure 10-24: Distribution of traffic from marshalling yards - transhipment sites (Project One)

Finally, concrete mixers will also come from two specific concrete plants. The map below shows their routing. The following distribution of use of both transhipment sites applies:

- Concrete plant 1: 50%
- Concrete plant 2: 50%

Figure 10-25: Distribution of traffic from concrete plants (Project One)

10.3.2.1.8 Distribution of site traffic across the sites – construction phase

The table below provides an overview of the use of the Vopak and Vesta site access points for future site traffic.

Table 10-23: Distribution of site traffic across sites – construction phase

	Vopak access road – northern site zone	Vesta access road – southern site zone
Vehicles	100	0
Buses	0	100
Minibuses	100	0
Freight from marshalling yards	0	100
Concrete mixers	0	100

10.3.2.1.9 Internal traffic circulation – construction phase

Finally, traffic flows will also be generated as a result of internal movements. On the one hand, this concerns the transport of employees between the northern and southern site zones. These will be organised as much as possible using shuttle buses. During the morning rush hour, the shuttle buses will take employees from the northern to the southern site. They will then return empty to the northern site, where they will remain parked throughout the day. In the evening, they will drive empty to the southern site, and then take site personnel back to the northern site.

On the other hand, lorries will also travel between the two construction sites, organised with freight shuttles. The shuttle freight will travel between the two construction zones throughout the day.

They are both estimated as follows:

Table 10-24: Number of shuttles between both construction sites per day during peak period – construction phase

Month	67 June 2024	68	69 Aug 2024	81 Aug 2025	82	83	84	85	86	87 March 2025
Shuttle buses	59	59	57	69	70	70	70	67	62	54
Shuttle freight	17	17	17	12	11	8	7	7	6	3

10.3.2.1.10 Overview of traffic flows – construction phase

The tables below provide an overview of the total amount of traffic during peak times in the construction phase, taking into account the distribution over time and across the network.

*Table 10-25: Overview of traffic flows at construction sites (PAE) – construction phase**

	Vopak entrance (north)		Vesta entrance (south)	
	Incoming	Departing	Arriving	Departing
5 a.m.-6 a.m.	339 (+299)	21 (+21)	43 (+38)	0 (+0)
6am-7am	476 (+470)	75 (+31)	64 (+64)	52 (+47)
7am-8am	205 (+32)	14 (+1)	70 (+20)	77 (+77)
3pm-4pm	19 (+7)	120 (+27)	47 (+46)	51 (+26)
4pm-5pm	40 (+27)	504 (+331)	69 (+68)	96 (+46)
5pm-6pm	38 (+32)	536 (+449)	36 (+36)	83 (+58)

*Figures in brackets indicate the surplus of site traffic compared to the existing situation.

- During rush hour, we see a sharp increase in traffic at the entrance and exit of Vopak, where a large proportion of the site personnel arrive and depart.
- We also see an increase during the day, which is due to trucks arriving and departing.
- An increase can also be observed at the entrance and exit of Vesta. This is mainly due to the additional freight traffic for this construction site. In addition, it is assumed that all buses and shuttle buses also arrive at the entrance to Vesta.

10.3.3 Road safety – construction phase

Road safety is being studied as a theme for the various modes of transport. This takes into account the number of conflicts between similar or different modes of transport. A collision with a lorry is more serious than one with a passenger car.

The following indicators are examined:

- the number of locations where conflicts occur. The visibility and layout of the conflict point are important here. A conflict point involving only passenger cars is safer than a conflict point involving passenger cars and lorries;
- the type of conflict that occurs. Conflicts between road users travelling at very different speeds or on very different scales will be assessed more negatively than conflicts between road users travelling at similar speeds and/or on similar scales;
- the number of conflicts.

The indicator is assessed qualitatively.

Table 10-26: Assessment framework 'Road safety – construction phase'

Significance level	Description	Representation
Significant negative effect	There is a significant negative effect because there are more points of conflict, because there are more conflicts, because readability deteriorates and/or because there are more conflicts between participants with strong different speeds and scales.	-3
Negative effect	There is a negative effect because there are more points of conflict or because the clarity of the existing points of conflict deteriorates. The type of conflict is similar to the current one, but there are more conflicts.	-2
Limited negative effect	There is a limited negative effect if the number of conflict points and the readability remain the same, while either the type of conflict or the number of conflicts between the various road users changes.	-1
Negligibleeffect	No change with regard to the current situation concerning the traffic safety.	0
Limited positive effect	There is a limited positive effect if the number of conflict points and readability remain the same and there is virtually no change in the type of conflict. The number of conflicts between the different road users does decrease.	+1
Positive effect	There is a positive effect because there are fewer points of conflict or because the clarity of the existing points of conflict is improved. The type of conflict +2 is similar to the current one, but there are fewer conflicts.	
Significant positive effect	There is a significant positive effect because there are fewer points of conflict, because there are fewer conflicts, because readability improves and/or because there are fewer conflicts between road users with strong different speeds and scale.	+3

10.3.3.1 Description of effects for the various modes of transport – construction phase

The potential effects on the traffic safety of pedestrians, cyclists and motorised traffic are described. A distinction is made between public domain and private zones on the site.

10.3.3.1.1 Pedestrian traffic – construction phase

There are currently no footpaths along Scheldelaan. There are no public transport stops on Scheldelaan, which means that there are few pedestrians anyway. There is no exchange of people between the various companies and the distances between them are large. The pedestrians who do walk along Scheldelaan mainly come from the parking lanes on Scheldelaan, although parking along Scheldelaan is rare. The Antwerp Port Authority strongly encourages companies to provide sufficient parking spaces on their own premises so that the parking spaces along Scheldelaan do not have to be used.
Pedestrians have to use the verges or cycle paths to reach the various company entrances.

Due to the lack of footpaths, businesses are required to provide the necessary parking spaces for both their own employees and visitors on their own premises. The lack of pedestrian facilities in the public domain makes it dangerous for pedestrians to walk along Scheldelaan.

Separate walking areas will be provided for pedestrians on the construction sites, separated from other motorised traffic. The necessary parking spaces will be provided, so that the parking spaces on Scheldelaan will not need to be used.

Assessment of pedestrian traffic

There are no changes to the current situation with regard to traffic safety. The effect is negligible (0).

10.3.3.1.2 Cyclists – construction phase

The road safety of cyclists on the main cycle path, designated as a supra-local functional cycle route (BFF) and located along Scheldelaan, is being examined.

In addition, the specific crossing movements of cyclists across Scheldelaan in relation to reaching their destinations will be examined. Finally, the focus will be on the Vopak (northern yard area) and Vesta (southern yard area) company entrances, as well as the reach of the bicycle bus stop.

1. **Effect on through bicycle traffic along Scheldelaan**
   The continuous two-way cycle path (BFF) along Scheldelaan runs on the western side of Scheldelaan between Tijsman Tunnel and the Inovyn entrance. At the Inovyn intersection, cyclists must cross safely, and the two-way cycle path runs on the eastern side between Inovyn and Berendrechtsluis.
   The increase in traffic during the construction phase will not have a negative impact on the safety of bicycle traffic between the Tijsman Tunnel and Inovyn. This is because the two-way cycle path is completely separate from Scheldelaan and does not cross any driveways.
   Between Inovyn and Vopak, the two-way cycle path is located on the side of the companies and there will be an impact on bicycle traffic. Potential conflicts between the Inovyn and Vopak intersections are as follows:

- Cyclists crossing at the Inovyn intersection;
  The crossing of the cycle path over Scheldelaan is currently conflict-free in terms of traffic light control. Provided that this crossing can remain conflict-free during the construction phase, no negative impact on traffic safety is expected at the entrance to Inovyn. However, due to the increase in traffic, it is possible that the traffic light system will have to be adjusted, which may increase waiting times for cyclists crossing the road. This will mainly affect cycling comfort.
- Route of the two-way cycle path between Inovyn and the Vopak intersection;
  Between the Inovyn intersections and the IMB access point, and between IMB and the Vopak intersection, the two-way cycle path runs partly separate from Scheldelaan (by means of a parking lane between the cycle path and the carriageway).
  At the entrances, the parking lane transitions into an exit lane for traffic heading towards IMB and Vopak. At the exit lane, the two-way cycle path runs alongside the carriageway. The lack of a safety lane between both the parking lane and cycle path and between the exit lane and cycle path creates the potential for conflicts. There is no safety lane between the parking lane and the cycle path to accommodate opening car doors. Due to the lack of footpaths, users of this parking zone are forced to use the cycle path to reach their destination. However, the parking lanes along Scheldelaan are rarely used. A safety lane of at least 1 metre should be provided between the turning lane and the cycle path. Although the proximity of the cycle path increases the visibility of cyclists, the fact that it is a two-way cycle path means that the distance between (heavy) turning traffic and cyclists travelling in the opposite direction is too small. These potential conflict situations already exist in the current road situation, but as traffic increases (cyclists and motorised traffic), the number of conflict situations will rise.

- Crossing entrances to IMB and Vopak (northern yard area)
  The IMB and Vopak intersections are not controlled by traffic lights. The two-way cycle path is marked with priority. There are no road markings (double arrows) on the cycle path to emphasise the fact that it is a two-way cycle path. Two-way cycle paths have a higher risk of accidents at intersections than one-way cycle paths, because motorised traffic does not always expect bicycle traffic in both directions. These potential conflict situations already exist in the current road situation, but as traffic increases (cyclists and motorised traffic), the number of conflict situations will rise.

Assessment of through bicycle traffic

There is a limited negative effect (-1) for through bicycle traffic at the Vopak intersection. This is due to the increase in (freight) traffic on the access road. Both the number and type of conflicts (increase in freight<->bicycle) are increasing. The number of conflict points and the legibility of the conflict points remain the same.
A negligible effect (0) is expected at the IMB intersection, as no additional traffic will use this entrance during the construction phase. The number of conflicts, conflict points, readability and type of conflict will remain the same.

2. Impact on local bicycle crossings

In order to improve bicycle accessibility to the Vesta, Bayer and ASA companies, a number of bicycle crossings have been provided and a local two-way cycle path has been constructed on the eastern side of Scheldelaan.

Between I-hub and ASA and between Bayer and Vesta, there is an unprotected bicycle crossing over Scheldelaan, which is reduced locally to one lane in each direction (2x1). The bicycle crossing is marked on the road, but is not a priority crossing. As traffic increases, the number of conflict situations will increase. The gaps between two consecutive vehicles will also become smaller, meaning that cyclists will have to wait longer to cross. When traffic is too heavy, there is a risk that cyclists crossing the road will take risks and attempt to cross even when there is insufficient space between vehicles, resulting in dangerous road situations.

A traffic light-controlled crossing for cyclists has been provided at ASA. Provided that this crossing can also remain conflict-free in the traffic light system during the construction phase, no negative impact on road safety is expected at this intersection. However, due to the increase in traffic, it is possible that the traffic light system will have to be adjusted, which may increase waiting times for cyclists crossing the road. This will mainly affect cycling comfort.

Assessment of local bicycle crossings

There is a limited negative effect (-1) on local bicycle crossings. This is due to the increase in traffic.

3. Impact on cyclists' access to the business park (Vopak and Vesta) and the bicycle bus stop

There is a lack of high-quality bicycle facilities between the Scheldelaan cycle path and the relevant sites at the various business entrances. At both entrances, cyclists are mixed in with motorised traffic. An increase in traffic will lead to a rise in the number of potential conflicts.

Figure 10-26: photo of Vopak entrance (left), Vesta entrance (right)

The Scheldelaan bicycle bus stop is located near the Tijsmanstunnel west. Between Scheldelaan and the stop, there is a two-way cycle path separated by concrete barriers. On Scheldelaan, there is a traffic light-controlled bicycle crossing that connects the two-way cycle path on Scheldelaan west with the connection to the bicycle bus stop. The northern part of the bicycle crossing, which runs across the exit lane from N101 Scheldelaan to Tijsmanstunnel, is not protected by traffic lights. The cycle path is marked as having right of way here.
This bicycle crossing is located outside the most frequently used routes between Scheldelaan and Tijsmanscomplex, which are determined by the location of the construction sites. Only the small percentage of traffic that uses the Antwerp – project area route via Scheldelaan will place additional strain on this crossing. The greatest safety risk lies in the crossing that is currently marked as having right of way, as this creates potential conflicts between crossing cyclists and turning traffic.

Assessment of local access for cyclists

There is a limited negative effect (-1) for bicycle traffic on local access roads to Vopak and Vesta. This is due to the increase in (freight) traffic. Both the number and type of conflicts (increase in freight<->bicycle) are increasing. The number of conflict points and readability remain the same.

10.3.3.1.3 Motorised traffic – construction phase

The consequences for road safety of the expected increase in traffic during the construction phase are being investigated. The focus is on the Vopak, IMB, Inovyn and Vesta intersections. The potential conflicts with active road users have already been described in the section on pedestrians and cyclists. The effect of additional traffic on road safety at the intersections is examined in more detail below. The following factors are important in terms of road safety:

- Capacity assessment: are there sufficient gaps in through traffic on Scheldelaan to allow traffic to flow safely? If this is not possible, appropriate traffic light control must be considered.
- Is the configuration of the intersection adapted to the additional traffic? For example, is the length of the Scheldelaan acceleration lanes sufficient? If not, traffic will build up on the Scheldelaan through lanes, with possible consequences for road safety.
- In the case of a traffic light-controlled intersection, it must be determined whether the additional traffic can be handled safely.

The impact assessment discussed in § 10.3.5 (Motorised traffic – Intersection management – construction phase) shows that the Vopak intersection is heavily congested and that traffic lights are desirable during the evening rush hour. Given the presence of the supra-local functional cycle path, conflicts between cyclists and construction site traffic must be carefully studied. Specifically for the Vopak intersection, a separate report provides a thorough study of the intersection (Appendix 4.22) to discuss impacts and possible solutions.
The IMB and Vesta intersections have sufficient residual capacity to handle traffic safely. The light-controlled Inovyn intersection can be easily regulated during the construction phase.

Assessment of motorised traffic

There is a negligible effect (0) on motorised traffic at the IMB, Inovyn and Vesta entrances.

10.3.3.2 Assessment of traffic safety effects – construction phase

There is a limited negative effect (-1) on road safety for vulnerable road users during the construction phase. This is because the nature of the conflicts changes and the number of conflicts also increases significantly. However, the number of conflict points will remain the same (this aspect was decisive in the choice of a limited negative assessment rather than a negative one). During the construction phase, there will be a considerable amount of additional freight and passenger traffic. They will use the intersections at Vopak and Vesta.

However, visibility at the various intersections is good and it is possible to implement mitigating measures. The separate study on the impact on the Vopak intersection (Appendix 4.22) shows that securing the intersection during the construction phase is necessary for road safety reasons.

Additional options are being further studied as accompanying measures, in addition to the project-integrated measures already outlined above in § 10.3.1. These accompanying measures need to be discussed further with the road authority:

- Elimination of unprotected bicycle crossings on Scheldelaan;
- Extending the two-way cycle path on the western side;
- Removing parking spaces along Scheldelaan;.
- Securing the Vopak intersection by means of traffic lights (conflict-free regulation);
- Correct implementation of markings and signage for better legibility;
- At intersections that are not protected by traffic lights:

  It is proposed to apply road markings (double arrow) on the marked cycle path to further emphasise the presence of cyclists in both directions. Warning sign M9 indicating a two-way cycle path, in combination with traffic sign B07 and a stop line for the cycle path, will be provided at the junction... This will emphasise the presence of cyclists more effectively than in the current situation.
- Separation of motorised traffic and vulnerable road users on company sites. These measures are

discussed in more detail in § 10.7.1.

10.3.4 Motorised traffic – Road segment and network management – construction phase

Due to the size of the project and the high volume of traffic generated during the construction phase, the traffic network in a wide area will be studied. For this reason, the Antwerp Regional Traffic Model (RVm) will be used. This model makes it possible to use different reference situations (e.g. reference situation before and after the works around Oosterweel). The specific information about the traffic generation of Project One will be manually added to the global reference situations known from the model. An estimate of the possible traffic effects will be made on the basis of 'expert judgement'.

The assessment uses the I/C ratio – the saturation level. This reflects the ratio between the expected intensities (in PAE per hour) and the capacity on a particular road section. The assessment looks at the extent to which the intensities evolve in relation to the reference situation. At the same time, it is examined whether a certain limit value is exceeded. If the I/C ratio is less than 80%, smooth traffic flow is expected. An I/C ratio above 90% is considered problematic. The reference framework below is used (see table). In summary, it can be said that if the increase in traffic results in a saturation level above 80%, the assessment is gradually negative.

Table 10-27: Assessment of limit values for I/C ratio – road segments – construction phase

		Increase in traffic intensities (in PAE)				Status quo	Decrease in traffic intensities (in PAE)			
		>50%	20-50	10-20	5-10	<5	5-10	10-20	20-50	>50%
I/C ratio future situation	>100%	-3	-3	-3	-2	0	0	0	+1	+1
	90-100%	-3	-3	-2	-1	0	0	+1	+2	+2
	80-90%	-2	-2	-1	-1	0	+1	+2	+3	+3
	<80%	-1	-1	0	0	0	+1	+3	+3	+3

The table in Appendix 4.14 provides an overview of the number of vehicles per segment during each rush hour. It shows that for most segments, the increase in saturation level is limited and that the critical value of 80% is not exceeded. There are a few exceptions:

- Segment 7: Segment A12 towards the Netherlands, southeast of junction A12/R2
  - at 6 a.m.: increase from 7% to 91% (-1)
- Segment 8: Segment A12 towards Antwerp, southeast of junction A12/R2

  - at 4 p.m.: increase from 5% to 81% (-1)
  - at 5 p.m.: increase from 7% to 83% (-1)
- Segment 12: Tijsman Tunnel towards Antwerp (eastbound)
  - at 4 p.m.: increase from 5% to 90% (-1)
  - at 5 p.m.: increase from 7% to 81% (-1)

Appendix 4.15 provides an overview of the 24-hour intensities. These are relevant for the disciplines Air and Noise.

This section only looks at the traffic situation in 2017. The 2030 model already includes the extra capacity on the Antwerp Ring Road and Tijsman Tunnel. However, it is expected that Project One will be completed before the work on the Antwerp Ring Road and Tijsman Tunnel is finalised.

The above segments will experience significant disruption during the works on the Antwerp Ring Road. In § 10.5.3 therefore examines in more detail the overlap between the construction phase of Project One and the construction phase of the Oosterweel link.

Mitigating and accompanying measures in relation to traffic management are discussed in § 10.7.1.

10.3.5 Motorised traffic – Intersection management – construction phase

In industrial environments, smooth traffic flow at intersections is crucial to ensuring smooth traffic flow. Various methods are used to estimate the saturation level of intersections, depending on the type of intersection. Priority-controlled intersections are estimated using the Harders method, traffic light intersections are subjected to an I/C test based on the Highway Capacity Manual, and finally, the method described in Service Order 266 AWV is also used.

The intersections that will be studied are:

- Existing and planned entrance and exit Vopak x Scheldelaan
- Existing entrance and exit IMB x Scheldelaan
- Existing entrance and exit Inovyn x Scheldelaan
- Existing and planned entrance and exit Vesta x Scheldelaan
- Existing intersections R2 x Scheldelaan

The tables in the following sections show the degree of resolution of the intersections. The result in the existing situation is shown in brackets. This makes it easy to determine the impact of the various construction sites. The flowcharts for the intersections can be found in Appendix 4.16 and Appendix 4.17.

The table below indicates the reference framework used for the assessment. Appendix 4.11 provides more information about the methodologies used.

Table 10-28: Assessment of saturation limits at intersections

		Increase in traffic intensities (in PAE)				Status quo	Decrease in traffic intensities (in PAE)			
		>50%	20-50	10-20	5-10	<5	5-10	10-20	20-50	>50%
Saturation level future situation	>100%	-3	-3	-3	-2	0	0	0	+1	+1
	90-100	-3	-3	-2	-1	0	0	+1	+2	+2
	80-90%	-2	-2	-1	-1	0	+1	+2	+3	+3
	<80%	-1	-1	0	0	0	+1	+3	+3	+3

NIVEAU	I/C	CONGESTIEKANS	CYCLUS LENGTE	1STE GROENFASE VOLDOENDE	GEMIDDELDE VERTRAGING/VTG
A	≤ 55%	Geen	80s	Altijd	≤10s
B	55% - 64%	Zeer weinig	90s	Bijna altijd	10-20s
C	64% - 73%	Weinig	100s	Meestal	20-35s
D	73% - 82%	Beperkt	110s	Vaak	35-55s
E	82% - 91%	Mogelijk	120s	Minder vaak	55-80s
F	91% - 100%	15 – 60min/dag	>120s	Wachtrij na 1e groenfase	≥80 s
G	100%-109%	60 – 120 min/dag	>120s	Lange wachtrij en gedragswijziging (route, tijdstip)	
H	> 109%	> 120 min/dag	>120s		

When assessing intersections, checks will be made to ensure that capacity is not exceeded. This exercise will be carried out for both existing and future situations. If capacity problems are identified, it will be examined whether the type of intersection is adequate. For example, if queues are too long at a priority-controlled intersection, it may be proposed to switch to installing a traffic light system. The physical layout of intersections will also be evaluated in terms of road safety. Where necessary, adjustments will be proposed. A separate report will be drawn up for the Vopak intersection.

10.3.5.1 Intersections complex 12-Lillo – construction phase

The ICU method will again be used for these traffic light-controlled intersections. In the current situation, the clearance levels appeared to be sufficient at most times (both with figures for 2017 and 2030). The configuration of the intersections will remain unchanged, and the bypasses for right-turning traffic will remain in place (from the R2 towards Scheldelaan-Noord and from Scheldelaan-Zuid towards the R2).

When traffic from the construction phase is added to existing traffic, an increase in saturation levels can naturally be observed. This increase is limited for the R2-West intersection, although it is around 9% higher during the evening rush hour. Nevertheless, the impact on traffic flow remains limited. This can be explained logically:

- During the morning rush hour, the large flow of additional traffic from Antwerp has a bypass to turn right and therefore has little impact on the flow of traffic at the intersection.
- During the evening rush hour, 70% of the additional traffic drives straight ahead, so it also has a limited impact on the flow of traffic at the intersection.
- The exception to this is at 4 p.m., when the increase is 6% to a saturation level of 87%. This leads to a limited negative effect (-1) for the R2-West intersection. For the other rush hours, there is a negligible or no effect (0) in terms of traffic flow.

A different picture emerges at the R2-East junction. This junction is hardly affected during the morning rush hour, but experiences a very sharp increase in congestion during the evening rush hour (between 4 p.m. and 6 p.m.). Again, this is easy to explain: 60% of the additional traffic is expected to turn left here towards Antwerp. This leads to a significant negative effect (-3) for the R2-East intersection. For mitigating and accompanying measures, please refer to § 10.7.1.

In practice, traffic distribution may differ, as route selection will also depend on the traffic situation at any given moment. When there is significant congestion at the R2 x Scheldelaan intersection, vehicles heading towards Antwerp may be more likely to take complex 11 to join the A12. However, this will not be implemented on a structural basis, as modelling shows that it could lead to structural problems.
at complex 13, where the A12 and R2 motorways converge.

Table 10-29: Assessment of R2 intersections – Construction phase (2017)

	R2 – West		R2 – East	
	LoS (2017)	I/C (2017)	LoS (2017)	I/C (2017)
5–6	C (A)	68% (54%)	A (A)	51% (51%)
6am-7am	C (B)	70% (62%)	B (B)	60% (59%)
7am-8am	D (D)	79% (78%)	B (A)	56% (54%)
3pm-4pm	D (D)	80% (80%)	E (E)	84% (83%)
4pm-5pm	E (D)	87% (81%)	F (E)	96% (82%)
5pm-6pm	D (C)	77% (68%)	H (G)	121% (100%)

LoS = Level of Service, I/C = Intensity over Capacity ratio; A(<55%) to D(<82%) indicates acceptable saturation levels, E(=82%) to F(<100%) indicates critical saturation levels and G(=100%) to H(>109%) indicates oversaturation.

10.3.5.2 Intersections at Vopak, IMB and Vesta entrances – construction phase

Given that these junctions currently operate according to a traditional right-of-way system, whereby traffic on Scheldelaan has right of way, the first step is to assess whether traffic lights are desirable from a traffic management perspective (in accordance with AWV service order 266 – Traffic Light Design Manual 2020). The assessment below applies to the construction phase (2017 model). This shows that traffic lights are desirable at Vopak during the evening rush hour. In terms of traffic flow, a negative effect (-2) is therefore expected at the Vopak intersection (in the case of a classic right-of-way system) and a negligible or no effect (0) at the intersection of IMB and Vesta.

Table 10-30: Assessment of intersections Vopak, IMB, Vesta – construction phase (2017 and 2030)

	Scheldelaan x Vopak entrance	Scheldelaan x IMB entrance	Scheldelaan x Vesta entrance
6 a.m.-7 a.m.	No traffic lights required	No traffic lights required	No traffic light required
7 a.m.-8 a.m.	No traffic light required	No traffic lights required	No traffic lights required
8 a.m.-9 a.m.	No traffic light required	No traffic lights required	No traffic lights required

	Scheldelaan x Vopak entrance	Scheldelaan x IMB entrance	Scheldelaan x Vesta entrance
3 p.m. to 4 p.m.	No traffic lights required	No traffic light required	No traffic light required
4pm-5pm	**Traffic lights are desirable**	No traffic lights required	No traffic lights required
5 p.m. to 6 p.m.	**Traffic lights are desirable**	No traffic lights required	No traffic lights required

Specifically for the Vopak intersection, a separate report provides a thorough study of the intersection (Appendix 4.22). This report was drawn up by the EIA experts as part of this EIA and focuses specifically on the intersection at the Vopak entrance. It seeks solutions for the design of this intersection. Various scenarios and variants for traffic light systems are examined.

Further consultation with the road authority will determine which solutions can be implemented. An initial report has already been shared with AWV. An agreement has been reached with AWV to install traffic lights at this intersection.

10.3.5.3 Inovyn entrance intersection – construction phase

The intersection at Inovyn is also traffic light-controlled and is therefore assessed using the ICU method. This entrance will not generate any additional traffic flows during the construction phase. However, through traffic on Scheldelaan will increase significantly. As expected, this will lead to a sharp rise in the saturation level during rush hour. However, this will remain well below the critical threshold of 82%.

In terms of traffic flow, a negligible effect (0) is therefore expected at the Inovyn intersection during the construction phase.

Table 10-31: Assessment of Inovyn intersection – construction phase (2017)

	Scheldelaan junction x Inovyn entrance	
	LoS (2017)	**I/C (2017)**
5 a.m.-6 a.m.	A (A)	40% (32%)
6-7	A (A)	50% (38%)
7am-8am	A (A)	48% (47%)
3pm-4pm	A (A)	48% (47%)
4pm-5pm	B (A)	58% (49%)
5pm-6pm	B (A)	58% (46%)

LoS = Level of Service, I/C = Intensity over Capacity ratio; A(<55%) to D(<82%) indicates acceptable saturation levels, E(=82%) to F(<100%) indicates critical saturation levels, and G(=100%) to H(>109%) indicates oversaturation.

10.3.5.4 Assessment of traffic flow at intersections – construction phase

In terms of traffic flow, a negligible effect (0) is expected for most intersections. This does not apply to the Vopak intersection, for which a separate study was conducted (Appendix 4.22).

In addition, the flow rate at the R2 x Scheldelaan intersections appears to deteriorate significantly during the evening rush hour. A limited negative effect (-1) is expected for the western intersection, and a significant negative effect (-3) for the eastern intersection. For mitigating and accompanying measures, please refer to § 10.7.1.

10.3.6 Motorised traffic – Parking – Passenger cars – construction phase

Traditionally, when assessing parking, a balance is sought between meeting parking demand on the one hand (limiting parking pressure) and avoiding an oversupply of parking on the other (which could discourage the use of public transport, bicycles, etc.). A parking occupancy rate of 85% to 100% is considered ideal.

Table 10-32: Assessment framework 'Car parking – construction phase'

Significance level	Description	Representation
Significant negative effect	The number of planned parking spaces is far from sufficient, which will significantly increase the pressure on public parking spaces for passenger cars. The number of parking spaces provided is far too high, which encourages users to use their cars much more.	-3
Negative effect	The number of parking spaces provided is insufficient, resulting in a limited increase in parking pressure from passenger cars on public land. The number of parking spaces provided is excessive, which users are more inclined to use the car.	-2
Limited negative effect	The number of planned parking spaces is just sufficient, which means that there is sometimes limited parking pressure of passenger cars on public land.	-1
Negligible or no effect	The number of parking spaces provided is sufficient, so there is no parking pressure on the surrounding area.	0
Limited positive effect	N/A	+1
Positive effect	N/A	+2
Significant positive effect	Not applicable	+3

Given the context, it seems desirable to focus primarily on accommodating the parking pressure generated during the construction phase. Deliberately limiting the number of parking spaces during the construction phase is unlikely to lead to a modal shift, but is more likely to result in additional parking pressure on public roads, which is undesirable. Therefore, 100% parking occupancy is considered ideal during this phase.

Future passenger traffic related to the various sites (cars and minibuses) will be completely concentrated in the northern site area, accessible via the Vopak entrance. From there, employees will be taken to the southern site by shuttle buses.

10.3.6.1 Number of parking spaces – construction phase

During the construction phase, the northern entrance (Vopak) will mainly be used as the access route. All passenger traffic will arrive via the Vopak entrance and park in the site car park. Minibuses will also arrive via the Vopak entrance and park on the northern site. This has space for 864 + 54 cars and 38 minibuses. There are also 36 spaces for bicycles. No parking spaces are provided on the sites for large buses. Finally, there are also 66 lorry parking spaces.

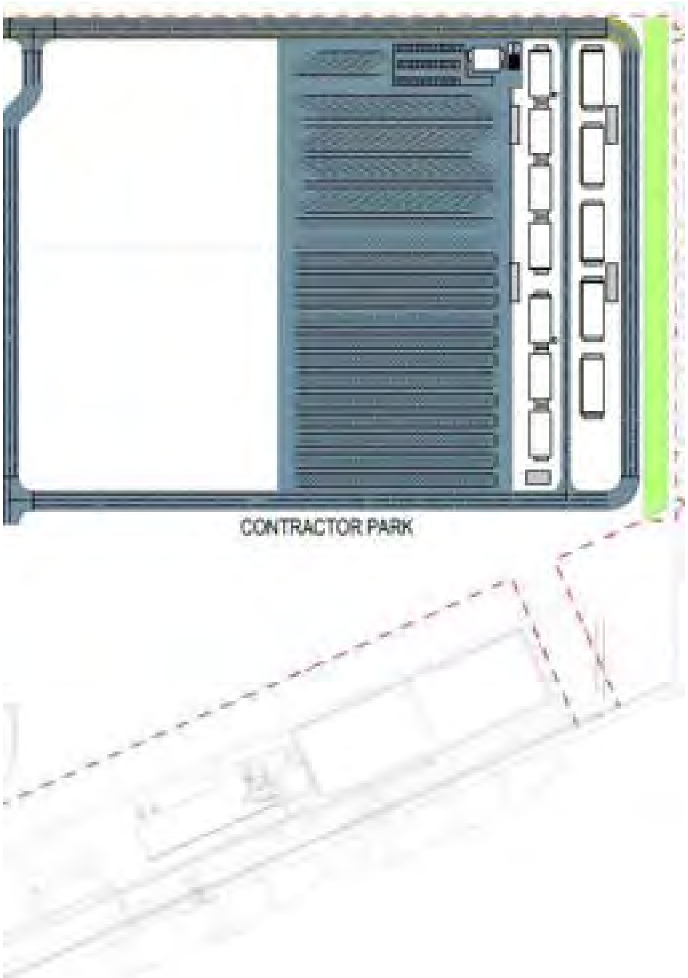


Figure 10-27: Parking area via Vopak access

10.3.6.2 Estimated passenger traffic – construction phase

The following overview shows the maximum load on the parking zone during the peak period expected around October 2025. As indicated, the peak in the number of vehicles is taken into account for parking, not PAE. This will take place in month 83.

Table 10-33: Number of vehicles for site personnel – construction phase

Mode of transport	Percentage	Vehicles/bicycles	Parking spaces/bicycle parking facilities
Bicycle	1	30	32
Motorcycles, public transport (50-50)	1	15	18
bus	50	29	-

Mode of transport	Percentage	Vehicles/bicycles	Parking spaces/bicycle parking facilities
Minibus	15	38	58
car (1.15 per vehicle)	33	727	918

In this simulation, the occupancy rate of the parking zone for passenger cars is 84%. There is a residual capacity of 137 parking spaces. The occupancy rate of the car park for minibuses is 66%. In the simulation, there is a surplus of 20 parking spaces for minibuses.

For buses, locations will be provided on the southern site where employees can get on and off. This will prevent buses from having to stop on Scheldelaan.

There will be 18 parking spaces for motorcycles and 32 parking spaces for bicycles. At peak times, occupancy will therefore be approximately 95%. The layout of this parking zone allows for an expansion of the number of parking spaces for cyclists and motorcyclists.

10.3.6.3 Assessment of passenger traffic parking – construction phase

At peak times, the occupancy rate of the parking zone for site traffic is 84%. Based on the current estimate of peak load, the number of planned parking spaces is sufficient, which means that there will be no parking pressure on the surrounding area. The effect is assessed as negligible or no effect (0). Consideration could be given to phasing in this number of parking spaces, as there will be a significant surplus of parking spaces before and after the peak period.

10.3.7 Motorised traffic – Parking – Lorries – Construction phase

When assessing lorry parking, the main consideration is meeting parking demand. This is to avoid lorries parking in public areas or queuing on public roads. A parking occupancy rate of 95% to 100% is considered ideal.

Table 10-34: Assessment framework 'Truck parking – construction phase'

Significance level	Description	Representation
Significant negative effect	The number of designated parking spaces is structurally insufficient, resulting in the parking pressure from lorries on public domain .	-3
Negative effect	The number of parking spaces provided is insufficient, resulting in increased parking pressure of lorries on public land increases to a limited extent.	-2
Limited negative effect	The number of parking spaces provided is just sufficient, resulting in sporadic limited parking pressure from lorries on public land.	-1

Significance level	Description	Representation
Negligible or no effect	The number of planned parking spaces is sufficient, so there is no parking pressure on the surrounding area.	0
Limited positive effect	N/A	+1
Positive effect	Not applicable	+2
Significant positive effect	Not applicable	+3

10.3.7.1 Number of parking spaces – construction phase

A … in § 10.3.1, a number of measures are already planned to limit the number of freight transports to the construction sites. T… lso result in fewer parking spaces being required for lorries.

F… ıern yard area, freight traffic from the main entrance on Scheldelaan follows the designated route to the lorry parking s… re are 66 parking spaces for lorries in this northern yard area (see Figure 10-27).

During the construction phase, a number of laydown zones will be set up on the southern site. There are no grouped parking spaces for freight traffic; parking spaces will be linked to the various laydown zones (with a minimum of six spaces for the southern site). Lorries will not wait on Scheldelaan, but will be accommodated on the site itself.

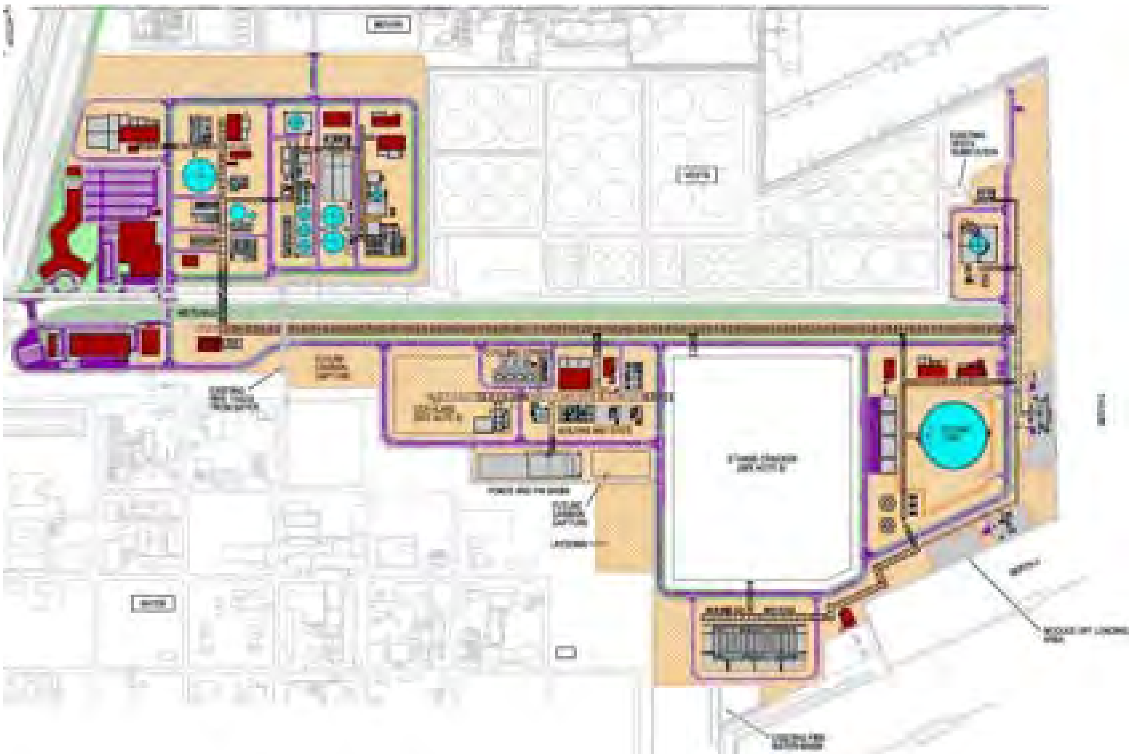


Figure 10-28: Laydown organisation – construction phase southern part of the project area

10.3.7.2 Estimated freight traffic – construction phase

During the peak of the construction phase, an estimated 137 lorries per day will arrive at the sites. The majority of these lorries will travel to the southern construction zone. Freight traffic will be spread out as much as possible and will arrive outside rush hour. The maximum hourly load is estimated at 10% of the daily total. This equates to around 8 lorries per hour at both sites. Lorries may well remain on site for longer, which means that occupancy will be higher. Nevertheless, the number of lorry parking spaces will by no means be insufficient.

10.3.7.3 Assessment of lorry parking – construction phase

The number of planned parking spaces is more than sufficient, which means that there will be no parking pressure on the surrounding area. The effect is assessed as negligible or no effect (0). Consideration could be given to phasing in this number of parking spaces, as there will be a large surplus of parking spaces before and after the peak period.

10.4 Impact description and impact assessment – operational phase

The effects on mobility are described and assessed according to the following impact groups:

- Road safety (for the various modes of transport)
- (Motorised traffic – road network management)
- Motorised traffic – intersection flow
- Motorised traffic – passenger car parking
- Motorised traffic – lorry parking

Before these aspects can be assessed, an estimate is made of the increase in traffic and any necessary infrastructure adjustments.

10.4.1 Traffic generation – operational phase

The extent of traffic generation is not assessed as standard in an EIA. However, the impact of additional traffic movements is estimated in various impact groups.

This chapter therefore merely constructs a mobility profile of the site, which can be used to estimate how much traffic is expected and how this would be distributed, both in terms of mode of transport and allocation on the network.

This chapter specifically discusses the ‘distribution across modes’ and frames it within general policy objectives and/or usual achievable shares of certain modes.

10.4.1.1 Number of employees Project One – operational phase

Project One will result in the employment of new employees and contractors. For the surrounding businesses, the number of employees, visitors, contractors, etc. is expected to remain the same. In the context of mobility, the following chapters therefore focus solely on the Vesta entrance (to the Project One site).

Table 10-35: Maximum number of persons Project One site – Operational phase

People	Project One
Employees – non-shift	268
Employees – shift	90
Contractors	150
Visitors	25
Total number of visitors to the site	533

*Total number of employees working in shifts, working in 5 shifts. Only 1/5 are therefore present on site, except during shift changes (6 a.m., 2 p.m. and 10 p.m.).

10.4.1.2 Modal split employees – operational phase

Project One aims to achieve the modal split shown below as soon as the new site becomes operational. For reference, the Flemish average (based on the most recent OVG 6 Travel Behaviour Survey) is shown. Various initiatives are being taken to achieve this ambition.

The shift system, which involves working in three shifts, will make it easier to use public transport.

Initiatives have already been taken to promote cycling. These will be rolled out further from the launch of the site:

- Voluntary bicycle lease plan;
- Organisation of training courses on the safe use of electric bicycles;
- Showers and changing rooms are provided on site;
- An online health platform called 'INEOS Energy Station' motivates employees to stay healthy. Employees can take on challenges and, for example, register the number of kilometres they cycle.
- INEOS offers cycling and sports equipment to its staff at affordable prices;
- Safe cycle paths are provided on the Project One site.
- Covered bicycle parking facilities are provided at the Project One site, with the option of charging electric bicycles.

In addition, efforts are being made to encourage carpooling. The following measures are being taken to this end:

- Information campaigns about carpooling;
- Participation in the carpool platform in the Port of Antwerp;
- Reserved carpool parking spaces near the entrance to the administrative building;
- Developing policy on compensation for carpooling and the guarantee of getting home when you carpool.

For the other companies (Vopak, IMB, Inovyn, Vesta), the same modal split as in the existing situation will continue to apply (see § 10.2.2.2).

Table 10-36: Modal split employees – operational phase

Vehicle choice	Modal split – existing situation	Modal split – Project One	Flemish average (OVG 6)
Bicycle	8	17	21.84
Public transport l-bus	4	8	9.59
Motor	5	4	0.53
Carpool	4%	6%	2.10
Car	79	64	63.26
Other	0	0	2.68

Project One has the ambition to continue to focus on a *modal shift* in the future. The following issues are being investigated and may be implemented:

- Home office rotation (i.e. working from home for part of the week) can be implemented for positions that do not require daily on-site presence (e.g. IT, HR, finance, etc.).
- Incentives for electric bicycles.
- Carpool programmes will be further developed.
- Further options for collective bus transport are being investigated. Collaboration with other partners in the field of buses is being evaluated.
- Contractors will be encouraged to carpool from their business locations.

The table below shows the modal split for the various users of Project One.

Table 10-37: Modal split by type of user – operational phase

User	Modal split for cars	Interpretation
Employees not on shift	64%	Arrive at times when use of the l-bus and Cycle Bus is possible.
Employees – shift	64	The shift regime (8-hour shifts) for Project One allows employees to use the l-bus and Bike Bus.
Visitors	100	Are expected to arrive individually by car.
Contractors	64	Contractors are expected to arrive by car/minibus (to transport work equipment), but they are expected to carpool.

10.4.1.3 Maximum number of employees and vehicles to site Project One – operational phase

The table below provides an overview of the maximum number of employees who will work at the Project One site on a daily basis during the operational phase. It indicates how many of them will travel by car, taking into account the modal split discussed earlier.

	Persons	Vehicles	Notes
Employees - non-shift 268		171	64% with car
Employees - shift	90	57	Working in 5 shifts, so 1/5 present on site at any given time, except during shift changes (6 a.m., 2 p.m. and 10 p.m.), 64% with car
Contractors	150	96	64% with car
Visitors	25	25	100% by car

10.4.1.4 Modal split for goods transport – operational phase

The table below provides an overview of the expected annual freight flows. This does not include deliveries of food, office supplies and similar items.

Table 10-38: Modal split for freight transport – operational phase

	Supply (tonnes/year)	Outflow (tonnes/year)	Total (tonnes/year)	Modal split
Ships	2,205,000	178,750	2,383,750	57.8
Pipes	0	1,730,500	1,730,500	41.9
Trucks	0	12,000	12,000	0.3

The percentage of freight transport within total goods transport is very small and therefore amply meets the general policy objective of the Port of Antwerp regarding freight transport (freight transport at 42%).

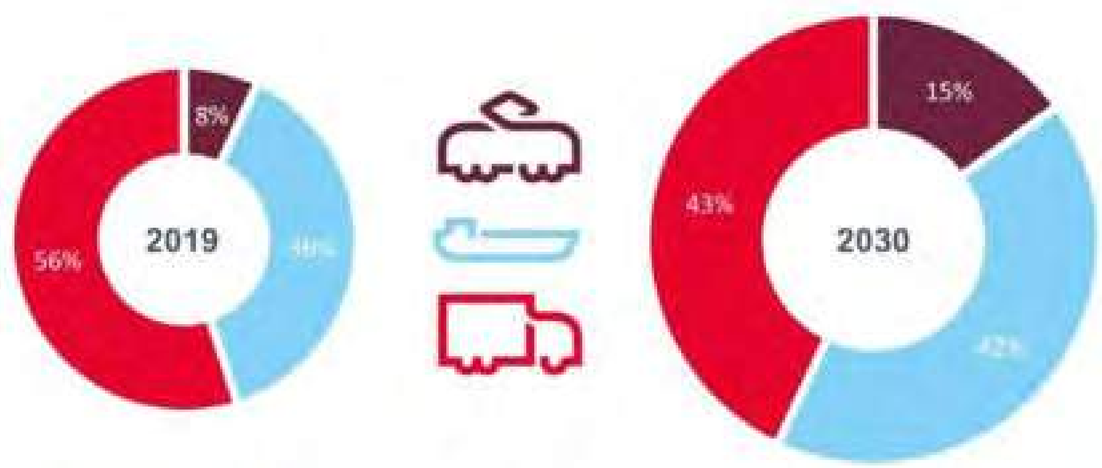


Figure 10-29: Policy objective regarding freight transport Port of Antwerp (source: https://www.portofantwerp.com/nl/transport-van-en-naar-de-haven)

10.4.1.5 Number of lorries to Project One site – operational phase

The table below provides an overview of the number of lorries per day to the Project One site. The existing Vesta entrance will be used for this purpose. The number of lorries at the other sites will remain unchanged.

Employees	Trucks Vesta	Project One lorries	Notes
Trucks	1	5	
Train	<1	0	

10.4.1.6 Traffic distribution throughout the day for Project One site (Vesta entrance) (employees and freight) – operational phase

For the operational phase, the same distribution throughout the day as in the existing situation is assumed. This was described in § 10.2.2.4. The tables below provide an overview of the number of vehicles arriving at and departing from the site per hour during the operational phase. Table 10-39 provides an overview of the number of passenger car equivalents (1 PW = 1 PAE, 1VR = 2.5 PAE). The increase compared to the existing situation is shown in brackets. The figures for Vopak and Inovyn remain unchanged.

Table 10-39: Overview of traffic flows at business sites – PAE – operational phase (increase compared to existing situation in brackets)

	Entrance Project One (Vesta)	
	Incoming	Departing
5 a.m.-6 a.m.	17 (+12)	0 (+0)
6am-7am	1 (+1)	17 (+12)
7am-8am	165 (+115)	2 (+1)
3pm-4pm	7 (+6)	79 (+54)
4pm-5pm	4 (+4)	170 (+120)
5pm-6pm	1 (+1)	99 (+74)

10.4.1.7 Traffic distribution across the road network for Project One sites (employees and freight) – operational phase

As explained in § 10.2.1.5.2.1, the following distribution of traffic across the network is assumed for the various sites. For passenger cars:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%.
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 25%.
- South (Antwerp city and agglomeration), via Scheldelaan to Antwerp: 5%.

- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

For freight traffic:

- North (North Antwerp and the Netherlands), via Scheldelaan to complex 11-Zandvliet: 10%.
- East (Ghent, Linkeroever, East Flanders), via Scheldelaan to complex 12-Lillo and then Liefkenshoek Tunnel: 30%.
- South (city and agglomeration of Antwerp), via Scheldelaan to Antwerp: 0%
- East (Kempen, Mechelen, Brussels, wider region around Antwerp), via Scheldelaan to complex 12-Lillo and then Tijsmanstunnel: 60%.

This places a particularly heavy burden on the 12-Lillo complex. In the context of a worst-case scenario calculation, this is a good starting point, as this is already the busiest junction in the vicinity of Project One.

10.4.2 Road safety – operational phase

Road safety is considered as a theme for the various modes of transport. The number of conflicts between similar or different modes of transport is taken into account. A collision with a lorry is more serious than a collision with a passenger car.

Table 10-40: Assessment framework 'Road safety – operational phase'

Significance level	Description	Display
Significant negative effect	There is a significant negative effect because there are more points of conflict, because there are more conflicts, because the readability deteriorates and/or because there are more conflicts between road users with widely differing speeds and scale.	
Negative effect	There is a negative effect because there are more points of conflict or because the readability of existing points of conflict deteriorates. The type of conflict is similar to the current one, but there are more conflicts.	-2
Limited negative effect	There is a limited negative effect if the number conflict points and readability remain the same, while either the type of conflict, or the number of conflicts between different road users changes.	-1
Negligibleeffect	No change with regard to the current situation in terms of road safety.	0
Limited positive effect	There is a limited positive effect if the number of conflict points and readability remain the same, there is virtually There has been no change in the type of conflict. The number of conflicts between different road users is decreasing.	+1
Positive effect	There is a positive effect because there are fewer points of conflict or because the visibility of existing conflict points improves. The type of conflict is similar to the current one, but there are fewer conflicts.	+2
Significant positive effect	There is a significant positive effect because there are fewer points of conflict, because there are fewer conflicts, because readability improves and/or because there are fewer conflicts between road users with very different speeds and scale.	+3

10.4.2.1 Description of effects for the various modes of transport – operational phase

The possible effects on the road safety of pedestrians, cyclists and motorised traffic are described. A distinction is made between public domain and private zones on the site.

10.4.2.1.1 Pedestrian traffic – operational phase

The situation for pedestrians on Scheldelaan will remain unchanged. The necessary parking spaces for employees and visitors will be provided on the site itself, eliminating the need to use the parking spaces along Scheldelaan. As a result, little to no pedestrian traffic is expected on the public domain along Scheldelaan. The redevelopment of the administrative building will strictly separate motorised traffic and pedestrians.

Assessment of pedestrian traffic

There are no changes to the current situation with regard to road safety. The impact is assessed as negligible or no effect (0).

10.4.2.1.2 Cyclists – operational phase

The traffic safety of cyclists on the main cycle path, included as a supra-local functional route, located along Scheldelaan, is examined. In addition, the crossing movements of cyclists across Scheldelaan in order to reach their destinations are examined. Finally, the study will zoom in on the entrances to the Vopak, IMB, Inovyn and Vesta companies, as well as the reach of the bicycle bus stop.

1. Effect on through bicycle traffic along Scheldelaan

The continuous two-way cycle path (BFF) along Scheldelaan runs on the western side of Scheldelaan between Tijsmanstunnel and the Inovyn entrance. At the Inovyn intersection, cyclists must cross over, and the two-way cycle path runs on the eastern side between Inovyn and Berendrechtsluis.

The increase in traffic during the operational phase will not have a negative impact on the safety of bicycle traffic between the Tijsman Tunnel and Inovyn. This is because the two-way cycle path here is completely separate from Scheldelaan.
Between Inovyn and Vopak, the two-way cycle path is located on the side of the companies and there may be an impact on cycle traffic. No additional conflicts are expected between the Inovyn and Vopak intersections, as the increase in traffic in that direction will be limited.

Assessment of through bicycle traffic

There is a negligible effect (0) on through bicycle traffic. This is because the increase in traffic north of the Inovyn entrance will be limited.

2. Impact on local bicycle crossings

The effects on road safety as described in the construction phase section also apply here. During the operational phase, traffic volume will be significantly lower than during the construction phase. However, there will be an increase compared to the current traffic situation, which will lead to a rise in the number of conflicts.

Assessment of local bicycle crossings

There is a limited negative effect (-1) on local bicycle crossings. This is due to the increase in traffic movements.

3. Impact on cyclists' access to the business park (Vopak, IMB and Project One, Inovyn, Vesta) and the bicycle bus stop

Access for cyclists to the administrative building (Vesta/Project One) will be redesigned during the construction phase. Cycle paths and pedestrian facilities will be separated from road traffic, thereby reducing the number of conflicts.
The volume of traffic at the Vesta entrance will increase as a result of additional freight and passenger traffic. Employees of Vesta and Project One who arrive by bicycle will therefore be confronted with more (freight) vehicles.

The site and the Vopak access road will not be modified as part of this project. Traffic volume on the Vopak access road will return to current levels. The number of conflicts on the Vopak, IMB and Inovyn access roads will remain unchanged.

The situation for the Scheldelaan bicycle bus stop, located near the Tijsmanstunnel west, is the same as in the current situation. The bicycle crossing is protected by traffic lights; no additional conflicts are expected.

Assessment of local access for cyclists

No change to the current situation with regard to traffic safety (no effect (0)) at the Vopak, IMB and Inovyn sites. However, a limited negative effect (-1) is expected for current employees of the Vesta site, as the number of potential conflicts with traffic will increase.

10.4.2.1.3 Motorised traffic – operational phase

The consequences for road safety of the expected increase in traffic during the operational phase are being examined. The focus is on the Vesta/Project One intersection. The potential conflicts with vulnerable road users have already been described in the section on pedestrians and cyclists. The effect of additional traffic on road safety at the intersections will be studied in more detail. The following are important in terms of road safety:

- Capacity assessment: are there sufficient gaps in through traffic on Scheldelaan to allow traffic to flow safely? If this is not possible, appropriate traffic light control must be considered.
- Is the configuration of the intersection adapted to the additional traffic? For example, is the length of the Scheldelaan acceleration lanes sufficient? If not, traffic will build up on the Scheldelaan through lanes, with possible consequences for road safety.
- In the case of a traffic light-controlled intersection, it must be determined whether the additional traffic can be handled safely.

In addition, consideration is also being given to the locations where Scheldelaan will be reduced from two lanes to one lane and what the expectations are in terms of road safety in the event of an increase in traffic.

The impact assessment described in § 10.4.4 (Motorised traffic – Intersection management – operational phase) shows that the intersections (Vopak, IMB and Vesta) generally still have sufficient residual capacity. The traffic light-controlled intersection at Inovyn can be easily managed during the operational phase.

10.4.2.2 Assessment of road safety effects – operational phase

The impact on road safety during the operational phase is slightly negative (-1). This is mainly because the number of conflicts will increase due to the rise in motorised traffic. The number of conflict points for through bicycle traffic will remain the same.

A limited negative effect can be expected at the Vesta access point, where the concentration of motorised traffic will increase. This will lead to an increase in the number of conflicts. This will result in a limited negative effect (-1).

However, accompanying measures are possible that could further improve road safety. The following options could be studied further:

- Eliminating unprotected bicycle crossings on Scheldelaan.
- Removing parking spaces along Scheldelaan.
- Securing the Vesta/Project One intersections by means of traffic light control (conflict-free regulation).

- Correct and consistent implementation of markings and signage at the various entrances.
- At intersections that are not secured by traffic lights:
  - It is proposed to apply road markings (double arrow) to the marked cycle path to further emphasise the presence of cyclists in both directions. Warning sign M9 indicating a two-way cycle path, in combination with traffic sign B07 (stop sign for priority road) and a stop line for the cycle path, will be provided at the intersection... This will emphasise the presence of cyclists more effectively than in the current situation.
- Separation of motorised traffic and vulnerable road users on company sites.

This is discussed in more detail in § 10.7.2.

10.4.3 Motorised traffic – Road segment and network management – operational phase

The greatest traffic impact will occur during the construction phase, as this is when the largest flows (both freight and employees) will be generated. For this reason, the handling of road segments during the operational phase will not be studied separately. Handling at intersection level will be particularly relevant during this phase, as discussed below.

10.4.4 Motorised traffic – Intersection handling – operational phase

Various methods are used to estimate the saturation of intersections. Priority-controlled intersections are estimated using the Harders method, and traffic light intersections are subjected to an I/C test based on the Highway Capacity Manual. More information on this can be found in Appendix 4.11.

The intersections that will be studied are:

- Existing entrance and exit Project One (Vesta) x Scheldelaan
- Existing intersections R2 x Scheldelaan

The tables in the following chapters show the degree of resolution of the intersections. The result in the existing situation is shown in brackets. This makes it easy to determine the impact of the construction of Project One. The flowcharts for the intersections can be found in Appendices 4.18, 4.19, 4.20 and 4.21.

The table below indicates the reference framework used for the assessment.

Table 10-41: Assessment of saturation limits at intersections

		Increase in traffic intensities (in PAE)				**Status quo**	**Decrease in traffic intensities (in PAE)**			
		>50%	20-50	10-20	5-10	<5	5-10	10-20	20-50	>50%
Future saturation level situation	>100%	-3	-3	-3	-2	0	0	0	+1	+1
	90-100	-	-3	-	-1	0	0	+1	+2	+2
	80-90%	-2	-2	-1	-1	0	+1	+2	+3	+3
	<80%	-1	-1	0	0	0	+1	+3	+3	+3

It is possible that an intersection type that was planned for the construction phase can be optimised again for the operational phase (e.g. optimisation of traffic lights).

10.4.4.1 Intersection complex 12-Lillo – operational phase

The ICU method is again used for these light-controlled intersections. For an explanation of this method, please refer to Appendix 4.11. In the current situation, the clearance levels appeared to be sufficient at most times (both with figures for 2017 and 2030). The exception to this is the eastern intersection during the evening rush hour, where the saturation level in the baseline scenario is already 100%. The configuration of the intersections will remain unchanged, and the bypasses for right-turning traffic will remain in place (from the R2 towards Scheldelaan-Noord and from Scheldelaan-Zuid towards the R2).

When traffic from the operational phase is added to existing traffic, an increase in saturation levels can obviously be observed. This increase is always between 0 and 5%. In terms of traffic flow, a negligible or no effect (0) is generally expected at both intersections. Between 4 p.m. and 5 p.m., a limited negative effect (-1) is expected for the eastern intersection, based on both the 2017 and 2030 figures. It is important to note that the complex will be redesigned as part of the 2nd Tijsman Tunnel project, which is currently in the design phase. The exit complex will also be redesigned, assuming that sufficient traffic capacity will be provided.

Table 10-42: Assessment of intersections R2 – Operational phase (2017 and 2030) (the existing situation is shown in brackets).

	R2 – West				R2 – East			
	LoS (2017	I/C (2017)	LoS (2030)	I/C (2030)	LoS (2017	I/C (2017)	LoS (2030)	I/C (2030)
5-6	A (A)	55% (54%)	D (D)	77% (77%)	A (A)	51% (51%)	A (A)	47% (47%)
6am-7am	B (B)	62% (62%)	E (E)	84% (84%)	B (B)	59% (59%)	B (B)	60% (59%)
7am-8am	D (D)	79% (78%)	E (E)	84% (83%)	A (A)	55% (54%)	B (B)	62% (60%)
3pm-4pm	D (D)	80% (80%)	E (E)	84% (83%)	E (E)	85% (83%)	D (D)	80% (79%)
4pm-5pm	E (D)	82% (81%)	D (D)	82% (80%)	E (E)	86% (82%)	F (E)	91% (87%)
5pm-6pm	C (C)	69% (68%)	B (B)	60% (58%)	G (G)	103 (100%)	G (F)	101% (98%)

A (<55%) to D (<82%) indicates acceptable saturation levels, E (82%-91%) to F (91-100%) indicates critical saturation levels, and G (100%-109%) to H (>109%) indicates oversaturation.

10.4.4.2 Intersection entrance Project One (entrance Vesta) – operational phase

Given that this entrance currently operates according to a traditional right-of-way system, whereby traffic on Scheldelaan has right of way, the first step is to assess whether traffic lights are desirable from a traffic management perspective (in accordance with AWV service order 266, see Appendix 4.11). The assessment below applies to the operational phase, both in 2017 and 2030. It shows that no traffic lights are needed at the entrance to Project One (Vesta entrance).

Table 10-43: Assessment of intersections Project One (Vesta) – operational phase (2017 and 2030)

	Scheldelaan x Project One (Vesta) entrance
6 a.m.-7 a.m.	No traffic lights required
7 a.m.-8 a.m.	No traffic lights required
8 a.m.-9 a.m.	No traffic light required
3pm-4pm	No traffic light required
4pm-5pm	No traffic lights required
5pm-6pm	No traffic light required

10.4.4.3 Assessment of traffic flow at intersections – operational phase

For the various intersections, the impact of the additional traffic during the operational phase will be limited. The increase in saturation levels will remain below or equal to 5% and the threshold value of 82% will generally not be exceeded. This applies to the various rush hours, based on figures from both the 2017 and 2030 traffic models. The traffic flow at the intersections is estimated to have a negligible or negative effect (0).

An exception to this is the R2-East intersection, where saturation levels of 100% are already being recorded during the evening rush hour (4 p.m. to 6 p.m.) in the current situation. The additional traffic will lead to oversaturation of this intersection (limited negative effect (-1)).

A limited negative impact (-1) is expected at the Project One intersection (Vesta entrance), particularly for vehicles leaving the site. Flexible working hours will ensure a better distribution of departing traffic and reduce the problem. Traffic on Scheldelaan itself will not be affected.

10.4.5 Motorised traffic – Parking – Passenger cars – operational phase

During the operational phase, a traditional assessment of parking is appropriate. A balance is sought between meeting parking demand on the one hand (limiting parking pressure) and avoiding an oversupply of parking on the other (which could discourage the use of public transport, bicycles, etc.). A parking occupancy rate of 85% - 100% is then considered ideal. The assessment framework below will be used.

Table 10-44: Assessment framework 'Parking for passenger cars – operational phase'

Significance level	Description	Representation
Significant negative effect	The number of planned parking spaces is far from sufficient, which means that the parking pressure from private cars on public property. The number of parking spaces provided is far too high, which encouraging users to use their cars much more.	-3
Negative effect	The number of parking spaces provided is insufficient, which will cause the parking pressure of passenger cars in the public domain increases to a limited extent.	-2

Significance level	Description	Display
	The number of planned parking spaces is excessive, which will encourage users to use their cars more.	
Limited negative effect	The number of parking spaces provided is just sufficient, which sometimes results in limited parking pressure of passenger cars on public land.	-1
Negligibleornoeffect	The number of parking spaces provided is sufficient, resulting in there is no parking pressure on the surrounding area.	0
Limited positive effect	The number of planned parking spaces has a slight surplus, which means there is no parking pressure on the the surrounding area and discourages users from increased car use.	+1
Positive effect	The number of planned parking spaces is in surplus, which means that there is no parking pressure on the surrounding area. The number of planned parking spaces is just sufficient, encouraging users to reduce their car use their cars.	+2
Significantpositiveeffect	There is no surplus of parking spaces, which means Users are encouraged not to use the car.	+3

During the operational phase, parking pressure during possible shift changes will require extra attention.

10.4.5.1 Supply and use of passenger parking spaces – operational phase

No distinction is made between parking for visitors, parking for permanent employees and parking for contractors and temporary workers.

10.4.5.1.1 Provision of parking spaces – operational phase

A total of 460 parking spaces will be provided on the Project One site. 160 of these spaces will be designated as overflow parking. This means that 300 parking spaces will be available for the daily operation of Project One. The remaining 160 spaces can be used on days when more people (with cars) are expected to be present (e.g. turnover, exceptionally bad weather, etc.). Initially, 34 charging points for electric vehicles will be provided. This number may be expanded in the future.

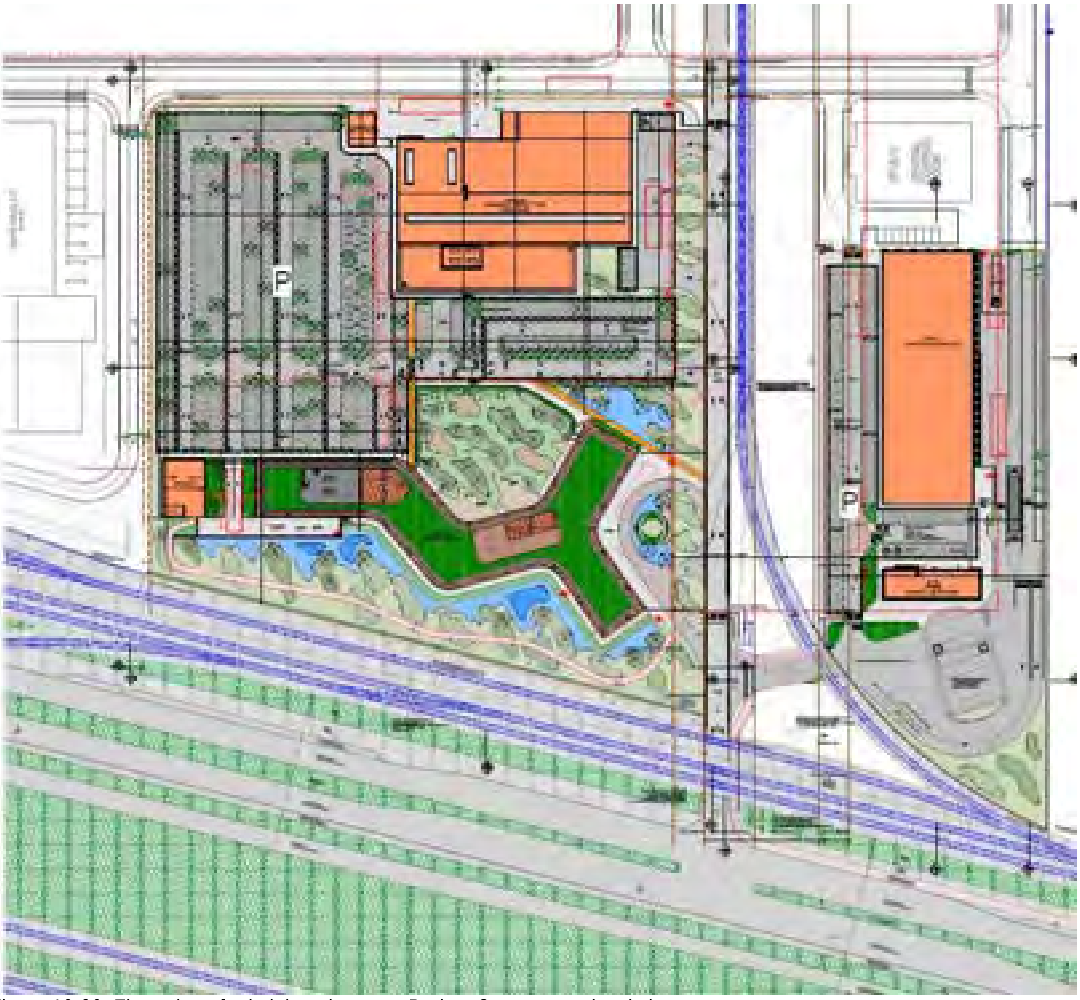


Figure 10-30: Floor plan of administrative zone Project One – operational phase

10.4.5.1.2 Parking – operational phase

The table below shows the number of arriving and departing vehicles at the new Project One site during the operational phase, as well as the resulting parking occupancy.

Based on the modal split (64% car) for white-collar and blue-collar workers, 262 parking spaces will be used throughout the day. That is 87% of the available spaces, excluding the overflow parking. This achieves ideal parking occupancy.

Table 10-45: Parking occupancy at Project One site – operational phase

	460 available spaces			
	Incoming	Departing	Parkers	Occupancy (%)
4-5 hours	0	0	12	4
5-6	12	0	24	8
6am-7am	1	12	12	4
7am-8am	115	1	126	42

	460 places available			
	Incoming	Departing	Parkers	Occupancy (%)
8 a.m.-9 a.m.	115	1	241	80
9am-10am	7	1	247	82
10am-11am	7	7	247	82
11 a.m.-12 p.m.	13	7	253	84
12:00-13:00	13	13	253	84
1:00 p.m. to 2:00 p.m.	22	13	262	87
2–3 p.m.	11	23	251	84
3pm-4pm	6	54	203	68
4pm-5pm	4	120	86	29
5pm-6pm	1	75	12	4
6pm-7pm	0	0	12	4

Assessment of parking for permanent employees:

With an occupancy rate of 87%, the car park has a good balance. With the overflow car park, there is also sufficient reserve capacity to cope with variations in traffic on the site and during major maintenance work.

The effect of employee parking is assessed as negligible (0) as a good balance has been found in the parking provision.

- gemiddelde bezettingsgraad 0-50%: groot overaanbod aan parkeerplaatsen;
- gemiddelde bezettingsgraad 50-70%: licht overaanbod aan parkeerplaatsen;
- gemiddelde bezettingsgraad 70-90%: goede bezettingsgraad;
- gemiddelde bezettingsgraad 90-100%: licht tekort aan parkeerplaatsen;
- gemiddelde bezettingsgraad > 100 %: groot tekort aan parkeerplaatsen.

Figure 10-31: Guidelines for Mobility Impact Studies, Mobility Assessment and Mober (2018)

10.4.5.1.3 Assessment of passenger traffic parking – operational phase

The number of parking spaces provided for visitors, permanent employees, contractors and temporary workers is sufficient, so there is no parking pressure on the surrounding area. The impact is assessed as negligible or no effect (0). With the overflow car park, there is also ample reserve capacity for peak periods, which means that pressure on the surrounding area can also be avoided at those times.

10.4.5.2 Provision and use of bicycle parking facilities at Project One site – operational phase

Initially, only employees and workers who would come by bicycle will be taken into account.

10.4.5.2.1 Provision of bicycle parking facilities – operational phase

Initially, 72 bicycle parking spaces will be provided in a separate covered bicycle parking facility in the north-east corner of the admin campus. A two-way cycle path runs to the bicycle parking facility (see Figure 10-32). Thirty-four of these will be equipped with charging equipment for electric bicycles. In time, it will be possible to expand this provision.

Figure 10-32: Floor plan of the administrative zone of Project One – section of bicycle parking facility – operational phase

10.4.5.2.2 Use of bicycle parking facilities – operational phase

Based on the expected *modal split* and the expected number of employees, the following estimate can be made of the number of cyclists for the Project One site during the operational phase.

Table 10-46: Distribution of employees – Operational phase

	Total (100%)	Private car (64%)	Carpool (6%)	Motorcycle (4%)	Public transport (8%)	Bicycle (17%)
Employees	268	171	16	11	21	45
Labourers	90 (5 shifts), max. 2 shifts present = 36	23	2	2	3	6

10.4.5.2.3 Assessment of bicycle parking facilities – operational phase

The number of planned bicycle parking spaces is more than sufficient. However, there are two factors that may lead to increased use of the bicycle parking facilities:

- The current modal split is not favourable. Initiatives will be taken to make it more sustainable. This will lead to an increase in the number of cyclists. In the long term, it may be necessary to convert some of the planned parking spaces into bicycle parking facilities.
- Developments in the field of electric bicycles, speed pedelecs and taxation will also promote a further increase in the number of cyclists.

The aspect of bicycle parking facilities is therefore assessed as having a negligible or no effect (0), as there is room for growth (which, admittedly, could be quickly exhausted). Continuous monitoring remains necessary.

10.4.6 Motorised traffic – Parking – Lorries – operational phase

When assessing truck parking, the main consideration is meeting parking demand. This is to avoid spillover into the public domain or queues on the carriageway. A parking occupancy rate of 95% - 100% is considered ideal. The following assessment framework is used.

Table 10-47 Assessment framework 'Truck parking – operational phase'

Significance level	Description	Representation
Significant negative effect	The number of planned parking spaces is structurally ample Insufficient, resulting in parking pressure from lorries on public land is increasing significantly.	-3
Negative effect	The number of planned parking spaces is insufficient, resulting in increased parking pressure from lorries on public to a limited extent.	-2
Limited negative effect	The number of planned parking spaces is just sufficient, resulting in sporadic limited parking pressure of lorries on public land.	-1
Negligibleornoimpact	The number of planned parking spaces is sufficient, so there is no parking pressure on the surrounding area.	0
Limited positive effect	Not applicable.	+1
Positive effect	Not applicable	+2
Significant positive effect	Not applicable	+3

10.4.6.1 Provision of parking spaces for freight traffic – operational phase

At the entrance to Project One (east side entrance to Vesta), there will be space for six additional freight parking spaces. These will only be used by lorries travelling to Project One. A weighbridge will be provided.

Figure 10-33: Floor plan of the Project One administrative zone – operational phase

10.4.6.2 Use of parking spaces for freight traffic – operational phase

Five lorries are expected at the Project One site on a daily basis.

10.4.6.3 Assessment of lorry parking – operational phase

Freight traffic arrives spread out throughout the day. With even distribution and smooth handling at check-in, this results in a maximum of one parked lorry per hour, which means there will always be ample margin. The parking capacity is more than sufficient, so there will be no parking pressure on the surrounding area. The surplus of parking spaces is intended to ensure that there is sufficient space even at peak times or when there is a concentration of freight, in order to prevent parking along Scheldelaan. The impact is assessed as <u>negligible or no effect (0).</u>

10.5 Cumulative effects

10.5.1 Quay wall

The initiator of the quay wall construction is the Antwerp Port Authority, and the environmental permit (with project EIA) was obtained on 28 October 2020. The information in this chapter is based on the EIA prepared by Antea on behalf of the Antwerp Port Authority.

Construction of the quay wall started in March 2021. Phases 1 and 2 of the quay wall have been completed. See § 5.4.1 for more information about the quay wall.

10.5.1.1 During the construction phase

The construction phase of the quay wall at Canal Dock B2, between docks 1 and 2, overlaps with the development works for Project One (preparatory groundworks, construction of new installations such as production units, tanks, loading and unloading installations, etc.). Cumulative effects will therefore occur during the construction phase of both projects.

The total construction period for the quay wall is estimated at approximately 33 calendar months. Work commenced in early 2021 and is scheduled for completion by early 2024.

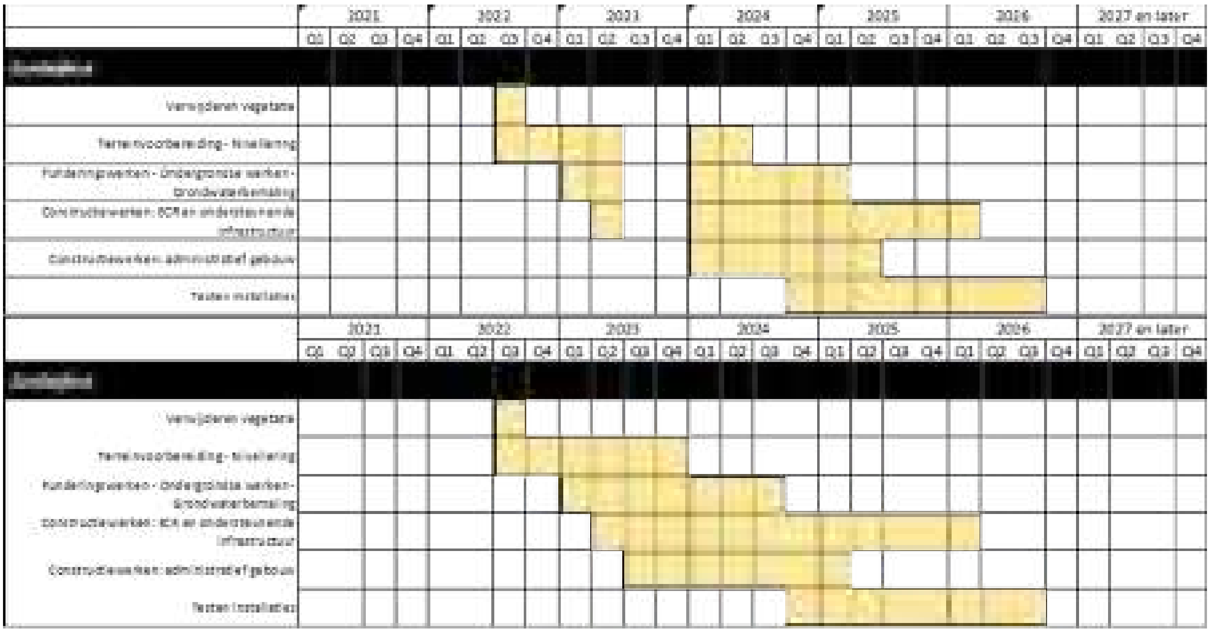


Figure 10-34: Proposed schedule for the works

The construction of the new quay wall will generate site traffic. This site traffic will be spread across the various phases of the project, with the main site traffic being generated by the transport of excavated soil and fill soil. It should be noted that most of the soil transport, namely the approx. 1.6 million m³ of dredged material for the widening and deepening of the canal dock near the new quay wall, will be transported by water and will therefore not generate any road traffic. The delivery of materials for the construction of the combi wall (tubular piles, MV piles and sheet piles) will also be carried out by water.

The excavated soil for the construction pit for the new quay wall and the backfill soil totals approximately 41,354 m³ (65,878 m³ - 24,524 m³), or approximately 62,031 tonnes. The duration of the delivery and removal will be 4 months or 84 working days (based on 21 working days per month).

Taking into account a load capacity of approximately 40 tonnes/lorry, this will therefore require
1,551 lorry journeys will be required. This equates to approximately 19 journeys (38 movements) per day. The lorries will travel via the site road and Scheldelaan to the higher road network (R2 and A12).

The peak period in absolute PAE for Project One is in month 67 – June 2024 (see Appendix 4.12). The traffic generated by the works on the quay wall (19 trips per day during the peak period / 47.5 PAE) combined with the site traffic from Project One will remain below the maximum PAE in month 67, which is being studied in this EIA to estimate the effects during the construction phase. However, the peak in site traffic for the quay wall is likely to have occurred earlier (in the first months of the construction phase, when most of the materials were delivered) and therefore overlap even less with the build-up to the peak in site traffic for Project One.

For road transport, there may therefore be a cumulative effect over a period of four months, which will only have an impact in the port area (outside residential areas). However, the impact will be very limited, so a negligible effect (0) is expected.

10.5.1.2 During the operational phase

Now that the quay wall has been (partially) completed, it can be put into use for the further construction work on Project One. No cumulative effects are expected now; on the contrary, the quay wall provides additional mooring places and facilitates the supply of materials by ship.

The EIA for the quay wall estimated that the new quay wall will increase the number of ships handled annually in the port. This growth is estimated at approximately 1% of the total number of ships currently handled.

10.5.2 Execution of utility works by Elia and Waterlink

In 2023 and 2024, Elia and Waterlink will be carrying out work on utility pipes along Scheldelaan. As a result of this work, traffic on Scheldelaan will temporarily be restricted to two lanes in each direction. An additional development scenario is therefore being calculated here to estimate the impact of this reduction on Scheldelaan.

10.5.2.1 Timing and content of the works

Elia's works commenced at the end of 2023 and will last for one year. During this period, all traffic on Scheldelaan will be restricted to two lanes in each direction. The worksite extends from the junction with the Tijsman Tunnel to the Project One site.

In addition, Waterlink will also carry out work along Scheldelaan. This work is also planned for 2023-2024. Waterlink's work will have a more limited impact, as it is planned in the pipe trench next to the carriageway.

A calculation will therefore be carried out in which all traffic will have to be handled on a 2x1 carriageway.

10.5.2.2 Assessment framework – Handling of road segments and network

In this development scenario, we are only assessing the segments of Scheldelaan.

The I/C ratio – the saturation level – is again used for the assessment. This reflects the ratio between the expected intensities (in PAE per hour) and the capacity on a particular road section. In this context, the main focus is on whether a certain limit value is exceeded. This is because capacity on Scheldelaan is declining. If the I/C ratio is less than 80%, smooth traffic flow is expected. An I/C ratio above 90% is considered problematic.

Table 10-48: Assessment of limit values for I/C ratio – road segments

		Increase in traffic intensities (in PAE)				Status quo	Decrease in traffic intensities (in PAE)			
		>50%	20-50	10-20	5-10	<5	5-10	10-20	20-50	>50%
I/C ratio future situation	>100%	-3	-3	-3	-2	0	0	0	+1	+1
	90-100	-3	-3	-2	-1	0	0	+1	+2	+2
	80-90	-2	-2	-1	-1	0	+1	+2	+3	+3
	<80%	-1	-1	0	0	0	+1	+3	+3	+3

10.5.2.3 Overview of traffic intensities at Project One construction site

During the Elia and Waterlink construction period, the traffic volumes shown below are expected during month 67. This month represents the worst-case scenario with the highest estimated number of vehicles. These figures are used for traffic allocation, similar to the methods used in previous chapters (spread throughout the day, spread across the road network, etc.).

Table 10-49: Expected vehicles for Project One construction site during utility works

	Month 67
Buses	10
Minibuses	29
Passenger cars	686
Shuttle buses	59
Concrete mixers	53
Freight between north and south zones	32
Freight directly to the north zone	11
Freight directly to the south zone	24
Freight from transhipment sites to south zone	17
Total freight to southern zone	**136**
Freight to transhipment sites	10

10.5.2.4 Comparison between Project One site and Elia and Waterlink site

In order to assess the impact of the Project One construction site at this stage, the intensities for the relevant road segments are listed below. The numbering of the segments corresponds to the numbering used earlier in this report. As in the chapter on the construction phase, only the figures from the 2017 base model are used.

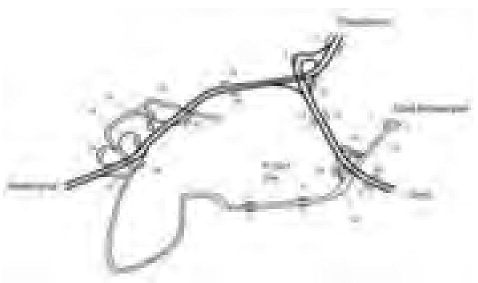


Figure 10-35: Overview of road segments

The following segments are being studied:

- 1: Scheldelaan north towards Bergen-op-Zoom (NL);
- 2: Scheldelaan north towards Project One;
- 3: Scheldelaan middle lane towards Project One;
- 4: Scheldelaan centre towards Antwerp;
- 5: Scheldelaan south towards Project One;
- 6: Scheldelaan south towards Antwerp.

10.5.2.4.1 Scenario: Traffic on 2x1 instead of 2x2

This shows that for most segments, the reduction in capacity does not cause any problems, as the critical value of 80% is not exceeded. However, there are a few important exceptions:

- Segment 3: Scheldelaan middle segment, between complex R2 and Project One
  - at 5 a.m.: increase of 16% to 92%: negative effect (-2)
  - at 6 a.m.: increase of 25% to 112%: significant negative effect (-3)
  - at 7 a.m.: increase of 4%: no effect (0)
    - The increase due to construction traffic is very limited during this time. The saturation is the result of other traffic already on this segment.
- Segment 4: Middle section of Scheldelaan, between Project One and complex R2
  - at 4 p.m.: increase of 18% to 106%: significant negative effect (-3)
  - at 5 p.m.: increase of 23% to 115%: significant negative effect (-3)

Mitigating and accompanying measures in relation to traffic flow are possible and are discussed in § 10.7.3.

Table 10-50: Overview of intensities and capacities Development scenario for Elia and Waterlink utility works

	Segment	Excluding Project One site					Including Project One construction site				
		PAE 2017 model	Cap model 2017	Sat model 2017	Cap Elia	Sat Elia	Increase in Project One yard	PAE model + shipyard	Cap yard Project One	Cap Elia	Sat shipyard Project One + Elia
	1	983	3,414	29	3,414	29	-	983	29	3,414	29%
	2	494	3,440	14	3,440	14	24	518	15	3,440	15
	3	1,304	3,414	38	1,707	76	260	1,564	46	1,707	92
	4	692	3,440	20	1,720	40	17	709	21	1,720	41
	5	180	3,440	5	3,440	5	9	189	5	3,440	5
5 6 hou	6	167	3,440	5	3,440	5	-	167	5%	3,440	5%
	1	860	3,414	25	3,414	25%	1	861	25	3,414	25
	2	886	3,440	26%	3,440	26	36	922	27	3,440	27
	3	1,483	3,414	43	1,707	87	421	1,904	56	1,707	112%
	4	1,133	3,440	33	1,720	66	47	1,180	34%	1,720	69
	5	237	3,440	7	3,440	7	15	252	7	3,440	7
6 7 hou	6	617	3,440	18	3,440	18	1	618	18	3,440	18
	1	1,286	3,335	39	3,335	39	2	1,288	39	3,335	39
7 8 hou	2	728	3,434	21%	3,434	21	1	729	21	3,434	21

	Segment	Excluding Project One site					Including Project One shipyard				
		PAE 2017 model	Cap model 2017	Sat model 2017	Cap Elia	Sat Elia	Increase in Project One yard	PAE model + shipyard	Cap Project One site	Cap Elia	Sat shipyard Project One + Elia
	3	1,896	3,304	57	1,652	115	64	1,960	59	1,652	119%
	4	914	3,440	27%	1,720	53	46	960	28	1,720	56
	5	418	3,327	13	3,327	13	1	419	13	3,327	13
	6	596	3,437	17	3,437	17	1	597	17	3,437	17
	1	785	3,379	23	3,379	23	1	786	23	3,379	23
	2	1,074	3,440	31%	3,440	31	1	1,075	31	3,440	31
	3	1,039	3,360	31	1,680	62	46	1,085	32%	1,680	65
	4	1,561	3,440	45%	1,720	91	63	1,624	47%	1,720	94%
-16	5	472	3,395	14	3,395	14	1	473	14	3,395	14
3 nm	6	254	3,440	7	3,440	7	1	255	7	3,440	7
	1	703	3,396	21	3,396	21	24	727	21	3,396	21
	2	996	3,439	29	3,439	29	1	997	29	3,439	29
	3	905	3,382	27	1,691	53	68	973	29	1,691	58
	4	1,509	3,440	44	1,720	88	319	1,828	53	1,720	106
-5 nm	5	460	3,408	13	3,408	13	1	461	14%	3,408	14
4 nm	6	207	3,440	6	3,440	6	10	217	6	3,440	6
	1	583	3,375	17	3,375	17	36	619	18	3,375	18
	2	1,125	3,439	33	3,439	33	1	1,126	33	3,439	33
	3	762	3,348	23	1,674	46	52	814	24	1,674	49
	4	1,577	3,440	46	1,720	92	407	1,984	58	1,720	115%
-18	5	486	3,375	14	3,375	14	1	487	14	3,375	14%
5 nm	6	310	3,439	9	3,439	9	15	325	9	3,439	9

10.5.2.5 Conclusion

The reduction in the number of available lanes on Scheldelaan (2x1 instead of 2x2) reduces capacity. This does not cause problems on most segments and at most times. As expected, however, segments 3 (morning rush hour) and segments 4 (evening rush hour) carry too much traffic, mainly due to the increase caused by construction traffic.

In a scenario where all traffic on Scheldelaan between R2 and Project One has to use a 2x1 carriageway, significant negative effects (-3) are expected on this segment. However, in practice, it is expected that employees of surrounding businesses will adjust their driving routes and use the 11-Zandvliet complex and the north side of Scheldelaan during this period.

10.5.3 Oosterweel connection

After consultation with Lantis, it appears that the construction period for Project One overlaps significantly with that of the works managed by Lantis. These include the works on the Antwerp Ring Road, Oosterweel, Tijsman Tunnel, etc. This chapter therefore takes a closer look at the cumulative effects of the various construction sites. It examines the capacity of several road sections (R2, A12) and the consequences of changes in traffic patterns.

10.5.3.1 Assessment framework – Road segment and network settlement

Due to the size of the project and the high volume of traffic generated during the construction phase and the size of the Lantis sites, the traffic network in a wide area is being studied.

For this reason, the Antwerp Regional Traffic Model (RVm) is being used, which has also been used to calculate various scenarios for the Lantis construction period. Specific information about the traffic generated by Project One is being manually added to the reference situation for the Lantis construction site. An assessment of the possible traffic effects is being made on the basis of expert judgement.

The assessment uses the I/C ratio – the saturation level. This reflects the ratio between the expected intensities (in PAE per hour) and the capacity on a particular road section. The assessment looks at the extent to which the intensities evolve in relation to the reference situation. At the same time, it is examined whether a certain limit value is exceeded. If the I/C ratio is less than 80%, smooth traffic flow is expected. An I/C ratio above 90% is considered problematic. The reference framework below is used (see table). In summary, it can be said that if the increase in traffic results in a saturation level above 80%, the assessment is gradually negative.

Table 10-51: Assessment of limit values for I/C ratio – road segments – construction phase

		Increase in traffic intensities (in PAE)				Status quo	Decrease in traffic intensities (in PAE)			
		>50%	20-50	10-20	5-10	<5	5-10	10-20	20-50	>50%
I/C ratio future situation	>100%	-3	-3	-3	-2	0	0	0	+1	+1
	90-100%	-3	-3	-2	-1	0	0	+1	+2	+2
	80-90	-2	-2	-1	-1	0	+1	+2	+3	+3
	<80%	-1	-1	0	0	0	+1	+3	+3	+3

10.5.3.2 Overview of relevant sites Lantis

Specifically, the following relevant works are planned as part of the Oosterweel connection:

- Works on the Antwerp Ring Road, starting in approximately 2022, duration approximately 8 years.
  - The capacity of the ring road will be reduced by one lane (= approximately 1,500 PAE/hour) in the southbound direction, along the entire route from the Jozef Masure Bridge to the E313 exit lane (segment 52 below).
  - Traffic will be redistributed due to reduced capacity. Traffic from the Netherlands to Linkeroever will travel via the Liefkenshoek Tunnel instead of the Kennedy Tunnel.
- Construction of the Scheldt Tunnel, starting in 2021.
  - Scheldelaan will be closed at the Kastelweg intersection; only local traffic to TPA will be permitted. Traffic will be diverted via OWS – Kastelweg.
- Construction of the second Tijsman tunnel, currently in the study phase, no timing for implementation yet.
- Work on the Oosterweel junction, planned for 2026-2027.

Figure 10-36: Indication of capacity reduction on the A12 between Jozef Masurebrug and the E313 exit lane

10.5.3.3 Results of traffic model development scenario

As part of the above-mentioned works, simulations were carried out by the Flemish Traffic Centre. These simulations examine the impact of the various construction phases. Like the models used previously for 2017 and 2030, this model is based on the existing *modal split*. The ambitious 50/50 *modal split* proposed by the Antwerp Transport Region is therefore not yet included.

The figures below are excerpts from the traffic model that was constructed for the Lantis site. They show the expected intensities on different road sections. The figures indicate PAE/hour, based on the most significant quarter hour. These intensities are therefore *worst case scenarios* for the morning and evening rush hours respectively. In this case, these occur between 7 a.m. and 8 a.m. and between 5 p.m. and 6 p.m. respectively.

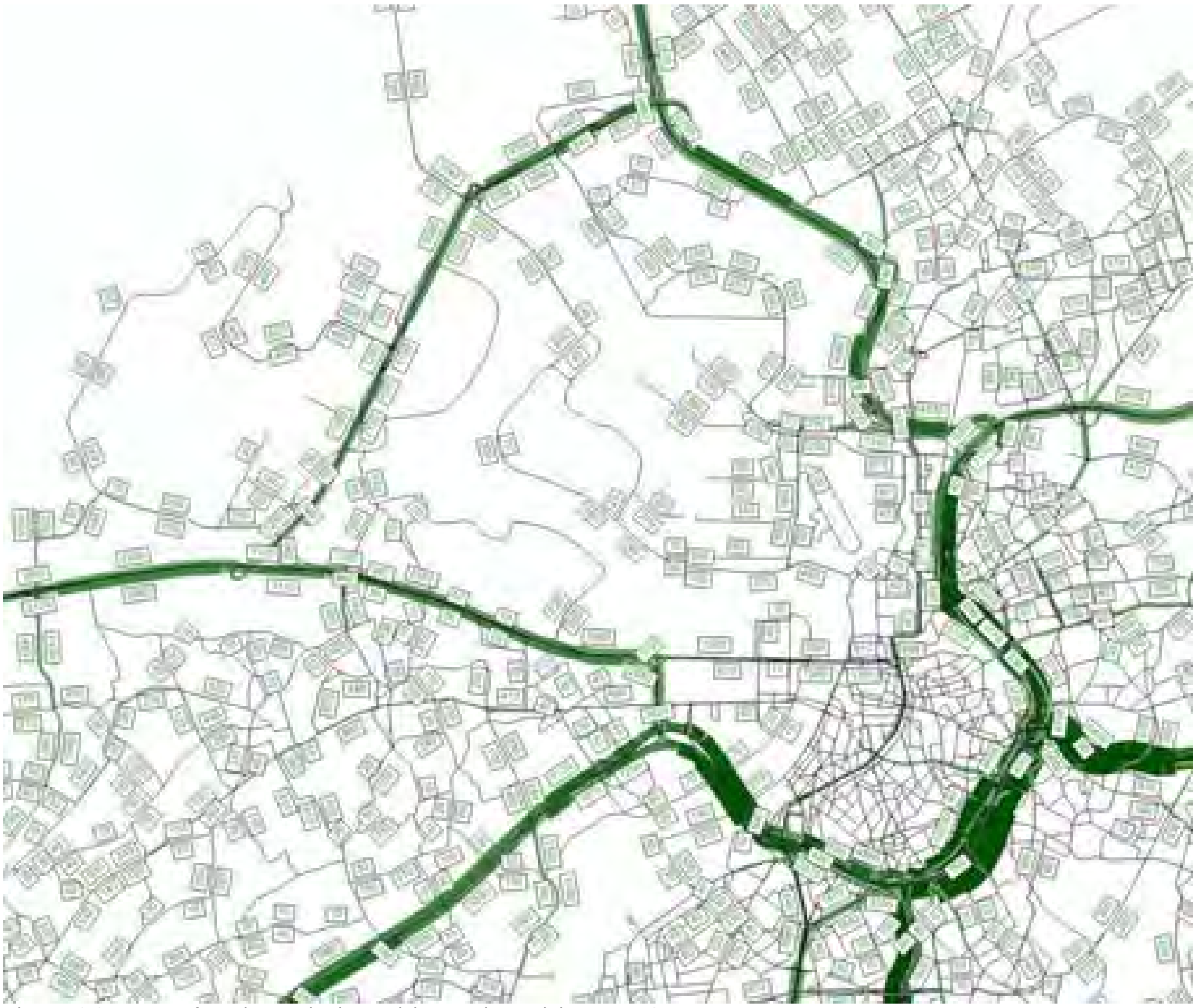


Figure 10-37: Extract from the Lantis site model – morning rush hour – AMS

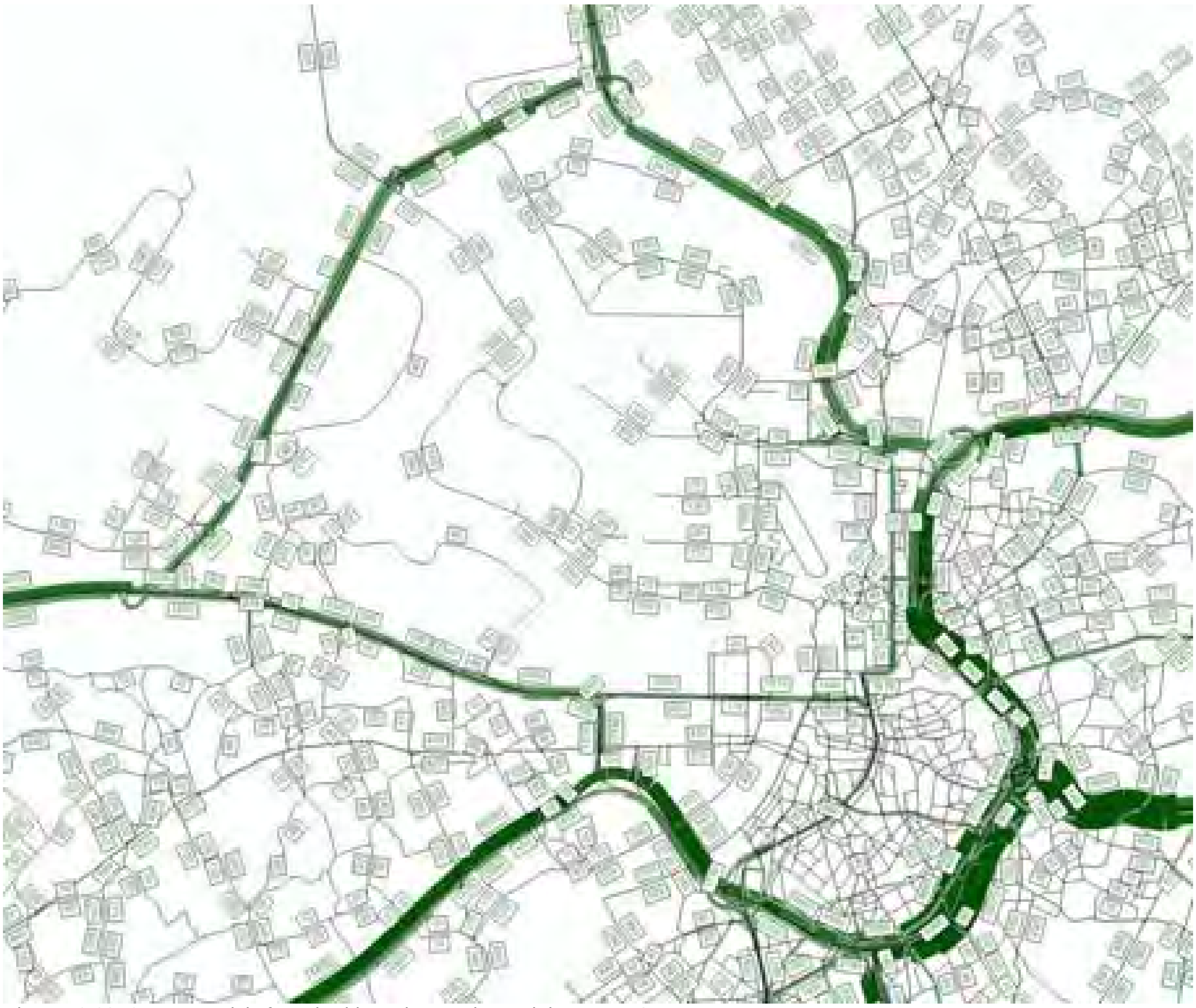


Figure 10-38: Cut-out model of Lantis shipyard – evening rush hour – AMS

10.5.3.4 Comparison between Project One construction site and Lantis construction site

In order to assess the impact of the Project One construction site, the intensities for the relevant road segments are listed below. The numbering of the segments corresponds to the numbering used earlier in this report. In each case, both the figures from the 2017 base model and the Lantis model are shown so that both can be compared.

The figures obtained from the Lantis model are an extrapolation of the busiest quarter hour. The specific figures for 6 a.m. to 7 a.m., which are in fact most relevant to Project One's construction traffic, were therefore not provided. The table below shows that in the 2017 model, some road sections are more heavily congested between 6 a.m. and 7 a.m., while other road sections are more heavily congested between 7 a.m. and 8 a.m.

However, the figures between 7 a.m. and 8 a.m. provide a good reference. The segments that are more heavily loaded between 6 a.m. and 7 a.m. according to the 2017 model also have ample reserve capacity according to the Lantis model (segments 12 and 17), or already deserve extra attention with the intensities used (segments 7 and 11). The use of the extrapolation of the busiest quarter hour is therefore justified and sufficiently representative.

The same consideration applies to the evening rush hour, with the difference that the busiest quarter of an hour effectively corresponds to the busiest time interval for Project One (5 p.m. to 6 p.m.).

The following segments are being studied:

- 7: A12 northbound;
- 8: A12 southbound;
- 11: Tijsman Tunnel westbound;
- 12: Tijsman Tunnel eastbound;
- 17: Liefkenshoek Tunnel westbound;
- 18: Liefkenshoek Tunnel eastbound;
- 52: additional segment, between Jozef Masurebrug and exit lane E313 southbound.
  - Capacity will be reduced in this segment during the works on the Antwerp Ring Road.
  - According to the distribution of traffic across the road network, provided by INEOS and explained in § 10.3.2.1.7, it can be expected that around 50% of construction traffic will travel on this segment.

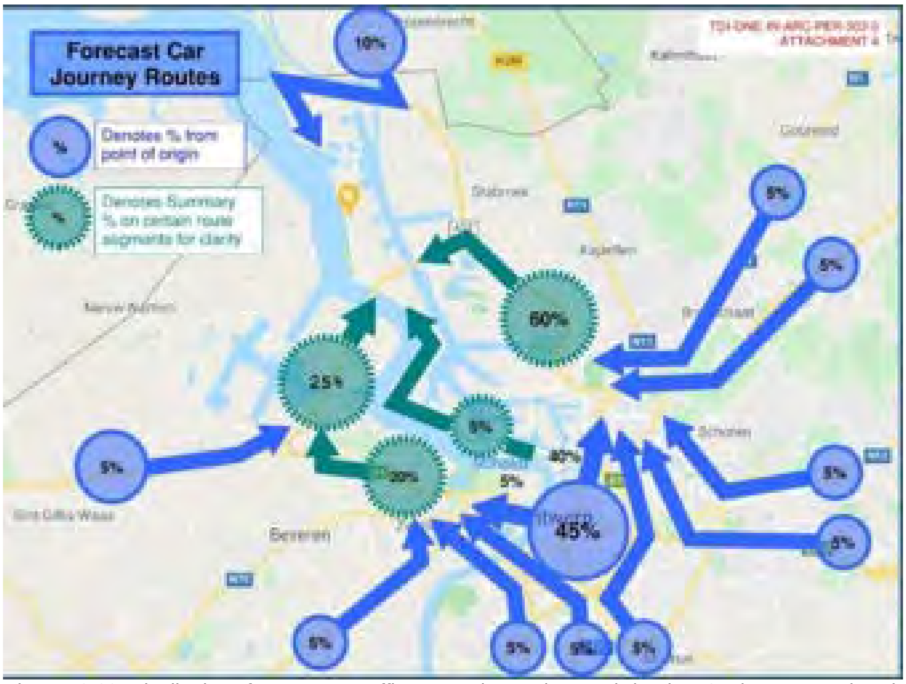


Figure 10-39: Distribution of passenger traffic across the road network (Project One) – construction phase

The following figures are given for both models:

- (1): PAE model;
- (2): Theoretical capacity model;
- (3): Saturation according to model (PAE/CAP = (1)/(2));
- (4): Increase in PAE due to Project One shipyard;
- (5): PAE model + PAE Project One site;
- (6): Saturation of site traffic (4)/(5).

Table 10-52: Overview of intensities and capacities Development scenario Oosterweel

		Model 2017						Model Lantis					
	segment	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	7	3,321	3,971	84	297	3,618	91	4,370	3,971	110	297	4,667	118
	8	2,252	3,998	56	15	2,267	57	2,880	3,998	72	15	2,895	72%
6 7 hours	11	2,773	4,274	65	297	3,070	72	3,390	4,274	79	297	3,687	86
	12	1,929	4,300	45	16	1,945	45%	1,640	4,300	38	16	1,656	39

	segment	Model 2017						Model Lantis					
		(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	17	1,705	4,300	40	8	1,713	40	2,060	4,300	48	8	2,068	48
	18	1,891	4,300	44	129	2,020	47	2,100	4,300	49	129	2,229	52
	52	7,006	8,000	88	13	7,019	88	5,100	6,500	78%	13	5,113	79
	7	3,118	3,676	85	10	3,128	85	4,370	3,676	119	10	4,380	119
	8	3,212	3,943	81	26	3,238	82	2,880	3,943	73	26	2,906	74%
	11	2,554	4,211	61	12	2,566	61	3,390	4,211	81	12	3,402	81
	12	1,635	4,300	38	28	1,663	39	1,640	4,300	38%	28	1,668	39
	17	1,496	4,254	35	14	1,510	36	2,060	4,254	48	14	2,074	49
	18	2,011	4,300	47	7	2,018	47	2,100	4,300	49	7	2,107	49
7 8 hou	52	7,073	8,000	88%	22	7,095	89	5,100	6,500	78%	22	5,122	79
	7	2,491	3,821	65	21	2,512	66%	2,830	3,821	74	21	2,851	75
	8	3,028	3,989	76%	195	3,222	81	3,410	3,989	85	195	3,605	90
	11	2,682	4,247	63	23	2,705	64	2,460	4,247	58	23	2,483	58
	12	3,657	4,300	85	197	3,853	90	3,850	4,300	90%	197	4,047	94
	17	3,091	4,284	72	87	3,178	74	2,720	4,284	63	87	2,807	66
-5 n.m.	18	2,938	4,300	68%	12	2,950	69	2,900	4,300	67%	12	2,912	68
4 n.m.	52	6,956	7,466	93	162	7,118	95	5,100	5,966	85	162	5,262	88%
	7	2,599	3,535	74%	21	2,620	74	2,830	3,535	80	21	2,851	81
	8	2,936	3,882	76	293	3,228	83	3,410	3,882	88	293	3,703	95
	11	2,595	3,861	67	22	2,617	68	2,460	3,861	64	22	2,482	64
	12	3,190	4,299	74	294	3,484	81	3,850	4,299	90	294	4,144	96
	17	2,960	3,902	76	128	3,088	79	2,720	3,902	70	128	2,848	73%
-18	18	2,342	4,297	55	11	2,353	55	2,900	4,297	67%	11	2,911	68
5 n.m.	52	6,986	6,857	102	244	7,230	105	5,100	5,357	95	244	5,344	100

This shows that for most segments, the increase in saturation is limited and that the critical value of 80% is not exceeded. However, there are some important exceptions:

- Segment 7: Segment A12 towards the Netherlands, southeast of junction A12/R2
  - at 6 a.m.: increase of 8% to 118%: negative effect (-2)
    - Given that, according to the 2017 model, traffic is heavier between 6 a.m. and 7 a.m. than between 7 a.m. and 8 a.m., this may be a slight underestimate. However, the percentage increase will remain virtually unchanged, so a negative effect (-2) is still expected.
- Segment 8: Segment A12 towards Antwerp, southeast of junction A12/R2
  - at 4 p.m.: increase of 5% to 90%: limited negative effect (-1)
    - Given that, according to the 2017 model, traffic is heavier between 4 p.m. and 5 p.m. than between 5 p.m. and 6 p.m., this may be a slight underestimation. However, the percentage increase will remain virtually unchanged, so a limited negative effect (-1) is still expected.
  - at 5 p.m.: increase of 7% to 95%: limited negative effect (-1)
- Segment 11: Tijsman Tunnel towards Ghent (westbound)
  - at 6 a.m.: increase of 7% to 86%: limited negative effect (-1)
    - Given that, according to the 2017 model, traffic is heavier between 6 a.m. and 7 a.m. than between 7 a.m. and 8 a.m., this may be a slight underestimation. However, the percentage increase will remain virtually unchanged, so a limited negative effect (-1) is still expected.
- Segment 12: Tijsman Tunnel towards Antwerp (eastbound)
  - at 4 p.m.: increase of 4% to 94%: negligible effect (0)
    - Given that, according to the 2017 model, traffic is heavier between 4 p.m. and 5 p.m. than between 5 p.m. and 6 p.m., this may be a slight underestimation. However, the percentage increase will remain virtually unchanged, so the expected effect will still be negligible (0).
  - At 5 p.m.: increase of 6% to 96%: limited negative effect (-1)
- Segment 52: A12 southbound between Jozef Masurebrug and exit lane to E313 (southbound)
  - at 5 p.m.: increase from 5% to 100%: limited negative effect (-1)

Mitigating and accompanying measures in relation to traffic flow are possible and are discussed in § 10.7.3.

10.5.3.5 Conclusion

Due to the reduction in capacity on the A12 towards Merksem, a large part of the traffic flows on the Antwerp Ring Road will shift. A considerable portion of this traffic will travel via the A12 to the Tijsman Tunnel and Liefkenshoek Tunnel, which means that more traffic can be expected on segment 7 during the morning rush hour. This shift is so significant that the road segment under study will be saturated. (negative effect -2).

Conversely, problems will arise during the evening rush hour as a result of the reduction in capacity on the southbound section of the A12 (section 52). More than 50% of Project One's construction traffic is expected to follow this route, which will also lead to congestion on this section of road (section 52). However, the percentage increase is limited, so a limited negative effect (-1) is expected.

A limited negative effect (-1) is also expected on segment 8 during the entire evening rush hour from 4 p.m. to 6 p.m. According to the Lantis model, a significant increase in traffic is also expected on this segment, to which the construction traffic from Project One must be added.

A limited negative effect (-1) is also expected in the Tijsman Tunnel (segment 11 during the morning rush hour and segment 12 during the evening rush hour). The Lantis construction site is expected to cause an increase in traffic on the R2, which will be compounded by the incoming and outgoing construction traffic from Project One.

10.6 Development scenarios

10.6.1 ECA

On 15 July 2016, the Flemish Government took the initial decision for the Complex Project 'Realisation of additional container handling capacity in the Antwerp Port Area' (abbreviated to ECA).

The project has three objectives: to create additional container handling capacity, to develop associated industrial/logistics sites on the port platform, and to construct a multimodal access route to the main transport network. On 31/01/2020, the Flemish Government took the preferred decision regarding the realisation of additional container handling capacity in the Antwerp Port Area. An amended Process Note was published on 13/06/2023 following the completion of the elaboration phase. For an explanation of the approach chosen for the further procedures, please refer to section 5.5.1 of this EIA.

According to the preferred alternative (alternative 9), the realisation of the complex ECA project will mainly result in additional shipping traffic and the impact on supra-local road traffic will be limited. The following conclusion is drawn with regard to road traffic:

> *“The impact on the higher road network is also very limited in all alternatives in access scenario 1 and access scenario 2. For each alternative, there are a maximum of 1 to 2 road segments where a limited negative effect is observed. In general, we see that the R2 (which is the least congested Scheldt crossing at motorway level in both reference situations) is subject to additional congestion. Due to the already high congestion of the Kennedy Tunnel, only a limited proportion of the additional traffic will choose this route, which means that the impact here will remain limited." (CP ECA p67)*

However, the increase in that segment of the R2 is limited to around 50 to 150 PAE per rush hour per direction. This impact is only expected after the completion of a number of infrastructure projects within the framework of ECA.

A clear timeline for these works and their expected impact is not known. However, it is expected that not all interventions will be completed before the end of the construction phase of Project One.

This development scenario is of little relevance to the Mobility discipline.

10.7 Recommendations, mitigating measures and accompanying measures

The overview below sets out recommendations (desirable), mitigating measures and accompanying measures. For each measure, it is indicated for which negative effect it is proposed, whether it is necessary or rather desirable, and who is responsible for its implementation/organisation. A distinction is made between organisational measures and infrastructural measures.

Accompanying measures include possible interventions to the road network that could primarily improve traffic safety and traffic flow on and around Scheldelaan in general. These measures are highly dependent on the ambitions of the road authority and cannot be realised by Project One on its own.

10.7.1 Mitigating and accompanying measures – construction phase

The measures included in § 10.3.1. Measures from Project One – construction phase” also apply here.
application and should be implemented as much as possible during the construction phase.

Table 10-53: Mitigating and accompanying measures during the construction phase

Measure	Influence on which negative effect	Type of measure	Responsible
Monitoring of parallel construction sites and current traffic situations for better management of construction site traffic. For example, at certain times it may be more advantageous to use complex 11 in order to relieve complex 12 and the R2 intersections. To this end, consultations will be held with the relevant authorities prior to and during the construction phase, including biweekly impact management meetings and weekly urban coordination meetings.	Traffic flow on road segments Traffic flow at intersections R2 x Scheldelaan	Necessary mitigating organisational measure	Project One in consultation with Lantis, AWV, PoA, City of Antwerp
Clear signage for construction site traffic. Possible dynamic signage depending on traffic control. **- Signage on public roads** **- IOB will consult with the competent authorities about the possibility of dynamic signage for traffic control purposes.**	Traffic flow on road segments Traffic flow at intersections R2 x Scheldelaan Road safety for cyclists	Necessary mitigating infrastructure measures	Project One AWV
Further initiatives to encourage collective transport, for example by contractually obliging contractors, for example, to transport workers per bus/water bus/minibustothesitetobring	Traffic managementroad segments Traffic flow at intersections R2 x Scheldelaan	Necessary mitigating organisational measures	Project One
Implementation of sustainable transport on the construction site (shared bicycles, electric vehicles, etc.).	Traffic managementintersectionsScheldelaan	Desirable	Project One
Monitoring of modes and use of parking spaces, with the possibility of adjusting available spaces to benefit more sustainable modes (e.g. reserved parking spaces for carpooling).	Parkingpassenger cars	Desirable	Project One
Phased provision of parking spaces in the northern yard area, depending on the necessity of the project.	Parkingpassenger cars	Desirable	Project One
Regular and transparent communication about the works to employees.		Desirable	Project One
Working with adjusted shifts in order to avoid rush hour periods.	Traffic managementroad segments Traffic management at intersections R2 x Scheldelaan	Necessary mitigating	Project One

Measure	Impact on which negative effect	Type of measure	Responsible
		Infrastructural measure	
Separation of motorised traffic and active road users on company sites, for example by providing a parallel cycle path between Scheldelaan and the internal access road, so that cyclists do not come into conflict with motorised traffic.	Road safety for cyclists	Necessary mitigating infrastructure measure	Project One
Securing intersections along Scheldelaan; • **Securing the Vopak intersection by means of traffic lights. A design for this is already being discussed with AWV, with a view to having a cooperation agreement in place regarding implementation and financing prior to the permit application.** • **Correct implementation of markings and signage for improved legibility**	Road safety for cyclists Road safety for motorised traffic Traffic flow on road segments Traffic flow at intersections	Accompanying infrastructure measures	Project One, in consultation with AWV
Optimisation of Scheldelaan x R2 intersections. For example, adding extra acceleration lanes at the Scheldelaan x R2-East intersection.	Traffic flow on road segments Traffic flow at intersections	Accompanying infrastructure measures	AWV

10.7.2 Recommendation, mitigating measures and accompanying measures – operational phase

Table 10-54: Recommendation, mitigating and accompanying measures during the operational phase

Measure	Impact on which negative effect	Type of measure	Responsible
Further initiatives to encourage cycling, public transport, carpooling, etc., with a view to achieving a more sustainable modal split for commuting. By way of comparison, reference is made to the modal split that applies to commuting in Flanders. 60% use the car as drivers, while according to conservative estimates, this will still be 64% under Project One. In order to achieve the 60% target, various initiatives are being further studied: **1. Implementation of a mobility budget** **2. Rolling out a carpooling platform** **3. Organisation of awareness-raising campaigns** **4. Encouraging the use of the Ibus**	Traffic flow at intersections R2 x Scheldelaan	Necessary mitigating organisational measure	Project One
Monitoring of modes and use of parking spaces, with the possibility of adjusting available spaces in favour of more sustainable modes.	Parking for passenger cars	Desirable	Project One
Securing the Vesta entrance (with a different intersection configuration) to improve clarity and traffic safety.	Road safety for cyclists Road safety for motorised traffic	Accompanying infrastructure measures	Project One, in consultation with AWV
Correct implementation of markings and signage for improved clarity.	Road safety for cyclists Traffic flow on road segments	Accompanying infrastructure measure	Project One, in consultation with AWV
Optimisation of Scheldelaan x R2 intersections. For example, adding extra waiting lanes at the Scheldelaan x R2-East intersection.	Traffic flow at Scheldelaan x R2 intersections Traffic flow on road segments	Accompanying infrastructure measure	AWV

10.7.3 Mitigating and accompanying measures – cumulative effects and development scenarios

10.7.3.1 Cumulative effects of Elia and Waterlink utility works

Table 10-55: Mitigating and accompanying measures cumulative effects of Elia and Waterlink utility works

Measure	Impact on which negative effect	Type of measure	Responsible
Limit construction traffic from the Antwerp and Flanders regions. This will be communicated during contract negotiations, in order to provide as much group accommodation as possible to the north or west of the site.	Settlement of road segments during the Elia construction phase	Desirable	Project One
Allow site traffic to also arrive from the north (A12 – exit 11 Zandvliet – northern part of Scheldelaan).	Settlement of road segments during the construction phase Elia	Mitigating measure	Project One
Focus on passenger transport by water, for example using the Waterbus or own initiatives.	Resolution of road segments during the Lantis construction phase Positive *modal split*	Desirable	Project One

10.7.3.2 Cumulative effects of Oosterweel

To limit the expected disruption during the works on the Antwerp Ring Road and Oosterweel, Lantis is working on a comprehensive disruption reduction plan. This plan is mainly based on offering alternatives to private car traffic, for example by further expanding bicycle networks, increasing the number of park-and-ride facilities in the wider Antwerp area, and optimising and expanding public transport services. In this way, Lantis hopes to remove around 1,500 PAE from the main road network during the construction phase, so that the available capacity is sufficient during that period.

Table 10-56: Mitigating and accompanying measures for the Oosterweel development scenario

Measure	Impact on which negative effect	Type of measure	Responsible
Focus on collective transport for all employees during construction. This includes carpooling, use of Waterbus/I-bus/Bicycle bus, etc.	Settlement of road segments during the Lantis construction phase Positive *modal split*	Desirable	Project One
Connect to the P&R facilities being built by Lantis as part of the Oosterweel project. These will be located in interesting locations in the wider vicinity of the Project One project area. IOB can provide additional shuttle buses.	Traffic management for road segments during the Lantis construction phase Traffic management for intersections R2 x Scheldelaan Traffic management for road segments Scheldelaan	Necessary mitigating measures	Project One Lantis

Measure	Impact on which negative effect	Type of measure	Responsible
Use these parking zones to further limit individual passenger traffic to the site.	Road safety for all road users	Organisational measure	
Restrict construction traffic via the Antwerp region and the Antwerp main roads (R0, A12, R2).	Handling of road segments during the Lantis construction phase	Desirable	Project One
Avoid the Tijsman Tunnel during the construction phase by routing construction traffic via complex 11-Zandvliet and Scheldelaan.	Traffic management for road segments during the Lantis construction phase Traffic management at intersections R2 x Scheldelaan	Desirable	Project One
Focus on passenger transport by water, for example using the Waterbus or other initiatives.	Traffic management for road segments during the Lantis construction phase Positive *modal split*	Desirable	Project One

10.8 Decision

The effects of Project One on mobility were outlined in this chapter. Both the effects of the construction phase and the operational phase were discussed.

10.8.1 Construction phase

The following effects have been identified for the construction phase:

- Road safety (for the various modes of transport)
  - Pedestrians: negligible effect (0)
  - Through bicycle traffic at the Vopak entrance: limited negative impact (-1)
  - Local bicycle crossings: limited negative impact (-1)
  - Cyclists on Vopak and Vesta access roads: limited negative impact (-1)
  - Motorised traffic: negligible effect (0)
- Motorised traffic – road network capacity
  - For most segments: negligible or no effect (0)
  - On a few segments (Liefkenshoek Tunnel + Tijsman Tunnel, A12 towards the Netherlands): limited negative effect (-1)
- Motorised traffic – intersection flow
  - At most intersections: negligible or no effect (0)
  - At the Vopak x Scheldelaan intersection: negative effect (-2)
  - At the R2 x Scheldelaan West intersection during the evening rush hour: limited negative (-1)
  - At the R2 x Scheldelaan Oost intersection during evening rush hour: significant negative effect (-3)
- Motorised traffic – passenger car parking: negligible or no effect (0)
- Motorised traffic – lorry parking: negligible or no effect (0)

The proposed mitigating and accompanying measures are discussed in § 10.7.1.

The construction phase for Project One is extensive and will take several years. This will undoubtedly put additional pressure on the road network. Project One is aware of this and has therefore started planning and organising this work at an early stage. Based on a sustainable strategy, efforts will be made to avoid unnecessary transport as much as possible by pre-assembling construction components and transporting large units by water. Smaller components will also be collected at marshalling yards and then transported to the site in groups.

Project One is also working on a plan to get as many of the workers who will be working on the site to travel to the construction sites collectively as possible. As the various contractors are not yet known at this stage, there is no complete overview of this situation and, for safety reasons, a large proportion of individual transport is still being assumed. Project One will include this aspect in the contract discussions with contractors and will keep a close eye on parallel construction sites and temporary traffic situations. Further periodic coordination with AWV, the Port of Antwerp and Lantis will remain necessary in the future.

Future site traffic will be accommodated as much as possible at a single central location (northern site zone) and then transported collectively to the southern site location. The plan and organisation of this reception zone and central car park has already been drawn up and will be further optimised. It is important to have clear and separate flows for the different modes of transport: pedestrians and cyclists, buses, cars and freight traffic.

Although collective transport for workers (using buses and minibuses) is already being used, the number of additional vehicles during the peak of the construction phase will remain so high that they will have a significant impact on the flow of traffic on some road segments. In the Liefkenshoek Tunnel (R2) and on the A12 towards the Netherlands, this will lead to a limited negative effect (-1).

In addition, some intersections will experience heavier traffic. Most intersections will still have sufficient capacity to handle the additional traffic. The intersection of the R2 and Scheldelaan West will experience a limited negative effect (-1). A negative effect (-2) is expected at the intersection with the Vopak entrance.

This intersection will therefore be equipped with traffic lights, which will improve traffic flow and safety. This is expected to result in a limited negative effect (-1). A separate report will be drawn up for this intersection (see Appendix 4.22).

At the R2 x Scheldelaan Oost intersection, this will even have a significant negative effect (-3). By 2024, this intersection will already have a high saturation level, meaning that even a small increase will cause traffic congestion. During the entire construction phase, the increases will be significant and saturation levels of >100% are expected.

As mentioned earlier, maximum use is made of collective transport for contractors and traffic is directed along the most desirable routes. In addition, it is best to take the traditional rush hours into account when drawing up work schedules. Ideally, employees should arrive before the morning rush hour and leave again in the early afternoon. This will help to avoid traffic peaks. In this way, the effect can be mitigated to a negative effect (-2).

Additional accompanying measures are possible, such as optimising the R2 x Scheldelaan intersections. Such interventions offer opportunities for Scheldelaan as a whole and are located on roads managed by AWV, meaning they cannot be implemented by Project One itself. Further (periodic) coordination with AWV, the Port Authority and Lantis will remain necessary in the future.

No effects (0) are expected in terms of parking, either for passenger cars or lorries.

In terms of road safety, limited negative effects (-1) are expected. This applies to both through cyclists and cyclists crossing local junctions at the various business entrances. A number of measures have already been taken to address this, such as limiting road transport (by focusing on transport by ship), combining many small loads into a few large lorries (by working with marshalling yards), and avoiding freight transport during rush hour. Nevertheless, a limited negative impact (-1) is still expected in terms of road safety.

A number of optimisations are still possible on Scheldelaan to make traffic safer and smoother. These are discussed in § 10.7.1.

For the impact assessment of the Project One site in parallel with the Lantis site, please refer to § 10.5.3.

10.8.2 Operational phase

The following effects have been identified for the operational phase:

- Road safety (for the various modes of transport)
  - Through bicycle traffic: negligible impact (0)
  - Local bicycle crossings: limited negative impact (-1)
  - Cyclists on Vesta slip road: limited negative effect (-1)
  - Motorised traffic at Vesta entrance: limited negative effect (-1)
- Motorised traffic – intersection flow
  - At most intersections: negligible or no effect (0)
  - At Project One intersection (Vesta entrance): limited negative (-1)
  - Before R2-East intersection; limited negative effect (-1)
- Motorised traffic – passenger car parking: negligible effect (0)
- Motorised traffic – lorry parking: negligible or no effect (0)

The proposed mitigating and accompanying measures are discussed in § 10.7.2.

During the operational phase, the effects on mobility will be considerably more limited compared to the construction phase. The number of expected vehicles, both passenger and freight, will then be considerably smaller. No effects (0) are therefore expected on the road segments studied. A limited negative impact (-1) is expected at the R2 x Scheldelaan Oost intersection, as this intersection is already virtually saturated in the current situation. The 2nd Tijsman Tunnel project may provide relief here in the future. In addition, the junction with the entrance to Project One (Vesta entrance) will be subject to heavier traffic. A limited negative impact (-1) is also expected there in terms of traffic flow.

Project One will therefore continue to focus on a more sustainable *modal split*. This will not only reduce emissions, but will also improve traffic flow at entrances and intersections. The proposed accompanying measures for optimisation during the construction phase can also have a positive effect on Project One and Scheldelaan as a whole during the operational phase.

Due to the increase in traffic, a negligible effect (0) is currently expected in terms of road safety for through cyclists. However, a limited negative effect (-1) is expected for local bicycle crossings. Nevertheless, a number of steps are being taken in the design that will make it possible to improve the overall traffic system.

The increase in traffic on the Vesta entrance (not controlled by traffic lights) is considered unfavourable, as it will lead to more unprotected conflicts between (heavy) vehicles and cyclists (limited negative effect (-1)).

In terms of parking availability for passenger cars, a negligible effect (0) is expected. By utilising an overflow car park (160 parking spaces) that can only be used on exceptional occasions, the average parking occupancy rate will be around 87%. This is ideal. The overflow car park also allows for exceptional parking demand to be accommodated and avoids parking pressure on the surrounding area.

No effect (0) is expected for lorry parking at the Vesta entrance.

A number of optimisations are still possible on Scheldelaan to make traffic safer and smoother. These are discussed in § 10.7.2.

10.8.3 Cumulative effects

10.8.3.1 Cumulative effects – construction of quay wall

The peak period in absolute PAE for Project One is in month 67 – June 2024. The traffic generated by the works on the quay wall, combined with the site traffic for Project One, will remain below the maximum PAE in month 67, which is being studied in this EIA to estimate the effects during the construction phase. However, the peak in site traffic for the quay wall is likely to occur earlier and therefore overlap even less with the build-up to the peak in site traffic for Project One. A negligible effect (0) is therefore expected.

10.8.3.2 Cumulative effects – ELIA and Waterlink utility works

During the planned utility works by Elia and Waterlink, significant disruption is expected for a period of one year.

A scenario in which traffic flows on 2x1 lanes instead of 2x2 lanes was studied. In this scenario, significant negative effects (-3) can be expected. The reduction in the number of available lanes on Scheldelaan (2x1 instead of 2x2) will decrease capacity. This does not cause problems on most segments and at most times. However, as expected, segments 3 (morning rush hour) and segments 4 (evening rush hour) carry too much traffic, mainly due to the increase caused by construction traffic.

However, it is expected that employees of surrounding companies along Scheldelaan will adjust their driving routes during this period and make more use of the 11-Zandvliet complex and drive via the northern side of Scheldelaan. There is still plenty of spare capacity on that side, so no issues are expected in practice.

10.8.3.3 Cumulative effects – Oosterweel

However, the works carried out as part of the Oosterweel project, managed by Lantis, will have adverse effects. Due to the reduction in capacity on the A12 towards Merksem, a large part of the traffic flows on the Antwerp Ring Road will shift. A significant proportion of this will travel via the A12, Tijsman Tunnel and Liefkenshoek Tunnel to Linkeroever, in order to avoid traffic jams towards the Kennedy Tunnel.

As a result, more traffic is expected on the A12 towards the Tijsman Tunnel during the morning rush hour. This shift is so significant that the road segment under consideration will be saturated. The additional construction traffic for Project One will only exacerbate this saturation (negative effect (-2)). This also means that the construction traffic itself will be caught in traffic jams.

Conversely, problems will arise during the evening rush hour as a result of the reduction in capacity on the A12 segment towards Merksem (segment 52). More than 50% of Project One's construction traffic is expected to follow this route, which will also lead to congestion on this section of road. A limited negative effect (-1) is expected.

According to the Lantis model, a significant increase in traffic is also expected during the evening rush hour (4 p.m. to 6 p.m.) on the A12 from the Tijsman Tunnel towards Antwerp. This will be compounded by traffic from Project One, which will have a limited negative impact (-1) on that section of the road.

The same thing happens in the Tijsman Tunnel (morning rush hour towards Ghent, evening rush hour towards Antwerp). Due to the Lantis construction site, an increase in traffic is expected on the R2, to which the incoming and outgoing construction traffic from Project One will be added. This also leads to a limited negative effect (-1).

10.8.4 Development scenarios

One development scenario was discussed in the context of this EIA. No additional negative effects related to the ECA are expected in terms of mobility.

10.8.4.1 Development scenario – ECA

Significant increases in traffic are expected for the ECA project, but these will only manifest themselves after the completion of Project One. The expected increases in traffic from Project One during the operational phase are not such that negative interference is expected.