

Appendix 9.5: Atmospheric Emissions from South Stream Russia Construction and Pre- Commissioning Phase

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1 Introduction

This Appendix presents anticipated quantities of atmospheric emissions emitted during the Construction and Pre-Commissioning Phase of the South Stream Offshore Pipeline Project – Russian Sector.

The calculated emissions have been used to present total mass of emissions per pollutant and greenhouse gas as well as time-weighted emission rates for air quality modelling. This appendix supports subsequent tables provided in **Chapter 9 Air Quality** and **Chapter 5 Project Description**.

This appendix presents the methodology, emissions factors and calculated values used for modelling of point and areas sources presented in **Chapter 9 Air Quality**.

The methodology for calculating emissions quantities has been based on assumptions of fuel consumption for each activity within each phase and considers:

- Vessel emissions;
- Road traffic emissions;
- Construction (Diesel) plant equipment emissions; and
- Large Generator sets emissions.

Further breakdown of each of these activities methodology and calculations of emissions is presented in the following sections of this appendix.

Greenhouse gas emissions are presented as eCO₂ or Carbon Dioxide equivalent which assumes a greenhouse gas potential of 21 for CH₄, 310 for N₂O and 1 for CO₂.

2 Summary of Total Emissions

Table 1 presents the total emissions of pollutants and greenhouse gas emissions for the Construction and Pre-commissioning Phase of the South Stream Offshore Pipeline Project – Russian Sector.

Table 1 is equal to the total values presented in Tables A.1 (x 4 pipelines), B.1, C.1 and D.1.

Table 1 Total Atmospheric Emissions during Construction and Pre Commissioning (tonnes)

NO _x	CO	PM	NMVOC	CH ₄	N ₂ O	CO ₂	SO ₂	eCO ₂	Fuel
16,501	1,944	344	644	61	4	672,405	6,069	674,853	295,521

2.1 Atmospheric Emissions from Construction / Pre-Commissioning Vessels

The following data was used to calculate fuel consumption per unit time and factored for tonnes of fuel consumed per year.

- Type of vessel;
- No of vessels required;
- Days of service for project; and
- Main engine power rating, efficiency of engine and unitisation of main engine per day.

EMEP / EEA Emissions factors were applied to peak and factored annual fuel consumption to quantify emissions of pollutant per unit time for modelling of peak emissions in grams per second and averaged out over a year for long term pollutant modelling. Carbon Dioxide equivalent (eCO₂) assumes a greenhouse gas potential of 21 for CH₄, 310 for N₂O and 1 for CO₂.

Table A.1 Emissions Data Summary (Tonnes/Pipeline)

Parameter	NO _x	CO	PM	NMVOC	CH ₄	N ₂ O	CO ₂	SO ₂	eCO ₂	Fuel
Near shore <30 mbsl	271	26	5	10	0.9		10,912	104	10,932	4,405
Offshore 30-600 mbsl	773	73	15	28	2.7		31,131	296	31,187	7,675
Offshore >600 mbsl	2,817	266	54	100	9.7		113,410	1,077	113,613	51,787
Pre Commissioning	108	10	2	4	0.4		4,359	41	4,367	1,380
Total per pipeline	3,970	374	76	142	14	-	159,812	1,517	160,099	65,246
Total (all 4 pipelines)	15,880.08	1,496.98	303.44	566.42	54.62	-	639,249	6,069	640,396	260,984

The following tables provide values used for nearshore vessel pollutant modelling and calculating overall vessel pollutant and greenhouse gas emissions.

Table A.2 Emission Factors

Pollutant	NO _x	CO	NMVOC	SO ₂	PM ₁₀	CO ₂	CH ₄	N ₂ O
kg/tonne fuel	78.50	7.40	2.80	30.00	1.50	3160.00	0.27	0.22
g/kWh	6.57	0.62	0.23	2.51	0.13	264.56	0.02	0.02

Ref. Table 3-2, Chapter 1.A.3.d of the 2009 EMEP / EEA Emission Factors, Tier 1 Efs for ships using marine diesel oil / marine gas oil

Table A.3 Diesel Parameters

Parameter	Value	Unit
Diesel Heating value	43	MJ/kg
Diesel Heating value	12	kWh/kg
Density of Diesel	850	kg/m ³
CO ₂ Emission Factor	3160	kg/tonne fuel
Percentage Sulphur Fuel Content	1.5	%

Ref. EU Directive 2009/30/EC Article 4. 1.5% S content according to Reg SG 66/25.07.2003 (ships diesel fuel)

Table A.4 Short Term Emissions Data Summary (g/s) for Dispersion Modelling

Parameter	Short Term NO _x (g/s)	Short Term CO (g/s)	Short Term PM (g/s)	Short Term NMVOC (g/s)	Short Term CH ₄ (g/s)	Short Term N ₂ O (g/s)	Short Term CO ₂ (g/s)	Short Term SO ₂ (g/s)
Near shore <30 mbsl	716.0	67.5	13.7	25.5	2.5		28824.2	273.6
Offshore 30-600 mbsl	609.8	57.5	11.7	21.7	2.1		24545.6	233.0
Offshore >600 mbsl	698.2	65.8	13.3	24.9	2.4		28104.8	266.8
Pre Commissioning	118.7	11.2	2.3	4.2	0.4		4777.4	45.4
Dredging only	67.8	10.6	2.1	4.0	0.4		4527.7	43.0

Table A.5 Long Term Emissions Data Summary (g/s) for Dispersion Modelling

Parameter	Long Term NOx (g/s)	Long Term CO (g/s)	Long Term PM (g/s)	Long Term NMVOC (g/s)	Long Term CH ₄ (g/s)	Long Term N ₂ O (g/s)	Long Term CO ₂ (g/s)	Long Term SO ₂ (g/s)
Near shore <30 mbsl	8.6	0.8	0.2	0.3	0.0		346.0	3.3
Offshore 30-600 mbsl	24.5	2.3	0.5	0.9	0.1		987.2	9.4
Offshore >600 mbsl	89.3	8.4	1.7	3.2	0.3		3596.2	34.1
Pre Commissioning	3.4	0.3	0.1	0.1	0.0		138.2	1.3
Dredging only	1.3	0.1	0.0	0.0	0.0		54.2	0.5

Table A.6 Vessels Usage

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
PSV days (all put into offshore)	PSV (Pipelay Supply Vessel)	1	195	7,160	60	7.16	35
Offshore > 600 mbsl	Deep water Lay Vessel	1	71	70,000	40	70	35
Offshore > 600 mbsl	Deep water Lay Vessel	1	44	70000	25	70	35
Offshore > 600 mbsl	Tugs	1	71	13,880	60	13.88	35
Offshore > 600 mbsl	Tugs	1	44	13880	25	13.88	35
Offshore > 600 mbsl	PSV (Pipelay Supply Vessel)	5	0	7,160	60	7.16	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Offshore > 600 mbsl	PSV (Pipelay Supply Vessel)	5	0	7160	25	7.16	35
Offshore > 600 mbsl	Survey Vessel	2	71	7,604	60	7.604	35
Offshore > 600 mbsl	Survey Vessel	2	44	7604	25	7.604	35
Offshore > 600 mbsl	MSV (Multi Service Vessel)	2	71	10,000	60	10	35
Offshore > 600 mbsl	MSV (Multi Service Vessel)	2	44	10000	25	10	35
Offshore > 600 mbsl	Helicopter	1	8		60	0	35
Offshore > 600 mbsl	Crew boats, fast cats	1	4	2,520	60	2.52	35
Offshore > 600 mbsl	Maintenance vessel	1	4	7,160	60	7.16	35
Offshore > 600 mbsl	fuel/waste water collector vessel	1	4	610	60	0.61	35
Offshore > 600 mbsl	rescue vessel	1	0	9,548	60	9.548	35
"Offshore (30 mbsl - 600 mbsl)	Intermediate depth pipelay vessel	1	9	20,500	40	20.5	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
"Offshore (30 mbsl - 600 mbsl)	Intermediate depth pipelay vessel	1	38	20,500	25	20.5	35
"Offshore (30 mbsl - 600 mbsl)	Anchor Handling Tugs	2	9	13,880	60	13.88	35
"Offshore (30 mbsl - 600 mbsl)	Anchor Handling Tugs	2	38	13,880	25	13.88	35
"Offshore (30 mbsl - 600 mbsl)	Survey Vessel	2	9	7,604	60	7.604	35
"Offshore (30 mbsl - 600 mbsl)	Survey Vessel	2	38	7,604	25	7.604	35
"Offshore (30 mbsl - 600 mbsl)	PSV (Pipelay Supply Vessel)	3	0	7,160	60	7.16	35
"Offshore (30 mbsl - 600 mbsl)	PSV (Pipelay Supply Vessel)	3	0	7,160	25	7.16	35
"Offshore (30 mbsl - 600 mbsl)	MSV (Multi Service Vessel)	2	9	10,000	60	10	35
"Offshore (30 mbsl - 600 mbsl)	MSV (Multi Service Vessel)	2	38	10,000	25	10	35
"Offshore (30 mbsl - 600 mbsl)	Helicopter	1	2		60		35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
"Offshore (30 mbsl - 600 mbsl)	Crew boats, fast cats	1	1	2,520	60	2.52	35
"Offshore (30 mbsl - 600 mbsl)	Maintenance vessel	1	1	7,160	60	7.16	35
"Offshore (30 mbsl - 600 mbsl)	fuel/waste water collector vessel	1	1	610	60	0.61	35
"Offshore (30 mbsl - 600 mbsl)	rescue vessel	1		9,548	60	9.548	35
"Shallow water pipelay section (23-30 mbsl)	Shallow water laybarge	1	6	3,750	40	3.75	35
"Shallow water pipelay section (23-30 mbsl)	Shallow water laybarge	1	3	3,750	25	3.75	35
"Shallow water pipelay section (23-30 mbsl)	Anchor Handling Tugs	2	6	13,880	60	13.88	35
"Shallow water pipelay section (23-30 mbsl)	Anchor Handling Tugs	2	3	13,880	25	13.88	35
"Shallow water pipelay section (23-30 mbsl)	PSV (Pipelay Supply Vessel)	2	0	7,160	60	7.16	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
"Shallow water pipelay section (23-30 mbsl)	PSV (Pipelay Supply Vessel)	2	0	7,160	25	7.16	35
"Shallow water pipelay section (23-30 mbsl)	Survey Vessel	2	6	7,604	60	7.604	35
"Shallow water pipelay section (23-30 mbsl)	Survey Vessel	2	3	7,604	25	7.604	35
"Shallow water pipelay section (23-30 mbsl)	MSV (Multi Service Vessel)	2	6	10,000	60	10	35
"Shallow water pipelay section (23-30 mbsl)	MSV (Multi Service Vessel)	2	3	10,000	25	10	35
"Shallow water pipelay section (23-30 mbsl)	Crew boats, fast cats	1	1	2,520	60	2.52	35
"Shallow water pipelay section (23-30 mbsl)	Maintenance vessel	1	1	7,160	60	7.16	35
"Shallow water pipelay section (23-30 mbsl)	fuel/waste water collector vessel	1	1	610	60	0.61	35
"Shallow water pipelay section (23-30 mbsl)	rescue vessel	1		9,548	60	9.548	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Dredging (from 23 to 27 m mbsl)	Small survey vessel	1	5	500	60	0.5	35
Dredging (from 23 to 27 m mbsl)	Small survey vessel	1	19	500	25	0.5	35
Dredging (from 23 to 27 m mbsl)	Tug	1	5	4,536	60	4.536	35
Dredging (from 23 to 27 m mbsl)	Tug	1	19	4,536	25	4.536	35
Dredging (from 23 to 27 m mbsl)	TSHD (Trailer Suction Hopper Dredger)	1	5	6,330	60	6.33	35
Dredging (from 23 to 27 m mbsl)	TSHD (Trailer Suction Hopper Dredger)	1	19	6,330	25	6.33	35
Dredging (from 23 to 27 m mbsl)	Crew boats, fast cats	1	1	2,520	60	2.52	35
Dredging (from 23 to 27 m mbsl)	Maintenance vessel	1	1	7,160	60	7.16	35
Dredging (from 23 to 27 m mbsl)	fuel/waste water collector vessel	1	1	610	60	0.61	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Dredging (from 23 to 27 m mbsl)	rescue vessel	1		9,548	60	9.548	35
Backfilling	TSHD (Trailer Suction Hopper Dredger)	1	4	6,330	60	6.33	35
Backfilling	Tug	1	4	4,536	60	4.536	35
Backfilling	Small survey vessel	1	4	500	60	0.5	35
Backfilling	Crew boats, fast cats	1	1	2,520	60	2.52	35
Backfilling	Maintenance vessel	1	1	7,160	60	7.16	35
Backfilling	fuel/waste water collector vessel	1	1	610	60	0.61	35
Backfilling	rescue vessel	1		9,548	60	9.548	35
Above Water Tie in	Support Vessel	1	19.25	15,086	60	15.086	35
Above Water Tie in	Small survey vessel	1	19.25	500	60	0.5	35
Above Water Tie in	Crew boats, fast cats	1	1	2,520	60	2.52	35
Above Water Tie in	fuel/waste water collector vessel	1	1	610	60	0.61	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Above Water Tie in	rescue vessel	1		9,548	60	9.548	35
Post lay seabed intervention	Maintenance vessel	1	2	7,160	60	7.16	35
Post lay seabed intervention	Rock Dumping Vessel	1	35	8,390	60	8.39	35
Post lay seabed intervention	Support Vessel	1	35	15,086	60	15.086	35
Post lay seabed intervention	Crew boats, fast cats	1	1	2,520	60	2.52	35
Pre-commissioning (shallow water)	fuel/waste water collector vessel	1	1	610	60	0.61	35
Pre-commissioning (shallow water)	rescue vessel	1		9,548	60	9.548	35
Pre-commissioning (shallow water)	Spread vessel	1	26.3	15,086	60	15.086	35
Pre-commissioning (shallow water)	Crew boats, fast cats	1	1	2,520	60	2.52	35
Pre-commissioning (shallow water)	fuel/waste water collector vessel	1	1	610	60	0.61	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Pre-commissioning (shallow water)	rescue vessel	1		9,548	60	9.548	35
Dredging (from 23 to 27 m mbsl)	Crew boats, fast cats	1	1	2,520	60	2.52	35
Dredging (from 23 to 27 m mbsl)	Maintenance vessel	1	1	7,160	60	7.16	35
Dredging (from 23 to 27 m mbsl)	fuel/waste water collector vessel	1	1	610	60	0.61	35
Dredging (from 23 to 27 m mbsl)	rescue vessel	1		9,548	60	9.548	35
Backfilling	TSHD (Trailer Suction Hopper Dredger)	1	4	6,330	60	6.33	35
Backfilling	Tug	1	4	4,536	60	4.536	35
Backfilling	Small survey vessel	1	4	500	60	0.5	35
Backfilling	Crew boats, fast cats	1	1	2,520	60	2.52	35
Backfilling	Maintenance vessel	1	1	7,160	60	7.16	35
Backfilling	fuel/waste water collector vessel	1	1	610	60	0.61	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Backfilling	rescue vessel	1		9,548	60	9.548	35
Above Water Tie in	Support Vessel	1	19.25	15,086	60	15.086	35
Above Water Tie in	Small survey vessel	1	19.25	500	60	0.5	35
Above Water Tie in	Crew boats, fast cats	1	1	2,520	60	2.52	35
Above Water Tie in	fuel/waste water collector vessel	1	1	610	60	0.61	35
Above Water Tie in	rescue vessel	1		9,548	60	9.548	35
Post lay seabed intervention	Maintenance vessel	1	2	7,160	60	7.16	35
Post lay seabed intervention	Rock Dumping Vessel	1	35	8,390	60	8.39	35
Post lay seabed intervention	Support Vessel	1	35	15,086	60	15.086	35
Post lay seabed intervention	Crew boats, fast cats	1	1	2,520	60	2.52	35
Pre-commissioning (shallow water)	fuel/waste water collector vessel	1	1	610	60	0.61	35

Continued...

Construction Activities	Type of Vessel	Number of Vessels	No Days (for calculation purposes)	Power rating (KW)	Utilisation %	Power rating (MW)	Efficiency (%)
Pre-commissioning (shallow water)	rescue vessel	1		9,548	60	9.548	35
Pre-commissioning (shallow water)	Spread vessel	1	26.3	15,086	60	15.086	35
Pre-commissioning (shallow water)	Crew boats, fast cats	1	1	2,520	60	2.52	35
Pre-commissioning (shallow water)	fuel/waste water collector vessel	1	1	610	60	0.61	35
Pre-commissioning (shallow water)	rescue vessel	1		9,548	60	9.548	35

Complete.

2.2 Atmospheric Emissions from Construction / Pre-Commissioning Road Traffic

The following data was used to calculate fuel consumption per unit time and factored for tonnes of fuel consumed per year:

- Anticipated number of road traffic for each period of the construction of the Landfall Section Site;
- Average emission rate for cars and heavy duty vehicles;
- Average fuel consumption for cars and heavy duty vehicles; and
- Average distance of travel.

Carbon Dioxide equivalent (eCO₂) assumes a greenhouse gas potential of 21 for CH₄, 310 for N₂O and 1 for CO₂.

Table B.1 Atmospheric Emissions from Construction / Pre-Commissioning traffic (tonnes)

Activity	NO _x	CO	PM	NM VOC	CH ₄	N ₂ O	CO ₂	SO ₂	eCO ₂	Fuel
Construction - Traffic	7.01	25.51	0.14	3.16	0.55	0.07	1,341.90	0.01	1,030.77	1,374

The following tables provide values used for road traffic emissions impact screening pollutant modelling and calculating overall traffic pollutant and greenhouse gas emissions.

Table B.2 Anticipated Road Traffic

start	finish	Weeks	Days	exceptional	trucks	cars
Site preparation/access roads	11/03/2014	18/07/2014	19	129	12	1,451
Micro tunnelling	19/07/2014	05/05/2016	94	656	33	8,287
Pipeline construction	02/08/2014	20/04/2015	38	261	68	5,572
Landfall facilities fill import	16/06/2014	12/11/2014	22	149	0	17,108
Reinstatement pipeline route	14/12/2015	30/05/2016	24	168	0	8,896
Landfall facilities construction	13/11/2014	18/02/2016	66	462	40	1,060
Reinstatement pipeline route	14/01/2015	30/05/2016	72	502	8	2,323

Table B.3 Average Tier 1 Emission Factors (g/Kg)

	NO _x (g/kg)	CO (g/kg)	PM (g/kg)	NM VOC (g/kg)	CH ₄ (g/kg)	N ₂ O (g/kg)	CO ₂ (g/kg)
Emission rate for cars (tier 1)	8.73	84.70	0.03	10.05	1.75	0.21	3180
Emission rate for HDV (tier 1)	33.37	7.58	0.94	1.92	0.29	0.05	3140

Table B.4 Diesel Parameters

Parameter	Value	Unit
Diesel Heating value	43	(MJ/kg)
Density of Diesel	850	(kg/m³)
Diesel (Fuel 2009) ppm	8	ppm

Ref. EU Directive 2009/30/EC Article 4

Table B.5 Average Fuel Consumption Tier 1

Passenger Car	70	(g/km)
HDV	240	(g/km)

Table B.6 Average Emission rates (g/km)

	NO _x (g/km) [(g/kg) x (g/m]	CO (g/km) [(g/kg) x (g/m]	PM (g/km) [(g/kg) x (g/m]	NM VOC (g/km) [(g/kg) x (g/m]	CH ₄ (g/km) [(g/kg) x (g/m]	N ₂ O (g/km) [(g/kg) x (g/m]	CO ₂ (g/km) [(g/kg) x (g/m]	SO ₂ (g/km) [(ppm) x (g/m]
Emission rate for cars (tier 1)	0.6111	5.929	0.0021	0.7035	0.1225	0.0144	222.6	0.001
Emission rate for HDV (tier 1)	8.0088	1.8192	0.2256	0.4608	0.0696	0.0122	753.6	0.004

Table B.7 Emission Rates (kg/km)

	NO _x (kg/km)	CO (kg/km)	PM (kg/km)	NMVO C (kg/km)	CH ₄ (kg/km)	N ₂ O (kg/km)	CO ₂ (kg/km)	SO ₂ (kg/km)	Fuel (kg/km)
Site prep/access rds	6.4	9.9	0.2	1.3	0.2	0.0	844	0.00	396
Pipeline construction	33.2	55.5	0.8	7.4	1.3	0.2	4,493	0.02	2,234
Shore crossing	14.6	35.6	0.3	4.6	0.8	0.1	2,294	0.01	1,435
Landfall facilities	10.5	101.4	0.0	12.0	2.1	0.2	3,808	0.02	4,105
Reinstatement pipeline route	5.4	52.7	0.0	6.3	1.1	0.1	1,980	0.01	2,135
Landfall facilities construction	27.1	12.3	0.7	2.3	0.4	0.1	2,723	0.01	485
Reinstatement pipeline route	15.8	17.0	0.4	2.5	0.4	0.1	1,868	0.01	683
Total	70.1	255.1	1.4	31.6	5.5	0.7	13,419	0.1	10,307

Table B.8 Average Distance travelled per vehicle

Route	Distance
Novorossiysk to site	100 km

2.3 Atmospheric Emissions from Construction Schedule

The following data was used to calculate fuel consumption per unit time and factored for tonnes of fuel consumed per year:

- Anticipated type and number of construction plant for schedule requirements;

- Assumed plant operating duration for schedule requirements;
- Assumed plant operation percentage per 10 our day; and
- Engine power rating, efficiency of engine.

European engine emissions standards were applied to peak and factored annual fuel consumption to quantify emissions of pollutant per unit time for modelling of peak emissions in grams per second and averaged out over a year for long term pollutant modelling. Carbon Dioxide equivalent (eCO₂) assumes a greenhouse gas potential of 21 for CH₄, 310 for N₂O and 1 for CO₂.

Table C.1. Atmospheric Emissions from Construction Plant (tonnes)

Activity	NO _x	CO	PM	NMVOC	CH ₄	N ₂ O	CO ₂	SO ₂	eCO ₂	Fuel
Construction - Site Preparation	7.0	9.0	0.6	1.0	0.1	0.1	521	0.01	545	471
Construction - Microtunnelling	279.5	88.7	20.9	27.1	1.3	0.9	7,142	0.09	7,463	10,774
Construction - Landfall Facilities	18.8	21.6	1.3	2.7	0.3	0.2	1,401	0.02	1,464	1,701
Construction - Trench Excavations	3.1	3.5	0.2	0.5	0.0	0.0	229	0.00	239	207
Construction - Pipe Installation	7.2	7.5	0.5	1.1	0.1	0.1	514	0.01	538	465
Construction - Demob/Reinstatement of pipelines area	3.6	4.3	0.3	0.5	0.1	0.0	268	0.00	280	243
Total	319	135	24	33	1.9	1.3	10,076	0.13	10,529	13,861

The following tables provide values used for road traffic emissions impact screening pollutant modelling and calculating overall plant pollutant and greenhouse gas emissions.

Table C.2: Construction Schedule

Schedule	Start	End	Weeks	Days	Bulldozer	Grader	Excavator	Tipper	Shovel	Sideboom	Crane	Welders	Bending	Generator
Site Prep	11-Jul-14	26-Nov-14	20	138	4	2	4	6	2	0				2
Microtunnelling			87	609			4				3			2
Landfall facilities	20-Nov-14	24-Mar-16	70	490	2	1	2	2	1		2			4
Trench Excavation	09-Oct-14	19-Dec-14	11	71	1	1	4	2	2					2
Pipeline installation	27-Oct-14	10-Feb-15	16	106	1	1	2	1	1	6		10		4
Demob/reinstatement of pipelines area	23-Mar-16	27-Jul-16	18	126	1	1	2	2	2					2

Table C.3: Diesel Parameters

Parameter	Value	Unit
Diesel Heating value	43	(MJ/kg)
Density of Diesel	850	(kg/m³)
CO2 Emission Factor	3160	(kg/tonne)
Percentage Sulphur Fuel Content	0.002	(%)

Ref. EU Directive 2009/30/EC Article 4

2.3.1 Site Preparation

Table C.i.1 Site Preparation Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Bulldozer	4	250	75	138	3.5	5	0.3	0.5	0.05	0.035
Grader	2	90	50	138	3.5	5	0.4	0.5	0.05	0.035
Excavator	2	100	75	138	3.5	3.5	0.2	0.5	0.05	0.035
Tipper	2	75	50	138	4	5	0.4	0.7	0.05	0.035
Shovel	2	75	75	138	4	5	0.4	0.7	0.05	0.035
Generator	2	250	50	138	3.5	3.5	0.2	0.5	0.05	0.035

Table C.i.2 Site Preparation Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m3/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Bulldozer	7.50	35.00	77,143	1,794	1.79	248	2.1	291.3
Grader	0.90	35.00	9,257	215	0.22	30	0.3	35.0
Excavator	1.50	35.00	15,429	359	0.36	50	0.4	58.3
Tipper	0.75	35.00	7,714	179	0.18	25	0.2	29.1
Shovel	1.13	35.00	11,571	269	0.27	37	0.3	43.7
Generator	2.50	35.00	25,714	598	0.60	83	0.7	97.1

Table C.i.3 Site Preparation Raw Emission Rates assuming 100% utilised plant

Equipment	NO _x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NMVOC (g/s) [(No.) x (kW) x (g/kWh)]	CH ₄ (g/s) [(No.) x (kW) x (g/kWh)]	N ₂ O (g/s) [(No.) x (kW) x (g/kWh)]	CO ₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO ₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)]
Bulldozer	0.97	1.39	0.08	0.14	0.01	0.01	73.49	0.00
Grader	0.18	0.25	0.02	0.03	0.00	0.00	13.23	0.00
Excavator	0.19	0.19	0.01	0.03	0.00	0.00	14.70	0.00
Tipper	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.00
Shovel	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.00
Generator	0.49	0.49	0.03	0.07	0.01	0.00	36.74	0.00

Table C.i.3 Site Preparation Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Bulldozer	0.115	0.164	0.010	0.016	0.002	0.001	8.683	0.000
Grader	0.014	0.020	0.002	0.002	0.000	0.000	1.042	0.000
Excavator	0.023	0.023	0.001	0.003	0.000	0.000	1.737	0.000
Tipper	0.013	0.016	0.001	0.002	0.000	0.000	0.868	0.000
Shovel	0.020	0.025	0.002	0.003	0.000	0.000	1.302	0.000
Generator	0.038	0.038	0.002	0.005	0.001	0.000	2.894	0.000

2.3.2 Microtunneling

Table C.ii.1 Microtunneling Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Generator	2	904	100	609	14.4	3	1.1	1.3	0.05	0.035
Redundant Generator	2	648	10	609	14.4	3	1.1	1.3	0.05	0.035
Peripheral Generator	2	200	100	609	3.5	3.5	0.2	0.5	0.05	0.035
Crane	3	250	40	609	3.5	3.5	0.2	0.5	0.05	0.035
Excavator	4	102	50	609	3.5	5	0.3	0.5	0.05	0.035
Bore Pile Drilling Rig	1	480	50	609	3.5	3.5	0.2	0.5	0.05	0.035

Table C.ii.2 Microtunneling Fuel Consumption

Equipment	Combined Engine Power Rating (MWhr/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Generator	43.39	35.00	446,318	10,379	10.38	6,321	12.2	7,436.6
Redundant Generator	3.11	35.00	31,993	744	0.74	453	0.9	533.1
Peripheral Generator	9.60	35.00	98,743	2,296	2.30	1,398	2.7	1,645.3
Crane	7.20	35.00	74,057	1,722	1.72	1,049	2.0	1,233.9
Excavator	4.90	35.00	50,359	1,171	1.17	713	1.4	839.1
Bore Pile Drilling Rig	5.76	35.00	59,246	1,378	1.38	839	1.6	987.2

Table C.ii.3 Microtunneling Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NM VOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)
Generator	7.23	1.51	0.55	0.65	0.03	0.02	132.87	0.00
Redundant Generator	5.18	1.08	0.40	0.47	0.02	0.01	95.24	0.00
Peripheral Generator	0.39	0.39	0.02	0.06	0.01	0.00	29.40	0.00
Crane	0.73	0.73	0.04	0.10	0.01	0.01	55.12	0.00
Excavator	0.40	0.57	0.03	0.06	0.01	0.00	29.98	0.00
Bore Pile Drilling Rig	0.47	0.47	0.03	0.07	0.01	0.00	35.27	0.00

Table C.ii.3 Microtunneling Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Generator	7.232	1.507	0.552	0.653	0.025	0.018	132.867	0.0017
Redundant Generator	0.518	0.108	0.040	0.047	0.002	0.001	9.524	0.0001
Peripheral Generator	0.389	0.389	0.022	0.056	0.006	0.004	29.395	0.0004
Crane	0.292	0.292	0.017	0.042	0.004	0.003	22.047	0.0003
Excavator	0.198	0.283	0.017	0.028	0.003	0.002	14.992	0.0002
Bore Pile Drilling Rig	0.233	0.233	0.013	0.033	0.003	0.002	17.637	0.0002

2.3.3 Landfall Facilities

Table C.iii.1 Landfall Facilities Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Bulldozer	2	250	75	490	3.5	5	0.3	0.5	0.05	0.035
Grader	1	90	50	490	3.5	5	0.4	0.5	0.05	0.035
Excavator	2	100	75	490	3.5	3.5	0.2	0.5	0.05	0.035
Tipper	2	75	50	490	4	5	0.4	0.7	0.05	0.035
Shovel	1	75	75	490	4	5	0.4	0.7	0.05	0.035
Crane	2	250	50	490	3.5	3.5	0.2	0.5	0.05	0.035
Generator	4	250	50	490	3.5	3.5	0.2	0.5	0.05	0.035

Table C.iii.2: Landfall Facilities Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Bulldozer	3.75	35.00	38,571	897	0.90	440	1.1	517.1
Grader	0.45	35.00	4,629	108	0.11	53	0.1	62.1
Excavator	1.50	35.00	15,429	359	0.36	176	0.4	206.8
Tipper	0.75	35.00	7,714	179	0.18	88	0.2	103.4
Shovel	0.56	35.00	5,786	135	0.13	66	0.2	77.6
Crane	2.50	35.00	25,714	598	0.60	293	0.7	344.7
Generator	5.00	35.00	51,429	1,196	1.20	586	1.4	689.5

Table C.iii.3 Landfall Facilities Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWhr)]	CO (g/s) [(No.) x (kW) x (g/kWhr)]	PM (g/s) [(No.) x (kW) x (g/kWhr)]	NM VOC (g/s) [(No.) x (kW) x (g/kWhr)]	CH₄ (g/s) [(No.) x (kW) x (g/kWhr)]	N₂O (g/s) [(No.) x (kW) x (g/kWhr)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)
Bulldozer	0.49	0.69	0.04	0.07	0.01	0.00	36.74	0.0005
Grader	0.09	0.13	0.01	0.01	0.00	0.00	6.61	0.0001
Excavator	0.19	0.19	0.01	0.03	0.00	0.00	14.70	0.0002
Tipper	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.0001
Shovel	0.08	0.10	0.01	0.01	0.00	0.00	5.51	0.0001
Crane	0.49	0.49	0.03	0.07	0.01	0.00	36.74	0.0005
Generator	0.97	0.97	0.06	0.14	0.01	0.01	73.49	0.0009

Table C.iii.3 Landfall Facilities Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Bulldozer	0.152	0.217	0.013	0.022	0.002	0.002	11.483	0.00015
Grader	0.018	0.026	0.002	0.003	0.000	0.000	1.378	0.00002
Excavator	0.061	0.061	0.003	0.009	0.001	0.001	4.593	0.00006
Tipper	0.035	0.043	0.003	0.006	0.000	0.000	2.297	0.00003
Shovel	0.026	0.033	0.003	0.005	0.000	0.000	1.722	0.00002
Crane	0.101	0.101	0.006	0.014	0.001	0.001	7.655	0.00010
Generator	0.203	0.203	0.012	0.029	0.003	0.002	15.310	0.00019

2.3.4 Trench Excavation

Table C.iv.1 Trench Excavation Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Bulldozer	1	250	75	71	3.5	5	0.3	0.5	0.05	0.035
Grader	1	90	50	71	3.5	5	0.4	0.5	0.05	0.035
Excavator	4	100	75	71	3.5	3.5	0.2	0.5	0.05	0.035
Tipper	2	75	50	71	4	5	0.4	0.7	0.05	0.035
Shovel	2	75	75	71	4	5	0.4	0.7	0.05	0.035
Generator	4	250	50	71	3.5	3.5	0.2	0.5	0.05	0.035

Table C.iv.2 Trench Excavation Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Bulldozer	1.88	35.00	19,286	449	0.45	32	0.5	37.5
Grader	0.45	35.00	4,629	108	0.11	8	0.1	9.0
Excavator	3.00	35.00	30,857	718	0.72	51	0.8	59.9
Tipper	0.75	35.00	7,714	179	0.18	13	0.2	15.0
Shovel	1.13	35.00	11,571	269	0.27	19	0.3	22.5
Generator	5.00	35.00	51,429	1,196	1.20	85	1.4	99.9

Table C.iv.3 Trench Excavation Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NMVOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)
Bulldozer	0.24	0.35	0.02	0.03	0.00	0.00	18.37	0.0002
Grader	0.09	0.13	0.01	0.01	0.00	0.00	6.61	0.0001
Excavator	0.39	0.39	0.02	0.06	0.01	0.00	29.40	0.0004
Tipper	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.0001
Shovel	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.0001
Generator	0.97	0.97	0.06	0.14	0.01	0.01	73.49	0.0009

Table C.iv.4 Trench Excavation Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Bulldozer	0.015	0.021	0.001	0.002	0.000	0.000	1.117	0.000014
Grader	0.004	0.005	0.000	0.001	0.000	0.000	0.268	0.000003
Excavator	0.024	0.024	0.001	0.003	0.000	0.000	1.787	0.000023
Tipper	0.007	0.008	0.001	0.001	0.000	0.000	0.447	0.000006
Shovel	0.010	0.013	0.001	0.002	0.000	0.000	0.670	0.000008
Generator	0.039	0.039	0.002	0.006	0.001	0.000	2.978	0.000038

2.3.5 Pipe Installation

Table C.v.1 Pipe Installation Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NMVOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Bulldozer	1	250	75	106	3.5	5	0.3	0.5	0.05	0.035
Grader	1	90	75	106	3.5	5	0.4	0.5	0.05	0.035
Excavator	2	100	75	106	3.5	3.5	0.2	0.5	0.05	0.035
Tipper	1	75	50	106	4	5	0.4	0.7	0.05	0.035
Shovel	1	75	50	106	4	5	0.4	0.7	0.05	0.035
Sideboom	6	230	50	106	3.5	3.5	0.2	0.5	0.05	0.035
Crane		250	50	106	3.5	3.5	0.2	0.5	0.05	0.035
Welders	10	20	50	106	6.4	5.5	0.6	1.1	0.05	0.035
Bending machine	1	129	50	106	3.5	3.5	0.2	0.5	0.05	0.035
Generator	4	250	50	106	3.5	3.5	0.2	0.5	0.05	0.035

Table C.v.2 Pipe Installation Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Bulldozer	1.88	35.00	19,286	449	0.45	48	0.5	55.9
Grader	0.68	35.00	6,943	161	0.16	17	0.2	20.1
Excavator	1.50	35.00	15,429	359	0.36	38	0.4	44.7
Tipper	0.38	35.00	3,857	90	0.09	10	0.1	11.2
Shovel	0.38	35.00	3,857	90	0.09	10	0.1	11.2
Sideboom	6.90	35.00	70,971	1,650	1.65	175	1.9	205.8
Welders	1.00	35.00	10,286	239	0.24	25	0.3	29.8
Bending machine	0.65	35.00	6,634	154	0.15	16	0.2	19.2
Generator	5.00	35.00	51,429	1,196	1.20	127	1.4	149.1
Bulldozer	1.88	35.00	19,286	449	0.45	48	0.5	55.9

Table C.v.3 Pipe Installation Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NM VOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)
Bulldozer	0.24	0.35	0.02	0.03	0.00	0.00	18.37	0.0002
Grader	0.09	0.13	0.01	0.01	0.00	0.00	6.61	0.0001
Excavator	0.19	0.19	0.01	0.03	0.00	0.00	14.70	0.0002
Tipper	0.08	0.10	0.01	0.01	0.00	0.00	5.51	0.0001
Shovel	0.08	0.10	0.01	0.01	0.00	0.00	5.51	0.0001
Sideboom	1.34	1.34	0.08	0.19	0.02	0.01	101.41	0.0013
Welders	0.36	0.31	0.03	0.06	0.00	0.00	14.70	0.0002
Bending machine	0.13	0.13	0.01	0.02	0.00	0.00	9.48	0.0001
Generator	0.97	0.97	0.06	0.14	0.01	0.01	73.49	0.0009

Table C.v.4 Pipe Installation Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NM VOC	CH₄	N₂O	CO₂	SO₂
Bulldozer	0.022	0.032	0.002	0.003	0.000	0.000	1.667	0.00002
Grader	0.008	0.011	0.001	0.001	0.000	0.000	0.600	0.00001
Excavator	0.018	0.018	0.001	0.003	0.000	0.000	1.334	0.00002
Tipper	0.005	0.006	0.001	0.001	0.000	0.000	0.333	0.00000
Shovel	0.005	0.006	0.001	0.001	0.000	0.000	0.333	0.00000
Sideboom	0.081	0.081	0.005	0.012	0.001	0.001	6.136	0.00008
Welders	0.022	0.018	0.002	0.004	0.000	0.000	0.889	0.00001
Bending machine	0.008	0.008	0.000	0.001	0.000	0.000	0.574	0.00001
Generator	0.059	0.059	0.003	0.008	0.001	0.001	4.446	0.00006

2.3.6 Demobilisation/Reinstatement of pipelines

Table C.vi.1 Demobilisation/Reinstatement of pipeline Schedule Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Bulldozer	1	250	75	126	3.5	5	0.3	0.5	0.05	0.035
Grader	1	90	75	126	3.5	5	0.4	0.5	0.05	0.035
Excavator	2	100	75	126	3.5	3.5	0.2	0.5	0.05	0.035
Tipper	2	75	50	126	4	5	0.4	0.7	0.05	0.035
Shovel	2	75	50	126	4	5	0.4	0.7	0.05	0.035
Generator	2	250	50	126	3.5	3.5	0.2	0.5	0.05	0.035

Table C.vi.2 Demobilisation/Reinstatement of pipeline Schedule Plant Parameters

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Bulldozer	1.88	35.00	19,286	449	0.45	57	0.5	66.5
Grader	0.68	35.00	6,943	161	0.16	20	0.2	23.9
Excavator	1.50	35.00	15,429	359	0.36	45	0.4	53.2
Tipper	0.75	35.00	7,714	179	0.18	23	0.2	26.6
Shovel	0.75	35.00	7,714	179	0.18	23	0.2	26.6
Bulldozer	1.88	35.00	19,286	449	0.45	57	0.5	66.5
Generator	2.50	35.00	25,714	598	0.60	75	0.7	88.6

Table C.vi.3 Demobilisation/Reinstatement of pipeline Schedule Plant Parameters Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NMVOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)
Bulldozer	0.24	0.35	0.02	0.03	0.00	0.00	18.37	0.0002
Grader	0.09	0.13	0.01	0.01	0.00	0.00	6.61	0.0001
Excavator	0.19	0.19	0.01	0.03	0.00	0.00	14.70	0.0002
Tipper	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.0001
Shovel	0.17	0.21	0.02	0.03	0.00	0.00	11.02	0.0001
Generator	0.49	0.49	0.03	0.07	0.01	0.00	36.74	0.0005

Table C.vi.4 Demobilisation/Reinstatement of pipeline Schedule Plant Parameters Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Bulldozer	0.026	0.037	0.002	0.004	0.000	0.000	1.982	0.000
Grader	0.009	0.013	0.001	0.001	0.000	0.000	0.713	0.000
Excavator	0.021	0.021	0.001	0.003	0.000	0.000	1.586	0.000
Tipper	0.012	0.015	0.001	0.002	0.000	0.000	0.793	0.000
Shovel	0.012	0.015	0.001	0.002	0.000	0.000	0.793	0.000
Generator	0.035	0.035	0.002	0.005	0.000	0.000	2.643	0.000

2.4 Atmospheric Emissions from Pre-commissioning Schedule

The following data was used to calculate fuel consumption per unit time and factored for tonnes of fuel consumed per year:

- Anticipated type and number of construction plant for schedule requirements;
- Assumed plant operating duration for schedule requirements;
- Assumed plant operation percentage per 10 our day; and
- Engine power rating, efficiency of engine.

European engine emissions standards were applied to peak and factored annual fuel consumption to quantify emissions of pollutant per unit time for modelling of peak emissions in grams per second and averaged out over a year for long term pollutant modelling. Carbon Dioxide equivalent (eCO₂) assumes a greenhouse gas potential of 21 for CH₄, 310 for N₂O and 1 for CO₂.

Table D.1 Atmospheric Emissions from Pre-commissioning Plant (tonnes)

Activity	NO _x	CO	PM	NMVOC	CH ₄	N ₂ O	CO ₂	SO ₂	eCO ₂	Fuel
Landfall and Nearshore Plant	2.2	0.5	0.2	0.2	0.01	0.01	40.5	0.001	1.8	34.3
Landfall hydrotesting per pipeline)	0.4	0.4	0.0	0.1	0.01	0.00	29.9	0.000	31.3	27.1
Compressor & Boosters	71	71	4	10	1.01	0.71	5,364	0.068	5,605	4,850
Total per pipeline	74	72	4	10	1.03	0.72	5,434	0.069	5,638	4,911
Total (4 pipelines)	294	287	17	42	4	3	21,738	0.3	22,553	19,645

The following tables provide values used for road traffic emissions impact screening pollutant modelling and calculating overall plant pollutant and greenhouse gas emissions.

Table E.3: Diesel Parameters

Parameter	Value	Unit
Diesel Heating value	43	(MJ/kg)
Density of Diesel	850	(kg/m³)
CO2 Emission Factor	3160	(kg/tonne)
Percentage Sulphur Fuel Content	0.002	(%)

Ref. EU Directive 2009/30/EC Article 4

2.4.1 Landfall and Nearshore Section

Table E.i.1 Landfall and Nearshore Section Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Water Extraction Pump	2	1000	100	1	14.4	3	1.1	1.3	0.05	0.035
Diesel flooding pump	2	700	100	1	14.4	3	1.1	1.3	0.05	0.035
Hydrostatic Pump	2	700	100	1	14.4	3	1.1	1.3	0.05	0.035
High Pressure Compressor	4	1095	100	2	14.4	3	1.1	1.3	0.05	0.035
Air Drying Unit	1	1095	100	1	14.4	3	1.1	1.3	0.05	0.035
Nitrogen Membrane Unit	1	672	100	1	14.4	3	1.1	1.3	0.05	0.035

Table E.i.2: Landfall and Nearshore Section Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Water Extraction Pump	20.00	35.00	205,714	4,784.05	4.78	5	5.6	5.6
Diesel flooding pump	14.00	36.00	140,000	3,255.81	3.26	3	3.8	3.8
Hydrostatic Pump	14.00	37.00	136,216	3,167.82	3.17	3	3.7	3.7
High Pressure Compressor	43.80	38.00	414,947	9,649.94	9.65	19	11.4	22.7
Air Drying Unit	10.95	39.00	101,077	2,350.63	2.35	2	2.8	2.8
Nitrogen Membrane Unit	6.72	40.00	60,480	1,406.51	1.41	1	1.7	1.7
Water Extraction Pump	20.00	35.00	205,714	4,784.05	4.78	5	5.6	5.6

Table E.i.3: Landfall and Nearshore Section Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NM VOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)]
Water Extraction Pump	8.00	1.67	0.61	0.72	0.03	0.02	146.98	0.002
Diesel flooding pump	5.60	1.17	0.43	0.51	0.02	0.01	102.88	0.001
Hydrostatic Pump	5.60	1.17	0.43	0.51	0.02	0.01	102.88	0.001
High Pressure Compressor	17.52	3.65	1.34	1.58	0.06	0.04	321.88	0.004
Air Drying Unit	4.38	0.91	0.33	0.40	0.02	0.01	80.47	0.001
Nitrogen Membrane Unit	2.69	0.56	0.21	0.24	0.01	0.01	49.38	0.001

Table E.i.4: Site Preparation Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Water Extraction Pump	0.009	0.002	0.001	0.001	0.000	0.000	0.168	0.000002
Diesel flooding pump	0.006	0.001	0.000	0.001	0.000	0.000	0.117	0.000001
Hydrostatic Pump	0.006	0.001	0.000	0.001	0.000	0.000	0.117	0.000001
High Pressure Compressor	0.040	0.008	0.003	0.004	0.000	0.000	0.735	0.000009
Air Drying Unit	0.005	0.001	0.000	0.000	0.000	0.000	0.092	0.000001
Nitrogen Membrane Unit	0.003	0.001	0.000	0.000	0.000	0.000	0.056	0.000001

2.4.2 Landfall Hydrotesting per pipeline

Table E.ii.1: Landfall Hydrotesting per pipeline Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NM VOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Diesel flooding pumps	1	50	100	8	4	5	0.4	0.7	0.05	0.035
Diesel hydrostatic test pumps	1	10	100	12	14.4	5.5	0.6	1.1	0.05	0.035
Primary high pressure compressor	2	300	100	12	3.5	3.5	0.2	0.5	0.05	0.035
Air drying unit	1	300	100	12	3.5	3.5	0.2	0.5	0.05	0.035

Table E.iii.1 Landfall hydrotesting per pipeline Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m³/DAY) [(kg/Day) x (kg/m³)]	Fuel Consumption (m³) [(m³/DAY x DAY)]
Diesel flooding pumps	0.50	35.00	5,143	120	0.12	1	0.1	1.1
Diesel hydrostatic test pumps	0.10	35.00	1,029	24	0.02	0	0.0	0.3
Primary high pressure compressor	6.00	35.00	61,714	1,435	1.44	17	1.7	20.3
Air drying unit	3.00	35.00	30,857	718	0.72	9	0.8	10.1

Table E.iv.2 Landfall hydrotesting per pipeline Raw Emission Rates assuming 100% utilised plant

Equipment	NO_x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NMVOC (g/s) [(No.) x (kW) x (g/kWh)]	CH₄ (g/s) [(No.) x (kW) x (g/kWh)]	N₂O (g/s) [(No.) x (kW) x (g/kWh)]	CO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)]
Diesel flooding pumps	0.06	0.07	0.01	0.01	0.00	0.00	3.67	0.00005
Diesel hydrostatic test pumps	0.04	0.02	0.00	0.00	0.00	0.00	0.73	0.00001
Primary high pressure compressor	0.58	0.58	0.03	0.08	0.01	0.01	44.09	0.00056
Air drying unit	0.29	0.29	0.02	0.04	0.00	0.00	22.05	0.00028

Table D.i.4 Landfall hydrotesting per pipeline Annual Emission Rate (g/s) assuming Plant utilised for 31% of day (no night time use) and No. of Days

Equipment	NO_x	CO	PM	NMVOC	CH₄	N₂O	CO₂	SO₂
Diesel flooding pumps	0.001	0.001	0.000	0.000	0.000	0.000	0.034	0.000000
Diesel hydrostatic test pumps	0.001	0.000	0.000	0.000	0.000	0.000	0.010	0.000000
Primary high pressure compressor	0.008	0.008	0.000	0.001	0.000	0.000	0.604	0.000008
Air drying unit	0.004	0.004	0.000	0.001	0.000	0.000	0.302	0.000004

2.4.3 Combined Compressor & Booster Units

Table E.iii.1 Combined Compressor & Booster Units Plant Parameters

Plant	Number	Est. Power (kW)	Utilisation 10 hour day (%)	Duration (DAY)	NO _x (g/kWh)	CO (g/kWh)	PM (g/kWh)	NMVOC (g/kWh)	CH ₄ (g/kWh)	N ₂ O (g/kWh)
Combined Compressor & Booster Units	80	440	100	24	3.5	3.5	0.2	0.5	0.05	0.035

Table E.iii.1 Combined Compressor & Booster Units Fuel Consumption

Equipment	Combined Engine Power Rating (MWh/DAY) [(kW) x No.]	Efficiency (%)	Fuel Consumption (MJ/DAY) [(MWh/DAY) x Eff]	Fuel Consumption (kg/DAY) [(MJ/DAY) x (MJ/kg)]	Fuel Consumption (Tonne/DAY) [(kg/DAY)/1000]	Fuel Consumption (Tonne) [(Tonne/DAY) x (DAY)]	Fuel Consumption (m ³ /DAY) [(kg/Day) x (kg/m ³)]	Fuel Consumption (m ³) [(m ³ /DAY x DAY)]
Combined Compressor & Booster Units	844.8	35	8,689,371.43	202,078.41	202.08	4,850	237.7	5,705.7

Table E.iii.1 Combined Compressor & Booster Units Emission Rates

Equipment	NO _x (g/s) [(No.) x (kW) x (g/kWh)]	CO (g/s) [(No.) x (kW) x (g/kWh)]	PM (g/s) [(No.) x (kW) x (g/kWh)]	NMVOC (g/s) [(No.) x (kW) x (g/kWh)]	CH ₄ (g/s) [(No.) x (kW) x (g/kWh)]	N ₂ O (g/s) [(No.) x (kW) x (g/kWh)]	CO ₂ (g/s) [(No.) x (kW) / (MJ/kg) x (kg/tonne)]	SO ₂ (g/s) [(No.) x (kW) / (MJ/kg) x (%Sx2)]
Combined Compressor & Booster Units	34	34.22	1.96	4.89	0.49	0.34	2,586.79	0.03