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A8.1 CARBON EMISSIONS

8.1 INTRODUCTION

This Appendix provides the background and assumptions to the study which considers the carbon emissions associated with accessing St Helena by ship and by aircraft.

8.1.1 Overview

Emissions of carbon dioxide (CO_2) have been calculated for a number of scenarios, with and without the proposed airport. This has allowed the CO_2 emitted per scenario and per passenger to be compared.

Currently the island is accessed by ship from the UK, Cape Town or Walvis Bay (Namibia), or by RAF flight from the UK to Ascension (and then by ship to St Helena). Following completion of the proposed airport, it is unlikely to be possible to travel by ship as a passenger. There will be regular flights from South Africa to St Helena, and possibly from other countries.

To undertake these emissions calculations and comparisons several assumptions have been made, these are detailed in the Section 8.2, Methodology. The significance of these assumptions is considered in the Section 8.4, Conclusions. Notably, only emissions of the key greenhouse gas CO_2 have been considered; emissions of other greenhouse gases have not been considered. Only emissions from aircraft and ships are considered, emissions from other sources, or emissions resulting from a potential increase in development on the island, are not considered.

The following scenarios have been studied:

Without St Helena Airport
1. Cape Town – St. Helena (RMS St. Helena)
2. UK Brize Norton – Ascension – St. Helena (RAF flight and RMS St. Helena)
3. UK Portland – Tenerife – Ascension – St. Helena (RMS St. Helena)
4. UK Heathrow – Cape Town – St. Helena (commercial flight and RMS St. Helena)

With St Helena Airport
5. Cape Town – St. Helena (commercial flight)
6. UK Heathrow – Cape Town – St. Helena (commercial flight)

8.1.2 Global Warming and Climate Change

This study is necessary due to the impact that emissions of greenhouse gases such as CO2, have on the environment. There is now universal agreement that anthropogenic emissions of greenhouse gases are having an impact on the environment. Greenhouse gases are naturally present in the atmosphere and are essential as they regulate the temperature of the Earth. However, their concentrations in the atmosphere have increased dramatically in the last 50-100 years, largely as a result of the burning of fossil fuels and deforestation.

Consequently, global temperatures are rising at a rate greater than has been previously recorded. Whilst there is still uncertainty regarding the extent of rising temperatures and the effect this will have on, for example, sea levels and ocean currents, global warming is now at the forefront of politics worldwide.

8.2 METHODOLOGY

For the Cape Town to St Helena scenarios (1 and 5), and for the UK to St Helena scenarios (2, 3, 4 and 6) the following comparisons have been made:

- Total CO_2 emissions per 1-way trip;
- Total CO_2 emissions per 1-way trip per (St Helena bound) passenger; and
- Total CO_2 emissions per year (for St Helena bound passengers).

8.2.1 Shipping Emissions

8.2.1.1 Information Sources

The RMS St Helena provides the only regular passenger service to and from St Helena. The ship is capable of carrying up to 130 passengers and up to 1,000 tonnes of freight. Andrew Weir Shipping (AWS) operate the ship and have provided the following for 2006: passenger numbers, mileages, timetabling information, and fuel type and consumption data (refer to Tables 8.1 and 8.2).

The net calorific value (NCV) of residual fuel oil and marine gas oil, used by RMS, was sourced from the Intergovernmental Panel on Climate Change's (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). The CO_2 emissions factors for the two fuels were sourced from the same document. These figures are presented in Table 8.3. Residual fuel oil is used when in open sea and marine gas oil is used in port. AWS estimate that 6 tonnes of marine gas oil is used per day in port. Based on scheduling information, it is estimated that the ship is in port for approximately 35 days per year.

Table 8.1 RMS St Helena Mileage and Estimated Fuel Consumption

From	To	Leg distance / nautical miles	Fuel consumption / tonnes
Portland	Tenerife	1530	95.6
Tenerife	Ascension	2203	137.7
Ascension	St Helena	706	44.1
St Helena	Walvis Bay	1225	76.6
St Helena	Cape Town	1700	106.3
Walvis Bay	Cape Town	734	45.9
Ascension	Vigo	3096	193.5
Portland	Vigo	621	38.8
Tenerife	Vigo	912	57.0

Notes: Fuel consumption based on average weather conditions and average speed of 14 knots per hour.

Table 8.2 RMS Passenger Numbers by Leg

From	To	Average Passenger numbers by leg
Portland	Tenerife	2
Portland	St Helena	48
Portland	Cape Town	2
Portland	Ascension	4
Cape Town	Portland	2
Cape Town	St Helena	109
Cape Town	Ascension	7
Cape Town	Walvis Bay	8
St Helena	Cape Town	44
St Helena	Portland	31
St Helena	Ascension	71
St Helena	Walvis Bay	34
Ascension	St Helena	62
Ascension	Cape Town	3
Ascension	Walvis Bay	2
Ascension	Portland	1
Walvis Bay	Cape Town	9
Walvis Bay	St Helena	32
Walvis Bay	Ascension	6
Walvis Bay	Portland	2
Tenerife	Portland	1
Tenerife	Cape Town	3
Vigo	Portland	1

Table 8.3 Fuel Properties

Fuel	Net calorific value (NCV) (TJ/t)	CO_2 emissions factor (t/TJ)
Residual Fuel Oil (RFO)	0.0404	77.4
Marine Gas Oil (MGO)	0.0430	74.1

TJ: Terajoule. 1 TJ = 1×10^{12} Joules

8.2.1.2 Calculations

The average emissions of CO_2 per (St Helena bound) passenger for each leg of the RMS St Helena's trip were calculated according to the following procedure:

1. Fuel consumption per leg was provided by AWS.
2. The calorific value of the fuel consumed per leg (TJ) was calculated by multiplication of the fuel consumption (t) by the net calorific value of the fuel (TJ/t).
3. CO_2 emitted (t) per leg calculated by multiplication of the CO_2 emission factor (t/TJ) by the calorific value of the fuel consumed (TJ).
4. CO_2 emitted per passenger per leg determined by division of the CO_2 emitted per leg, by the total number of passengers.

Annual emissions were determined with reference to the scheduling information, provided by AWS; the total number of (St Helena bound) passengers was multiplied by the CO_2 emitted per passenger per leg.

Emissions of CO_2 whilst in port were calculated for the whole year and expressed in tonnes and as a percentage of the total emissions from RMS St Helena annually.

8.2.2 Aircraft Emissions

8.2.2.1 Information Sources

The RAF operates a scheduled service between RAF Brize Norton (Oxfordshire), Ascension, and The Falkland Islands (termed the South Atlantic Airbridge). The RAF provided details of flight distances between Ascension and Brize Norton, the aircraft type, and flight schedules. Details regarding fuel consumption could not be provided and therefore estimates have been made based on aircraft specific parameters and flight distance (further details below). The information provided is presented in Table 8.4.

Table 8.4 RAF Flight Information

Flight Distance	**Ascension – Brize Norton: 6760 km**
Aircraft Type	The contracted carrier for the MoD was a Boeing 747, but changed to a DC10 in October 2007
Schedules	3 flights per fortnight, 78 per year

Data regarding the number of non-military passengers per flight is not recorded, nor is the proportion of those who continue from Ascension to St Helena by ship. However, generally, the number of 'indulgence' passengers on the airbridge is limited to around 44 per flight, and this includes military connections/families for Ascension. The RAF were able to provide a rough estimate of those bound for St Helena: approximately half of the 44 places are military connections and approximately half again are people employed on Ascension. This would leave a maximum of 11 per flight who could possibly be travelling onwards to St Helena. A realistic estimate may be 5 per flight, or approximately 400 per year.

The net calorific value (NCV) of jet fuel, was sourced from the Intergovernmental Panel on Climate Change's (IPCC) Guidelines for National Greenhouse Gas Inventories (IPPC, 2006), as was the CO_2 emissions factor for jet fuel.

Table 8.5 Fuel Properties

Fuel	**Net calorific value (NCV) (TJ/t)**	**CO_2 emissions factor (t/TJ)**
Jet kerosene	0.0441	71.5

Scheduled air traffic forecasts after opening of the airport on St Helena are based on the use of a B737 800, with 162 seats. It has been assumed that in the first year (2011) 135 of the seats will be occupied per flight on average, and therefore 7,020 passengers during 2011. Of these, it has been assumed for the purpose of the assessment that half will have commenced their trip in the UK. Whilst scheduled flights may originate from various airports, such as Cape Town, Johannesburg, Walvis Bay and London airports, for the purposes of this assessment, it has been assumed that all flights are from Cape Town.

Flight distances between Cape Town and St Helena, and Heathrow and Cape Town, have been estimated based on shortest routes.

A B747-400 has been taken as a typical aircraft to fly between Heathrow and Cape Town.

True aircraft speeds and fuel consumption rates have been sourced from a Eurocontrol Agency document (Eurocontrol Agency, 2004), where aircraft performance summary tables are listed. The document contains data for 91 aircraft types, including the DC-10, B737-800 and B747-400, modelled by the Base of Aircraft Data (BADA) Revision 3.6. For each aircraft type the true air speed, rate of climb/descent and fuel flow for conditions of climb, cruise and descent at various flight levels are listed. The data used are provided in Table 8.6.

For the purposes of this study, the differing fuel consumption rates during climb and descent have not been explicitly factored into the calculations. The increased fuel consumption during climb will be approximately cancelled out by the reduced fuel consumption during descent; during climb fuel consumption is approximately two to three times that during cruise, and during descent fuel consumption is approximately a quarter to a half of that during cruise. The rates of climb and descent have been assumed to be approximately equal.

Typical emissions for each aircraft during the Landing and Take Off (LTO) cycle have been sourced from the European Environment Agency's Emissions Inventory Guidebook (EEA, 2006).

Table 8.6 Aircraft Data

Aircraft	True Air Speed (km/h)	[1] Fuel consumption (kg/min)	LTO cycle, typical CO_2 emissions / t
DC-10	878	155.3	7.50
B737-800	821	47.3	2.60
B747-400	880	119.3	10.72

Note: [1] Low, nominal and high fuel consumption data were available; the high figures are quoted here, corresponding to fully laden aircraft.

It was estimated that 500 people currently access the island from the UK via South Africa per year. It was necessary to make this approximation to enable the annual emissions for Scenario 4 to be calculated.

8.2.2.2 Calculations

The average emissions of CO_2 per passenger for each scenario were calculated according to the following procedure:

1. Fuel consumed was calculated from the flight time and fuel consumption rate.
2. The calorific value of the fuel consumed per flight (TJ) was calculated by multiplication of the fuel consumed (t) by the net calorific value of the fuel (TJ/t).
3. CO_2 emitted (t) per flight calculated by multiplication of the CO_2 emission factor (t/TJ) by the calorific value of the fuel consumed (TJ), and the addition of aircraft specific LTO cycle CO_2 emissions.
4. CO_2 emitted per passenger per flight determined by division of the CO_2 emitted per flight, by the total number of passengers.

Annual emissions were determined by multiplication of the total number of (St Helena bound) passengers by the CO_2 emitted per passenger per flight.

8.2.3 Assumptions and Limitations

- Only CO_2 emissions from aircraft and the RMS St Helena have been considered; emissions of other greenhouse gases, such as methane, nitrogen oxides, and the secondary formation of ozone have not been considered.
- Emissions from sources other than the aircraft, such as airport ground vehicles, have not been considered.
- Changes in fuel consumption during aircraft climb and descent have not be assessed quantitatively. However, emissions during the Landing and Take Off (LTO) cycle have been included in the calculations.
- CO_2 emissions from sources associated with increased tourism on the island, as a result of the proposed air access, have not been considered.
- Emissions from RMS St Helena whilst in port have been calculated assuming 35 whole days spent in port per year (based on 2006 scheduling information)
- The transport of freight is not considered.
- For the purposes of the assessment people can only access the island via RAF flight to Ascension followed by RMS St Helena, or by RMS St Helena from Cape Town or Portland (UK).
- Accessing the island via Walvis Bay or by any other means, or in the future via flight from other countries or airports is not considered here.
- Aircraft are assumed to fly via the shortest routes, with the exception of the RAF flight for which mileage information was provided by the RAF.
- 80% of the aircraft seats are assumed to be occupied on average.
- The average number of passengers on the Brize Norton to Ascension RAF flight that are bound for St Helena is not known and so has been estimated as discussed.
- The number of people who currently travel to St Helena from the UK by the various routes is not known; estimations have been made where necessary.
- A future scenario of one return flight per week (B737-800) to St Helena is assumed. It should be noted however that current projections are for a rapid increase in the number of flights to the island once the airport is operational.
- It is assumed that half of those predicted to travel to St Helena in the future start their journey in the UK (Heathrow).
- Potential improvements in ship or aircraft fuel efficiency in the future, or the prospect of alternative fuels to those currently in use, have not been considered.

8.3 RESULTS

The results of the study are presented in Tables 8.7 to 8.9; RMS St Helena calculations are presented in Table 8.7[1], aircraft calculations are presented in Table 8.8, and a comparison of the emissions for each scenario are presented in Table 8.9. Each scenario is summarised in the following text, where emissions per trip, per passenger and per year are provided.

Emissions per trip are calculated for each mode of transport, but no consideration is given to factors such as the final destination of the ship/aircraft, or the numbers of people on board. For example the CO_2 emitted between Brize Norton and Ascension is present irrespective of the fact that only approximately 20 civilian seats are available per flight, and some of those are occupied by people flying to The Falkland Islands.

Emissions per passenger were calculated by dividing the trip emissions by the number of passengers (including those passengers who are not bound for St Helena).

Emissions per year were calculated by multiplication of the passenger emissions by the total number of passengers bound for St Helena.

8.3.1 Scenario Summaries

The following emissions figures for RMS St Helena include port emissions, calculated as described in the methodology section. The aircraft emissions figures include LTO cycle emissions, as described in the methodology section.

[1] Emissions of CO_2 whilst in port were calculated for the whole year, based on the assumption of 6 tonnes marine gas oil (MGO) used per day for 35 days per year. Total CO_2 emissions attributable to MGO equate to 4.1% of the total emissions associated with the ship per year. Therefore the CO_2 emissions per trip and per year for each leg were approximated by increasing the CO_2 emissions attributable to residual fuel oil by 4.1%.

8.3.1.1 Without Air Access

Scenario 1: Cape Town – St Helena (RMS St Helena)
Emissions from the RMS St Helena have been calculated from Cape Town to St Helena, via Walvis Bay and by the direct route. The split of passengers going by each route was not known therefore for the purposes of this assessment an average of the mileage and fuel consumption for the two routes was used:

- Emissions per trip: 372 tonnes CO_2
- Emissions per passenger: 2.31 tonnes CO_2
- Annual Emissions: 3464 tonnes CO_2

Scenario 2: UK Brize Norton – Ascension – St Helena (RAF flight and RMS St Helena)
Emissions from the RAF aircraft and RMS St Helena have been summed and are summarised:

- Emissions per trip: 377 tonnes CO_2
- Emissions per passenger: 3.31 tonnes CO_2
- Annual Emissions: 1289 tonnes CO_2

Scenario 3: UK Portland – Tenerife – Ascension – St Helena (RMS St Helena)
Emissions from the RMS St Helena have been calculated from the UK to St Helena:

- Emissions per trip: 903 tonnes CO_2
- Emissions per passenger: 17.1 tonnes CO_2 per passenger bound for St Helena
- Annual Emissions: 1807 tonnes CO_2

Scenario 4: UK Heathrow – Cape Town – St Helena (commercial flight and RMS St Helena)
Emissions from the RAF aircraft and RMS St Helena have been summed and are summarised:

- Emissions per trip: 631 tonnes CO_2
- Emissions per passenger: 3.09 tonnes CO_2
- Annual Emissions: 1543 tonnes CO_2

8.3.1.2 With Air Access

Scenario 5: Cape Town – St Helena (commercial flight)
Aircraft (B737-800) emissions are summarised:

- Emissions per trip: 36.8 tonnes CO_2
- Emissions per passenger: 0.27 tonnes CO_2
- Annual Emissions: 1915 tonnes CO_2

Scenario 6: UK Heathrow – Cape Town – St Helena (commercial flight)
Aircraft (B747-400 & B737-800) emissions are summarised:

- Emissions per trip: 295 tonnes CO_2
- Emissions per passenger: 1.05 tonnes CO_2
- Annual Emissions: 4639 tonnes CO_2

8.3.2 Scenario Comparisons

It is important that comparisons are made on a 'like-for-like' basis. Where this is difficult to achieve, the implications are discussed below:

8.3.2.2 Cape Town to St Helena (Scenario 1 vs. Scenario 5)

In the future, flights to St Helena will have one key purpose, to carry 'Saints' and tourists to the island. Currently the RMS St Helena does not just transport 'Saints' and tourists to St Helena, but also continues to Ascension and onwards to the UK, or goes via Walvis Bay. For the purposes of this assessment the indirect route to St Helena, via Walvis Bay (which accounts for half of the trips from Cape Town to St Helena), has been ignored.

It can be seen from Table 8.9 that on a per trip basis, 10 times more CO_2 would be emitted from the RMS St Helena than from the B737-800. Similarly, on a per passenger basis 8.5 times more CO_2 would be emitted from the RMS St Helena than from the B737-800. Annually, about 1.5 times more CO_2 is predicted from the RMS St Helena, based on six sailings and 52 flights per year.

8.3.2.2 UK to St Helena (Scenario 2, 3 & 4 vs. Scenario 6)

From the UK people can currently access St Helena via RAF flight to Ascension (Scenario 2), via the RMS St Helena from Portland, or via commercial flights to South Africa/Namibia (Scenario 4). In the future, access will be via flights to South Africa/Namibia, and then onward flights to St Helena (Scenario 6). It should be noted however that direct flights from the UK and other countries will be possible.

Similar concerns as those expressed for the Cape Town to St Helena comparison (above) are valid here, namely that the RMS St Helena serves several purposes, in particular it transports people between Ascension and St Helena, and also the RAF flight to Ascension is part of a longer flight to the Falkland Islands. The numbers of passengers on the RAF flight whose final destination is St Helena is small compared to the total number of people on the aeroplane. For the purposes of this assessment the indirect route to St Helena, via Walvis Bay (which accounts for half of the trips from Cape Town to St Helena), has been ignored, and Cape Town has been assumed to be the hub for passengers accessing St Helena via commercial flights currently and in the future.

As can be seen from Table 8.9, CO_2 emissions per trip, per year and per passenger vary considerably for the four scenarios. For the existing scenarios total emissions per trip vary from 377 tonnes to 903 tonnes. For the future scenario less CO_2 is predicted to be emitted per trip (295 tonnes) than for any of the existing scenarios. Per passenger, approximately three times less CO_2 would be emitted in the future scenario when compared with the two existing scenarios which involve aircraft. Most emissions are associated with Scenario 3 (RMS St Helena, UK to St Helena) on both a per trip and per passenger basis. Annually, an increase in emissions of 150-400% is predicted between the existing scenarios and future scenario. This increase is a consequence of the increase in the number of visitors predicted to visit St Helena, as a result of the provision of air access.

Table 8.7 RMS St Helena CO2 Emission Calculations*

Leg	Trips per Year	Leg Length	Fuel Consumption / t		Energy Output / TJ		CO_2 Emissions / t			
							Excluding port emissions		*Including port emissions	
		N Miles	/ trip	/ year	/ trip	/ year	/ trip	/ year	/ trip	/ year
					UK → St Helena					
Portland-Tenerife	2	1530	96	191	3.86	7.7	299	598	311	623
Tenerife-Ascension	2	2203	138	275	5.56	11.1	431	861	448	896
Ascension-St Helena	2	706	44	88	1.78	3.6	138	276	144	287
Total				*555*			*868*	*1735*	*903*	*1806*
					St Helena → UK					
Vigo-Portland	2	621	39	78	1.57	3.1	121	243	126	253
Tenerife-Vigo	2	912	57	114	2.30	4.6	178	356	186	371
Ascension-Tenerife	2	2203	138	275	5.56	11.1	431	861	448	896
St Helena-Ascension	2	706	44	88	1.78	3.6	138	276	144	287
Total				*555*			*868*	*1736*	*904*	*1807*
					Cape town → St Helena					
Cape Town-St Helena (direct)	6	1700	106	638	4.29	25.8	332	1993	346	2075
Cape Town-Walvis Bay (indirect)	5	734	46	229	1.85	9.3	143	717	149	747
Walvis Bay-St Helena (indirect)	5	1225	77	383	3.09	15.5	239	1197	249	1246
Mean of the direct and indirect routes	*11*	*1830*	*114*	*1258*	*4.62*	*50.8*	*358*	*3933*	*372*	*4094*
					St Helena → Cape Town					
St Helena-Cape Town (direct)	6	1700	106	638	4.29	25.8	332	1993	346	2075
St Helena-Walvis Bay (indirect)	6	1225	77	459	3.09	18.6	239	1436	249	1495
Walvis Bay-Cape Town (indirect)	5	734	46	229	1.85	9.3	143	717	149	747
Mean of the direct and indirect routes	*11*	*1830*	*114*	*1258*	*4.62*	*50.8*	*358*	*3933*	*372*	*4094*
					Ascension ↔ St Helena (excluding the UK ↔ St Helena voyage)					
St Helena-Ascension	15	706	44	662	1.78	26.7	138	2070	144	2154
Ascension-St Helena	15	706	44	662	1.78	26.7	138	2070	144	2154
**Emissions in Port (6 tonnes marine gas oil per day for 35 days per year)*				*210*				*669*		*n/a*
Grand Total				***5,710***						***16,146***

Table 8.8 Aircraft CO_2 Emissions Calculations

For scenario:	Route	Aircraft	Flights / Year	Distance / km	Flight time / hrs	True air speed / km/h	During Cruise				CO_2 emissions, including Cruise and LTO Cycle / t
							Fuel consumption		Energy Output / TJ	CO_2 emissions / t	
							kg/min				
2	Brize Norton – Ascension	DC10	78	6760	7.7	878	155.3	71.8	3.16	226	**234**
5	Cape Town – St Helena	B737-800	52	3141	3.8	821	47.3	10.9	0.48	34.2	**36.8**
4,6	Heathrow – Cape Town	B747-400	-	9647	11.0	880	119.3	78.5	3.46	248	**258**

Table 8.9 Scenario Emissions Comparison Table

Scenario			CO_2 emissions / t								
			[1]RMS St Helena			[2]Aircraft			Total		
			/ trip	/ year	/ passenger	/ flight	/ year	/ passenger	/ trip	/ year	/ passenger
Without Air Access											
1	Cape Town – St Helena	*(RMS St Helena)*	372	3464	2.31				**372**	**3464**	**2.31**
2	UK Brize Norton – Ascension – St Helena	*(RAF flight & RMS St Helena)*	144	867	2.22	234	422	1.08	**377**	**1289**	**3.31**
3	UK Portland – Tenerife – Ascension – St Helena	*(RMS St Helena)*	903	1807	17.1				**903**	**1807**	**17.1**
4	UK Heathrow – Cape Town – St Helena	*(B747-400 & RMS St Helena)*	372	1155	2.31	258	388	0.78	**631**	**1543**	**3.09**
With Air Access											
5	Cape Town – St Helena	*(B737-800)*				36.8	1915	0.27	**36.8**	**1915**	**0.27**
6	UK Heathrow – Cape Town – St Helena	*(B747-400 & B737-800)*				295	4639	1.05	**295**	**4639**	**1.05**

Notes: [1] Inclusive of emissions whilst in port; [2] Inclusive of emissions associated with the LTO cycle

8.4 CONCLUSIONS

8.4.1 Key Findings

Four existing scenarios and two future scenarios were examined. These allowed a direct comparison to be made between accessing the island from South Africa (Cape Town) by ship and by aircraft, and comparisons of different methods of accessing the island now and in the future (by air), from the UK. With cognisance of the assumptions and limitations, discussed further below, the findings are summarised:

- To access the island from Cape Town, approximately 10 times more CO_2 would be emitted from the RMS St Helena than from an aircraft. Per passenger this equates to approximately 8.5 times more CO_2. Annually, about 1.5 times more CO_2 is predicted to be emitted from the RMS St Helena, based on six sailings and 52 flights per year from Cape Town.
- Accessing the island from the UK exclusively by air is predicted to be more efficient in terms of CO_2 emissions, than the three existing UK scenarios. The greatest emissions are associated with accessing the island from the UK exclusively by ship.
- On a per-passenger basis, approximately three times less CO_2 is predicted to be emitted by accessing the island from the UK by aircraft in the future, than by a combination of aircraft and ship currently.
- On a per-trip and per-passenger basis, travel by air is more efficient in terms of emissions of CO_2 than travel by RMS St Helena.
- The with-airport calculations have been based on passenger numbers in the first year after completion of the airport. Passenger numbers are predicted to rise sharply in the 30 or so years after the completion of the airport. Total CO_2 emissions will therefore also rise sharply, even if accompanied by improvements in aircraft efficiency.

8.4.2 Assumptions and Limitations

To undertake this study a number of assumptions were made. It is instructive that the importance of these assumptions and the limitations they introduce are discussed in relation to the key findings. The assumptions and limitations of greatest significance are:

- The transport of freight is not considered. This limitation is likely to have introduced uncertainty into the scenario comparisons. The RMS St Helena has a dual purpose in that it transports people and freight. However, the future scenarios assessed here have only considered passenger aircraft, which have a far smaller capacity for freight and therefore comparisons between the emissions calculations for aircraft and the RMS St Helena should be treated with caution. In general the emissions calculations for the RMS St Helena will be higher because they include the movement of freight, and therefore the comparisons as presented will be biased towards aircraft travel. No attempt has been made to disaggregate RMS emissions associated with the movement of objects other than people and their luggage. SHG is considering several options for the provision of sea-borne cargo including regular charter, spot charter, and a St Helena owned freighter. Each option would have different levels of emissions but it is likely that a bespoke freight transport service would be more efficient than the RMS.
- CO_2 emissions from sources associated with increased tourism on the island, as a result of the proposed air access, have not been considered. The provision of air access will lead to a sharp increase in development on the island, to cater with the projected increase in visitor numbers. This development is likely to result in increased carbon emissions. Attempts to quantify these emissions are outside the scope of this study.

- A future scenario of one return flight per week to St Helena is assumed. It should be noted however that current projections are for a rapid increase in the number of passengers and flights to the island once the airport is operational. For example by 2040 10 flights per week are predicted (1550 people). This will clearly have a very significant bearing on annual emissions, but a less significant bearing on 'per passenger' emissions. Annually, CO_2 emissions may be up to 10 times greater in 2040 than 2011, assuming 10 flights per week in 2040, rather than one in 2011. However, this may be considered to be a worst-case estimate due to likely improvements in aircraft efficiency and fuel use, and the likelihood of direct flights to the island from a greater number of airports.
- An important issue is the differing effects of CO_2 emissions at altitude. The total contribution of aircraft emissions to global anthropogenic CO_2 emissions is considered to be about 2% (IPCC, 1999). However, this relatively small contribution should be seen in relation to the fact that the majority of aircraft emissions are injected almost directly into the upper free troposphere and lower stratosphere. The IPCC has estimated that the contribution to radiative forcing is greater, about 3.5 % (EEA, 2006). Based on this figure the aircraft emissions calculated should be multiplied by 1.75 to make them comparable with the ship emissions in terms of their global warming potential.

The following assumptions and limitations are of lesser significance but should be taken into account when considering the key findings of the study:

- Only CO_2 emissions from aircraft and the RMS St Helena were considered; emissions of other greenhouse gases, such as methane and nitrogen oxides, were not considered. CO_2 is frequently used as a proxy for all greenhouse gases, assessing the scenarios in this way provides a robust basis for comparisons to be made.
- Emissions from sources other than the aircraft, such as airport ground vehicles, have not been considered. The vast majority of CO_2 emissions are emitted during the flight, rather than from associated airport activities, therefore this assumption should not be considered important.
- Changes in fuel consumption during aircraft climb and descent have not been assessed quantitatively. However, emissions during the Landing and Take Off (LTO) cycle have been included in the calculations. As discussed, the increased fuel consumption during climb will be approximately cancelled out by the reduced fuel consumption during descent; therefore. this assumption should not be considered important.
- Emissions from RMS St Helena whilst in port have been calculated assuming 35 whole days spent in port per year (based on 2006 scheduling information). This assumption will not introduce significant error into the calculation of the CO_2 emissions.
- For the purposes of the assessment the island currently can only be accessed via RAF flight to Ascension followed by RMS St Helena, or by RMS St Helena from Cape Town or Portland (UK). These assumptions were necessary to allow comparisons to be made, and represent the vast majority of the current methods of access.
- Accessing the island in the future via flight from other countries or airports is not considered here. At this stage it is not confirmed where aircraft will fly from. However Cape Town is one of the nearest major airports with connections worldwide. Another possibility are direct flights from the UK to the island; these would reduce emissions when compared with flying via South Africa from the UK.

- Aircraft are assumed to fly via the shortest routes, with the exception of the RAF flight for which mileage information was provided by the RAF. This assumption is unlikely to be significant.
- 80% of the aircraft seats are assumed to be occupied on average. This figure is thought to be reasonable; a higher percentage would reduce the ‘per passenger’ CO_2 emissions, whereas a lower percentage would increase the ‘per passenger’ CO_2 emissions.
- The average number of passengers on the Brize Norton to Ascension RAF flight that are bound for St Helena is not known and so has been estimated as discussed. This assumption will have no impact on the ‘per passenger’ calculations, but will have an impact on the annual emissions. However, the St Helena bound passenger figures (per flight (~5) and annually (~400)) would appear to be reasonable.
- The number of people who currently travel to St Helena from the UK by the various routes is not known; estimations have been made where necessary. The estimations made will have no impact on the ‘per passenger’ calculations, but will have an impact on the annual emissions. However, the estimations made are deemed to be reasonable.
- It is assumed that half of those predicted to travel to St Helena in the future start their journey in the UK (Heathrow). Such an assumption was necessary to determine the predicted annual emissions for Scenario 6, and therefore will introduce uncertainty in the annual emissions predicted.
- Potential improvements in ship or aircraft fuel efficiency in the future, or the prospect of alternative fuels to those currently in use, have not been considered. Due primarily to the current and projected high cost of fuel, aircraft efficiency especially is likely to improve. There would appear to be little likelihood of alternative fuels with reduced carbon emissions being used in the near future.