9. Noise and Vibration

9.1. Introduction

9.1.1. This chapter provides the noise and vibration assessment operation of the proposed scheme The assessment has been carried out according to the guidance provided for a Detailed assessment in the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 7 (HD 213/11) 'Noise and Vibration' of November 2011.

9.1.2. The assessment includes the prediction of noise and vibration levels at receptors within the study area from the construction and operation of the proposed scheme.

Consultation

9.1.3. Consultation was undertaken with South Ayrshire Council Environmental Health Department on 9 May 2013. Response was received on 24 May 2013 stating that the ES should include a prediction of noise levels from the proposed development and routes to the construction site. The response stated the ES should contain an assessment of noise impacts upon nearby residential properties. The consultation process is discussed in full detail within Chapter 3.

9.2. Regulatory and Policy Framework

Legislative Background

Land Compensation (Scotland) Act 1973

9.2.1. Part I of the Land Compensation Act provides a means by which compensation can be paid to owners of land or property which has experienced a loss in value caused by the use of public works, such as new or improved roads. Noise and vibration are two of the factors which would be considered in any claims for compensation, but the claim should consider all changes.

The Noise Insulation (Scotland) Regulations 1975

9.2.2. The Noise Insulation (Scotland) Regulations 1975 (were made under Part II of the Land Compensation (Scotland) Act 1973) imposes a duty on authorities to provide, or make a grant towards, installation of noise insulation at eligible properties affected by new roads or an altered road. The regulations refer specifically to residential properties within 300 m of the new and altered road, and the noise level reaches or exceeds 68 dB LA10,18h with at least 1dB(A) resulting from the increase in traffic.

9.2.3. Grants are not currently available to householders affected by increased traffic noise along existing roads resulting from re-routing or traffic management schemes or general increase in traffic flow.

9.2.4. Regulation 5 of the NISR provides relevant authorities with discretionary powers to undertake or make a grant in respect of the cost of undertaking noise insulation work in or to eligible buildings with respect to construction noise.

The Environmental Protection Act (EPA) 1990

9.2.5. Since 1 April 1996, by virtue of the Environment Act 1995, the Environmental Protection Act 1990 (the 1990 Act) has given Scottish Local Authorities considerable and wide-ranging powers to tackle noise nuisance. S. 79 of the 1990 Act imposes a duty on local authorities to take reasonable steps to investigate complaints of nuisance and to inspect their area from time to time to detect statutory noise nuisances.

9.2.6. Part III of the EPA 1990 all local authorities have a duty to investigated noise complaints arising from premises and construction vehicles and plant during period of work.

The Control of Pollution Act 1974

9.2.7. The Control of Pollution Act 1974 (the 1974 Act) was largely repealed by the Environmental Protection Act 1990. However, sections that are extant give local authorities powers to control noise from construction sites. Section 61 of this act sets out procedures for those undertaking works to obtain a 'prior Consent' for construction works within agreed noise limits.

Planning Policy Context

National Planning Framework for Scotland 2

9.2.8. Published in June 2009, the NPFS2 is the Scottish Government's strategy for Scotland's long term spatial development. It guides Scotland's development to 2030, setting out strategic development priorities to support the Scottish Government's central purpose – sustainable economic growth.

9.2.9. NPFS2 paragraph 84 highlights the requirement of Strategic noise mapping and Noise Action Plans under the EU Environmental Noise Directive 2002/49/EC (and the Environmental Noise (Scotland) Regulations 2006). Their aim is to manage and reduce environmental noise where necessary and preserve quiet areas, with the initial focus on the Edinburgh and Glasgow conurbations and major roads (such as the M74 and A82), railways and airports.

9.2.10. Nevertheless, none of the affected routes by the proposed scheme is a major road (under the END "major road" is a regional, national or international road, designated by the Member State, which has more than three million vehicle passages a year).

Planning Advice Note 1/2011 Planning and Noise

9.2.11. Advice on the role of the statutory planning system in helping to prevent and limit the adverse effects of noise as set out in Planning Advice Note (PAN) 1/2011 Planning and Noise. Before a Noise Impact Assessment (NIA) is commissioned, planning authorities and applicants are advised to:

- Agree any potential representative limits of noise and/or the relevant NIA methodology in the context of the proposed development, its location and the surrounding area.
- Establish criteria for assessing any significant adverse noise impact or predict and describe ambient noise levels (including noise from transport sources) that the proposed development is likely to generate and/or is likely to be subjected to.

9.2.12. Further information on NIA methodologies is provided in the Technical Advice Note (TAN) Assessment of Noise which guides noise professionals in the preparation and evaluation of noise impact assessment.

Ayrshire Joint Structure Plan (AJSP) – Growing a Sustainable Ayrshire

9.2.13. Approved in November 2007, the AJSP states that regarding air, noise and light pollution consideration must be given to both the location of sources of pollution, which are likely to require Environmental Impact Assessments, and to the siting of new development close to existing sources of pollution such as a motorway or an industrial site. In addition, it also recognises that there are areas where pollution problems already exist and which require to be addressed.

9.2.14. It establishes as an environmental action that the three Ayrshire councils shall not be supportive of new development that would expose large numbers of people to unacceptable levels of air, noise and light pollution.

Other Guidance

Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 7, HD 213/11 Revision 1 – Noise and Vibration, November 2011.

9.2.15. DMRB HD 213/11 provides the procedure for assessing the impact of noise from road schemes.

9.2.16. DMRB HD 213/11 also requires evaluation of any potential temporary noise and vibration impacts. This requires identification of maintenance or construction activities that are likely to take place and assessing the impact (including duration) on people, dwellings and other sensitive receptors.

Calculation of Road Traffic Noise (CRTN) 1998

9.2.17. The CRTN memorandum describes the procedures for calculating noise from road traffic.

9.2.18. The procedures assume typical traffic and noise propagation conditions which are consistent with moderately adverse wind velocities and directions during the specified periods. All noise levels are expressed in terms of the index LA10,1h or LA10,18h in dB. The value of LA10,1h is the noise level exceeded for just 10% of the time over a period of one hour. The LA10,18h is the arithmetic average of the values of LA10,1h for each of the eighteen one-hour periods between 6 to 24 hours.

BS 5228:2009, Code of practice for noise and vibration control on construction and open sites – Part 1: Noise and Part 2 Vibration

9.2.19. BS 5228-1 describes a method for predicting noise levels from construction activities. It provides typical source noise levels and takes account of the different types of activity that can occur in predicting the consequential noise level. The method takes account of the distance between sources and receptors, the durations of activities, and the effect of natural or purpose-built barriers and screens.

9.2.20. BS 5228-1 Annex E describes methods for evaluating the significance of construction noise. In this document the significance of the noise impact from construction activities has been assessed and determined using Table 9.1 which presents trigger levels regarding the existing ambient noise levels.

Table 9.1 Construction Noise Significance Threshold (reproduced from BS 5228-1 Table E.1)

Period	Period Classification	Threshold Value dB		
		Category A[51]	Category B[52]	Category C[53]
Night time	23:00 – 07:00	45	50	55
Evening and Weekends	19:00 – 23:00 Weekdays 13:00 – 23:00 Saturdays 07:00 – 23:00 Sundays	55	60	65
Daytime	07:00 – 19:00 Weekdays 07:00 – 13:00 Saturdays	65	70	75

WHO Guidelines for community noise, 1999 and WHO Night Noise Guidelines for Europe, 2009

9.2.21. The WHO Guidelines state guidance values for the different time periods of a day. A summary of those values is shown in Table 9.2 below.

[51] Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
[52] Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
[53] Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

Table 9.2 WHO Guidelines for Outside Values				
Health effect	**Parameter**	**Time period**	**Guideline [dB(A)]**	**Source**
Serious annoyance	LAeq,16h	Daytime and evening	55[54] (free field)	WHO, 1999
Moderate annoyance	LAeq,16h	Daytime and evening	50 (free field)	WHO, 1999
Sleep disturbance,	LAeq,8h	Night	45[55] (free field)	WHO, 1999
Sleep disturbance	LAmax	Night	60 (free field)	WHO, 1999
Night noise guideline (NNG)	Lnight	Night	40 (free field)	WHO, 2009
Interim target for NNG (IT)	Lnight	Night	55 (free field)	WHO, 2009

9.3. Assessment Methodology

9.3.1. The assessments carried out for the proposed scheme and the corresponding methodology are summarised in Table 9.3.

[54] The currently superseded Planning Policy Guidance 24 (PPG 24): Planning and Noise assumed that the figure of 55 dB(A) was free-field regarding the Environmental Health Criteria 12 – Noise, World Health Organisation, 1980.
[55] WHO, 1999 states that *"In dwellings, the critical effects of noise are on sleep, annoyance and speech interference. To avoid sleep disturbance, indoor guideline values for bedrooms are 30 dB LAeq for continuous noise and 45 dB LAmax for single sound events. At night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB LAeq and 60 dB LAmax, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB."* Also, WHO, 1999 section 2.4.3 refers to the incident sound pressure level more than the façade noise level without corrections caused by reflections to the façade. Then, it is assumed that these levels represent free-field figures.

Table 9.3 Procedures for Assessing Impacts			
Period of impact	**Source**	**Parameter**	**Methodology**
Temporary during construction	Noise	LAeq,T (dB)	BS 5228-1
	Ground-borne Vibration	PPV (mm/s)	BS 5228-2
	Ground-borne Vibration	PPV (mm/s)	(Watts 1990)[56] Construction traffic in diversion roads
	Noise	Criteria NISR	BS 5228-1
Permanent post construction	Noise	LA10,18h (dB)	DMRB HD 213/11
	Noise nuisance	% bothered	DMRB HD 213/11
	Noise at night	Lnight,outside (dB)	DMRB HD 213/11
	Noise nuisance at night	% bothered at night	DMRB HD 213/11
	Air-borne vibration nuisance	% bothered	DMRB HD 213/11
	Noise	NISR Criteria	Memorandum of Advice and Instruction NISR No. 1/74
	Ground-borne vibration	PPV (mm/s)	(Watts 1990)

Ground-borne vibration

Ground-borne vibration caused by construction works

9.3.2. Piling will not be required during construction of the proposed scheme, however some blasting may be undertaken to remove rock head at depth.

9.3.3. Blasting can generate both ground-borne vibration waves and airborne pressure waves. These are produced over a range of frequencies including those which are audible and those which are below the lower end of the audible spectrum. Nevertheless, the adoption of good blasting practices would reduce the inherent and associated impulsive noise: prior warning to members of the public, individually if necessary, is important.

9.3.4. Any proposal to use blasting must be subject to agreement with South Ayrshire Council.

9.3.5. DMRB HD 213/11 states that structural damage to buildings can occur when levels are above 10 mm/s in terms of Peak Particle Velocity (PPV, i.e. the maximum speed of movement of a point in the ground during the passage of a source of vibration).

[56] Watts, G.R. (1990). Traffic induced vibration in buildings. TRRL RR246, Transport and Road Research Laboratory, Crowthorne.

9.3.6. BS 5228-2 section E.2 states a method for the prediction of vibration from blasting sites. This requires trial blasts in order to measure vibration at different distances from the blast and produce a graph. This will plot the largest single component vibration against the distance m from the blast, divided by the square root of the maximum instantaneous charge. Vibration limits are commonly expressed as a statistical average to take account of the inherent variability of blasts. The scaled distance graph can be used as an indication of likely vibration magnitudes at various distances.

9.3.7. Annex A of Minerals Planning Guidance Note MPG 9 and Scottish Government Circular 26/1992 give illustrative guides to the planning conditions on vibration limits. These state that:

9.3.8. "ground vibration as a result of blasting operations shall not exceed a peak particle velocity of [6 mm/sec] [10 mm/sec] in 95% of all blasts measured over any period of [six months] and no individual blast shall exceed a peak particle velocity of [12 mm/sec] as measured at vibration sensitive buildings. The measurement to be the maximum of three mutually perpendicular directions taken at the ground surface."

9.3.9. This indicates that the statistical limit should be chosen, for example, between 6 mm/s and 10 mm/s and that the maximum value should not normally exceed 12 mm/s.

9.3.10. The Minerals Planning Guidance 9 also gives some guidance in methods to be employed for minimizing effects from blasting as that no blasting should be carried out on the site except between the following times: "[1000 and 1200 hours] and [1400 and 1600 hours] on Mondays to Fridays; and [1000 and 1200 hours] on Saturdays; there should be no blasting or drilling operations on Sundays, Bank Holidays or National Holidays;

9.3.11. Also it is noted that the precise levels of peak particle velocity that will be acceptable will depend on the type of mineral being worked, the blasting operations being carried out, and local circumstances. Generally, individual blasts should not exceed 12 mm/sec ppv. Average levels should not exceed 10 mm/sec ppv and usually will not be below 6 mm/sec ppv, in 95% of all blasts, although lower levels may be appropriate in certain circumstances. The appropriate monitoring period must be a period which, relative to the length of time over which blasting is to be carried out, will ensure that the 95% confidence level is being met.

9.3.12. Most of the previous named guidance is related to Mines and Quarries works and it is not directly applicable to road construction works. Consequently, any potential to use blasting must be subject to agreement with South Ayrshire Council regarding, e.g. community relations, trial measurements, control of vibrations, measurements, etc. to limit noise and vibration to within acceptable limits. Accordingly, a ground-borne vibration assessment has not been undertaken for the construction works.

Ground-borne vibration caused by construction traffic in diversion roads

9.3.13. The majority of the works will be offline. Besides, construction traffic will be likely on site and, consequently, no estimation has been undertaken to determine the impact on existing traffic noise levels along the A77.

9.3.14. Ground-borne vibration PPVs caused by the use of the proposed scheme in the structure of buildings close to heavily trafficked roads rarely exceed 2 mm/s and typically are below 1 mm/s. Normal use of a building such as closing doors, walking on suspended wooden floors and operating domestic appliances can generate similar levels of vibration to those from road traffic. Therefore, since in the consultation process, ground-borne vibration on existing routes has not been identified as a current or potential problem and traffic is not expected to pass very close to buildings in the proposed scheme, ground-borne vibration assessment has not been undertaken for road traffic.

Temporary construction noise

9.3.15. Temporary noise and vibration impacts are normally those that occur between the start of advance works and the end of the road project construction period. The term 'disruption due to construction' is commonly used to describe such temporary impacts which occur on both people and the natural environment. In addition to the impacts due to the construction of the road project itself, disruption can arise from advance works, for example to divert utilities, and these works may extend well beyond the road construction site.

Permanent traffic noise assessment

9.3.16. On completion of the new road, traffic noise will be produce associated traffic flows and decrease in the traffic from other roads. Traffic noise is influenced by various factors such as traffic flow, traffic speeds, percentage Heavy Goods Vehicles (HGVs), topography, type of road surface, distance from the road and any obstructions between road and receptor.

9.3.17. DMRB considers the baseline year as the year of opening of the project. The future assessment year is typically the 15th year after the opening year of the project. For this scheme the baseline opening year is considered 2018, the future assessment year 2033. Traffic data for 2033 is not available at the time of assessment, therefore 2031 data has been used within the noise modelling programme.

9.3.18. The DMRB HD 213/11 short-term assessment is based in the following comparison:

- Do-Minimum scenario in the baseline year against Do-Something scenario in the baseline year.

  In the present scheme i.e. Do-Something 2018 – Do-Minimum 2018 (short term)

9.3.19. The DMRB HD 213/11 long-term assessment is based in the comparison between the following two previously made comparisons:

- Do-Minimum scenario in baseline year against Do-Minimum scenario in the future assessment year.

  In the present scheme, i.e. Do-Minimum 2033 – Do-Minimum 2018 (long term)

- Do-Minimum scenario in the baseline year against Do-Something scenario in the future assessment year.

  i.e. Do-Something 2033 – Do-Minimum 2018 (long term)

9.3.20. Noise levels at all noise sensitive receptors have been predicted in accordance with CRTN using the modelling software NoiseMap 5 (NoiseMap Ltd). It is recognised that this method has its limitations and that predicted noise levels are approximate. To assess accuracy, predicted baseline noise levels have been compared with measured values, as discussed in detail in Appendix G1.

9.3.21. The noise model includes terrain data, buildings, ground cover type, road surface type, and other structures that may screen or reflect noise. To ensure an accurate representation of the proposed scheme, design drawings were incorporated into the model. Noise levels were generated utilising existing and future traffic flow data. This data includes 18-hour traffic flows between 06:00 and 24:00 hours, percentage of Heavy Goods Vehicles (%HGV) and average speed in km/h.

Permanent night traffic noise assessment

9.3.22. The World Health Organisation's 'Night Noise Guidelines for Europe' (WHO 2009) states an aspirational target night noise guideline (NNG) of 40 dB Lnight,outside, with an Interim Target (IT) of 55 dB Lnight,outside for situations where the achievement of the NNG is not feasible in the short term (Lnight,outside is the equivalent outdoor sound pressure level associated with a particular type of noise source during night time hours (23:00 – 07:00) calculated over a period of a year).

9.3.23. DMRB requires a night time assessment to be undertaken when the threshold criterion of 3 dB Lnight,outside noise change in the long term is exceeded, but only where an Lnight, outside greater than 55dB is predicted in any scenario. The TRL report 'Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping' provides a technique for predicting Lnight. Three methods are presented with Method 1, which relies on the provision of hourly traffic flows, preferred. Here, CRTN is used to calculate values of LA10,1h which can then be converted to LAeq,1h values to derive Lnight.

9.3.24. However, CRTN notes calculations of noise level for traffic flows below 50 veh/h are unreliable. As detailed within Table 9.4 and Table 9.5 night time traffic flows fall below these levels and therefore this method was not used. Method 2 was not used as the required traffic data were not available; therefore Method 3 has been implemented. This method is considered potentially the least reliable of the three since it relies on the assumption that different road types will, on average, produce a reasonably consistent diurnal flow pattern.

Table 9.4 Night time hourly traffic flows 2018										
Time	2018 (Opening Year)									
	North of Bypass	North of Maybole	Cassillis Road	Maybole High Street	South of Bypass	South of Maybole	B7023 within Maybole	B7023 outside Maybole	Maybole Bypass North	Maybole Bypass South
23:00 - 24:00	168	55	59	55	33	129	18	17	112	100
00:00 - 01:00	56	17	16	14	6	38	9	9	38	34
01:00 - 02:00	42	12	15	13	8	37	6	3	31	29
02:00 - 03:00	39	8	10	10	7	38	4	4	32	31
03:00 - 04:00	38	11	12	10	6	33	3	2	28	27
04:00 - 05:00	47	11	11	12	7	37	5	4	34	31
05:00 - 06:00	117	30	31	29	15	95	10	5	86	80

Table 9.5 Night time hourly traffic flows 2033										
Time	2033 (Future Year)									
	North of Bypass	North of Maybole	Cassillis Road	Maybole High Street	South of Bypass	South of Maybole	B7023 within Maybole	B7023 outside Maybole	Maybole Bypass North	Maybole Bypass South
23:00 - 24:00	192	60	64	63	39	160	20	16	134	119
00:00 - 01:00	65	21	20	17	8	46	8	9	44	39
01:00 - 02:00	51	11	15	14	10	44	6	4	40	35
02:00 - 03:00	48	11	13	11	7	45	3	3	39	38
03:00 - 04:00	48	11	13	14	7	43	6	3	36	35
04:00 - 05:00	60	13	14	12	6	44	5	5	44	40
05:00 - 06:00	137	35	35	31	17	110	10	4	101	93

9.3.25. With Method 3, CRTN is used to determine LA10,18h which is then used to determine Lnight using the following relationship:

$Lnight_t = 0.90 \times LA10,18h - 3.77$ dB

A correction of 2.5dB is then deducted from the derived Lnight level (which is a façade level) to obtain the equivalent Lnight,outside level (which is a free-field level).

Permanent traffic induced vibration impacts

9.3.26. DMRB requires an assessment of traffic–induced vibration to be undertaken, where appropriate, for dwellings located within 40m of the carriageway, with the following comparisons considered:

- Do-Minimum scenario in baseline year against Do-Minimum scenario in the future assessment.
- Do-Minimum scenario in baseline year against Do-Something scenario in the future assessment year.

Assessment of cumulative impacts

9.3.27. DMRB states 'an assessment of cumulative noise and vibration impacts should be undertaken. This should include identifying where impacts are expected from the combined action of noise or vibration with other environmental topic-specific impacts upon people, dwellings or other sensitive receptors. The cumulative assessment is discussed within Chapter 15 (Cumulative Impacts).

Determination of baseline conditions

9.3.28. Noise measurements were undertaken, with results, limitations and constraints discussed within Appendix G1. Drawing No. 25000182/ENV/002 in Appendix G1 illustrates the noise measurement locations. A comparison of measured noise levels with those predicted by the noise model is undertaken as part of the validation exercise for the model.

Determination of impact significance

9.3.29. DMRB HD 213/11 states that the magnitude of noise impact from a project should be classified into levels of impact in order to assist with the full assessment of a project. It classifies magnitude of impacts from traffic noise in terms of noise change as included in Table 9.6 (short term) and Table 9.7 (long term).

Table 9.6 Classification of Magnitude of Noise Impacts in the Short Term (reproduced from DMRB HD 213/11 Table 3.1)	
Noise Change, dB LA10,18h	**Magnitude of Impact**
0	No change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table 9.7 Classification of Magnitude of Noise Impacts in the Long Term (reproduced from DMRB HD 213/11 Table 3.2)	
Noise Change, dB LA10,18h	**Magnitude of Impact**
0	No change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

9.3.30. DMRB HD 213/11 paragraph 3.36 states that in terms of road traffic noise, a methodology has not yet been developed to assign a level of significance according to both the value of a resources and the magnitude of an impact. However, DMRB also states that a change in noise level of 1 dB LA10,18h in the short term is considered perceptible while in the long term that corresponds to a change in noise level of 3 dB LA10,18h. Such increases should be mitigated if possible. Consequently, in terms of significance, the impacts are classified in the present document as perceptible or significant or not perceptible or not significant.

9.4. Study Area and Assumptions and Limitations

Study Area

9.4.1. In accordance with DMRB, the study area considers land one kilometre from the carriageway edge of the bypassed or improved routes located within the start and end points of the physical works associated with the scheme. Additionally, DMRB requires an assessment within 600m from all affected routes, an affected route being where there is the possibility of a change of 1 dB LA10,18h or more in the short-term or 3 dB LA10,18h or more in the long-term. A quantitative assessment has therefore been undertaken of properties within 600m of the bypass and existing A77 with a qualitative assessment undertaken for properties between 600m and 1km.

9.4.2. The calculation area is therefore defined as 600 m around the new road and the existing A77 in its bypassed section, as illustrated within Drawing No 25000182/ENV/9.1, Environmental Noise & Vibration Study Areas.

9.4.3. The main source of noise and vibration in the area is considered to be A77 traffic noise, which has a steady rate.

Assumptions and Limitations

9.4.4. The traffic noise predictions are based on traffic data collected for the study in terms of the 18 hour Annual Average Weekday Traffic (AAWT), the percentage Heavy Goods Vehicles (HGV) and average speed. Speeds below 20 km/h have been adjusted to 20 km/h.

9.4.5. Road surfacing for the existing roads has been considered impervious bitumen and for the proposed scheme has been considered as low-noise surface (Stone Mastic Asphalt).

9.4.6. Noise sensitive receptors have been identified in OS Address Plus Data, as those classified as either “Dwelling” or “Educational”. Thus, 2,272 “Dwelling” receptors and 4 “Educational” receptors have been identified. Fairknowe House Care Home (as dwelling) and the Ranch Caravan Park (as dwelling) were added manually as neither were in the database.

9.4.7. All committed development within the study area has been identified and modelled, i.e. new builds off the B7023 Culzean Road in north Maybole. These buildings sum 19 new receptors.

9.4.8. Every building has been considered 8 m tall and two storeys. Noise levels have been calculated with the receiver situated at 1.5 m on the ground floor and at 4 m on the first floor.

9.4.9. Construction information is limited in nature as detailed construction programme and sequencing will be determined by the Contractor who is not appointed at this stage. The duration of the works is anticipated to be approximately 18 months.

9.4.10. To undertake preliminary calculations under the Noise Insulation (Scotland) Regulations 1975, the technical memorandum CRTN 1988 has been used instead of the Memorandum of Advice and Instructions (Noise Insulation (Scotland) Regulations 1975) no. 1/74.

9.4.11. Regarding construction noise, it has been assumed that the haul routes are between 0.5 km and 1 km for articulated dump trucks whereas the tracked excavator-loader and generators have been assumed as steady noise sources. More assumptions can be found in the specific section of construction noise results.

9.4.12. Any caravans within the Ranch Caravan Park have not been included in the noise model, however two residential dwellings within the park have been modelled.

9.4.13. DMRB paragraph A1.17 vi states ‘Where a building is predicted to experience different changes on different facades, the least beneficial should be reported in the assessment table’. ‘If this approach would lead to the reporting of two or more facades (i.e. where the same least beneficial change is shown on two or more facades) then the change on the façades with the highest noise level in the Do-Minimum scenario should be reported’. Within this assessment, the worst case change is considered to be the largest increase in noise level experienced. This is reported within the assessment tables and where appropriate, noise levels at multiple facades are discussed within the text of this report.

9.5. Baseline Conditions

9.5.1. The proposed scheme is located to the north of Maybole within a surrounding rural character setting. A description of the existing networks is provided within Chapter 1: Introduction and Proposed Scheme.

9.5.2. Road traffic noise is the dominant noise source in the study area, from the main road network and local roads. However, additional noise sources in the area include pedestrian activity, birds calling, noise from the railway and aircraft noise, and agricultural activity.

Distribution of Noise Sensitive Receptors

9.5.3. Noise Sensitive properties within 600 m from the carriageway edge of the scheme and the existing A77 are listed within Table 9.8. Properties expected as new developments are seventeen (+17) in the first 50 m from the scheme and two (+2) further than 50 m from the scheme.

Table 9.8 Property Counts within Distance Bands of the Proposed Scheme and the Other Modelled Roads* (including new developments)*

Distance Band	Number of dwellings	Number of other sensitive receptors
0 – 50 m	641 + 17	1
51 – 600 m	1,633 + 2	3
Total within 600m	2,293	4

* The extent of the modelled roads are shown, for example, in Drawing No 25000182/ENV/9.2

9.5.4. Noise levels have been calculated at sensitive receptors, which include dwellings, hospitals, schools, community facilities, designated sites (e.g. AONB, National Park, SAC, SPA, SSSI, SAM) and public rights of way.

9.5.5. Some noise sensitive receptors, which have been considered relevant, are detailed within Table 9.9.

Table 9.9 Representative Noise Sensitive Receptors and Typical Locations		
Noise Sensitive Receptor	**Distance from Existing A77 (m)**	**Distance from Proposed Scheme(m)**
East Ennoch Farm	1200	290
Kirklandhill Farm	755	45
Fairknowe House Care Home	270	630
Cargliston House	1000	380
16 Crosshill Road	195	715
Nether Culzean Farm	70	370
The Ranch Caravan Park	35	600
Gardenrose Primary School	650	240
St Cuthberts Primary School	30	570
Laigh Grange Farm	630	550
St Murray's Farm	996	475
New Development at Burns Drive	380	100

9.5.6. No AONB, National Park, SAC, SPA, or SSSI designated sites are located within the 1 km study area.

9.5.7. There is one Scheduled Monument located within the town of Maybole - Maybole Collegiate Church (NS 3010 0980). It is located approximately 135m from the existing A77 and 900 m from the proposed scheme.

9.5.8. Community facilities are located within the study area of Maybole, which includes local shops, post office, town hall, fuel station, doctor's surgery and veterinary practice. The majority of the proposed works will be undertaken offline with no works being carried out near Maybole town centre.

9.5.9. There are no public rights of way within the study area. However there are two core paths identified in the South Ayrshire Councils Interim Draft Core Path Plan (Feb 2009) (see chapter 10.) that are used for cycling.

Baseline Noise Monitoring Survey

9.5.10. Noise monitoring was undertaken between May and June 2013 to provide verification to the noise model and collate ambient noise levels for various properties. It was undertaken during day time and night time in accordance with CRTN and the Memorandum of Advice and Instruction NISR to quantify road traffic noise.

9.5.11. Noise monitoring was undertaken using a Sound Level Meter Class 1 Bruel&Kjaer 2250 and a Sound Calibrator Class 1 Bruel & Kjaer 4189. All measurements were attended surveys. The weather conditions are detailed within Appendix G1.

9.5.12. Detailed information of the noise measurement locations is illustrated within Appendix G1 – Noise Measurement Site Survey. The measurement location results and the predicted modelled results for the key receptors are summarised in Table 9.10.

Table 9.10 Comparison of Predicted and Measured Noise Levels

Noise Sensitive Receptor	Measured (2013 survey)	Predicted (Do-Minimum 2018)
	LA10,18h (dB)	LA10,18h (dB)
New Development at Burns Drive	53.1	47.3
Gardenrose Path	56.9	48.8
16 Crosshill Road	62.0	64.9
Cargliston House	49.1	42.2
Kirklandhill Farm	44.4	38.9
Nether Culzean Farm	60.1	59.2
Laigh Grange Farm	64.8	61.2
Gardenrose Path (night)	32.9	37.7

9.5.13. More of the receptors located in rural areas or on the outskirts of the town do not show a good correlation between the measured levels and the predicted ones, i.e Gardenrose Path, Cargliston House, and Kirklandhill Farm. The differences are likely to be due to the presence of other noise sources that when combined with the low levels of road traffic noise in the area produce higher measured noise levels than predicted noise levels. In addition, a combination of the fact that some minor roads are below the range of applicability of CRTN,1998 and the use of the shortened measurement procedure (Memorandum of Advice and Instruction Noise Insulation (Scotland) Regulations) could have caused the measurement of higher levels.

9.5.14. The correlation is better at the receptors closer to the main road network and, therefore, dominated by road traffic noise, i.e 16 Crosshill Road, Nether Culzean Farm and Laigh Grange Farm.

9.5.15. Drawings Nos 25000182/ENV/9.8 to 9.11 show the predicted traffic noise levels in the calculation area for the scenarios Do-Minimum baseline and future assessment year and, Do-Something baseline and future assessment year.

9.6. Scheme Design

9.6.1. The proposed scheme is designed to reduce the traffic flow through Maybole town centre. The scheme passes between existing properties through rural land to the north-west of Maybole.

9.6.2. The proposed route from the south of Maybole commences climbing relatively steep topography in cutting, in excess of 10 m deep until it reaches the crest adjacent to the Culzean Road roundabout (B7023) and traverse a dip in the natural ground on high embankment in excess of 10m while the alignment continues to rise in level through a cutting (typical 8 to 10nm deep) towards the next crest at Kirklandhill Path which coincides with the high point in the alignment. At this location the proposed alignment is approximately 175 m north of the residential dwellings. The road then falls away northwards generally in a combination of shallow cut and fill (typical 1-4 m) following the existing topography to a low point south of Alloway Road (B7024). At this location the alignment follows the existing Ayr to Stranraer railway line in plan nominally at grade for approximately 300 m to a high point in the natural topography, before finally dropping in level through sidelong cutting up to 8 m deep to the tie-in with the existing A77 at Smithston.

9.6.3. The road being within up to 10 m cuttings will result in a barrier method in place for properties. A noise reduction surface will be used to surface the carriageway with the speed limited to 60mph on the bypass.

9.7. Impact Assessment

Construction noise assessment

9.7.1. Full details of construction works are not available at this stage, however a best estimate based on previous experience is supplied in the following table. Most of the scheme will be constructed off-line. Typical works likely to occur include earthworks, backfilling and rolling capping, sub base compaction, black topping and traffic management.

Table 9.11 Construction programme

Description	Duration
Overall	18 months
Earthworks	12 months with some tie in work extended to 15 or 18 months. Not likely to extend beyond 6 months in any one area.
Drainage and pavement	Following earthworks. Not likely to extend beyond 6 months in any one area.
Finishes (safety fencing, signs, etc.)	Towards the last 6 months of the overall program.

9.7.2. At the southern tie-in the use of single lane working will require single lane convoy traffic management at final stages due to the reduction to 7.3 m width at the tie-in.

9.7.3. There will be construction work online at Gardenrose Path, Kirklandhill Path, and B7024 Alloway Road bridge. All three areas will require traffic management from single way working to full closures. At Laigh Grange Road permanent or temporary diversions are required during road construction.

9.7.4. Noise sensitive receptors likely to experience disruption due to construction within 100 m are:

- Broomknowes Farm
- The Ranch Caravan Park
- Residential properties at Gardenrose Path
- Kirklandhill Farm
- Burns Drive properties
- Residential properties at Kirklandhill Path
- Carrick Academy.
- Properties at Laigh Grange

9.7.5. Properties close to the tie in of the scheme and the current A77 route where junctions are being altered will experience disruption during construction. The properties are likely to experience a significant impact during construction.

9.7.6. The Ranch Caravan Park, Kirklandhill Farm, Broomknowes Farm and residential properties near Burns Drive, Kirklandhill Path and Gardenrose Path are located within 50m of the propose scheme and will therefore suffer a detrimental impact during construction.

9.7.7. Noise in the vicinity of working areas will be unavoidable, arising from the movement and loading/unloading of vehicles and machinery, earthworks, rock removal, tipping of rock and all other associated construction activities. The extent of the noise and vibration impacts will vary throughout the scheme; depending on design and the contractor's methods of working and working hours.

9.7.8. BS 5228 contains reference noise levels of different construction equipment and activities in order to predict noise at receptors from certain activities. An overview of typical activities is listed in Table 9.12.

Table 9.12 Current Sound Level Data on Site Equipment and Site Activities for Proposed Construction Plant (Table C4 & C5 from BS 5228-1)

Equipment Type	LAeq, dB at 10 m
Tracked excavator- loader	80
Articulated dump truck	81 LAmax, dB at 10 m
Generator	74

9.7.9. The predicted noise levels have been modelled according to BS 5228-1 using Noise Map 5 modelling software.

9.7.10. The results are based on the following assumptions:

- Earthworks will constitute the worst case scenario regarding noise.

- The length of the project is expected to be approximately 18 months and it is assumed that the earthworks will be approximately 12 months.
- The moved earthworks equates to 545,000 m^3.
- There will not be earthworks outside Monday to Friday from 07:00 to 19:00 h and Saturday from 07:00 to 13:00 h.

9.7.11. Blasting of bedrock has not been considered at this stage and any potential blasting works would be intermittent and short in nature and subject to agreement with South Ayrshire Council on acceptable limits.

9.7.12. The earthworks quantities result in approximately 31,800 articulated lorry movements, which equates to 20 movements per hour, assuming 8 h of work each day from Monday to Friday.

9.7.13. Since the measured ambient noise levels reproduced in Table 9.10 range from around 45 dB(A) to 65 dB(A) it is considered that the appropriate threshold values to apply are those reproduced in BS 5228-1 Table E.1 for Category A, i.e. 65 dB(A) for daytime (07:00-19:00 h) and Saturdays (07:00-13:00 h).

9.7.14. The results of the worst case scenario for the most affected façade at some selected receptors, which are close to the construction noise sources, are provided in Table 9.13. As shown in the last column, it is not expected to exceed the threshold values from BS 5228-1 Table E.1 for Category A for Daytime (07:00-19:00) and Saturdays (07:00-13:00).

9.7.15. It is noted that the table below shows the distance to the scheme, but at the closest points to properties only minor works will take place. The main works will be undertaken along the centre line of the proposed scheme.

9.7.16. For example the main works will be more than 50 m from Kirklandhill Farm (which is 10 m from minor works on the scheme) and also more than 80 m from residential properties at Kirklandhill Path (which is next to minor works on the scheme).

Table 9.13 Predicted Construction Noise Levels at Some Close Receptors				
Receptor	Distance to Scheme Extent (m)	Predicted LAeq,1h (dB)	Threshold LAeq,1h (dB)	Excess over Threshold[57] (dB(A))
Broomknowes Farm	50	59.7	65	0
The Ranch Caravan Park	20	59.1	65	0
Residential properties at Gardenrose Path	5	59.8	65	0
Kirklandhill Farm	10	58.3	65	0
Residential properties at Kirklandhill Path	0	61.1	65	0
Carrick Academy	21	58.1	65	0
Laigh Grange Farm	180	57.3	65	1 → 0[58]

9.7.17. Traffic management will be designed to minimise disruption. The location of welfare facilities is not resolved at this stage, but should be located to minimise disruption to local residents.

9.7.18. Works at evenings and weekends (i.e. 19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays) when the threshold value for Category A is 55 dB LAeq and at night (i.e. 23:00-07:00) when the threshold value for Category A is 45 dB LAeq are not expected. If they are required further consultation with the proposed contractor will be required.

Noise Insulation (Scotland) Regulation 1975

9.7.19. Regulation 5 of the NISR provides relevant authorities with discretionary powers to undertake or make a grant in respect of the cost of undertaking noise insulation work in or to eligible buildings with respect to construction noise.

9.7.20. BS 5228-1 section E.4 provides an example of criteria for the assessment of the significance of noise effects and also provides advice of requirements to meet in order to be offered noise insulation or temporary rehousing where the construction noise of the development causes, or is expected to cause, construction noise levels (pre-construction ambient plus construction noise) to exceed threshold values reproduced in the named BS 5228-1 section E.4.

9.7.21. The threshold values provided in BS 5228-1 section E.4 are related to the existing noise level in specific areas for different time periods, but as the lowest values for these threshold values are reproduced in Table 9.14.

[57] The threshold value represents the total noise level LAeq including construction, i.e. the pre-construction ambient noise plus the predicted construction noise. The methodology in order to sum sound levels can be found for example in BS 5228-1 section F.2.6.

[58] The threshold value represents the total LAeq noise level, i.e. the pre-construction ambient noise plus the predicted construction noise. Table 9.13 above reproduces the measured pre-construction ambient noise level of 64.8 dB(A) at Laigh Grange area, which results in an ambient noise level of 65.5 dB(A) (66 dB(A) rounded to the nearest whole number), when added to the predicted construction noise of 57.3 (see BS 5228-1 formula F.8).
However, BS 5228-1 Table E.1 Note 2 states that *If the ambient noise levels exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total LAeq noise level for the period increases by more than 3 dB due to the construction activity.* As, it can have been seen in the previous paragraph, construction activity only increases the pre-construction noise by 1 dB(A), i.e. from 65 dB(A) (64.8 dB(A) rounded to the nearest whole number) to 66 dB(A). Therefore, a significant effect is not deemed to occur due to the construction activity.

Table 9.14 Examples of time periods, averaging times and noise levels associated with the determination of eligibility for noise insulation (reproduced from BS 5228-1 Table E.2)			
Time	**Relevant time period**	**Averaging time, T**	**Noise insulation trigger level dB LAeq,T[59]**
Monday to Friday	07:00-08:00	1 h	70
	08:00-18:00	10 h	75
	18:00-19:00	1 h	70
	19:00-22:00	3 h	65
	22:00-07:00	1 h	55
Saturday	07:00-08:00	1 h	70
	08:00-13:00	5 h	75
	13:00-14:00	1 h	70
	14:00-22:00	3 h	65
	22:00-07:00	1 h	55
Sunday and Public Holidays	07:00-21:00	1 h	65
	21:00-07:00	1 h	55

9.7.22. The predicted noise levels due to construction noise at the sensitive receptors inside the study area are below 65 dB LAeq,1h60 in all the cases. Besides, as previously said, those construction activities are assumed to be carried out during daytime from 07:00 to 19:00 h and Saturday from 07:00 to 13:00 h.

9.7.23. Consequently, the thresholds values reproduced in Table 9.14 above are not expected to be reached for any of the times periods when the earthworks are assumed to be carried out. Therefore, neither noise insulation nor temporary rehousing would be necessary according to BS 5228-1 section E.4 if the earthworks are carried out in the time periods where the trigger level is greater or equal to 65 dB LAeq,T, i.e. all the periods except Monday to Saturday at night (22:00-07:00) and Sunday and Public Holidays at night (21:00-07.00).

Long term substantial earth moving

9.7.24. Where construction activities involve large scale and long term earth moving activities, BS 5228-1 section E.5 suggest that a limit of 55 dB LAeq,1h would be adopted for daytime construction noise for these type of activities, but only where the works are likely to occur for a period in excess of six months.

[59] All noise levels are predicted or measured at a point 1 m in front of the most exposed of any windows and doors in any façade of any eligible building.

[60] If potential blasting works were undertaken, a reassessment regarding construction noise will be necessary. Nevertheless, airborne noise produced by blasting is associated to short duration impulsive noises, which their influence in equivalent noise levels (as LAeq) depends enormously on their frequency, i.e. the number and intensity of the potential blasting works.

9.7.25. Although earthworks are assumed to last more than six months for the whole scheme, it is not expected that they will last more than six months in the same area. In building the construction noise model therefore it has been assumed that the works will be carried out in areas covering between 0.5 and 1 km of length at the same time, but they do not be undertake on the whole length of the project (over 5 km) at the same time.

9.7.26. Therefore, the limit of 55 dB LAeq,1h stated in BS 5228-1 section E.5 is not considered applicable in this case.

Post construction noise assessment – short-term

9.7.27. Short-term traffic noise has been assessed comparing the Do-Minimum scenario in the baseline year 2018 against the Do-Something scenario in the baseline year 2018 (i.e. Do-Something 2018 – Do-Minimum 2018). The results for some representative receptors are reproduced in Table 9.15.

9.7.28. It is noted, that the table below shows the façade with the highest noise level in the Do-Something scenario, e.g. for the properties along the scheme the values of the façade facing the scheme are reproduced.

9.7.29. The complete list for all the receptors and all the facades is reproduced in Appendix G.2.

Table 9.15 Short-term Noise Levels at the Representative Receptors			
Do-Something baseline year 2018 – Do-Minimum baseline year 2018 (short-term)			
Receptor	**Do-Minimum 2018 (dB LA10,18h)**	**Do-Something 2018 (dB LA10,18h)**	**Change in noise (dB LA10,18h)**
1- New Development at Burns Drive Area, Eastern Building, (W)	48.1	48.7	0.6
2- Fairknowe House Care Home (SE)	66.1	64.4	-1.7
3- 16 Crosshill Road, (NE)	66.2	66.2	0.0
4- The Ranch Caravan Park (W)	56.2	54.2	-2.0
5- East Enoch Farm, (S)	44.3	50.8	6.5
6- St Cuthberts Primary School, (NW)	63.9	58.6	-5.3
7- Nether Culzean Farm, (E)	60.9	55.7	-5.2
8- St Murrays Farm, (SE)	30.0	41.6	11.6
9- Laighgrange Farm, (E)	39.4	39.9	0.5
10- Cargilston, (SE)	33.4	40.9	7.5
11- Kirklandhill Farm, (SW)	42.2	49.4	7.2
12- Gardenrose Primary School, (SW)	45.4	47.0	1.6
13- 6, Macadam Place, (N)	36.4	53.7	17.3

9.7.30. The proposed scheme has a greater impact on the receptors located both north of Maybole and north of the proposed scheme, e.g. East Enoch Farm, Kirklandhill Farm, Cargilston, and St Murrays Farm. Nevertheless, all of them remain with noise levels less than or equal to 50 dB LA10,18h, except East Enoch Farm where a noise level of 50.8 dB LA10,18h has been predicted for the short term Do-Something scenario.

9.7.31. These results are due to the fact that those properties were previously located far from the existing main traffic noise sources (A77 Maybole, B7023 Culzean Road and B7024 Alloway Road) and with the proposed scheme in place will become some of the nearest properties to this new noise source. Also the proposed scheme will be built in cut at the sections that affect Kirklandhill Farm, Cargilston and St Murrays Farm, but on embankment at the section that affects East Enoch Farm.

9.7.32. The impact on the receptors located north of Maybole but south of the proposed scheme, e.g. the new development at Burns Drive area, and Gardenrose Primary School range from negligible to minor impacts except for those properties close to where the scheme will be built on embankment at Macadam Place.

9.7.33. Noise levels at 6 Macadam Place show a change of 17.3 dB, however the noise levels will remain low with a predicted noise level of 53.7 dB LA10,18h[61] for the short term Do-Something scenario.

9.7.34. The predicted existing noise level of 36.4 dB LA10,18h at 6 Macadam Place is extremely low and is based solely on road traffic while other noise sources would likely be present, such as farm machinery. This is supported by the measured noise levels in the vicinity which showed greater noise levels than the expected only from road traffic of 44.4 dB LA10,18h, which is nevertheless still a low value. It js likely therefore that the predicted existing noise level is an underestimate and that the increase is less than the 17.3 dB predicted. The increase reported within this assessment however utilises the larger increase as predicted.

9.7.35. Receptors that will experience a greater betterment are those located along the existing A77, i.e Nether Culzean and St Cuthberts Primary School with moderate and major betterments.

9.7.36. Properties along the B7023 range from no change/negligible to moderate betterments, i.e. Fairknowe House Care Home (north of the existent A77) and 16 Crosshill Road (south of the existent A77).

9.7.37. The short-term traffic noise level changes (taking the worst case façade) are reproduced in the following table and in Drawings Nos 25000182/ENV/9.2 and 25000182/ENV/9.5.

9.7.38. The number of dwellings that presents a significant increase of noise in the short term (i.e. a change ≥ 1 dB(A)) is 677, whereas the ones that present a significant decrease are 1,273. From this perspective, the proposed scheme is beneficial.

[61] LA10,18h (which is a façade level) can be converted to LAeq,16h (which is a free field level) using the formula 2.13 of the TRL report "Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping". Then, to convert between façade level and free-field level an additional 2.5 dB is needed. Therefore the WHO guidance value for moderate annoyance during day and evening, i.e. 50 dB LAeq,16h, would correspond to a noise level of 54.7 dB LA10,18h.

Table 9.16 Short-term Noise Impact Assessment (DMRB HD 213/11 Table A1.1)			
Do-Something baseline year 2018 – Do-Minimum baseline year 2018 (short-term)			
		Daytime	
Change in noise level		**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level LA10,18h	0.1 – 0.9	77	0
	1.0 – 2.9	155	0
	3.0 – 4.9	173	0
	5+	349	1
No Change	0	63	0
Decrease in noise level, LA10,18h	0.1 – 0.9	203	0
	1.0 – 2.9	424	2
	3.0 – 4.9	636	1
	5+	213	0

Post construction noise assessment – long-term

9.7.39. The long-term traffic noise assessment does not only include the daytime assessment but also includes the night-time noise assessment and the airborne vibration assessment.

9.7.40. Two different comparatives are made in the long-term, i.e. the Do-Minimum comparative and the Do-Something comparative, which are also compared between them in terms of noise nuisance and airborne vibration nuisance.

9.7.41. The Do-Minimum comparative compares the Do-Minimum scenario in the baseline year 2018 against the Do-Minimum scenario in the future assessment year 2033 (i.e. Do-Minimum 2033 – Do-Minimum 2018).

9.7.42. The results for the receptors considered as representative of different areas are reproduced in Table 9.17.

Table 9.17 Long-term Do-Minimum Noise Levels at the Representative Receptors						
Do-Minimum future assessment year 2033 – Do-Minimum baseline year 2018 (long-term)						
Receptor	Daytime (dB LA10,18h)			Night-time (dB LA10,18h)		
	DM 2018	DM 2033	Change in noise	DM 2018	DM 2033	Change in noise
1- New Development at Burns Drive Area, Eastern Building, (W)	48.1	48.6	0.5	37.0	37.5	n/a[62]
2- Fairknowe House Care Home (SE)	66.1	66.3	0.2	53.2	53.4	n/a
3- 16 Crosshill Road, (NE)	66.2	66.6	0.4	53.3	53.7	n/a
4- The Ranch Caravan Park (W)	56.2	56.6	0.4	44.3	44.7	n/a
5- East Enoch Farm, (S)	44.3	44.6	0.3	33.6	33.9	n/a
6- St Cuthberts Primary School, (NW)	63.9	64.4	0.5	51.2	51.7	n/a[63]
7- Nether Culzean Farm, (E)	60.9	61.4	0.5	48.5	49.0	n/a
8- St Murrays Farm, (SE)	30.0	30.5	0.5	20.7	21.2	n/a
9- Laighgrange Farm, (E)	39.4	39.7	0.3	29.2	29.5	n/a
10- Cargilston, (SE)	33.4	33.9	0.5	23.8	24.2	n/a
11- Kirklandhill Farm, (SW)	42.2	42.8	0.6	31.7	32.3	n/a
12- Gardenrose Primary School, (SW)	45.4	46.0	0.6	34.6	35.1	n/a
13- 6, Macadam Place, (N)	36.4	36.8	0.4	26.5	26.9	n/a

9.7.43. As would be expected with natural growth in traffic flows, the Do-Minimum comparative shows a slight increase (but not significant) in noise levels at all locations.

9.7.44. None of the receptors reach the traffic night noise level of 55 dB Lnight,outside. Therefore the night-time noise has not been assessed in those receptors.

[62] Night noise assessments are only undertaken when Lnight,outside ≥ 55 dB. Therefore, does not apply (n/a).
[63] Although night time assessment has to be undertaken only at dwellings, the figures for other noise sensitive receptors are reproduced here for information.

9.7.45. The long-term noise assessment for the Do-Minimum comparative is presented in Table 9.18. Drawings Nos 25000182/ENV/9.3 and 25000182/ENV/9.6 show the noise changes in 3 dB LA10, 18h bands.

Table 9.18 Long-term Noise Impact Assessment for the Do-Minimum Comparative (DMRB HD 213/11 Table A1.2)				
Do-Minimum future assessment year 2033 – Do-Minimum baseline year 2018 (long-term)				
		Daytime		Night-time
Change in noise level		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level $L_{A10,18h}$	0.1 – 2.9	2293	4	246
	3.0 – 4.9	0	0	0
	5.0 – 9.9	0	0	0
	10+	0	0	0
No Change	0	0	0	0
Decrease in noise level, $L_{A10,18h}$	0.1 - 2.9	0	0	0
	3.0 - 4.9	0	0	0
	5.0 - 9.9	0	0	0
	10 +	0	0	0

9.7.46. 246 dwellings reach the 55 dB Lnight,outside threshold value. Receptors along the current A77 present the highest traffic noise levels values where is where most of those 246 receptors are located.

9.7.47. The next long-term comparative is the Do-Something comparative. The Do-Something comparative compares the Do-Minimum scenario in the baseline year 2018 against the Do-Something scenario in the future assessment year 2033 (i.e. Do-Something 2033 – Do-Minimum 2018). The results for the receptors considered as representative of different areas are reproduced in Table 9.19 below.

Table 9.19 Long-term Noise Levels for the Do-Something Comparative at the Representative Receptors (DMRB HD 213/11 Table A1.2)						
Do-Something future assessment year 2033 – Do-Minimum baseline year 2018 (long-term)						
Receptor	**Daytime (dB LA10,18h)**			**Night-time (dB LA10,18h)**		
	DM 2018	**DS 2033**	**Change in noise**	**DM 2018**	**DS 2033**	**Change in noise**
1- New Development at Burns Drive Area, Eastern Building, (W)	48.1	49.2	1.1	37.0	38.0	n/a
2- Fairknowe House Care Home (SE)	66.1	64.6	-1.5	53.2	51.9	n/a
3- 16 Crosshill Road, (NE)	66.2	66.6	0.4	53.3	53.7	n/a
4- The Ranch Caravan Park (W)	56.2	54.5	-1.7	44.3	42.8	n/a
5- East Enoch Farm, (S)	44.3	51.4	7.1	33.6	40.0	n/a
6- St Cuthberts Primary School, (NW)	63.9	58.8	-5.1	51.2	46.7	n/a
7- Nether Culzean Farm, (E)	60.9	56.0	-4.9	48.5	44.1	n/a
8- St Murrays Farm, (SE)	30.0	42.2	12.2	20.7	31.7	n/a
9- Laighgrange Farm, (E)	39.4	40.3	0.9	29.2	30.0	n/a
10- Cargilston, (SE)	33.4	41.5	8.1	23.8	31.1	n/a
11- Kirklandhill Farm, (SW)	42.2	50.0	7.8	31.7	38.7	n/a
12- Gardenrose Primary School, (SW)	45.4	47.6	2.2	34.6	36.6	n/a
13- 6, Macadam Place, (N)	36.4	54.3	17.9	26.5	42.6	n/a

9.7.48. The results in Table 9.19 show a similar pattern to those presented in Table 9.15 for the short-term assessment. That is, the proposed scheme has a greater impact on the receptors located both north of Maybole and north of the proposed scheme, e.g. East Enoch Farm, Kirklandhill Farm, Cargilston, and St Murrays Farm. Nevertheless, most of them remain with noise levels less than or equal to 50 dB LA10,18h (except East Enoch Farm where a noise level of 51.4 dB LA10,18h has been predicted for the long term Do-Something scenario) with noise levels around 40 dB LA10,18h at Cargilston and St Murrays Farm.

9.7.49. The impact on the receptors located north of Maybole but south of the proposed scheme, e.g. the new development at Burns Drive area, and Gardenrose Primary School present also negligible impacts except for those properties close to where the scheme will be built on embankment (6 Macadam Place). Nevertheless, the noise levels will remain low with a predicted noise level of 54.3 dB LA10,18h at 6, Macadam Place for the long term Do-Something scenario.

9.7.50. Receptors which will experience a greater betterment are those located along the existent A77, i.e Nether Culzean and St Cuthberts Primary School with moderate betterments in the long term.

9.7.51. Properties along the B7023 present negligible changes in the long term Do-Something scenario, i.e. Fairknowe House Care Home (north of the existent A77) and 16 Crosshill Road (south of the existing A77).

9.7.52. The long-term traffic noise assessment for the Do-Something comparative is presented in Table 9.20 below. Drawings Nos 25000182/ENV/9.4 and 25000182/ENV/9.7 show the noise changes in 3 dB LA10,18h bands.

Table 9.20 Long-term Noise Impact Assessment for the Do-Something Comparative (DMRB HD 213/11 Table A1.2)				
Do-Something future assessment year 2033 – Do-Minimum baseline year 2018 (long-term)				
		Daytime		Night-time
Change in noise level		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level $L_{A10,18h}$	0.1 – 2.9	315	0	1
	3.0 – 4.9	146	0	0
	5.0 – 9.9	319	1	0
	10+	91	0	0
No Change	0	26	0	0
Decrease in noise level, $L_{A10,18h}$	0.1 - 2.9	682	2	1
	3.0 - 4.9	572	1	79
	5.0 - 9.9	142	0	85
	10 +	0	0	0

9.7.53. The above table shows that 556 dwellings experience significant increases (i.e. changes ≥ 3 dB(A)) whereas 714 dwellings experience significant decreases.

9.7.54. It is important to note that no single receptor presents significant increases at night, whereas 164 receptors present significant decreases at night. Although some properties present increases in noise in the long term during night time, the Lnight,outside levels remain below 55 dB(A) (WHO NNG interim target) which is the level night noise is assessed.

Long-term noise nuisance assessment

9.7.55. DMRB HD 213/11 states the assessment of permanent traffic nuisance impacts comparing the Do-Minimum scenario in the baseline year with the two possible scenarios that are available in the future assessment year. All calculations have to be based on the highest nuisance levels calculated during the first 15 years after opening the scheme.

9.7.56. For the Do-Minimum scenario the gradual changes between the Do-Minimum in the baseline year and the Do-Minimum in the future assessment year are assessed using DMRB HD 213/11 Figure A6.1.

9.7.57. For the Do-Something scenario, the highest nuisance levels can occur in either the Do-Something in the baseline year (due to an immediate increase of nuisance which are assessed using DMRB HD 213/11 Figure A6.2) or the Do-Something in the future assessment year (due to gradual changes of nuisance which are assessed using DMRB HD 213/11 Figure A6.1). Then, as previously stated, the highest of both values (either nuisance in Do-Something baseline year 2018 or nuisance in Do-Something future assessment year 2033) have to be reported as the level of nuisance for the Do-Something scenario64.

9.7.58. The noise nuisance results for both the Do-Minimum (which only considers steady states in the long term) and the Do-Something scenario (which considers both the short term and the long term) are shown in Table 9.21.

Table 9.21 Long-term Traffic Noise Nuisance Reporting Table for Detailed Assessments (DMRB HD213/11 Table A1.3)

Do-Minimum: Do-Minimum 2033 – Do-Minimum 2018
Do-Something: Maximum between Increase Do-Something 2018 and Do-Something 2033 – Do-Minimum 2018

		Do-Minimum	Do-Something
Change in nuisance level		**Number of dwellings**	**Number of dwellings**
Increase in nuisance level	< 10%	1873	188
	10 < 20%	0	160
	20 < 30%	0	180
	30 < 40 %	0	305
	> 40 %	0	228
No Change	0	420	130
Decrease in nuisance level	< 10%	0	1092
	10 < 20%	0	10
	20 < 30%	0	0
	30 < 40 %	0	0
	> 40 %	0	0

9.7.59. The results show that 1,061 dwellings will experience an increase in noise nuisance level, basically for the increase of noise in the short term Do-Something scenario, whereas 2,002 dwellings will experience decrease in noise nuisance levels for the same scenario.

[64] Although DMRB HD 213/11 states the permanent assessment traffic nuisance impacts as long-term assessment (see DMRB HD 213/11 A1.29.i) and ii)), actually, for the Do-Something scenario is assessed both the short-term (nuisance increase Do-Something 2018) and the long-term (nuisance Do-Something 2033 – nuisance Do-Minimum 2018).

9.7.60. The results for some receptors considered as representative of different areas are reproduced in Table 9.22.

Table 9.22 Long-term Traffic Noise Nuisance Reporting Table for Detailed Assessments at the Representative Receptors (DMRB HD213/11 Table A1.3)		
Do-Minimum: Do-Minimum 2033 – Do-Minimum 2018 Do-Something: Maximum between Increase Do-Something 2018 and Do-Something 2033 – Do-Minimum 2018		
Noise sensitive receptor	Do-Minimum	Do-Something
	(Change in % bothered)	
1- New Development at Burns Drive Area, Eastern Building, (W)	0	18*
2- Fairknowe House Care Home (SE)	0	-3**
3- 16, Crosshill Road, (NE)	1	24**
4- The Ranch Caravan Park (W)	0	-2**
5- East Enoch Farm, (S)	0	39*
6- St Cuthberts Primary School, (NW)	1	-8[65]**
7- Nether Culzean Farm, (E)	1	-6**
8- St Murrays Farm, (SE)	0	48*
9- Laighgrange Farm, (E)	0	0
10- Cargilston, (SE)	0	41*
11- Kirklandhill Farm, (SW)	0	41*
12- Gardenrose Primary School, (SW)	0	25*
13- 6, Macadam Place, (N)	0	54*

9.7.61. Table 9.22 shows that the change in percentage of people bothered by traffic noise in the long-term sharply increases at the dwellings located north of Maybole which are far from the existing roads but are close to the proposed scheme. The change in percentage of people bothered by traffic noise in the long-term decreases in the dwellings located near the A77 within Maybole. The increases in the Do-Something scenario are basically caused in the short term when the opening of the proposed scheme north of Maybole will significantly increase the very low road traffic noise levels of that area.

Long-term airborne vibration nuisance assessment

9.7.62. In accordance to DMRB HD 213/11, the airborne vibration assessment is restricted to dwellings within 40 m of the carriageway.

[65] Although noise nuisance assessment has to be undertaken only at dwellings, the figures for other noise sensitive receptors are reproduced here for information.
* Change in noise nuisance caused by the short term Do-Something scenario, i.e. + Do-Something 2018 (DMRB HD 213/11 Figure A6.2).
** Change in noise nuisance caused by the long term Do-Something scenario, i.e. Do-Something 2033 (DMRB HD 213/11 Figure A6.1) – Do-Minimum 2018 (DMRB HD 213/11 Figure A6.1).

9.7.63. 530 dwellings have been identified inside the 40 m buffer from the edge of the proposed scheme, the existing A77, the B7023 and the B7024.

9.7.64. Ten of them are situated within 10 m of the proposed scheme, i.e. some dwellings by B7023 Culzean Road (Burns Drive), some dwellings by Gardenrose Path and some dwellings by Kirklandhill Path.

9.7.65. DMRB HD 213/11 reports that the relationship between the percentage of people bothered by largely airborne vibration and the noise exposure index is similar to that for noise nuisance except the percentage of people bothered by vibration is lower at all exposure levels. For a given level of noise exposure the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for noise nuisance. An assessment of vibration nuisance is provided in Table 9.23 below.

Table 9.23 Long-term Traffic Airborne Vibration Nuisance Reporting Table for Detailed Assessments (DMRB HD213/11 Table A1.4)

Do-Minimum: Do-Minimum 2033 – Do-Minimum 2018
Do-Something: Do-Something 2033 – Do-Minimum 2018

		Do-Minimum	Do-Something
Change in nuisance level		**Number of dwellings**	**Number of dwellings**
Increase in nuisance level	< 10%	340	54
	10 < 20%	0	0
	20 < 30%	0	0
	30 < 40 %	0	0
	> 40 %	0	0
No Change	0	1	1
Decrease in nuisance level	< 10%	0	91
	10 < 20%	0	125
	20 < 30%	0	2
	30 < 40 %	0	0
	> 40 %	0	0

9.7.66. There are 341 dwellings with noise levels greater or equal to 58 dB LA10,18h within 40 m of the main carriageways in the Do-Minimum scenario of which, 340 dwellings experience an increase in vibration nuisance level.

9.7.67. In the Do-Something Scenario, there is an important reduction in the number of dwellings with noise levels greater or equal to 58 dB LA10,18h within 40 m of the main carriageways, a total of 273 dwellings (i.e. 68 dwellings less than in the Do-Minimum scenario). Of them, 54 dwellings experience an increase whereas 218 experience a decrease in vibration nuisance level.

9.7.68. This result is according with the fact that the traffic flows are being reduced from the existing A77, B7023 and B7024 (which have a big number of buildings located within 40m of their carriageways) to the proposed scheme (which has less buildings within 40m of the carriageway).

9.8. Significance of Effects

9.8.1. Table 9.24 shows the magnitude and significance of the impact in the short-term at the representative receptors.

Table 9.24 Impact of the Proposed Scheme in the Short-term at the Representative Receptors			
Do-Something baseline year 2018 – Do-Minimum baseline year 2018 (short-term)			
Receptor	**Change in noise (dB LA10,18h)**	**Magnitude**	**Significance**
1- New Development at Burns Drive Area, Eastern Building, (W)	0.6	Negligible	Not significant
2- Fairknowe House Care Home (SE)	-1.7	Minor beneficial	Not significant
3- 16, Crosshill Road, (NE)	0.0	No change	Not significant
4- The Ranch Caravan Park (W)	-2.0	Minor beneficial	Not significant
5- East Enoch Farm, (S)	6.5	Major	Significant
6- St Cuthberts Primary School, (NW)	-5.3	Major beneficial	Not significant
7- Nether Culzean Farm, (E)	-5.2	Major beneficial	Not significant
8- St Murrays Farm, (SE)	11.6	Major	Significant
9- Laighgrange Farm, (E)	0.5	Negligible	Not significant
10- Cargilston, (SE)	7.5	Major	Significant
11- Kirklandhill Farm, (SW)	7.2	Major	Significant
12- Gardenrose Primary School, (SW)	1.6	Minor	Significant
13- 6, Macadam Place, (N)	17.3	Major	Significant

9.8.2. The long-term daytimes values and are shown in Table 9.25.

Table 9.25 Impact of the Proposed Scheme in the Long-term at the Representative Receptors				
Do-Minimum: Do-Minimum 2033 – Do-Minimum 2018 Do-Something: Do-Something 2033 – Do-Minimum 2018				
Receptor	**Do-Minimum Change in noise (dB LA10,18h)**	**Do-Something Change in noise (dB LA10,18h)**	**Magnitude (over the difference)**	**Significance (over the difference)**
1- New Development at Burns Drive Area, Eastern Building, (W)	0.5	1.1	Negligible	Not significant
2- Fairknowe House Care Home (SE)	0.2	-1.5	Negligible beneficial	Not significant
3- 16, Crosshill Road, (NE)	0.4	0.4	No change	Not significant
4- The Ranch Caravan Park (W)	0.4	-1.7	Negligible	Not significant
5- East Enoch Farm, (S)	0.3	7.1	Moderate	Significant
6- St Cuthberts Primary School, (NW)	0.5	-5.1	Moderate beneficial	Not significant
7- Nether Culzean Farm, (E)	0.5	-4.9	Moderate beneficial	Not significant
9- Laighgrange Farm, (E)	0.3	0.9	Negligible	Not significant
10- Cargilston, (SE)	0.5	8.1	Moderate	Significant
11- Kirklandhill Farm, (SW)	0.6	7.8	Moderate	Significant
12- Gardenrose Primary School, (SW)	0.6	2.2	Minor	Significant
13- 6, Macadam Place, (N)	0.4	17.9	Major	Significant

9.8.3. As previously stated, both tables show that the greatest impact will be in those dwellings located north of Maybole, whereas the greatest betterment will be in those dwellings located along the existing A77.

Qualitative assessment of the study area outside the calculation area

9.8.4. DMRB requires a qualitative assessment of the noise impact to be undertaken for dwellings and other sensitive receptors that are within 1 km of the proposed scheme boundary but not within 600 m of an affected route. Receptors are identified in Drawing No. 25000182/ENV/9.1. The qualitative assessment is detailed below:

- West and Mid Brochloch Farm, East Enoch and Hillcrest located to the north of the scheme extents would be subject to no significant impacts at both opening and future assessment years due to noise levels as a result of the scheme being below 40 dB(A) (see Drawing No. 25000182/ENV/9.11).
- Glenside Forsyth, Fordhouse Farm, properties located to the south of Maybole town will be experience a decrease in noise levels.

The Noise Insulation (Scotland) Regulations 1975

9.8.5. The NISR 1975 imposes a duty on authorities to provide, or make a grant towards, installation of noise insulation at eligible properties affected by new roads or an altered road. The regulations refer specifically to residential properties which meet all the three following criteria:

- They are eligible buildings within 300 m of the new and altered road.
- The relevant noise level reaches or exceeds 68 dB LA10,18h.

  Do-Something 2033 ≥ 68 dB LA10,18h
- The relevant noise level is greater by at least 1 dB(A) than the prevailing noise level immediately before works were begun.

  Do-Something 2033 – Do-Minimum 2012 ≥ 1 dB LA10,18h

9.8.6. The appropriate road authority will carry out census counts in accordance with the procedure laid down for the General Traffic Census. The timing and the location of the counts will be used to assess which buildings will qualify for an original offer and will be based on the actual flow within the 12 months period after the road is officially opened to traffic.

9.8.7. Reassessment based on subsequent counts in the same month and at the same location shall be made the fifth, tenth and fifteenth year following the year of original assessment. These will establish those buildings which previously did not quality for an original offer but which will have become eligible by virtue of increased traffic flow.

9.8.8. For the assessment of eligibility under the NISR, the use of the methodology provided in the Memorandum of Advice and Instruction No. 1/74 should be used. However, an estimate is presented in Table 9.26 of the number of properties that could qualify under the NISR, which has been made using the methodology contained within CRTN instead of the named above methodology and where traffic forecasts have been used instead of traffic counts.

Table 9.26 Estimate of number of buildings which qualify under the NISR	
Scheme	**Number of building where NISR Criteria is met**
A77 Maybole Bypass	0

9.8.9. Therefore, with the proposed scheme, it is expected that no dwellings will qualify for noise insulation under NISR either in the assessment year or in any of the reassessment years.

9.9. Mitigation

Construction Noise and Vibration

9.9.1. Best practicable means of noise control, as described within BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Noise, and BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sites – Vibration, will be included in the contract specifications in order to minimise the risk of disturbance. These British Standards provide specific detail on suitable measures for noise control in respect of construction operations. Measures considered for works include:

- Operatives should receive training to effectively employ techniques to reduce site noise;
- Unnecessary noise should be avoided when carrying out manual operations and when operating plant and equipment;
- Appropriate mufflers and silencers should be fitted to machinery. All exhaust silencers should be checked at regular intervals to ensure efficiency and replaced immediately if required;
- Worker noise should be minimised e.g. radios/phones provided to aid communication across the site;
- Vehicles must not idle needlessly, and equipment switched off when not required;
- Where a choice of plant is available, the quieter option should be chosen.
- All plant must be well-maintained and service documentation available for inspection;
- Static plant items should be sympathetically sited away from noise sensitive areas, or alternatively screened where ever possible;
- Temporary acoustic screening should be utilised at sensitive parts of the boundary of the construction site. Effective acoustic screening must be manufactured from material with adequate sound transmission loss characteristics and must, at least, break the line of sight between source and receiver;
- Drop heights of materials from lorries and other plant will be kept to a minimum;

- Where access is required via minor roads, they will be identified and listed within construction contact details. The use of other roads will be prohibited. This will include traffic management diversion routes.
- Noise levels should be monitored through regular noise assessments during works;
- Percentage on-time of noise-generating equipment should be minimised;
- Construction works would be confined to the normal working hours as prescribed by South Ayrshire Council;
- The local community should be informed in advanced of noise-generating works.
- Proposals for any blasting operations should be subject to agreement and monitoring of acceptable limits with South Ayrshire Council;
- During backfilling, roller capping, compaction and black topping works, it is anticipated that the use of vibratory rollers be required. It is recommended that vibration monitoring be undertaken during construction in accordance with BS 5228 Part 4 and BS 7385 Part 1:1990:Evaluation and Measurement for Vibration in Buildings Part 1: Guide for measurement of vibrations and evaluation for their effects on buildings.

Operational Noise and Vibration

9.9.2. The road is located within a cutting with embankments specifically sculptured to negate the requirement for noise barriers. The effectiveness of this approach has been modelled with NoiseMap 5. The use of low-noise road surface for the proposed scheme assists in control of noise from the tyre interaction, which is a benefit for the proposed scheme with a high speed of 100kph.

9.9.3. Although major impacts have been predicted at the northern properties between the B7023 Culzean Road and Gardenrose Path, south of the proposed scheme, i.e. representative receptor 6, Macadam Place, the noise levels at that area will remain below the WHO guidelines. Therefore, no further mitigation has been recommended for that area.

9.10. Conclusions

9.10.1. Construction noise impacts are temporary in nature, lasting for the duration of construction works. Mitigation measures will be incorporated into the Construction Environmental Management Plan in line with the Construction Code of Practice (CoCP) to ensure that these impacts are kept to a minimum.

9.10.2. The dwellings located outside the 600 m calculation area but within the 1 km study area, will be subject to negligible impacts at both opening and future assessment years.

9.10.3. A significant noise impact in the short-term (i.e. changes ≥ 1 dB(A)) has been identified at 677 dwellings, whereas a significant betterment has been identified at 1,273 dwellings. The area with a greater impact will be north of Maybole and north of the scheme, whereas the area with a greater betterment will be along the existing A77.

9.10.4. In the long-term, 556 dwellings experience significant increases (i.e. changes ≥ 3 dB(A)) whereas 714 experience significant decreases. However, no single dwelling experiences significant increases at night, whereas 164 receptors experience significant decreases at night. Since night time is only assessed when the values of Lnight,outside are greater or equal to 55 dB(A) (level that the WHO consider as NNG interim target), this demonstrates that although some properties will present significant increases in noise in the long term (mainly to the north of Maybole), the ambient noise levels will remain relatively low.

9.10.5. In terms of noise nuisance, the results show that 1,061 dwellings experience an increase in noise nuisance level, whereas 2,002 dwellings will experience decreases in noise nuisance levels.

9.10.6. In terms of airborne vibration nuisance, there are 341 dwellings with noise levels greater or equal to 58 dB LA10,18h within 40 m of the main carriageways in the Do-Minimum scenario of which, 340 dwellings experience an increase in vibration nuisance level. In the Do-Something scenario, there is an important reduction in the number of dwellings with noise levels greater or equal to 58 dB LA10,18h within 40 m of the main carriageways, totalling 273 dwellings (i.e. 68 dwellings less than in the Do-Minimum scenario). Of them, 54 dwellings experience an increase whereas 218 experience a decrease in vibration nuisance level.

9.10.7. Overall, the scheme presents a clear beneficial gain in relation to noise and vibration.

9.10.8. No additional mitigation measures are required in addition to the sections to be constructed in cuttings and the low noise surface as part of the scheme design.

9.10.9. With the proposed scheme, no dwellings qualify for noise insulation under NISR.