REPUBLIC OF CYPRUS

MINISTRY OF COMMUNICATIONS AND WORKS
DEPARTMENT OF PUBLIC WORKS

ENVIRONMENTAL IMPACT ASSESSMENT OF THE UPGRADE TO SIX LANES OF THE SECTION OF THE NICOSIA-LIMASSOL MOTORWAY BETWEEN AGIA VARVARA AND NICOSIA, AND THE CONSTRUCTION OF AN INTERSECTION AT THE GSP STADIUM

FINAL ASSESSMENT REPORT

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1. INTRODUCTION

This study has been prepared following an expression of interest by the Ministry of Communications and Works (Public Works Department) of Cyprus, concerning the provision of services by specialist firms of consultants in connection with the preparation of an Environmental Impact Assessment of the upgrade, to six lanes, of the section of the Nicosia-Limassol motorway between Agia Varvara and Nicosia, and the construction of an intersection at the GSP Stadium (Contract no. PS/D/239).

This assessment presents the views expressed by the Cypriot consultancy firm A. F. MODINOS & S. A. VRAHIMIS, CHARTERED ARCHITECTS AND ENGINEERS, in collaboration with he consultancy firm *Environmental Management Consultants Ltd* of Nicosia.

The Nicosia - Agia Varvara section of the A1 motorway, as the connecting link between Nicosia and other towns, bears the heaviest traffic load,.

The assessment concerns the upgrade to six lanes of the section of the existing motorway between the road junction of the Strovolos industrial zone and Agia Varvara, 12.4 km in length. It includes the junction on Megalou Alexandrou Street at km 78+500, the junction on Vikela Street (buildings) west of the GSP Stadium, and the construction of a intersection next to the GSP Stadium, providing direct access to the stadium itself, as well as access to neighbouring areas. It also includes the connecting roads between the junction on Vikela Street and the Bravo factory at Latsia, between the Vikela junction and the road alongside the Metalco factory, and between the intersection next to the GSP Stadium and Archiepiskopou Kyprianou Street in Latsia.

The motorway in its present form comprises two traffic lanes of a combined width of 7 metres in each direction, with an asphalt shoulder 3 metres wide. The proposed cross-section includes a third lane, with a 3.5 metre widening of the existing roadway.

The object of the Environmental Impact Assessment is: to identify the expected positive and negative impacts of the project on the environment, on public health and on the amenities for residents and users of the area concerned; to discover the extent of the impacts individually and cumulatively; to submit proposals for measures to prevent, mitigate, minimise or, where possible, remedy or neutralise the identified negative impacts which can be managed; and to identify, individually and collectively, those impacts (and their extent) which cannot be managed, prevented, mitigated, minimised, remedied or neutralised, and which will remain severe even after adoption of the measures proposed by the consultants.

2. SUMMARY OF THE FINDINGS

This section of the report presents the findings of the environmental impact assessment. This is followed by a description of the impacts and the proposed mitigation measures for impacts on the man-made, biological and physical environment. The last section of this chapter presents the final conclusions and sets out the proposals made by the planning consultancy team, on the question of whether and how the project is to be implemented, with environmental criteria always borne in mind.

2.1 MAN-MADE ENVIRONMENT

2.1.1 Impact on urban planning zones

The main urban planning aspect of the project is the fact that it lies along an existing road route of major importance and is intended to function as part of that route. Thus, the area through which the project is to extend is already established, in urban planning terms, as an area which has the existing arterial road as its main feature, with all the positive and negative impacts that this entails for the immediate surroundings.

The urban planning zones already occupied by the motorway are shown in **Table 2.1** below.

Table 2.1: Occupied length of zones in the area assessed

Section	ZONES	Occupied length in metres
A	Ca4	4,625
	Da1	100
	Aa4	200
	Ba3	4,925
B	Ca4	7,700
	Ba3	3,000

A detailed description of the characteristics of the urban planning zones is given in Table D1 of ANNEX D.

For the development of industrial zone Ba3, a road network plan was recently prepared by the Urban Planning and Housing Department. This has been made available to Nicosia District Urban Planning Office so that it can be taken into account and implemented in the process of issuing urban planning permits. This plan envisages the creation of a service road network to provide organised access to the industrial estates, with a connection to the old Nicosia-Latsia road, with a view to progressively replacing the thoroughfares and crossings which now serve the development area. This plan also takes account of the motorway project.

As regards the impact of the service road network on the industrial units, it will be positive, because of the organised access provided, in contrast with the existing situation where the access routes are isolated from each other. Furthermore, since the plan was prepared recently, it takes account of both the existing and the future level of development. Additionally, for cases where properties are affected at particular points or along their boundaries due to construction of the service network, the question of expropriations is not expected to arise, since any effects will be offset by the provision of organised access, as specified in the relevant provisions of the Laws on Urban Planning, Land Use Planning and Regulation of Roads and Buildings – Cap. 46. The permits which have been issued recently take account of the creation of the road network.

The construction work on the proposed project and the absence of additional access routes are therefore not expected to have any impact on the urban planning zones in terms of changes of structure, changes of land use, etc.

Expropriation of privately owned property affected by the project will be on the basis of fair compensation as provided for in the relevant law.

2.1.2 Impact on land values

The upgrade of the section of the existing motorway will not have any negative impact on land values, beyond the impact due to construction of the motorway.

To summarise, the project extends through an area where road development is already the predominant land use. Housing development is isolated and the population concentration is negligible to non-existent. No crops are affected, nor is industrial development affected by the project, and consequently there is no likelihood of a reduction in any economic activity or production.

2.1.3 Impact on irrigated and cultivated land

In the area assessed, there is no land irrigated by large water development works (according to the policy declaration), nor are there any irrigation networks. There are only isolated boreholes meeting the needs of local market gardens.

The boreholes with the following code numbers are expected to be affected:

- **W721/98 Hydr. No 269** on plot 237 on Sheet/Plan 30/63 W2
- **W73/76** on plot 517 on Sheet/Plan 39/7 W1
- **W69/86 Hydr. No 196** on plot 512 on Sheet/Plan 39/7 W1

The first and third of these are situated in the expropriated area of land, and the second is on its boundary. Their locations are shown on Map 5π in ANNEX B.

2.1.4 Impact due to noise

2.1.4.1 Impact during construction

The impacts due to noise generated during the construction phase are based on the levels of noise pollution as calculated according to British Standard BS 5228.

The noise level at the boundaries of the site is 84 dB(A) at a distance of 10 metres from the source, and exceeds the limit of 75 dB(A). At 40 m, the noise level falls to 72 dB, at 75 m to 66.5 dB, at 100 m to 64 dB, at 200 m to 58 dB, and at 250 m to 56 dB. It is anticipated that about 70 people will be employed on each site. For protection against increased noise levels, these employees will need to wear hearing protection (protective coverings). Silencers could also be installed on the machines to reduce noise emissions.

Given that the nearest homes will be as far as 100 metres from the motorway, it can be seen that there will be no environmental deterioration, because calculations show that the minimum expected noise levels in those homes will be 66.5 dB, i.e. significantly below the criteria set by the assessment, i.e. 75 dB $L_{Aeq\ (1\ hour)}$.

Mitigation measures

In spite of this, it would be possible to implement some proposals referred to in British Standard BS 5228:84, regarding ways of creating an environment where construction noise can be controlled. Some of these points are as follows:

- Establishing good relations with people working and living near the area of the project by explaining the duration, methods and times for implementing the various stages of the project; adhering to the work timetable. This entails serious attention to any complaints, and taking measures where necessary. If the contractor, through the policy it pursues, shows an understanding attitude towards the people raising complaints, then those who have complained will be more tolerant.

- Noise levels should be monitored with sound meters in sensitive areas, to forestall complaints.

- The contractor should train the workers to follow good engineering practice.
  - I. Noise due to unnecessary activity should be avoided.
  - II. Inappropriate siting of machines (in relation to nearby residents) should be avoided.
  - III. Noise barriers should be used around noisy machines.
  - IV. Silencers, where available, should be used.
  - V. Faulty machines etc. should be reported.

In addition to the above, where there is strong opposition from nearby residents, the contractor must install noise barriers – even if these are not very high – to mitigate the conditions for some of those living nearby.

It should be emphasised, however, that impact due to noise will be of short duration and will occur only during the working hours of the day (maximum duration from 7:00 to 17:00).

2.1.4.2 Noise due to movement of heavy vehicles transporting raw materials and excavation spoil

The noise which will occur as a result of lorry traffic during the construction phase, at peak times, has been calculated at 61.24 dB at a distance of 10 metres from the centre of the road along which the heavy vehicles will be travelling, 47.34 dB at 50 metres and 41.24 dB at 100 metres. These estimates show that the expected noise level due to movement of heavy vehicles transporting raw materials will have no significant impact, since the noise level, even at 50 metres, is below the criteria set in the assessment, i.e. 75 dB $L_{Aeq\ (1\ hour)}$.

Assessing the impact due to movement of heavy vehicles serving the needs of the construction works for the road network in question, we note the following:

- The nuisance caused will be of short duration.
- It will not affect homes situated 100 metres away.
- There will be no impact on the residential nuclei of settlements, since they are situated more than 200 metres from the area of construction of the proposed project.

2.1.4.3 Impact during operation

To estimate the expected environmental impact on the basis of $L_{Aeq\ (1\ hour)}$, relevant estimates were made for the reference year 2002 and for the years 2010, 2015, 2020 and 2025. The noise level was estimated for the upgraded 6-lane motorway, including the section between the "Buildings" junction and the Bravo factory in Latsia (Plan 8 – ANNEX B), the Vikela Street extension and the connecting road between the GSP junction and the exit to Latsia (Plan 7 – ANNEX B).

On the above basis, the hourly noise level 10 metres from the road is calculated at 74 dB L_{Aeq} for the existing situation, 75 dB L_{Aeq} for the year 2010, 76 dB L_{Aeq} for 2015, 76.5 dB L_{Aeq} for 2020, and 77 dB L_{Aeq} for 2025.

The results of the calculations are as follows:

Table 2.2 : Estimated noise level (as a function of distance from the motorway)

Distance from road (m)	**5**		**10**		**50**	
	4-lane	6-lane	4-lane	6-lane	4-lane	6-lane
Noise level due to existing traffic (L_{Aeq}) – 2002	77.2	-	74.1	-	64.3	-
Noise level due to expected traffic (L_{Aeq}) – 2010	79.5	78.4	76.1	75.3	66.1	65.5
Noise level due to expected traffic (L_{Aeq}) – 2015	80.1	79.0	76.7	75.3	66.7	66.1
Noise level due to expected traffic (L_{Aeq}) – 2020	80.7	79.6	77.3	76.5	67.3	66.7
Noise level due to expected traffic (L_{Aeq}) – 2025	81.2	80.1	77.8	77.0	67.8	67.2

In this table, for the years 2010, 2015, 2020 and 2025, the noise level under the new traffic conditions has been calculated for two cross-sections of the motorway: the existing (4-lane) and the proposed (6-lane) cross-section. It is obvious that noise levels would improve as a result of widening of the roadway.

Assessing the level of nuisance in the residentially developed areas adjoining the motorway, we draw the following conclusions:

- With the upgrade of the motorway from 4-lane to 6-lane, the noise level in the neighbouring areas is reduced.
- For the basic noise level L_{Aeq} at a distance of 10 metres from the boundary line, the relevant limit of 65 dB is expected to be exceeded by 9 dB, 6 dB, 11 dB, 11.5 dB and 12 dB for the years 2002, 2010, 2015, 2020 and 2025 respectively. Taking account of the drastic reduction in noise level with increasing distance, and the presence of material (earth, vegetation, crash barriers etc.) between source and receiver, as well as the location for which the excess is calculated, and the existing housing development, it is estimated that the amount by which the limit is exceeded will be insignificant.
- At the distances where homes along the motorway are situated, the noise level is below 60.7 dB, 61.9 dB, 62.5 dB, 63.1 dB and 63.6 dB for the years 2002, 2010, 2015, 2020 and 2025 respectively. In all cases, the noise level is above the relevant limit of 55 dB (Protection of the quality of life against factors which interfere with communication, reduce concentration and productivity and cause nervous strain). Although these values will be lower in view of the drastic reduction in noise level when absorbent material is interposed between source and receiver, Chapter 9 proposes further measures to reduce noise to acceptable levels.
- The expected noise level in the municipalities of Latsia and Agia Varvara, the boundaries of which are about 500 m from the road axis, will not exceed 54 dB, a level which is below the 55 dB limit (Protection of the quality of life against factors which interfere with communication, reduce concentration and productivity and cause nervous strain). As above, these values will be lower in view of the drastic reduction in noise level due to intervening materials.
- In the other municipalities, the noise level due to operation of the motorway will be below 38 dB.

On the basis of the results of the survey to assess the levels of noise pollution in the project area due to operation of the motorway, no locations were identified where the noise level is expected to cause problems, except the homes which are near the motorway. These homes are situated at:

km 70+300
one (1) home at a distance of ≤ 100 metres

km 70+700
one (1) home at a distance of ≤ 100 metres

km 76+600
one (1) home at a distance of ≤ 100 metres

km 76+700
one (1) home at a distance of ≤ 100 metres

km 80+200 – km 80+600 (east of the motorway, immediately after the bridge at Latsia):
two (2) homes at a distance of 150 metres
one (1) home at a distance of 100 metres
one (1) home at a distance of 60 metres

three (3) homes at a distance of 80 metres

km 77+200 (west of the motorway, 300 metres from the weigh station):
three (3) homes at a distance of 100 metres

km 77+200 (east of the motorway, 300 metres from the weigh station):
one (1) home at a distance of 70 metres

In these locations, no new residential buildings are expected to be built in future.

Mitigation measures

In the above-mentioned locations of residential buildings, specific measures must be taken to reduce the noise levels to permissible limits. These noise pollution measures may include:

- **Suitable planting (planting technique)**

Suitable planting may significantly reduce noise pollution. Reduction in noise level depends on the vegetation planted (type and arrangement) and the distance from the motorway. The noise attenuation achieved by this method may be as high as 10 dB(A).

- **Construction of low-noise road surfaces**

The type of road surface has a significant effect on the noise level, which, of course, also depends on other factors such as speed, wet or dry surface, the frequency of the noise source etc. Porous road surfaces, to a varying degree depending on the size of the voids, reduce noise by 3-7 dB(A). A prerequisite for using such a road surface is that its specifications must meet the requirements laid down by the Public Works Department.

- **Construction of noise barriers**

These are the usual noise reduction measure. Their cross-section and the material of which they are made affect the level of noise reduction achieved. The type selected must also meet the basic requirements in terms of appearance, so that:

- the noise barrier serves as a landmark for drivers
- the shapes used are adapted to the features of the natural environment
- the environment is highlighted and protected

Taking the option of a noise barrier 3 metres high at a distance of 20 metres from the centre line of the nearest lane, the noise levels in the above-mentioned ‘problem’ locations in the year 2025 will be as shown in Table 2.3 below.

Table 2.3. Noise level, dB(A)

kilometric position	DISTANCE (m)	BEFORE	AFTER
70+300	**up to 100**	**63.6**	**51.9**
70+700	**up to 100**	**63.6**	**51.9**
76+600	**up to 100**	**63.6**	**51.9**
76+700	**up to 100**	**63.6**	**51.9**
77+200	**up to 100**	**63.6**	**51.9**
80+200 - 600	**up to 100**	**63.6**	**51.9**

The levels achieved comply with the recommended 55 dB(A) noise exposure limit for a village/urban environment during the day. Account must also be taken of the effect produced on sound attenuation levels by the existing vegetation and by the technical components of the motorway, which have not been taken into account in the calculation presented here.

2.1.5 Impact on archaeological monuments

The additional area occupied as a result of the upgrade of the Nicosia-Limassol motorway to six lanes is not expected to affect the antiquities which have been discovered at three points along the road route (Maps 5στ, 5π, 5ρ in Annex B).

2.1.6 Impact on access routes

During the construction work, problems are expected arise on the access routes both to the motorway and to areas whose access roads pass over or under the motorway.

Specifically, nuisance is expected arise at the following points:

- At km 71+500, temporary suspension of access to the motorway from the village of Kotsiatis
- At km 71+850, temporary suspension of the access route from the village of Nisou
- At km 74+500, temporary suspension of the access route from the village of Tseri and from the Idaliou industrial zone
- At km 79+600, temporary suspension of access to the Nea Lydra area
- At km 80+700, temporary suspension of access from the Bank of Cyprus Athletic Centre to the motorway
- At km 80+700, temporary suspension of the access route, which is transferred to Latsia (Arch. Kyprianou Street), with the construction of a connecting road from the junction at the GSP Stadium to that point

Access routes which extend, over part of their length, parallel to the motorway are also expected to be affected. Such routes are situated at:

- km 79+500. Alongside the cemetery of the villages of Nisou and Pera Choriou (east of the motorway)

- km 79+500. West of the motorway, unsurfaced road leading to the central storage buildings of the Department of Public Works (former XEKTE offices)

To assist residents in the area and those passing through the area, care must be taken to create auxiliary roads for the duration of the construction work. Access to the Nea Lidra area is particularly important, because of the lack of any other point of access to that area.

It is important to stress that this impact will be temporary, because on completion of the construction work, this nuisance will cease.

2.1.7 Impact on traffic

During the construction phase of the proposed project, an increase in traffic is expected. This will be due to the movement of heavy vehicles on the existing motorway. Furthermore, the expected traffic regulation during the construction work will result in reduced traffic speed and, probably, the concentration of vehicles in a single lane, because the second lane will be closed due to works.

On the assumption that there will be two sites simultaneously on one side of the motorway, with four lorries operating with a maximum hourly peak load equivalent to 20 journeys a day, the increase in heavy vehicle traffic is expected to be up to 12%, according to the construction phase and direction (a heavier traffic load is expected in the Nicosia direction).

The table below shows how each section of the motorway will be affected during the construction work.

Table 2.4.1: Impact on heavy vehicle traffic

Description	Large lorries Existing traffic	Large lorries Construction phase	Percentage increase (%)
To Limassol	902	982	9
To Nicosia	658	738	13

The increase in traffic load due to movement of heavy vehicles, for all traffic in both directions, is shown in the table below:

Table 2.4.2: Impact on vehicular traffic

Description	Total	Large lorries Construction phase	Percentage increase (%)
To Limassol	20,502	80	0.39
To Nicosia	21,219	80	0.37

The foregoing indicates a significant increase in heavy vehicle traffic. Although this increase is very small (< 0.5%) in relation to the total volume of vehicles (of all types) using the road, it is expected to have an impact on the smooth flow of traffic, firstly because the site vehicles will be travelling at low speed as they will be carrying building materials, and secondly because the movement of vehicles in a single lane, while the second lane is closed due to works, will create conditions of traffic congestion.

The primary means of mitigating this impact is the proper scheduling and planning of execution of the various phases of the project, to avoid the simultaneous presence of many construction machines, to the extent, of course, that this is feasible.

As regards traffic regulation during the construction work (widening of the motorway, intersections), this is expected to be arranged as follows:

The existing shoulder will be used temporarily as a traffic lane to allow temporary contraflow operation of the motorway. To make this possible, the necessary technical additions / adaptations must first be made to the existing shoulder at the points where there are engineering structures interrupting the shoulder. These additions will be constructed in such a way that there is no need to occupy the motorway traffic lanes.

The advantage of this type of traffic management during the construction work is that it will minimise traffic diversion and hence delays while the work is in progress, and at the same time will ensure that there is a safety zone for those working on the section undergoing upgrade (Plan 3 – ANNEX A).

On completion of the necessary works on the shoulder, traffic will use the fast lane in one direction and the other three lanes in the other direction. The directions of flow will be adapted according to peak hours.

The temporary traffic management scheme includes a contraflow lane, a safety zone and a construction zone.

Road safety

There is a relationship between the number of accidents noted on a road and the volume of traffic. Assuming a low traffic flow, the number of accidents is expected to be small; with a high traffic flow, a correspondingly high accident rate is expected. A low traffic flow in each lane will be achieved with the upgrade of the motorway from two to three lanes in each direction. However, it is important to stress that the other factors which may affect accident numbers remain constant, e.g. the geometrical characteristics of the road.

It is also anticipated that lighting will be installed at the intersection by the GSP Stadium and at the Megalou Alexandrou road junction. This is expected to have a positive effect on road safety for users of the motorway.

Motorways with centre reservations and controlled access are an obvious improvement to the road network, with a positive effect in reducing the number of accidents. In a study of the international literature, it was found that the structure of the centre reservation reduces both the number and the severity of accidents. Thus, for a centre reservation 12 metres wide, it was found that accidents were reduced by 13% on a four-lane motorway. Greek experience shows that on an arterial route with a 3-metre centre reservation, the reduction in the number of vehicles crossing the reservation is in the region of 40%.

2.1.8 Impact on infrastructure works

During the construction work, some of the existing infrastructure works are expected to be affected.

These works are as follows:

Electricity Authority of Cyprus (EAC)

- Within the new wider boundaries of the motorway, there is an 11 kV and low-voltage overhead network which is affected and must be relocated.
- The present location of the 132 kV overhead transmission line (Athalassa-Latsia and Latsia-Ergates circuits) is not affected, because it is almost entirely outside the limits of the proposed widening of the motorway. At the point where it passes above the bridge which is to be constructed over Megalou Alexandrou Street, the height of the lines above bridge level will be re-examined to ensure that it complies with the lower limits prescribed by law.
- The existing conduits crossing the roadway will need to be extended to the new boundaries of the widened asphalt road surface, and if a change of road surface is decided upon, the EAC will request the installation/construction of additional conduits.
- The transport hubs near the new GSP Stadium and on Megalou Alexandrou Street will need electric lighting. This calls for construction of the necessary EAC supply system to meet the electricity requirements for road lighting.

Cyprus Telecommunications Authority (CYTA)

- Local relocation of the fibre optic cable which runs along the centre reservation, at the construction site of the new intersection beside the GSP Stadium.
- Temporary suspension of operation of the emergency (SOS) telephones along the section being upgraded.
- Extension of the conduits crossing the roadway, at the points where emergency telephones are located.

Water Development Department

- The Tersefanou Pipeline crosses the motorway at km 78+550 (Map 5ε in ANNEX B and photograph 10 in ANNEX C). The pipeline will not be affected by the widening of the motorway.

Nicosia Water Board

- Possible relocation of the pipeline alongside the Latsia flyover (the exact position is shown on Map 5β in ANNEX B)

2.1.9 Impact on the biological environment

2.1.9.1 During construction

The most significant impacts on the biological environment during the construction work will be the result of occupation or degradation of habitats (due to dumping of materials, movement of vehicles, machines etc.), and disturbance (noise, dust) to species of fauna in the areas through which the road passes. Specifically, the most significant impacts will be as follows:

Impact on habitats

The project is expected to have negative impacts on the habitats of the area, due to partial occupation of these habitats and degradation of the surrounding area as a result of vehicle movement to and from the work sites.

The project is considered to have a particularly negative impact on the phrygana habitat, which shows great biodiversity in terms of species, and is included in Council Directive 92/43/EEC as a ‘natural habitat type whose conservation requires the designation of special area of conservation’. However, the severity of this impact is mitigated by the fact that the phrygana type of habitat exists in many parts of Cyprus, in a much more representative state and under more natural conditions.

Impact is also expected on the riverine environment of the Alykos and Gialias rivers. It should be noted that the River Alykos, in particular, retains very significant ecological characteristics, and the point where it intersects with the road is part of an area which has been proposed for inclusion in the European “Natura 2000” network. It is therefore considered essential that appropriate measures be taken to ensure that (a) the project does not disrupt the riverine habitats, and (b) any negative impact is remedied as soon and as effectively as possible.

Impact on flora

Impacts on the local flora are not expected to be particularly negative, despite the fact that the work to be carried out in the area will destroy populations of a number of species of flora, including some endemic species. It should be noted that no rare or threatened plants were identified when the inventory was taken. The species identified in the area of the assessment are, generally speaking, common in many areas of Cyprus, and in some cases correspond to much larger populations. No species is expected to be endangered as a result of implementation of the project.

Impact on fauna

The most severe impact due to road widening is expected to affect the bird fauna. This impact is expected to occur after destruction of the two rows of trees to right and left of the road, which serve as a protective wall that causes birds to fly upwards without hitting vehicles. Collisions of birds - especially nocturnal birds of prey - with vehicles can then be expected. This is borne out by data held by the planners, concerning birds colliding with vehicles on Cypriot motorways. For example, bird hits on the new Paphos-Limassol motorway, which is not tree-lined on both sides, are much more frequent, and may even result in the disappearance of a species from a particular area. On the other hand, bird hits are almost negligible on the tree-lined Limassol-Nicosia motorway. The species most affected by collisions with vehicles is *Tyto alba*. These problems occur mainly at points where the road is higher than the natural relief of the land, and where there are streams or rural roads running at right angles to motorways.

Mitigation measures

Natural habitats

Particular attention must be given to points where the road route intersects the Gialias and Alykos rivers. Work at the river crossing points must be avoided during the season when there is a flow of water, because materials are likely to be carried away by the water, causing degradation of the rivers at points to the east of the intersection point.

As a measure to counteract the impact arising at the points of intersection of the rivers with the proposed road route, it is proposed that the Public Works Department should undertake to clean up the stretches of river which are degraded by discharges of waste materials. It is also proposed that the same Department should take the necessary action to ensure that a ban on waste dumping is observed around these locations.

It is recommended that species of local flora should be used for landscaping the exposed areas on both sides of the road. Apart from the fact that these species are best adapted to the environment, their establishment will contribute towards maintaining the natural character of the area. The local flora offers many options in terms of plants of various sizes. Options are listed in Table 2.5.

Table 2.5. Species recommended for use in landscaping the area and restoring land degraded by the project.

3a. Trees

Latin name	Common name	Remarks
1. Ceratonia siliqua	Carob tree	Evergreen
2. Olea europaea ssp. oleaster	Olive tree	Evergreen
3. Pinus brutia	Turkish pine	Evergreen
4. Cupressus sempervirens	Cypress	Evergreen, tall, barrier tree
5. Tamarix smyrnensis	Tamarisk	In damp locations

3b. Shrubs

Latin name	Common name	Remarks
1. Bosea cypria	*Zoulatzia*	Endemic, evergreen, barrier
2. Calycotome villosa	Spiny broom	Thorny
3. Cistus creticus	Cretan cistus	Small bush
4. Genista sphacelata spp. sphacelata	Thorny gorse	Thorny
5. Laurus nobilis	Bay	Evergreen, barrier
6. Myrtus communis	Myrtle	Evergreen, barrier
7. Nerium oleander	Oleander	Evergreen, barrier

8. Pistacia lentiscus	Mastic	Evergreen, barrier
9. Pistacia terebinthus	Turpentine	Deciduous
10. Rhamnus alaternus	Italian buckthorn	Evergreen, barrier
11. Rosmarinus officinalis	Rosemary	Aromatic
12. Salvia fruticosa	Sage	Aromatic

Flora

1. During the road widening, particular care must be taken not to disturb the riverine ecosystems on the Alykos and Gialias rivers, which, as mentioned above, are now the main habitat for the freshwater turtle, which is threatened with extinction in Cyprus.

2. On completion of the road, both sides of the road must be replanted. When selecting the plants, preference will be given to species which do not produce fruit that attracts birds. This will help to prevent collisions of birds with vehicles (see options in Table 3).

3. The rows of trees must be at least 4 m high, in order to make birds fly higher above the moving traffic.

2.2 IMPACT ON THE NATURAL ENVIRONMENT

2.2.1. Impact on the atmosphere

2.2.1.1 During construction

The impact on atmospheric quality during construction is due to: dust emissions from the earthworks; emissions from units producing materials (asphalt production units), if these are not permanent installations situated away from the work site; and emissions due to the movement of vehicles used during construction. The main feature of these impacts is their temporary nature. These impacts will appear only during the construction phase, and their effects are reversible.

Earthworks

The emissions due to earthworks are associated with: ground clearance operations; excavation, tunnel boring, cut and fill operations; collection and use of aggregate (earth, sand etc.) for purposes of construction; movement of construction vehicles in the site areas and on unsurfaced auxiliary roads and temporary access roads which are to be constructed and used solely for the purposes of the project.

Dust emissions vary considerably from day to day and depend on the extent of the operations, the rate of construction work, the type of operations and the prevailing weather conditions.

The estimated quantity of dust emitted as a result of construction work is:

e_1 = 8 tonnes/month (or 11 kg/hour of continuous activity)

The estimated emissions due to collection and storage of materials (earth, sand etc.) in the site areas are as follows:

e_2 = 8 kg/day

Mitigation measures

The measures which can be taken to reduce dust emissions into the atmosphere include the following:

- Lorries, particularly when travelling through residential settlements, must be covered.

- The area in which excavation spoil is stored should be at some distance from residential areas.

- Areas where rubble and excavation spoil are accumulated must be sprayed in order to minimise dust emissions into the atmosphere.

Emissions due to movement of construction vehicles

Emissions due to construction-site vehicle traffic can be identified as: release of dust due to the movement of the vehicles in the site areas and on unsurfaced auxiliary roads; airborne pollutants from their engines (diesel engines).

On the basis of the equipment used on the construction site as shown in **Table 6.3,** the estimated quantities of pollutants emitted as a result of the movement of construction vehicles in the site areas and on the auxiliary and adjacent unsurfaced roads, are as follows:

e_3 = 24 kg/km/day

The emissions from the diesel engines of the excavation and construction machines, estimated on the basis of the emission coefficients given in **Table 2.6,** are as follows:

Table 2.6: Pollutant emission levels during the construction phase (kg/hr)

POLLUTANT MACHINE	CO	NOx	SO_2	Particulates	HC
Concrete compression machine	**0.363**	**1.18**	**0.115**	**0.108**	**0.16**
Heavy lorry	**0.846**	**1.97**	**0.214**	**0.122**	**0.090**
Road roller	**0.412**	**0.892**	**0.0689**	**0.0534**	**0.0663**
Lorry	**0.34**	**0.985**	**0.107**	**0.061**	**0.045**
Cement mixer	**0.067**	**0.275**	**0.025**	**0.0194**	**0.0328**
Loader	**1.48**	**4.84**	**0.472**	**0.442**	**0.656**
Grader	**0.337**	**1.607**	**0.197**	**0.141**	**0.064**
Bulldozer	**0.171**	**0.54**	**0.065**	**0.0572**	**0.040**

The expected emissions of airborne pollutants are very low, and consequently the impact on atmospheric quality in the project area will likewise be very low.

2.2.1.2 During operation

The estimate of atmospheric quality during the operational phase of the project is based exclusively on the impact of road traffic. The emissions consist of the airborne pollutants CO, NOx, HC, PM and SO_2.

Atmospheric quality in the project area was estimated using the US Environmental Protection Agency’s HIWAY2 mathematical model.

The HIWAY2 model was designed to calculate inert pollutants from vehicle emissions on motorways. A limitation of the original version of the model was that it could not represent any topographical irregularities in the area near the motorway. This limitation is not present in the model used here. The model takes account of the limitation of vertical dispersion of pollutants due to the formation of mixing layers.

Table 2.7 shows the estimated maximum concentrations for the years 2005 and 2025 respectively.

Table 2.7: Estimated maximum concentrations (mg/m^3)

YEAR	POLLUTANT	CONCENTRATIONS	QUALITY LIMITS
2005	NOx	83.6	400
	HC	32.3	____
	CO	245.7	30,000
	SO_2	54.8	250
2025	NOx	148.1	400
	HC	55.9	____
	CO	422.6	30,000
	SO_2	87.7	250

1. Cyprus air quality targets (quality limits for atmospheric air) according to the Pollution Control Law (Laws 70 of 1991 and 94(1) of 1992).

As the table shows, the atmospheric concentrations in the area of the project are well below the atmospheric quality limits laid down by Cypriot legislation. Bearing in mind that the concentrations were calculated for the most unfavourable weather conditions (atmospheric conditions highly stable, mixing height 100 metres), with pollutants remaining trapped near the ground, it can be seen that no deterioration in air quality is expected. Therefore, on the basis of the results provided by the HIWAY2 mathematical model, the operation of the project in question is not expected to have significant environmental impact.

2.2.2 Hydrological and hydrogeological impact

2.2.2.1 During construction

In the project area, there are significant water resources requiring protection during the construction phase. The surface water resources include the flows of the Kalogiros, Almyros, Alykos and Gialias rivers, and the Athalassa dam which is fed by the River Kalogiros. The underground water resources include the groundwater of the Newer (Upper) Clastics Aquifer, which extends mainly between the northern edges of the Almyros valley and Latsia (km 76+300 – km 80+300), the Gialias Alluvial Aquifer (km 70+800 – km 71+500), and the Gypsum Aquifer, which extends below this alluvial deposit.

It is expected that the impact on these water resources will be due to both liquid and solid waste.

The liquid waste consists mainly of the following:

- Liquid waste from the temporary sanitation facilities serving the needs of personnel in the site areas.

- Surface runoff, which may carry pollutants originating from construction machines, excavation spoil and roadbuilding materials, e.g. machine oil, hydrocarbons, dust and other chemical substances.

The solid waste during the construction phase can be classed as:

- Excavation spoil
- Plastic and other objects thrown away by employees
- Surplus building materials such as cement, iron, asphalt etc.

Hydrology

The road runs obliquely to the main natural drainage systems, and this increases the likelihood of negative impact during the construction phase. The impact due to construction work is expected to be predominantly temporary and reversible, but some impact may be non-reversible: this consists mainly in the interruption of natural runoff systems by earthworks and excavations, and the triggering of increased erosion and transfer of sediment to lower areas.

The excavation and earthworks may result in the formation of pools of stagnant water, especially in river valleys.

The discharge of machine oil and similar substances due to maintenance of vehicles and other machinery may result in contamination of surface water over the entire length of the road, and particularly in alluvial valleys.

The Megalou Alexandrou road junction lies in the catchment area of the Agios Georgios river, and its construction will inevitably affect the hydrological situation in the area, especially in terms of surface flow to the drainage systems. The greatest impact will be mainly from the western part of the junction, which is situated in a small individual basin in which the runoff on the south, west and north sides is towards the position of the existing bridge on the motorway (km 78+500). The branches of the junction cut obliquely through all the natural drainage systems, and suitable drains must be installed and measures must be taken to prevent drain blockage.

In the area south of the western part of the MEGA 1 arterial road, and in the area enclosed between the MEGA 1 and MEGA 2 arterial roads, large quantities of water may accumulate during periods of heavy rainfall. The artificial drainage system, as already designed, must be constructed promptly in order to prevent a build-up of stagnant water. It will also be necessary to avoid placing rubble or other materials in such a way that they could block the drains and natural drainage systems.

The road junction beside the GSP Stadium is in the catchment basin of the River Kalogiros, about 500 m south of the point where that river intersects obliquely with the motorway. It appears that the greatest immediate impact of the junction would fall on the tributary of the Kalogiros known as Laxia tou Hatzichristodoulou, which runs through the area south of the GSP Stadium and north of the junction, at a short distance from it. This tributary cuts diagonally across the proposed road to the west of the junction, so that part of its natural bed is confined between the south-east side of the GSP Stadium and the north-west corner of the junction. In this area, and south of the connecting road to the west of the junction, problems may arise, especially in the event of heavy rainfall, and suitable drains must be installed and measures taken to prevent them from becoming blocked.

During the construction phase, the artificial drainage system must be constructed sufficiently early, and it will also be necessary to avoid placing rubble or other materials in such a way that they could block the drains or create pools of stagnant water.

To summarise, the hydrological impact of the construction work may be as follows:

- Temporary and reversible interruption of the natural drainage network, due to excavation and earthworks.

- Contamination of surface and groundwater with used machine oil or fuel and other chemical substances which may be used in construction work.

- Formation of stagnant pools of water.

Measures which can be applied to prevent and/or mitigate the impact include all those which help to counteract the impact on the topography, geomorphology and natural drainage systems. Specific measures which must be applied are as follows:

- Restoration of the natural drainage system in areas disturbed by earthworks, excavation and embankments.

- Where major drainage routes have been disturbed or interrupted by earthworks, drains must be correctly designed with due regard to other factors, such as disruption to the system when drainage directions are changed, changes to the incline of the network due to the construction work, an increase in the erosion rate and an increase in the quantity of sediment.

- Careful positioning of the sites for disposing of unsuitable spoil, to avoid interruption of the main drainage routes.

- Designing the artificial systems in such a way as to minimise changes to the surface flows, while at the same time ensuring that these systems are adapted to the general network which provides natural drainage.

- Areas receiving water via the artificial drainage system must be protected against erosion and deposit of sediment, using one or more of the following measures, or other measures:
  - Increasing the number of drainage channels
  - Arranging the outlets from the drains in such a way as to avoid the creation of small waterfalls.
  - Covering the gutters or other drainage structures with concrete or stone, or a combination of the two.
  - Creating sediment traps at strategic points before the water is channelled into the natural drainage systems.

- Preventing the pollution of surface water with oil and other pollutants.

Hydrogeology

In the area of the project, there are sizeable aquifers in which the water quality may be adversely affected during the construction work. The following types of impact are expected:

- Disruption of the drainage system

- Contamination of groundwater by transfer of machine oil, toxic substances and other pollutants from the surface water

- Contamination of groundwater due to the use of chemicals in the drilling of exploratory boreholes, and pile driving in river beds

The likelihood of transfer of the above pollutants is higher in alluvial valleys, where the surface flows are greater and surface formations are much more permeable than in other areas.

- Contamination from the sanitation facilities on the work sites. This is regarded as direct impact, and is aggravated in cases where the installations are on highly permeable surface formations, such as alluvial deposits and loose gravel.

Although the above impacts may be non-reversible, they are not expected to be severe, since the quantities of pollutants generated are usually small, and can easily be limited by applying simple management measures.

During the construction work, it is estimated that about 140 people (workers, supervisors and engineers) will be on site every day. To serve the needs of these personnel, provision must be made for sanitation facilities.

The usual and most reliable practice in these cases is to make a soak pit. On the basis of the number of workers on each site (70) per day, and the average waste produced per person (50 litres), the estimated quantities of liquid waste will be in the region of:

ef = 3,500 litres/day

in the ‘domestic waste’ category in terms of composition.

On the basis of the above estimate, no problems are expected to arise on the ground or in the surface or ground water due to waste from the sanitation facilities of the sites.

Mitigation measures

Measures to protect groundwater include:

- Collecting machine oil and other toxic substances and disposing of them in accordance with the guidelines and requirements of the relevant laws

- Avoiding the use of chemicals to suppress dust emissions caused by vehicular traffic on unsurfaced roads and by earthworks

- Drawing up emergency plans for accidents involving vehicles carrying toxic substances

- Protecting boreholes adjoining the road, and preventing direct entry of pollutants into groundwater. This applies to boreholes in the valley of the River Gialias.

- Appropriate siting of temporary sanitation facilities. Areas with very high soil permeability - on the surface of aquifers, especially alluvial aquifers - should be avoided.

2.2.2.2 During operation

The movement of vehicles, performance of maintenance work, and the impact of climatological factors are expected to create some waste material which, through the road drainage system, may reach the surface and ground water in the area. The waste materials include, in particular:

- Lead, mainly from petrol. With the use of lead-free petrol in the near future, lead concentrations will decrease significantly.

- Organic compounds such as oil, lubricants and asphalt, which may release polyaromatic hydrocarbons.

- Mercury and cadmium from the galvanised parts of vehicles.

- Various toxic substances transported on vehicles which may be involved in accidents

- Insecticides/weedkillers which may be used to clear the road verges.

- Products of erosion from the slopes of embankments and cuttings.

The concentrations of most of the above-mentioned pollutants are not expected to be high enough to endanger the quality of surface and ground water. The impacts are expected to be more severe, though short-lived and local, during a storm after a long period of drought, or after an accident involving a vehicle carrying hazardous substances: a remote but real possibility.

Additionally, the presence and operation of the motorway over the past 25 years have inevitably caused certain permanent negative impacts on the natural hydrogeology of the area, which are primarily the following: a) complete sealing of the area occupied by the roadway, so that runoff has increased from approximately 15% to 25-30% of the rainfall, and b) interruption of the natural surface flow on one or both sides of the road, and its diversion via the artificial channels to the natural drainage systems at the points where the road intersects those systems, with a resulting increase in flow at those points. Under normal conditions, water would not be concentrated at particular points, but would pass gradually into the natural drainage system of the area. This factor becomes more serious in cases where the road runs obliquely to the natural drainage systems, as happens with the project in question.

In the Latsia area, i.e. from km 77+000 (Nea Lidra) to km 82+500 (end of the project), over a distance of 5.5 km, the increase in runoff due to the existing road, with an average annual rainfall of 350 mm, is calculated at 4,000-6,000 m^3 annually. With the addition of a third lane, which represents a 35% increase in roadway surface, the expected increase in runoff, in excess of natural runoff, will be in the region of 1,400-2,100 m^3, which is not expected to have an adverse effect on the water balance of the area, although this quantity is channelled directly into the runoff systems at the points where the road intersects them.

A third factor which has affected the natural hydrology of the project area is residential and industrial development. With this development, surface runoff has increased, and at the same time the natural runoff systems have been disrupted. To facilitate development, the local authorities have made interventions into the runoff systems, with the result that their drainage capacity has been restricted in some cases. Other interventions appear to have been made, entirely without authorisation or control, by private individuals; one of these is the construction of an embankment downstream of the Kalogiros bridge and only a few metres from it, to divert the river water. According to information gathered, the bridge was recently affected by flooding, and this was undoubtedly due to the construction of the embankment.

From the foregoing, it is clear that although the proposed addition of a third lane is not expected to have a significant impact on the prevailing hydrological conditions, the situation seems less favourable in areas where residential and industrial development are also present, and this appears to be due to the synergistic action of all the factors involved.

In the area of the Latsia municipality, the problem seems - in the light of an exchange of views with the staff of Technical Services - to be centred in the residential area east of the motorway section from km 81-000 to km 82+000, including the Apostolos Loukas refugee settlement. In that area, which is traversed by the Kakkaristra river, floods have occurred in recent years, the worst being in 1994. As a measure to alleviate the situation, all the water concentrated at the proposed GSP junction could be channelled to the River Kalogiros to the north.

A second area which the Municipality of Latsia has mentioned is that of the weigh station on the west side of the road (km 78+000), where the direct channelling of water from the Nea Lidra area via a drain appears to cause some problems during periods of heavy rainfall, both in the area itself and further down the valley of the Agios Georgios river. In this case, too, the factors that cause negative impacts are of various kinds and are associated with residential, industrial and road development and the type of artificial drainage system constructed.

The measures which must be taken to alleviate hydrological impact in the Latsia area appear to exceed the remit of this assessment, and should form part of a separate, special assessment.

2.2.3 Impact on soil

2.2.3.1 During construction

The project area contains land which is largely used for agriculture. Apart from this, the aquiferous strata are replenished by rainfall directly through the soil cover. It is therefore obvious that any impact on the soil will result in further impact on agricultural production, flora and the quality of groundwater and surface water.

The main impacts on the soil due to construction work are expected to be soil loss when soil is moved or covered with other materials, and contamination with liquid and solid waste.

Soil loss

- Loss of soil along the entire length of the road, due to excavation and earthworks. This impact is non-reversible and cannot be avoided.

- Loss of soil due to the construction of auxiliary access roads.

- Degradation of soil quality due to vehicular traffic. This impact is reversible.

- Loss of soil in areas where materials for earthworks are quarried, and in areas where unusable materials are deposited.

Liquid waste

The liquid waste which may contaminate the soil is mainly machine oil, fuel and other chemical substances which are discharged directly onto the soil or are carried by surface water and enter the soil. The result in every case is soil degradation. The concentration of pollutants is usually high near the soil surface, and decreases with depth.

Solid waste

The solid waste consists mainly of rubble from excavations, which is temporarily deposited in heaps before being reused in backfills or discarded if considered unusable. Such materials are expected be produced by the excavations scheduled for the sections: km 70+300 - km 70+430, km 72+020 - km 72+590, km 75+820 - km 76+060, km 78+580 - km 78+940, km 79+700 - km 80+080, km 80+500 - km 80+800, km 81+060 - km 81+140.

Solid waste may also be created by roadbuilding materials placed on the ground before use.

Although rubble and construction materials are ultimately moved elsewhere, residues of them inevitably remain on the ground, altering its physical composition and degrading its quality.

2.2.3.2 During operation

In the operational phase of the project, waste will begin to be generated as a result of vehicular traffic, road maintenance work and the action of climatic factors on the slopes of embankments and cuttings. The impact on geology is expected to be negligible; however, the impact on soil in areas adjacent to the road is expected to be rather more significant, as a result of the transfer of these pollutants via the road drainage system or in the atmosphere. The impacts are expected to be mainly as follows:

- Materials falling from the excavation slopes, requiring clearance.
- Disturbance of the natural drainage systems, resulting in increased erosion and the deposit of some of the erosion materials on the soils in the area, degrading their quality.
- Accumulation, in the soils adjacent to the road, of various pollutants from vehicles (lead, organic compounds, mercury, cadmium, toxic substances) and verge clearance (insecticides, weedkillers).

Mitigation measures

The proposed measures to mitigate the impact include:

- Before the start of any backfill or excavation work, the soil cover must be removed for reuse in replanting operations. There are soils along the entire route of the project, and their composition varies from place to place, according to the nature of the underlying rock.
- Soil should preferably be collected in excavation and backfill areas, for use in replanting works.
- The creation of large numbers of access roads to the project should be avoided.
- Discharge of machine oil and other pollutants in areas neighbouring the project should be avoided.
- Spraying of earth roads with chemicals to suppress dust should be avoided.
- The placing of rubble and construction materials in areas with good soil cover should be avoided or kept to a minimum.

2.2.4 Impact on topography and landforms

Topography

The project, over large sections, cuts obliquely through major morphological axes including, in particular, the valleys of the Kalogiros, Almyros, Alykos and Gialias rivers. The relief of the area is not very pronounced, but some significant differences of elevation occur on the south side of the Alykos valley and the north side of the Almyros valley. The greatest changes to the topography will occur mainly in the areas where excavations and earthworks are planned.

The changes to the topography will be permanent and non-reversible, since the maximum depths/heights of the most important excavations and earthworks are 3.5-12 metres and 4-8 metres respectively.

The excavations and earthworks will create artificial linear morphological features which will not be in keeping with the natural topographical features of the area, since the excavation and embankment slopes will not correspond to the topographical structures.

Additionally, new erosion and sedimentation paths may be created, and these may change the existing topographical structures. Significant changes will be made to the south side of the Alykos valley (km 72+020 – km 72+590) and the north side of the Almyros valley (km 75+820 – km 76+060), where the maximum depths of excavation are 12 metres and 9 metres respectively. Significant embankments will also be created in the lower parts of the same sides (at km 72+600 – km 73+120, with a maximum height of 8 metres, and at km 74+500 – km 75+300, with a maximum height of 4 metres). Five successive embankments will also be created between km 78+300 and km 82+360.

The likelihood of causing landslides in the excavation areas is very slight, given the relatively small gradients of the natural slopes and the nature of the rocks.

In addition to the permanent, non-reversible impacts of construction of the project, further impacts on topography are expected as a result of the operation of temporary sites where earthworks materials are quarried, and permanent sites where unusable spoil material is dumped.

The Megalou Alexandrou intersection is situated in the valley of the Agios Georgios river, and its construction will inevitably have negative impact on the topography of the area. The valley axis lies in a north-to-south direction, and is intersected obliquely or diagonally by certain linear structures of the intersection, particularly by the MEGA 1 branch of the intersection, which is elevated and visible from a considerable distance. The negative impacts of the eastern part of this branch, which has been constructed, are already apparent.

The construction of the intersection beside the GSP Stadium will inevitably have negative impacts on the topography, both during the construction phase and during the operational phase. The intersection is situated in the southernmost part of the Kalogiros river valley, and in terms of topography, the area is gently contoured, its main feature being the erosion formations due to the action of the river and its tributary to the south (Laxia tou Hatzichristoloulou). The land gradients in the area of the intersection are generally northward-facing, towards the bed of that tributary. The intersection is a further addition to the existing burden on the environment due to construction of the GSP Stadium.

Mitigation measures

Since the project in question consists in the widening of an existing road, options are limited as regards taking substantial measures to minimise impact on the topography. It is nevertheless advisable to take at least the following measures:

- Spoil materials which are unsuitable for embankments but suitable for other uses should be conveyed as directly as possible from the excavation sites to the places where they are to be used, to avoid dumping of large quantities of rubble in particular areas. It has already been mentioned that rubble consisting of marls or marly siltstones could be used to infill abandoned quarries adjacent to the road, or as covering material in the Kotsiatis refuse dump.

- Heaped material which cannot be used will be landscaped in a programmed manner, avoiding the formation of vertical or high drops which will make it difficult or impossible to re-establish flora or plant trees.

- Landscaped heaps of rubble must be harmonised with the topographic relief of the wider area, avoiding disruption of the natural drainage system or distortion of ridges.

- Dumping of materials on steep slopes should be avoided.

- A suitable artificial drainage system should be designed for the heaps of material, so that it is harmonised with the existing natural system, to prevent erosion of rubble or the formation of stagnant pools.

- Construction of traps for sediment and other products of erosion, to prevent the transfer of large quantities of these materials into the surrounding area.

- Immediate planting of trees / other vegetation on the exposed surfaces of the heaps, as soon as dumping and landscaping operations are completed.

2.2.4.2 Quarrying of borrow pits

On the basis of local surveys which have been carried out in the wider area around the project, and examination of the existing maps and geological reports, the following facts emerge, as regards materials which are considered suitable for use, and the locations in which they can be found:

The chalks of the Lefkara Formation can be seen in the southernmost part of the project, and occupy a considerable area of land which extends in a broad band from Kotsiatis in the west to Lympia in the east. In this area, there are currently no quarrying operations, and both the general level of development (roads, housing, stock rearing, reafforestation) and the physical landscape appear to impose considerable restrictions on the potential for quarrying.

The Synagma Formation, which runs north of km 72+100 to the end of the project, is very extensive and provides material suitable for earthworks. Over a strip of land 3-4 km wide, dozens of quarries operated in the past, and a number of these remain with open cuts despite the fact that they have been inactive for many years. Today, quarrying of Synagma gravels appears to be confined mainly to the west side of the road, due to the residential, industrial and stockbreeding development on the east side. The quarries now operating, and the locations for which quarrying applications have been submitted, are shown on Map 6 on a scale of 1:50,000, on the basis of data obtained from the Mines Service. Quarrying appears to be concentrated mainly in three zones: a) the southern uplands and southern edges of the Alykos valley (west of km 72+000 – km 72+500), b) the area between the Alykos and Almyros rivers, which is characterised by relatively thin (5-10 metres) discontinuous Synagma outcrops occupying the upper part of the hills in the area, and c) the area extending north of the edges of the Almyros valley, where the Synagma outcrop is continuous and its thickness greater, exceeding 10 metres in many places. Access to these areas is via the Kotsiatis and Tseri roads and a number of rural roads, as shown on Map 6.

The total volume of material which will be needed for earthworks in the project will be in the region of 200,000 m^3, broken down into 130,000 m^3 for the southern part (km 69+850 – km 76+400) and 70,000 m^3 for the northern part (km 76+400 – km 82+500). The total volume of spoil material suitable for reuse is 16,000 m3 for the southern part and 18,000 m^3 for the northern part. It will therefore be necessary to quarry 166,000 m^3 of borrow material from areas near the project, especially from the Synagma Formation.

Obtaining borrow material for earthworks appears to be more difficult in the southern part, owing to uncertainty over the possibility of quarrying chalks and the comparatively long distance (more than 3 km) from the nearest quarries and natural gravel deposits. In the central and southern [*sic*] part of the project, the problem is less serious, although in practice it seems that all the materials will have to be brought in entirely from the western side of the road.

The deposits, both chalk and gravel, are abundant and more than cover the needs of the project. The areas of the Synagma Formation are for the most part infertile or agriculturally very poor, and the vegetation is, without exception, of low stature and sparsely distributed.

Large-scale earthworks are necessary for the construction of the Megalou Alexandrou intersection, and the total volume of materials required, according to the existing data, appears to be in the region of 93,000 m^3. Excavations at the intersection are expected to produce material of a total volume of 2,000 m^3 which is considered suitable for reuse. The remaining quantity will therefore have to be brought in from elsewhere. Areas with suitable material (gravels) are situated about 2-3 km to the west and south-west of the intersection, as shown on Map 6 (ANNEX B).

The GSP intersection likewise requires large-scale earthworks, and the total volume of materials required, according to the existing data, is expected to be in the region of 134,000 m^3. Given that the material produced by the general excavation and by two small cuttings will be limited in volume and unsuitable for reuse in earthworks, the entire above-mentioned quantity will have to be brought from elsewhere. Areas with suitable material (gravels) in the required quantities are situated roughly 3-4 km to the south-south-west of the intersection, as shown on Map 6 (ANNEX B). The scope for obtaining materials from nearer locations appears to be seriously restricted by the housing development of recent years.

Mitigation measures

These measures can be divided into two categories: measures which it is advisable to take while the quarrying operations are in progress, and measures which should be taken after completion of operations.

A. Measures during the quarrying operations

- The proposed quarrying sites must be examined in advance to determine their extent, the reserves of suitable materials, and the qualitative characteristics of the material.

- The method of using the material should be correctly planned to ensure rational use.

- Creation of an artificial drainage system to prevent increased erosion and harmful transfer of sediment to adjoining areas.

- Systematic spraying of the unsurfaced access roads to suppress dust, which causes problems for crops and residential areas.

- Retention of surface soil or other material unsuitable for embankments, for use in the final restoration of the site after completion of excavation works.

B. Measures to restore quarry and rubble disposal sites

These measures include the following:

- Placing all unusable spoil in the empty spaces resulting from quarrying, to the extent, of course, that this is feasible (e.g. where quarrying areas are adjacent to excavation works). Adoption of this measure may sharply reduce the quantities of unusable materials that need to be dumped in disposal sites.

- Landscaping the quarrying and rubble disposal sites in a manner which is in keeping with the physical environment of the surrounding area. The work faces, in their final form, must not be higher than 4 metres and their overall gradient must not exceed 40°.

- Every effort should be made to replant the landscaped slopes, exposed surfaces and terraces as soon as possible.

- Landscaped sites which have been used for disposal of rubble and other materials must not cut vertically across existing structures such as natural drainage routes and ridges. The final landscaping must also follow the overall geometry of the topographic relief.

- Dumping of rubble on steep slopes must be avoided.

- Artificial drainage systems should be appropriately designed to avoid surface erosion of heaped materials and transport of quantities of sediment into adjoining drainage systems.

2.2.4.3 Dumping of rubble

As a result of the excavations to widen the existing cuttings, and the general excavation to remove 30 cm of surface soil from the road-widening area and slopes of the existing embankments, it is calculated that a volume of soil in the region of 212,000 m^3 will be generated. With on-site inspections and mapping, the suitability of the spoil materials for reuse in earthworks was examined. On the basis of this research, it is estimated that roughly 178,000 m^3 is unsuitable for reuse, since these materials consist of surface soils with a high content of organic matter, and Pliocene marl soils, which have a high plasticity index or consist of uniform silt or fine sand, and are unsuitable as materials that can provide the necessary compression. The remaining 36,000 m^3 represents spoil materials from the Synagma area, and consists of gravels which are considered suitable for reuse. The volumes of spoil materials are summarised in the table below, broken down into materials from the southern (km 69+850 – km 76+400) and northern section (km 76+400 - km 82+500).

Table 2.6: Volumes of spoil materials

Type of excavation	Southern section		Northern section		Total, m^3
	Usable, m^3	Unusable, m^3	Usable, m^3	Unusable, m^3	
Cuttings	18,000	55,000	16,000	37,000	126,000
General excavation		12,000		12,000	24,000
Excavation for the existing embankments		36,000		26,000	62,000
Total, m^3	18,000	103,000	16,000	75,000	212,000

At the Megalou Alexandrou intersection, the volume of materials produced by general excavation for removal of surface soil is expected to be in the region of 11,000 m^3. The materials are considered unsuitable for reuse in earthworks and must be disposed of. The nearest suitable site is Waste Dump 10 (see Map 6), on the site of a former quarry now used for waste disposal. Some of the reject materials could also be used to restore the quarries which are to be created for the excavation of borrow soils for earthworks.

At the intersection beside the GSP Stadium, the volume of soil from the excavation of two small cuttings is expected to be roughly 3,500 m^3. These materials are primarily of marly composition and must be disposed of. As a result of the general excavation to remove surface soil, it is expected that a volume in the region of 13,000 m^3 will be produced, which will be unsuitable for reuse in earthworks and must be disposed of. Suitable disposal sites have been described above and are shown on Map 6 (ANNEX B). The nearest site is Waste Dump 10, but some of this material could be used to restore the quarry sites used for excavation of borrow soils for earthworks.

The search to find suitable areas for disposal of reject materials covered an 8 km wide zone along the relevant stretch of road: roughly 4 km on each side. The main aim of the search was to find old abandoned quarries, or working quarries, where disposal of material could contribute towards restoring the parts disturbed by previous digging. Where distance from the project or problems of access allowed no alternative, natural hollows were located, where the disposal of materials would not result in a significant change to the topography or destruction of flora.

An effort was made to achieve a uniform geographical distribution of disposal sites along the entire length of the road. This effort was not a complete success in all respects, especially on the east side of the northern section of the road, because of the extensive residential development in the areas of Ilioupoli and Latsia. This development has extended as far as the sites of former quarries, and also causes access problems for heavy vehicles. To resolve this problem, sites of satisfactory capacity have been located to the west of the road, at relatively small distances from underpasses or flyovers, so that there is access from east to west. These sites are discussed in detail in paragraph **9.3.5.**

To allow more effective management control at the construction stage, the Construction Contract Terms could include provisions requiring the contractor(s) to suggest rubble dumping sites in advance (in accordance with the recommendations in paragraph 9.3.5).

2.2.4.4 Surplus construction materials

It is difficult to made an accurate estimate of the quantities of waste which will be produced as wastage from the construction materials, because it depends on the execution plan for the individual construction procedures, the methodology followed by each team in carrying out the work, and unforeseeable factors which cannot be precisely determined at this stage. On the basis of experience of similar projects, it is calculated that materials wastage will not exceed 2-3% of the total volume of concrete and reinforcement. To this should be added the quantities of rubble/waste resulting from interventions into the existing structures of the road which is to be widened. In the process of intervention into the existing road, rubble/waste material will be produced by interventions into concrete structures, into the existing asphalt surface, and into embankments, fencing and other structures.

The total quantity of waste must be safely dumped by the project supervisor in accordance with the instructions and regulations in the relevant laws concerning the disposal of building materials and other materials.

2.2.4.5 Landforms

The principal landforms in the project area are essentially the trapezoid and conical hills known as *koronides*. The *koronides* are characteristic landforms of the plain of Mesaoria, and their shape is due to the fact that their upper surface is covered with hard rock, usually calcareous sandstone or hard pan, while their sides consist of soft marly rocks. Other landforms characteristic of the area are small gorges (e.g. the Kakkaristra gorge) and beds of rivers and streams where habitats can become established.
The route of the road does not cross any significant landforms other than the beds of rivers and streams, which it intersects, for the most part, obliquely. Nevertheless, efforts must be made during the construction stage to avoid causing any impact to such features.

The impacts of the project on the landforms are likely to be non-reversible, and comprise the following:

- Partial or complete loss, due to excavations and earthworks
- Change of the geometry of the area, due to the proximity of structures to the landforms
- Effects due to the creation of auxiliary sites such as work sites and storage areas
- Disruption caused by the project to the natural landscape

Mitigation measures

- Any intervention into the *koronides* (hills) in the area should be avoided.
- The beds of rivers and streams should be kept in their natural state, and efforts should be made to minimise the changes by avoiding the dumping of rubble, and limiting excavations to those which are absolutely essential.
- Artificial slopes should be planted with local forms of vegetation.

2.2.5 Impact on the natural landscape – Appearance

The first, immediately obvious impact of new road construction is seen in the natural landscape. The earthworks entailed in the geometrical arrangement (cutting) of the road result in injury to the landscape, or destruction of the existing flora, or impact on the soil and surface water.

The impact depends on the relief of the area and the siting of the project within it, together with the engineering structures (underpasses and flyovers, viaducts etc.) and the level of housing development along the route of the road.

For this particular project, although it is an enlargement of an existing arterial route rather than a new roadbuilding project, the most significant impact on the natural landscape and its appearance will be due to the unavoidable destruction of the two rows of trees, to right and left of the road. Although this impact is temporary (since there will be tree-planting along the new boundaries of the motorway), the time required for restoration may be quite long. A set of management measures is therefore proposed in Chapter 9, to reduce this time to a minimum.

Furthermore, the presence of trees or shrubs near the arterial route will not only enhance the appearance and the structural behaviour of the road (slopes, erosion), but will affect noise dissemination and atmospheric quality.

Environmental impact is also expected as a result of construction of the intersection beside the GSP Stadium. The intersection will be elevated to a maximum height of 7 m above ground level, and will therefore be visible from a considerable distance in the area to the north-east of the intersection, where development is classed as residential (Map 1β, ANNEX B). It is expected, then, that residents in that area will experience the direct visual impact of the intersection. At present, there is limited, scattered residential development in the area, but this is expected to change in the future. In other directions, the intersection will not be visible from residential areas, either because there is no residential development (nor will there be any such development in future), or because other, higher structures (the GSP Stadium) intervene.

Mitigation measures

The proposed measures include:

In detail, the proposed measures are as follows:

- Readaptation of the project (after widening) to the existing planting (where possible). This is not only a matter of aesthetics and environmental sensitivity, but also represents an improvement in road safety, because it provides visual guidance for drivers or breaks up the monotony which slows their reactions. Failing this, the driver directs his gaze towards the end of a straight line and increases speed accordingly.

- In cases where aggregate is taken from the immediate vicinity of the arterial route, the landscape will need to be restored, both for aesthetic reasons and to prevent soil erosion. The same applies to the slopes, for exactly the same reasons. The long life of slopes is achieved through a combination of structural arrangement and planting, after the preparation of special planting designs. The plant species to be used will be selected within the scope of these planting designs, in accordance with the basic principle that shrubs which naturally grow in wider project area should be used. The reason for this is that these plants are best adapted to the specific environment, and their establishment will contribute towards maintaining the natural character of the area. Where these shrubs are considered insufficient (mainly because of their small size), it is recommended that they should be supplemented with plants which grow naturally in Cyprus, and specifically in environments as similar as possible to the area in question. Such species include the endemic shrub Bosea cypria, the aromatic shrub Rosmarinus officinalis, and the species Pistacia lentiscus, Nerium oleander and Calycotome villosa. It is also recommended that humus should be retained from the excavation of cuttings and reused for planting the slopes.

- During the construction of embankments, the vegetation of the surrounding area will be preserved, because this heightens the visual aspect of the environment. Likewise, the bankside vegetation of the surrounding area should be protected, because this heightens the visual aspect. Bankside vegetation of rivers and wetlands should be at least partly preserved.

- Where there are large oblique gradients, and hence larger areas occupied by the project and greater destruction of vegetation, fences made of branches should be erected to retain the soil material at the base of the embankment slope and to prevent damage to any existing stand of trees further down.

- To reduce nuisance at night due to the lights of vehicles using the intersection next to the GSP Stadium, it is proposed that suitable barriers (if deemed necessary) should be installed around the intersection. Barriers may be installed once the area's housing development has extended close to the intersection, after a study has been carried out to demonstrate the necessity or otherwise of such an intervention.

2.2.6 Impacts on geology

Along most of its length, the road extends over rocks of the Nicosia and Synagma Formations. Rocks of the Pachna and Lefkara Formations appear only in its southernmost section.

In the project area, the rocks do not appear to have any noteworthy characteristics which need to be preserved. The mineral resources of the area are confined essentially to Pliocene marls, of which there are significant outcrops in the Almyros and Alykos valleys; these are used for making bricks. Deposits of this argillaceous formation are extensive, but in terms of quality, not all are suitable for use. The project extends over only a small part of the marls, and is not considered to deprive the industry of this mineral.

However, it is likely, as can be seen in areas neighbouring the project (e.g. the Kakkaristra area), that during excavation, fossiliferous horizons will be discovered in the upper part of the Nicosia marls and the calcareous sandstones of the Athalassa member. In such cases, it is recommended that the relevant government department (Geological Survey Department) should be notified, with a view to a geological inventory, a survey of the locality, and collection of significant palaeontological findings. The areas where fossils are likely to be found are those of the Latsia intersection (km 81+000 – km 81+500), the north side of the Almyros valley (km 75+500 – km 76+000) and the south side of the Alykos valley (km 72+500 – km 73+000).

Landslides

Landslides do not occur in the project area, and the nature of the rocks and the gradients of the natural slopes are such that no landslides are expected to be caused by the excavations and other construction works.

2.3 QUANTIFICATION OF THE IMPACTS

The methodology to be followed in this assessment, for quantifying the impacts due to construction and operation of the project, is based on **Multiple Criteria Decision Analysis.** This methodology will be referred to as the 'Road Development Evaluation Model'. The model comprises five steps:

1. **Purpose:** definition of the basic purpose or objective
2. **Quantification of criteria:** mathematical description (ranking on the basis of coefficients) of each criterion
3. **Weighting of criteria:** determining their relative importance in achieving the basic purpose
4. **Quantification of scenarios:** calculating the total score (on the basis of a concentration function) for each scenario
5. **Ranking of scenarios:** comparative evaluation and ranking of the scenarios

The five steps of the model are briefly described below.

The advantages of this method can be summarised as follows:

- The method takes account of a large number of criteria, and also of interactions between criteria, using a decision-tree method of analysis (Step 2)
- It allows an analytical, more rational determination of weightings, using a table based on the formula N*(N-1)/2, comparing all the criteria (Step 3)
- It allows the grading of a scenario even when the data are not entirely accurate but are given with a certain degree of uncertainty, using a confidence interval (Step 4)
- The final ranking of scenarios is achieved with greater reliability, because scenarios which do not differ significantly from each other are assigned to the same category (Step 5)

2.3.1 Purpose

The general purpose of this study is to assess the environmental impact due to the work of upgrading and operating the Nicosia-Limassol motorway as a 6-lane motorway in its section between Agia Varvara and Nicosia. The mathematical coefficients set for each criterion, and the final score, provide a means of measuring the degree to which the natural and man-made environment will be able to withstand any impacts caused by project-related interventions.

2.3.2 Quantification of criteria

The first step in developing the model is the establishment of project impacts in relation to each criterion. This is done for each criterion, with a description of the impacts and assessment of their corresponding scores on a scale of 1-5, as follows:

- very slight impact, grade 1
- slight negative impact, grade 2
- moderate negative impact, grade 3
- strong negative impact, grade 4

- very strong negative impact, grade 5
- if the works are not in keeping with the classification of an area as ‘protected’, the impact is graded 100, in order to express mathematically the impossibility of implementing the proposed solution.

Usually the calculation is based either on a mathematical relationship between a physical quantity and the corresponding impacts, or on a table which sets out the impacts as a step function on a scale of 0-5. In some cases, a criterion may be further broken down into subcriteria, using an impact tree. Each subcriterion is treated in the above way, i.e. as a separate criterion. This aspect of the model makes it possible to examine interactions between criteria, where a criterion is shown as a subcriterion of another.

2.3.3 Weighting of criteria

In many decision-making situations, it may be found that the criteria do not contribute equally towards meeting the basic objective, or that from the point of view of the person taking the decisions, the criteria have variable degrees of importance. The relative importance of the criteria is determined in a separate analysis of tables, and is applied as a gradient vector at the grading stage. The criteria are compared, one to one, and the weighting vector of the criteria emerges as the primary eigenvector in the table of comparisons.

2.3.4 Grading of scenarios

The coefficients of the criteria are combined, using a cumulative function in which the score of each criterion is included after being weighted on the basis of the gradient vector. Additionally, to allow a better understanding of the grading, and without compromising the reliability of the method, the criteria are subdivided into three categories or groups of criteria which nevertheless have constant weighting factors. These weighting factors represent the relative importance of each criterion in relation to all the others, both at local level and at a broader level. These factors were obtained by grading each criterion separately on a scale of 0-5, as a percentage of the total score. At this stage of grading, the impact of each criterion can be determined approximately, using a confidence interval. Thus, if a criterion can determined precisely, it is graded with a number on the 0-5 scale, e.g. 3; on the other hand, if the available data are relatively uncertain, the criterion can be assigned to a probable range of grades, e.g. 1-2.

2.3.5 Ranking of scenarios

For purposes of ranking, each scenario receives a final score, as given by the concentration function Σ, and finally the various scenarios are ranked in order, one after another: first, second, third etc., according to their scores. This means that the scenario with the lowest score is ranked first (as the first choice, with the lowest overall environmental impact), the one with the next lowest score is ranked second, and so on. Since the coefficient for a certain criterion may be in the form of a probable range of grades instead of a single grade at Step 4, this also applies to the final score, as given by the concentration function. Thus, the final score of a scenario may prove to be a range of grades, and this range must be used for purposes of comparison. A scenario X will be considered better than a scenario Y if the lower limit X1 of the score range X1-X2 is higher than or equal to the upper limit Y2 of the range Y1-Y2. In this way, if two scenarios do not differ significantly from each other, they are assigned to the same category; this would not be the case if absolute numbers were used instead of confidence intervals in comparisons.

2.3.6 Quantification of impacts

An overall evaluation will then be made of the state of the environment WITH and WITHOUT the project in question, in order to highlight, quantitatively and qualitatively, the expected negative and/or positive impacts. The results are presented in the form shown in Tables 2.8 and 2.9 below, which were developed on the basis of the methodology described above.

In these tables:

- in the horizontal rows in each table, the various activities affecting the environment (e.g. vehicular traffic, operation of site machinery etc.) are entered

- in a vertical column in each table, the various criteria (as shown in Table 2.7) are entered

- the data in each table include an evaluation of the impact of each activity, which corresponds to the column, i.e. to the criterion in each row, with:

    - an evaluation of the magnitude of the impact (upper left), with scores from 0 (positive impact) to 5 (very strong impact),
    - an evaluation of the area affected by the impact (lower right), with the following ranks: I (only local), II (wider area of the project) and III (wider area at city level).

Table 2.7. Groups of criteria for multi-criterion analysis

Groups of criteria for multi-criterion analysis		
Natural environment – Ecology	Land uses – Social environment	Protected areas – Cultural environment
1. Morphology and landscape features **2.** Geological, tectonic and soil characteristics **3.** Hydrology / hydrogeology **4.** Atmosphere **5.** Flora, fauna **6.** Noise **7.** Energy	**8.** Land uses **9.** Access routes **10.** Transport / traffic **11.** Infrastructure **12.** Socio-economic environment **13.** Health and safety	**14.** Aesthetics **15.** Cultural heritage

For the coefficients selected, it should be understood that in view of the nature of the project – involving, as it does, roads of primary importance - and its importance at local and supralocal level, and the special nature of the work of laying sections of road, the views of the parties affected (Municipalities, Communes) were taken into account during investigation of the situation WITH the project, during construction and in the operational phase.

Lastly, it should be noted that the evaluation of the operational phase comprehensively covers the immediate effects of the project and the indirect impact at city level, for the above investigation over time, up to the time horizon of 2025.

On the basis of the foregoing, the choice of weighting factors for all the environmental factors in the evaluation tables is arranged into groups and analysed below:

Factor 1 (very slight weighting)

- **Criterion/criteria:**

- Infrastructure works: Only a limited degree of significance was noted in relation to impacts on utility networks; on the other hand, it is considered that the construction of a rainwater collection system will have positive impacts on the environment, since it will prevent flooding in the area (especially in the areas of the Latsia and Idaliou Municipalities).

Factor 2 (slight weighting)

- **Criterion/criteria:**

- Cultural heritage: Along the main section of the project (widening of the motorway), antiquities have been found during construction, at three points which had been largely overlooked. During the construction work, due care must be taken with excavation.

Factor 3 (moderate weighting)

- **Criterion/criteria:**

- Morphological and landscape features: The relief of the area is not particularly marked, but the changes resulting from the excavation and/or earthworks will be permanent and non-reversible.

- Geological, tectonic and soil characteristics: As a result of ground cover by the project, the characteristics of the subsoil and groundwater are expected to change. The subsoil, after excavation and removal of the topsoil, will be lined and covered with watertight materials which do not allow water to enter. The result will be, to a small extent, a change in the natural hydrology and a barrier to replenishment of the groundwater.

- Access routes: The construction work and the operation of the project will result in a temporary or even permanent interruption of access routes, increasing the traffic load on some alternative routes.

Factor 4 (heavy weighting)

- **Criterion/criteria:**

- Hydrology / hydrogeology: In the project area, there are significant aquifers, the quality of whose water may be adversely affected both during construction (poor management of liquid waste) and during operation of the project (leakage of liquid waste due to an accident).

- Flora / fauna: The impact on flora is significant, and the interventions are considered particularly harmful in places where the vegetation is already well developed, or where it contains a number of endemic plants. The impact on fauna lies mainly in the fact that when the trees lining either side of the road are removed, bird fauna crossing the motorway (individually or in flocks) will be endangered.

- Natural landscape / aesthetics: This criterion (both in the construction phase and in the operational phase) is the environmental factor which is highly significant in terms of social sensitivity. This is reinforced by the average motorway user's strong need for an improved and aesthetically upgraded landscape.

- Socio-economic environment: The assessment of the impact of the proposed project, on the basis of the existing socio-economic characteristics which generally prevail in the individual areas through which the project passes, is particularly important for determining the degree of acceptance of the project by residents in the immediate area. For this purpose, the following were evaluated: the main categories of area through which the project passes, and their main characteristics, as indicators of the existing structure and functioning of those areas; the views of the Municipalities and Communes in each area.

Factor 5 (very heavy weighting)

- **Environmental factors:**

- Atmosphere: This criterion (both in the construction phase and in the operational phase) is an environmental factor of the greatest importance both in the zone of immediate impact and in the wider impact zone, given the magnitude of:
  - the negative impact of the upgrade of a mass transport system on atmospheric quality (e.g. dust, gases, particulate pollutants etc.)
  - the expected positive impact at city level during the operational phase, and also the expected negative impact in the immediate area (local increase in pollutants etc.)

- Land uses: This criterion (both in the construction phase and in the operational phase) is an environmental factor of major importance in the zone of immediate impact, given the magnitude of the impact of such a mass transport system, first in terms of land use, and subsequently at the level of cultural and socio-economic structure and development. Significant impacts will be felt in areas where new road routes are to be constructed.

- Noise: This criterion is an environmental factor of major importance in the zone of immediate impact of the project, both in terms of airborne noise (operation of work sites), which will be of short overall duration but is likely to cause disturbance at night, and in terms of noise during the operational phase, which is expected to affect particular land uses (isolated homes along the motorway).

- Transport / traffic: Traffic impact on the immediate and the wider area is the most important parameter for project evaluation and will determine whether the project should be implemented.

- Accidents / safety: This criterion is an environmental factor of major significance, because accidents on a motorway are for the most part serious, with all the associated consequences.

- Energy: This criterion is an environmental factor of major significance, because use of the road network is directly linked with liquid fuel consumption; at national level, it represents 45% of the total consumption of liquid fuels.

Below, we present the detailed results of applying the methodology to the assessment of environmental impact in the immediate and wider area, for all the time scenarios:

- WITHOUT the project – Table 2.8
- WITH the project – Table 2.9

On the basis of analysis of Tables 2.8 and 2.9 below, the conclusion to be drawn is that the expected weighted impact for the scenarios WITH and WITHOUT the project is as follows:

- Scenario WITHOUT the project: impact score 283

- Scenario WITH the project: impact score 235

The above evaluations for the scenarios WITH the project take account of implementation of the management plan, which is analysed below in Chapter 9.

The above impact assessments are particularly interesting in view of the fact that:

- The total weighted impact for the scenario WITHOUT the project is higher than the corresponding impact WITH the project, on the basis of the expected development of these scenarios up to the final target year of 2025.

The above environmental assessment of the project is not sufficient in itself to allow a decision on its implementation, since the economic performance of the project in its wider social setting has not been included. Taking account of this aspect (see the technical and economic assessment), the project is expected to have impacts which are even more positive.

Table 2.8: Impact on the environment without the project

IMPACT ON THE ENVIRONMENT: WITHOUT THE PROJECT											
ENVIRONMENTAL FACTORS	**SPACE OCCUPIED**	**TRAFFIC CONDITIONS**	**OPERATION OF HEAVY VEHICLES AND MACHINES**	**EXCAVATIONS, CHANGES TO SOIL MORPHOLOGY**	**LIQUID WASTE**	**SOLID WASTE**	**CHANGES, CREATION OF NEW LAND USES**	**TREE FELLING, CHANGE OF NATURAL LANDSCAPE**	**TOTAL IMPACT OF THE FACTOR**	**WEIGHTING OF THE FACTOR**	**WEIGHTED IMPACT**
NATURAL ENVIRONMENT											
HYDROLOGY/ HYDROGEOLOGY	2 I	III	III	III	2 III	2 III	3 I	II	9	4	36
MORPHOLOGICAL/ LANDSCAPE CHARACTERISTICS	I			I	2 III	4 III			6	3	18
GEOLOGICAL/ TECTONIC/SOIL CHARACTERISTICS	I	I	I	I	2 I	III	I	II	2	3	6
FLORA / FAUNA	I	III	I	III	2 II	1 III	I	2 II	5	4	20
ATMOSPHERE	I	3 III	I	I	I		2 I	I	5	6	25
ENERGY	I	3 III	I	I	I		I	I	3	6	15
NOISE	I	3 I	I	I			2 I	II	5	6	25
MAN-MADE ENVIRONMENT											
LAND USES	3 I	3 II	I	I	I	III	I		6	5	30
SOCIO-ECONOMIC FRAMEWORK	I	3 III			I	III	3 III		6	4	24
VEHICULAR TRAFFIC	5 I	4 III	II			II	III		9	6	45
ACCESS ROUTES	2 I	I	I	I		III	I		2	3	6
INFRASTRUCTURE WORKS	2 I		I	III	III	I	I		2	1	2
ACCIDENTS / SAFETY	I	3 II	II	I	I	I	I	I	3	8	15

CULTURAL ENVIRONMENT											
NATURAL LAND-SCAPE/AESTHETICS	I	3 I	I	II	II	III	I	II	3	4	12
HISTORICAL AND CULTURAL ENVIRONMENT	2 I	III		I	I	III	I		2	2	4
TOTAL	16	25			8	5	10	2			**283**

Table 2.9: Impact on the environment with the project

IMPACT ON THE ENVIRONMENT: WITH THE PROJECT											
ENVIRONMENTAL FACTORS	**SPACE OCCUPIED**	**TRAFFIC CONDITIONS**	**OPERATION OF HEAVY VEHICLES AND MACHINES**	**EXCAVATIONS, CHANGES TO SOIL MORPHOLOGY**	**LIQUID WASTE**	**SOLID WASTE**	**CHANGES, CREATION OF NEW LAND USES**	**TREE FELLING, CHANGE OF NATURAL LANDSCAPE**	**TOTAL IMPACT OF THE FACTOR**	**WEIGHTING OF THE FACTOR**	**WEIGHTED IMPACT**
NATURAL ENVIRONMENT											
HYDROLOGY/ HYDROGEOLOGY	2 I	III	III	2 III	2 III	2 III	3 I	3 II	14	4	56
MORPHOLOGICAL/ LANDSCAPE CHARACTERISTICS	I	III	III	2 III	2 III			3 II	7	3	21
GEOLOGICAL/ TECTONIC/SOIL CHARACTERISTICS	I	I	I	3 I	2 I	III	I	2 II	7	3	21
FLORA / FAUNA	I	III	I	2 III	2 II	1 III	I	3 II	8	4	32
ATMOSPHERE	I	1 III	I	I	I		2 I	I	3	5	15
ENERGY		1 III							1	5	5
NOISE	I	2 I	I	I			2 I	II	4	5	20
MAN-MADE ENVIRONMENT											
LAND USES	3 I	1 II	I	I	I	III	I		4	5	20
SOCIO-ECONOMIC FRAMEWORK	I	2 III			I	III	2 III		4	4	16
VEHICULAR TRAFFIC	I	III	II			II	III			5	
ACCESS ROUTES	1 I	I	I	I		III	I		1	3	3
INFRASTRUCTURE WORKS	2 I		I	III	III	I	I		2	1	2
ACCIDENTS / SAFETY	I	II	II	I	I	I	I	I		5	

CULTURAL ENVIRONMENT											
NATURAL LAND-SCAPE/AESTHETICS	3 I		I	3 II	II	III	I	II	6	4	24
HISTORICAL AND CULTURAL ENVIRONMENT	I	III		I	I	III	I			2	
TOTAL	11	7		12	8	3	9	11			**235**

2.4. CONCLUSIONS

To summarise, the above tables present, in qualitative terms, the impacts of the upgrade and operation of the Nicosia-Limassol motorway.

Table 2.10: Table of project impacts during construction

Criterion	Description	Impact
Creation of dust	Immediate	Negative – Slight – Temporary
Atmospheric pollution	Exceptionally low pollutant levels	None
Rubble	Deposits of rubble	Negative – Severe
Noise	During construction, the noise levels will be within acceptable limits	Negative – Slight – Temporary
Traffic	Traffic congestion in the area assessed	Negative – Severe – Temporary
Biological environment	Occupation or degradation of habitats – disturbance of species of fauna – destruction of the two rows of trees along the motorway	Negative – Severe

The most severe impacts will result from the creation of rubble (controlled disposal of rubble, in accordance with instructions given by the relevant authorities, will greatly reduce any problems), and from the burden on the road network due to the lorries and machines circulating in the area (the temporary nature and relatively short duration of the expected burden on the road network, and the favourable public attitude regarding the necessity of the project, are expected to have a favourable influence in reducing the problem). Serious impact is also expected on the bird fauna of the area, as a result of destruction of the two rows of trees, to the right and left of the road, which act as protective walls causing the birds to fly upwards without colliding with vehicles. These problems occur mainly at points where the motorway is higher than the natural relief, and where there are streams or rural roads at right-angles to the motorway.

Table 2.11: Table of project impacts during operation

Criterion	Description	Impact
Traffic	Improvement in traffic conditions	Positive – Significant
Appearance of the landscape	Altered landscape	Negative – Severe – Reversible over a long period
Noise	Reduction in future noise levels – in adjacent homes, noise levels outside the acceptable limits	Negative - Severe

As the above table shows, the most significant positive impact which will occur in the operational phase is an improvement in traffic conditions on the road network served by the project. At the same time, noise levels will be reduced in neighbouring areas. Despite this reduction, however, noise in adjacent homes will exceed the permissible limits. This impact will be controlled with the appropriate management measures proposed in Chapter 9.

To conclude, the project is not expected to have significant environmental impact. It is estimated that any impacts occurring either during construction or in the operational phase, will not create a significant problem, given the necessity of the project for the Nicosia area, and the project supervisor's adoption of good management practices in the construction and operational phases. The project will have a significant positive impact, with a rapid improvement in traffic conditions, especially in peak hours, to and from Nicosia.