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PRELIMINARY DESIGN, FEASIBILITY STUDY,
DETAILED ENGINEERING DESIGN AND CONTRACT
DOCUMENTATION FOR THE REHABILITATION AND
PERIODIC MAINTENANCE OR STRENGTHENING OF
THE WORKS OF THE

LANET-NAKURU-MAU SUMMIT-TIMBOROA
AND
NAKURU-MOGOTIO ROADS

WORKING PAPER NO. 7
ENVIRONMENTAL IMPACT
ASSESSMENT

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CHIEF ENGINEER (ROADS)
MINISTRY OF ROADS AND PUBLIC
WORKS,
P. O. BOX 30260,
NAIROBI,

THE PERMANENT SECRETARY
MINISTRY OF ROADS AND PUBLIC
WORKS,
P. O. BOX 30260,
NAIROBI,

FILE COPY

**LANET – NAKURU - TIMBOROA
AND
NAKURU – MOGOTIO ROADS
ENVIRONMENTAL IMPACT ASSESSMENT**

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1 INTRODUCTION

1.1 General

This working paper is presented in accordance with the Terms of Reference for the design of the Lanet – Nakuru - Timboroa Road (98 km) and the Nakuru – Mogotio (38 km) Road. It presents the investigations and findings of the environmental impact assessment (EIA) and appropriate mitigation and support measures for the project. This report should be read in conjunction with Working Paper 1A, Traffic Studies, Working Paper No 1B, Axle Load Studies, Working Paper 2, Condition Survey of Structures & Drainage Systems, Working Paper 3B, Hydrological Studies and Working Paper 4, Preliminary Materials Investigation.

1.2 Location

The Lanet – Nakuru – Timboroa road (A104) starts from the junction at Lanet with the D302 road and ends just before Timboroa. The total length of the road is some 98 km and approximate chainages of some of the stations are:

1. Lanet – Nakuru Railway Bridge	Km 0 – Km 16
2. Nakuru Railway Bridge – High Point	Km 16 – Km 20.5
3. High Point – Molo River	Km 20.5 – Km 37.6
4. Molo River – Narrow Bridge	Km 37.7 – Km 66
5. Narrow Bridge – Timboroa	Km 66 – Km 98

The Nakuru – Mogotio road (B4) starts at the Nakuru KFA roundabout and progresses in a northerly direction until Mogotio. It is 38 km in length. Approximate chainages of some of the stations are:

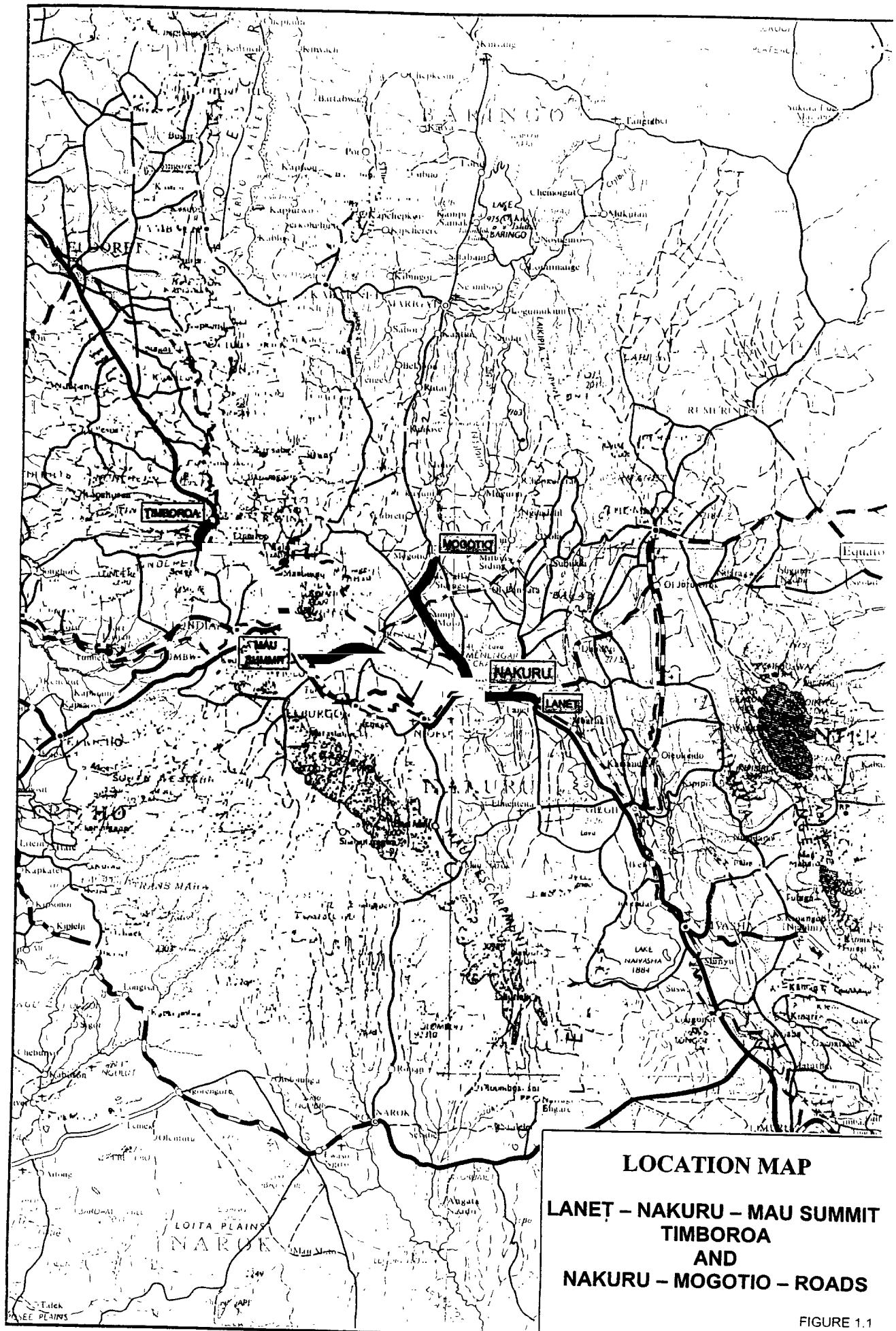
1. Nakuru KFA roundabout – Kampi ya Moto	Km 0 – Km 24.9
2. Kampi ya Moto – Mogotio	Km 24.9 – Km 38

Both project roads are presented in Figure 1.1.

1.3 Scope of the Study

The major objective of the environmental impact assessment (EIA) was to conduct analyses detailing the positive and negative impacts of the project on the environment and recommend appropriate mitigation and support measures to minimise any undesirable effects and maximise the benefits that could result from the improvement of the road. The analyses included, but were not limited by the following:

- a) the role of the project in the national and regional development plans
- b) the preservation of areas and land use of particular value including agricultural and natural conservation areas, forests and other important natural resources, cultural and historic sites etc.
- c) assessment of the direct impacts on agriculture and forestry, particularly the utilisation of fuel-wood and water.



LOCATION MAP
LANET - NAKURU - MAU SUMMIT
TIMBOROA
AND
NAKURU - MOGOTIO - ROADS

FIGURE 1.1

- d) the disturbance of vegetation and plans for re-vegetation.
- e) the prevention of soil erosion and sedimentation
- f) the prevention of health hazards arising from the impounding of water and pollution of water courses and sources.
- g) measures for the rehabilitation of construction material borrow pits and quarries.
- h) health and sanitation for the road construction labour units.
- i) the avoidance or mitigation of visual intrusion; and
- j) the assessment of the impact on demographic factors including the prevention of undesirable roadside developments and recommended regulations and measures to limit the negative impact on the adjacent communities and areas.
- k) the impact of the project on women.

1.4 Environmental Legislation

The new Environmental Management and Co-ordination Act came into force on 14 January 2000. This Act calls for the formation of an authority, NEMA which will be charged with the responsibility to '*exercise general supervision and co-ordination over all matters relating to the environment*'. It is anticipated that NEMA will be operational by July 2000.

In the meantime, the National Environment Secretariat (NES) which is a Department within the Ministry of Environment and Natural Resources is charged with the responsibility of monitoring issues relating to the environment in Kenya.

The new Act defines environmental impact assessment to be a '*systematic examination conducted to determine whether or not a programme, activity or project will have any adverse impacts on the environment*'. Part VI section 58 mandates the requirement for an environmental impact assessment and Schedule II, part 3 states that (a) all major roads and (b) all roads in scenic, wooded or mountainous areas and wetlands should undergo an environmental impact assessment.

Section 58 (7) comments that the EIA '*shall be conducted in accordance with the environmental impact assessment regulations, guidelines and procedures issued under this Act*'. However, to date no new regulations or guidelines have been issued and therefore, this assessment is based on the Draft Kenyan EIA guidelines issued in October 1996.

Other laws pertaining to the environment and of direct relevance to this study include:

- The Forestry Act (CAP 385)
- The Agriculture Act (CAP 318)
- The Wildlife Conservation and Management Act (CAP 376)
- The Water Act (CAP 372)
- The Government Lands Act (CAP 280)
- The Traffic Act (CAP 203)
- The Mining Act (CAP 306)

In addition, numerous laws dealing with environmental aspects, such as health and sanitation are contained in the Local Government Regulations of 1963.

Kenya is also signatory to a number of international conventions on the environment ranging from the Convention on Biological Diversity (1992) to the UN Framework on Climate Change (1992), both of which could potentially be affected by the project, albeit over the longer term.

1.5 Methodology of Assessment

In order for the EIA to be undertaken, current literature was reviewed and followed by field trips to the project area.

Reference was also made to the 1997-2001 District Development Plans for Nakuru and Uasin Gishu Districts.

1.6 Alternative Alignments

The existing road corridor and other possible alternative routes were examined to determine the most appropriate alignment for the design. This was done on the ground and with the aid of aerial photographs (1:25,000) and topographic maps at 1:50,000.

From both a design and environmental perspective the existing road is the most obvious choice for upgrading and no other preferred routes or modes of transport were identified.

2 ENVIRONMENTAL BASELINE CONDITIONS

The environmental baseline conditions of the project area can be sub-divided into bio-physical and socio-economic components which are described below:

Bio-Physical Environment

2.1 Topography and Climate

The alignment of the existing road can be sub-divided into the following main topographic sections:

- | | |
|---------------------------------------|-------------------|
| 1. Lanet – Nakuru Railway Bridge | Km 0 – Km 16 |
| 2. Nakuru Railway Bridge – High Point | Km 16 – Km 20.5 |
| 3. High Point – Molo River | Km 20.5 – Km 37.6 |
| 4. Molo River – Narrow Bridge | Km 37.7 – Km 66 |
| 5. Narrow Bridge – Timboroa | Km 66 – Km 98 |

Over section one, the road maintains a constant altitude of about 1880 m. Section two climbs gradually over 4 km. Over section three, the road is generally flat and straight to Molo River. Over section 4 the road climbs some 600 m within the first 12 km and continues to twist and turn for the remaining 16 km. Over the last section the road runs along a watershed and ends at Timboroa which has an altitude of 2700 m.

The Nakuru – Mogotio road immediately starts to climb from 1880 m to 2000 m over a distance of about 12 km. From this point the road steadily and gradually descends to 1583 m in Mogotio.

The rainfall varies significantly over the project roads by up to 600 mm. In Nakuru precipitation averages 900 mm per annum and rises to 1350 mm per annum in Kamaara and diminishes to 750 mm per annum in Mogotio.

Temperature fluctuations mirror rainfall with higher temperatures experienced in Mogotio and lower temperatures at Kamaraa. In Nakuru the mean maximum temperatures range between 25°C to 30°C, while the mean minimum temperatures vary between 10°C to 18°C.

2.1.1 Air Quality

The air quality in the immediate vicinity of the road is visually observed to be poor, particularly along the inclined road sections where black smoke can be observed covering road verge vegetation.

The dominant air pollutants are likely to be lead, nitrogen oxides, sulphur oxides, carbon monoxide, volatile organic compounds (VOCs) and particulate matter (PM). Ozone and carbon dioxide may also be significant.

The use of leaded petrol in Kenya with an average content of 0.4 g/l (Lovei 1998) is of concern, particularly for the 16 km urban section from Lanet through Nakuru and the other settlements along the road. *'Vehicular traffic, due to the use of leaded gasoline, remains the largest source of environmental lead pollution in many urban areas, often accounting for over 90% of all lead emissions in the atmosphere (Lovei, 1998)'*. Lead is a cumulative neurotoxin that impairs the brain development of children and has been connected to elevated blood pressure in adults which results in hypertension, heart attacks and premature death.

The use of high sulphur diesel (up to 1%) results in corresponding high emissions of sulphur dioxide which are known to cause respiratory problems and are responsible for acid rain.

In addition, the poor maintenance of vehicles and the illegal mixing of fuels, for example kerosene with diesel results in emissions rich in black smoke. Thus, the combined effects of poor vehicle maintenance, illicit fuel mixing, leaded petrol and high sulphur diesel are likely to cause elevated levels of nitrogen oxides, sulphur dioxide, carbon monoxide and dioxide, volatile organic compounds (VOCs), particulate matter (PM) and ozone within a 30 m corridor on either side of the road.

Noise levels are also likely to be significantly higher than ambient levels within the 30 m road corridor.

2.2 Geology and Soils

Both the roads from Lanet to Timboroa and from Nakuru to Mogotio overlie Quaternary and Tertiary volcanics.

The start of the road at Lanet is in the base of the Great Rift which in the vicinity of the road is dominated by Quaternary volcanics belonging to the Upper Menengai Series. Specifically, these deposits are comprised of loosely consolidated boulder tuff with pumice layers and unconsolidated ash which emanated from Menengai in recent times ($< 2 * 10^6$ years). In addition, there are outcrops of earlier trachyte flows and welded vitreous ignimbrites, porphyritic trachytes and phonolites, some of which are Tertiary in age. The road continues through the Rongai Plain and these volcanics until km 37.6 at the Molo River.

Shortly after the Molo River the road crosses a number of north south trending faults (approximately eight) and the lithologies are dominated by older Tertiary volcanics (trachytes, quartz trachytes, agglomerates, tuffs and sediments) for some 10 km.

At km 49 the road crosses into younger Quaternary Mau Summit sediments until the Mau Summit from where it passes into Tertiary welded tuffs and trachytes until Makutano. From Makutano to Timboroa the road mainly crosses the Tertiary Tinderet volcanics comprised of fine grained blue black phonolites.

There are four main soil types along the Lanet – Nakuru – Timboroa road.

Km	Soil type	Properties
0 - 14	Phaeozems	well drained / sandy clay loam
14 - 17	Lithosols	excessively well drained / reddish brown to brown clay
17 - 38	Andosols	excessively well drained / reddish brown to brown clay
38 - 61	Andosols	well drained / reddish brown to brown clay
61 - 94	Nitisols	well drained to moderately well drained / reddish brown to brown clay
94 - 98	Andosols	well drained to moderately well drained / dark reddish brown to dark brown clay

There are two main soil types along the Nakuru – Mogotio road.

Km	Soil type	Properties
0 - 3	Phaeozems	well drained / sandy clay loam
3 - 38	Andosols	well drained / sandy clay loam

Further details on the geology and soils can be found in the Preliminary Materials Report and Working Paper No 3B, Hydrological Studies, 2000.

2.3 Rivers, Drainage and Erosion

There are two major river/drainage crossings along the Lanet – Nakuru – Timboroa alignment as follows:

1. Km 35.6 Rongai River Bridge
2. Km 39.5 Molo River Bridge

and the same two major river crossings along the Nakuru – Mogotio alignment as follows:

1. Km 26.7 Rongai River Bridge
2. Km 36.2 Molo River Bridge

The catchments in the area (some 59) are generally small ($45 < 5 \text{ km}^2$) and characterised by flat to very steep terrain. The three largest catchments are River Ngosorr (108.5 km^2), Rongai (156.6 km^2) and Molo (250.0 km^2). Further details on the hydrology of the project area can be found in Working Paper 3B, Hydrological Studies.

The drainage was generally observed to be poor in the peri-urban and urban sections of the road and better in the rural areas. Near Mau Summit the steep slopes indicate the potential for high erosion without careful management as evidenced by erosion gullies.

2.4 Land use, Flora and Fauna

Urban, peri-urban and agricultural activities have greatly modified or eliminated the original plant and animal communities along both alignments, but to a lesser degree along the Nakuru – Mogotio road as would be expected.

The first 16 km of the Lanet – Nakuru – Timboroa road is urban with little to none of the original flora and fauna communities remaining. From km 16 to km 25, the road passes through an cultivated agricultural zone which decreases in intensity towards km 25. On the Mau escarpment, forest predominates on both sides of the road with evidence of clear felling and burning all the way to Timboroa. The predominant indigenous species in Nakuru District are African Pencil Cedar (*Juniperus procera*), East African Yellow Wood (*Podocarpus gracilior*), *Prunus africana*, *Dombeya getzenii* and *Aruninaria alpina*. In addition, there are commercial forests of East African Cypress, Pine and Eucalyptus.

The first 8 km of the Nakuru – Mogotio road grade from densely urban through to peri-urban land use again with little evidence of the original flora and fauna communities. At km 2.4 the Nakuru dump site can be seen and there is evidence of waste littering the roadside and burning. For the next 8 km the road passes through intensely cultivated agricultural land. The road then passes through a number of large farms with cultivation and livestock grazing. Between Machege and Mogotio the flora is and fauna is representative of a semi-arid climate with a sisal plantation on either side of the road near Mogotio. At km 35 a road kill (White-tailed Mongoose – *Ichneumia albicauda*) was observed and is illustrated in photograph 1.

Both commercial and subsistence agriculture was observed along both alignments and the main food and cash crops observed included wheat, maize, pyrethrum, vegetables and sisal. Livestock also plays an important role with cattle, sheep, goats and poultry observed.

Nakuru District has four major tourist sites: Lake Nakuru National Park, Menengai Crater, Mt. Longonot and Hells Gate. The Lanet to Timboroa road provides direct access to Lake Nakuru

National Park and Menengai Crater and indirect access to the other two sites through linkage with other major routes.

Uasin Gishu District is home to the rare Rothschild giraffe, Fashsons hartebeest and the Sitatunga, however, the District Development Plan of 1997-2001 does not state where these animals can generally be found and purely comments that the district has potential for tourism.

Socio-Economic Environment

2.5 Population and Migration

The road at Lanet starts in Nakuru District and crosses into Uasin Gishu District where it ends at Timboroa. Therefore, the road influences and affects the people living in both districts over and above the Trans African Highway traffic.

In 1997, the population for Nakuru was estimated to be 1.25 million and growing at a rate of 4.85% which would put it at over 1.5 million in 2001. In 1997, the population of Uasin Gishu was estimated to be 598,435 and growing at 3.7% which would put it in the region of 693,882 in 2001. Thus, the road will affect and influence more than 2.2 million in both districts (District Development Plan 1997-01).

More specifically the road will influence the people in Nakuru municipality, Njoro, Rongai, Elburgon and Molo divisions of Nakuru District and Ainboko division of Uasin Gishu which amounts to a predicted three quarters of a million people by 2001.

Neither district plans have information on in, or out-migration.

2.6 Status of Women

Enrolment of women in adult literacy classes is higher than for men in all divisions except for in the municipality of Nakuru District. Enrolment of girls at primary school level is generally slightly higher than for boys, but this is reversed at secondary school level in Nakuru District. No figures are given for adult literacy in Uasin Gishu District but the number of girls attending school is proportionally higher than boys at all levels. There is no special mention of women's issues in either District Development Plan. However, traditionally land is owned by men and culturally the man is the head of the household. This has a profound influence on the welfare of women in both districts.

2.7 Economic Activities/Occupation

The main economic activities in both districts are centred around agriculture, livestock and forestry with a growing industrial centre in Nakuru.

The leading cash and food crop in Uasin Gishu District is wheat. The district produces a third of the country's wheat. Other cash and food crops of importance in Ainabkoi division include maize, pyrethrum, vegetables, fruit and flowers. In Nakuru District the leading cash and food crop is maize with the number of hectares under wheat at less than half the number under maize. Other crops of importance include pyrethrum (Nakuru produces nearly 50% of the country's pyrethrum with the Kenya as the leading world supplier and insufficient supply to meet demand), sisal, coffee, tea, potatoes, millet, vegetables and fruit.

Income from all types of livestock (except pigs) steadily rose over the period 1991-1995 for Uasin Gishu except in 1995 where there was a marked depression in all activities due to insecurity. In Nakuru District all livestock production and sales were generally stable or showed slight increases or decreases from 1993-1995.

Forestry is an important activity in Nakuru District. There are 98 registered saw millers of which 10 are large scale in the District. Timber harvested has decreased from 1991 to 1994 (134,042 m³ to 105,793 m³) with no explanation given while fuelwood production has fluctuated from 5,603 m³ in 1991 to 73 m³ in 1992 to 2,320 m³ in 1994.

Forestry is the second most important activity after agriculture in Uasin Gishu District. Forests cover 31,496 ha (10% of the district area) of which 46% is indigenous, 46% plantation, 3% bamboo and 1% grassland trees. No figures or statistics are provided on harvesting rates, fuelwood use or licensed large and small scale operators.

Visual observations suggest that the forests are being exploited rather than sustainably utilised with large areas being clear felled and numerous incidents of burning.

Small scale and informal trading (food and beverage production, furniture making, metal work and sewing) is important in the emerging centres (Salgaa market) along the alignment.

2.8 Health and Education

The top three diseases for both Nakuru and Uasin Gishu Districts are:

1. Respiratory diseases;
2. Malaria; and
3. Skin diseases.

In addition, HIV/AIDs is of concern. However, Nakuru District reported only 362 and 364 cases in 1994 and 1995 while Uasin Gishu District reported a general incidence of 4.3% in the rural areas and 9.9% in the urban areas (the latter statistics were not given in relation to a particular age group or period of time).

Nakuru, Molo and Ainabkoi division have hospitals and the road provides direct and indirect access to these facilities. Rongai, Njoro and Bahati divisions only have a health centre in the event of an emergency. Furthermore, the District Development Plan for 1997-2001 clearly states that the equipment in all facilities is inadequate, scanning can only be done in Nairobi and there is a need for general rehabilitation including provision of vital facilities including an intensive care unit at Naivasha District Hospital.

The average ratio of primary to secondary schools is 4:1 for both Nakuru and Uasin Gishu Districts. Literacy levels, certainly adult literacy levels are said to be increasing in Nakuru District with the provision of adult literacy classes and the enrolment of over 4,000 adults in 1995. There is no discussion of adult literacy in the Uasin Gishu District Development Plan for 1997-2001.

The alignment provides direct access to at least 5 schools and most probably indirect access to a number of learning institutions. The Nakuru – Mogotio road provides access to at least 12 schools of which 3 provide secondary or tertiary education.

2.9 Non Motorised Transport

The number of pedestrians and bicycles using the existing routes are high in particular within the urban section of the road. Preliminary findings suggest that during peak hours over 500 people cross the road in places where there is no footbridge and over 1000 people walk along the road verge.

Bicycle counts indicate that the number of bicycles varies from a tenth of the number of cars (where vehicles have been sub-divided into six different categories) up to more than half the traffic along the B4 Machege – Mogotio road. Often the number of bicycles are approximately half the number of cars and therefore represent about 8 – 16% of the traffic along the route.

3 IDENTIFICATION AND PREDICTION OF IMPACTS

Any road project impacts the environment and community through which it passes. These impacts can be sub-divided into positive and negative impacts. It is important to consider the duration of the impact and at what phase of the project it occurs, i.e., is it short term (in the construction phase) or long term (over the life of the road) and is it direct (removal of top soil) or indirect (improving access to neighbouring areas). The impact of the environment on the road should also be considered.

It is important to note that for the Lanet – Nakuru - Timboroa Road a paved road already exists and has existed for over 15 years while the Nakuru – Mogotio road was constructed 27 years ago. Few changes are proposed to the current alignment and this significantly reduces the impact of the road on the surrounding environment.

3.1 The Positive Impacts

3.1.1 National / Regional Economy

The Lanet – Nakuru - Timboroa road forms part of the Trans African Highway providing access from north to south in Kenya and to a number of east and central African countries (Rwanda, Burundi, Democratic Republic of Congo, Uganda & Sudan) from the port of Mombasa on the Kenyan coast.

Road transport is the dominant form of transport in Kenya. It accounts for approximately 80-90% of the countries passenger and freight movements (excluding pedestrian transport) and provides the only access to most communities.

The Lanet – Nakuru – Timboroa Road passes through important agricultural and forestry zones. Rehabilitating the road will reduce people's transport costs considerably and there will be important time savings. This is a significant positive impact and will be particularly valuable to the Trans African traffic.

3.1.2 Occupation / Economic Activities

During the re-construction phase there will be some employment opportunities for both skilled and unskilled labour related directly to the road. Indirect opportunities could also arise from increased prospects for trading and the supply of food and water to the construction team, particularly on the Nakuru – Mogotio road which is less trafficked.

Over the design life of the road, the improved accessibility to and through the area is likely to impact positively on job opportunities. The overall impact is considered to be significant and positive.

3.1.3 Population and Migration

As the immediate population in the area of the road is expected to exceed three quarters of a million by 2001, and the population of both Nakuru and Uasin Gishu Districts is expected to exceed 2.2 million by 2001 the impact of an improved road will be significant and positive on the people living in the area.

No direct correlation has been established between an improved road and migration. However, it is likely that an improved road could result in in-migration from the neighbouring divisions, particularly to Nakuru town and the other smaller centres.

3.1.4 Status of Women

The direct benefits from an improved road to women are the obvious increased opportunities in agriculture, forestry and trading. The indirect benefits include better access to medical clinics and hospitals and time savings for a variety of activities for both women and children. More subtle benefits include increased opportunities for women to gradually improve their circumstances. In addition, some of the traditional roles are likely to be dropped and women in general are likely to become more assertive and have the ability to exert more direct control over their lives. This is considered to be a moderate positive impact.

3.1.5 Health and Education

An improved road will provide easier and quicker access to health and educational facilities. The impact is considered to be moderate and positive.

3.2 The Negative Impacts

3.2.1 Accidents

The incidence of all types of accidents (pedestrian-bicycle-vehicular) will increase significantly as a result of the larger volume and faster speeds attainable of vehicular traffic on the improved road. This impact is considered to be significant and negative but if adequate facilities for pedestrians and cyclists are provided, this could have a positive impact.

3.2.2 Air Quality

During the construction phase dust, noise, vibration and air emission levels will increase with the use of construction machinery. The impact is considered to be moderate and negative in the urban sections of the road and only slightly negative in the rural sections of the road.

Over the life of the road the volume of vehicles is likely to increase which will result in a corresponding increase in emissions. Owing to the urban and numerous steep sections of the road, this effect will be marked and could potentially negatively impact anyone living or working close to the road. The potential impact at this time is considered to be moderate to significant and negative, and should be monitored over time.

In addition, the increase in traffic volume will result in a corresponding increase in noise and vibration. This is likely to result in a significant impact to the buildings that are built close to the road, which at the present time generally occurs in Nakuru town and is beginning to occur in some of the smaller centres.

3.2.3 Diversion routes

It is envisaged that diversion routes will parallel the existing road during the upgrading phase or alternative alignments will be used. As a result some vegetation clearance and material stabilisation may be necessary. The potential impacts of poor diversion routes are significant and negative.

3.2.4 Flora and Fauna

During the construction phase there will be some removal of vegetation on both sides of the existing paved road, but the impact is expected to be minimal as most of the vegetation is secondary in nature.

The increase in traffic volume is likely to increase trade along the alignment, which in turn could adversely affect the forests with the sale of unregulated charcoal (reference photograph 2 with charcoal at Ksh 250 per sack) and timber.

3.2.5 Landscape Modification / Quarries and Borrow Pits

During the re-construction phase a number of borrow pits and quarries will be opened up as listed in the Preliminary Materials Report, 2000. There are at least 17 potential borrow pit sites and 9 potential stone quarry sites along the Lanet – Nakuru – Timboroa road and four potential borrow pit stone quarry sites along the Nakuru – Mogotio road.

The potential borrow pit and quarry sites were generally observed to be free of homesteads, buildings and other environmentally sensitive structures. Photograph 3 illustrates a potential borrow pit site (MS 2).

If the selected borrow pits and quarries are not rehabilitated after use the impact will be significant and negative.

Linked to the landscape modification resulting from exposed and exhausted borrow pits and quarries is the development of pools of stagnant water after rainfall events. These form ideal habitats for mosquitoes, particularly the malarial mosquito (*Anopheles spp*). Since malaria is the second most prevalent disease in both Nakuru and Uasin Gishu Districts, the potential impact is significant and negative.

3.2.6 Social Change

During the construction phase, work teams can bring social upheaval to small rural communities such as those found along the alignment. This includes the spread of sexually transmitted diseases, such as HIV/AIDS among others.

Over the life of the road, the improved accessibility to the area will continue to attract increased levels of crime and lawlessness and this is likely to be accompanied by a gradual breakdown in the traditional social structures. This impact is considered to be potentially slight and negative as the paved road has existed for a number of decades.

3.2.7 Water Quality

During the re-construction phase there will be a deterioration in the water quality of the surrounding area, mainly as a result of the spread of soil particulate matter and sedimentation particularly in the three rivers that the alignment cross. The impact will be more significant and negative during either of the two rainy seasons and is likely to be compounded by human activities, especially agricultural activities.

If the construction camps are sited near water courses or close to the forested areas, pollution from waste oil or chemical spills would be more significant than if the sites are located away from water courses.

Over the life of the road, there is the possibility that there will be a number of pollution incidents, such as an oil or chemical spill.

In places the existing paved road has scour channels on either side of the road, which have been caused by incidents of intense tropical rainfall. The effect will be similar for a reconstructed road, if it is not properly maintained. The potential impact is considered to be moderate and negative.

3.3 Table 3.1: Summary Table of the Potential Positive & Negative Impacts

IMPACT ON	CONSTRUCTION	LIFE OF ROAD	MITIGATION REQUIRED
National/Regional Economy		+	
Population and Migration		+	
Status of Women		+	
Economic Activities / Occupation	+	+	
Health and Education		+	
Accidents	-	-	✓
Air Quality	-	-	✓
Diversion Routes	-		✓
Flora and Fauna	-	-	✓
Landscape Modification / Quarries and Borrow Pits	-		✓
Social Change	-	-	✓
Water Quality	-	-	✓

+ potential positive impact
 - potential negative impact
 ✓ mitigation required

4 ENVIRONMENTAL MANAGEMENT PROGRAMME

In the preceding section, where a negative impact has been predicted, appropriate mitigation measures are recommended.

4.1 Mitigation during construction

4.1.1 Responsibility of the Contractor

Many of the potentially significant negative impacts identified in the EIA relate to the re-construction phase of the project and hence to the engineering contractors. Mitigative and support measures are therefore, best achieved through the incorporation of suitable clauses in the construction documents, which are enforced by the Supervising Engineer.

Clauses to be detailed should include the following:

1. Contractor sites should at all times be kept clean and tidy and appropriate measures should be taken for the storage, handling, transportation and disposal of all waste material. A proposed 'waste management plan' should be forwarded to the Engineer for approval prior to commencing work. Bio-degradable waste should be composted on site while appropriate measures for waste minimisation and recycling should be applied to all other wastes (plastic, glass, metal, paper, textiles, timber, asphalt, waste oil, lubricants and chemicals). Where possible burning of waste should be avoided.
2. The Contractor should be responsible for the provision of adequate sanitary facilities for his/her workforce and should not allow the discharge of any untreated sanitary waste into the groundwater or any surface watercourse. Proposed sanitary arrangements should be forwarded to the Engineer for approval prior to commencing work (an absolute minimum of at least one WC per 25 people – Plumbing and Engineering Services Design Guide-UK, 1988).
3. All vehicles and machinery shall be maintained in accordance with the original manufacturers' specifications and manuals to avoid excessive noise, vibration and vehicle exhaust pollution.
4. All asphalt plants shall be operated and maintained in accordance with the original manufacturers' specifications and manuals and in such a manner as to minimise the emissions of hydrocarbons and particulates.
5. The Contractor should douse all exposed dirt surfaces with water to reduce dust levels.
6. The Contractor shall take all reasonable measures to prevent spillage and leakage of materials likely to pollute any watercourse. In addition, construction camps should be sited away from water courses and construction teams should be guided on environmentally friendly operating procedures.
7. Basic training in construction health (specifically the hazards of commercial sex in relation to sexually transmitted diseases such as HIV/AIDS) and safety, first aid and the environment (social concerns specific to the area and waste management) should be provided to the construction team. Priority should be given to employing people from the area in order to boost the local economy.
8. Breeding sites for water-borne diseases should be eliminated or minimised, such as the stagnant water pools that develop in used borrow pits and quarries. This is the

responsibility of the Contractor and should be ensured by the Engineer. All borrow pits shall be re-graded, covered in topsoil and re-vegetated, preferably with indigenous species. In addition, all quarries should be rehabilitated. Borrow pits and quarries should be rehabilitated immediately after, or concurrently with use.

Rehabilitation should aim to restore the vegetation to its original condition, or preferably to improve on, the original vegetation complex found at borrow pit and quarry sites. A mixture of indigenous grasses, shrubs and trees should be planted, with the emphasis on trees for ornamental, wood-fuel and other agro-forestry uses. Consideration should be given to planting the African Pencil Cedar (*Juniperus procera*), East African Yellow Wood (*Podocarpus gracilior*), Rosewood and East African Olive (*Olea africana*). The rehabilitation programme should be executed by the Contractor in collaboration with the Forestry Officer for Nakuru and Uasin Gishu Districts.

Payment of the Contractor should be tied to evidence of sustainable seedling/tree growth. Typically, rehabilitation programmes are executed, but without supervision or participation of the local community, which results in tree death after a short period of time, usually less than one year.

If external quarry suppliers are used, provision should be made in the contract documents to ensure that they are obliged to have a rehabilitation plan and exercise due care for the environment as detailed in the above points. Photograph 4 illustrates bitumen drums directly placed on the soil with no hardstanding. In essence, external suppliers should comply to the same regulations as the Contractor.

9. Diversion routes should be no more than 6 m wide and should be within the road reserve. During the re-construction phase, any trees felled should be replaced, preferably with indigenous species. Any diversion routes which have to be outside the road reserve should be replanted, preferably with a mixture of indigenous species and with the advice of the Nakuru and Uasin Gishu Forest Officers.
10. During re-construction activities every effort should be made to minimise and reduce accidents with awareness training and clear procedures and signage placement.
11. Roadside drainage should not be discharged directly into cultivated land unless requested. In instances where it cannot be avoided, appropriate mitigation measures should be introduced such as the concrete lining of outfall channels at regular intervals to minimise the effect of flowing water and to spread the load between a number of subsistence farmers.
12. Consideration should be given to planting trees, preferably indigenous trees along the length of the road where they haven't already been planted and away from utilities (power and telephone lines) at regular intervals, such as every 15-20 metres. The road shoulders that are not paved or gravelled should have a ground cover of grass planted, again preferably indigenous grasses. Re-grassing should be carried out in a phased manner to minimise erosion and as work on the road proceeds.
13. Re-construction activities should not be undertaken during the rainy seasons. If, it is not possible to avoid carrying out construction activities during the rainy season, every effort should be made to minimise soil erosion and siltation of the seven water courses that the alignment crosses.

4.2 Mitigation for impacts over the life of the road

4.2.1 Accidents

Billboards should be placed at regular intervals indicating the required speed limit for a particular stretch of road and they should be vandal proof and clearly visible. In addition, the road should be regularly patrolled by traffic police.

In order to minimise accidents involving pedestrians and bicycles with vehicles, they should be provided with a separate, segregated path and cycle-way. Since the cost of providing a segregated path and cycle-way can vary enormously further research will be conducted during the detailed design stage, particularly for the urban centres and along the flatter road stretches. A ball park figure of US\$ 18,000 per km can be used to provide an indication of cost.

In addition, bus lay-bys should be improved through out the route, but particularly at Lanet, Nakuru, Salgaa Market (photograph 5), Mau Summit and Timboroa. Along the Nakuru – Mogotio road, lay-bys should be improved at Mogotio as illustrated in photograph 6 and Machege.

4.2.2 Air Quality

Further research should be done into the air quality particularly along the urban sections of the Nakuru – Lanet – Timboroa road.

Two types of survey should be undertaken: one on vehicle emissions and one on the ambient air at given distances perpendicular to a centre point in the road. The most cost effective system for measuring air pollutants currently available is based on the colourmetric indicator tubes. Measurements should be carried out for nitrogen oxides, carbon monoxide, sulphur dioxide and ozone. An approximate cost for a five day survey would be in the order of US\$ 5000.

Emission testing should be initiated during the annual vehicle inspection and vehicle owners / operators should be reminded that regular services minimise particulates and other gases. It has been shown in a number of studies that a relatively small number of vehicles contribute a disproportionate amount of pollution. For example, in 1991 a study in the UK showed that 12% of the vehicles were responsible for half the CO emissions (after Harrison 1996). This finding is likely to be mirrored along the Nakuru – Lanet - Timboroa road and the Nakuru – Mogotio road.

People should be discouraged from building houses close to the road due to the insidious effects of both air emissions and noise pollution.

At the strategic level, consideration should be given to phasing out leaded petrol and high sulphur diesel in Kenya. In addition, tax incentives should be provided for the introduction of unleaded petrol, low sulphur diesel and for the purchase of cleaner vehicles such as those with catalytic converters.

4.2.3 Flora and Fauna

In order to mitigate any illegal trade in tree products (timber, charcoal, woodfuel) and/or any other natural resources, there needs to be consultation with other Government Departments, such as the Forest Department and Kenya Wildlife Service on how best manage the problem. In general terms the cessation of any illegal trade, involves quantifying, legitimising and regular monitoring of it.

Special measures should be taken to preserve the forest zones at along both the Lanet – Nakuru – Timboroa and Nakuru – Mogotio road.

4.2.4 Social Change and Environmental Information Campaign

The re-construction of the road should be accompanied by periodic environmental information campaigns on:

- road safety;
- promotion of bicycle usage, particularly over short distances (0-10 km) as an environmentally friendly mode of transport;
- pollution reduction (both noise/vibration and exhaust emissions) through the regular service and maintenance of vehicles;
- the prevention of careless waste dumping such as used plastic bags (photograph 7) along the road (possibly encouraged with the use of 'No littering' signs accompanied by a fine of Ksh 1000 or more); and
- public health issues and specifically the hazards of commercial sex in relation to sexually transmitted diseases such as HIV/AIDS

The campaign could be initiated through the District Development Office in collaboration with interested NGOs working in the area. Different media (radio, television and newspapers) should be used.

4.2.5 Water Quality

Regular maintenance of the main bridges / culverts and all other side drains should be carried out (reference photograph 7). Consideration should be given to linking this in with other awareness programmes such as terracing of steep land and soil erosion minimisation through the use of appropriate vegetation (sisal fences) and structural traps (water catch pits).

5 CONCLUSIONS

The findings of the environmental impact assessment (EIA) conclude that the impact of rehabilitating the Lanet – Nakuru – Timboroa road and the Nakuru – Mogotio road is positive overall on the socio-economic environment of the area. However, the impact of the project on the bio-physical environment is potentially slightly to moderately negative both in the construction phase and over the life of the road, if appropriate mitigation and support measures are not employed.

The mitigative and support measures proposed are generally straight forward. The majority of the measures relate directly to sound operating practices both during the construction phase and subsequently over the operational life of the road.

Providing the road is re-constructed with due attention to the mitigation and support measures outlined, the project is likely to have a positive impact on both the bio-physical and socio-economic environment of the area.



Photo 1: A road kill (white tailed mongoose) at km 35 along the Nakuru – Mogotio road



Photo 2: Charcoal for sale at Ksh 250 per sack not far from Mau Summit.



Photo 3: A potential borrow pit site, MS2 along the Lanet - Nakuru - Timboroa road



Photo 4: Asphalt and Dense Bitumen Macadam (DBM) drums directly on soil

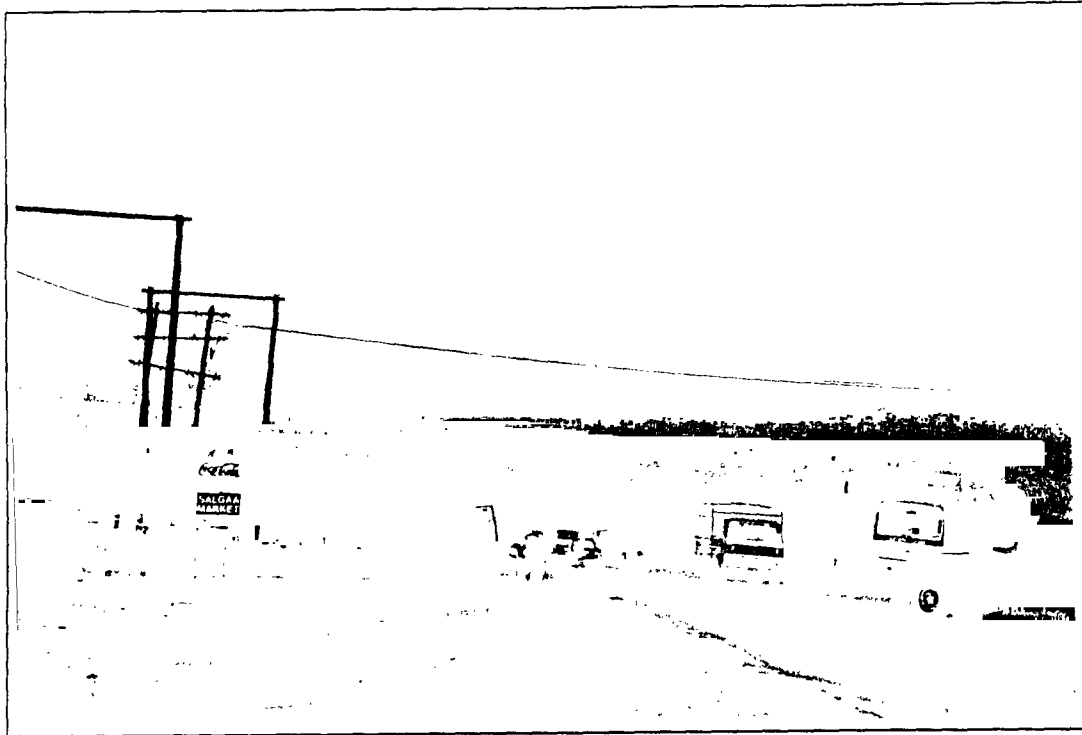


Photo 5: Salgaa Market along the Lanet – Nakuru – Timboroa road

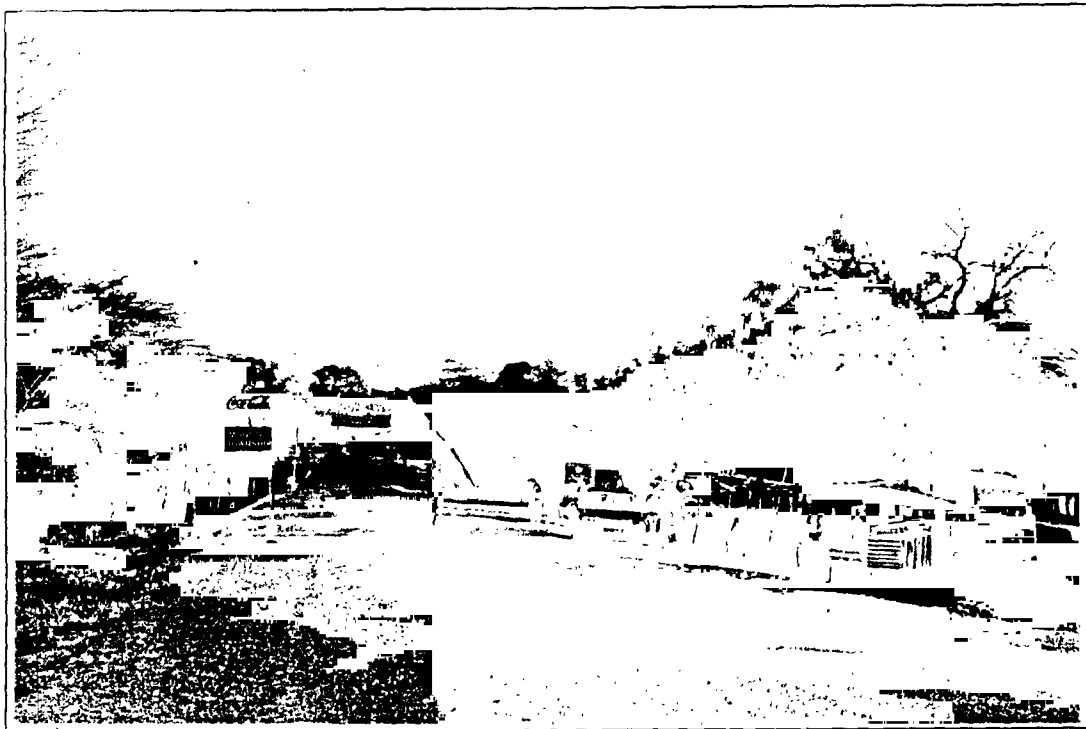


Photo 6: Mogotio along the Nakuru – Mogotio road



Photo 7: Plastic and other litter adjacent to a culvert along the Lanet - Nakuru - Timboroa road



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	Prepared by	Reviewed by	Approved by
ORIGINAL	NAME S GORDON	NAME P NDUATI	NAME P NDUATI
DATE 8-5-2000	SIGNATURE <i>SG</i>	SIGNATURE <i>P. Nduati</i>	SIGNATURE <i>P. Nduati</i>

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

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