(f) Upstream user impacts on project

There are numerous upstream users in the form of rural and urban communities and large scale agricultural activities including tea plantations. Evidence from the aforementioned water quality study indicates that water quality is not noticeably degraded by these activities.

(g) Project impact mitigation

The principal negative impact of this proposal is the total destruction of over 8 square kilometres of irreplaceable indigenous forest which represents over 4% of the existing forest area; no mitigation can prevent or ameliorate this loss. The inundation of the existing waterworks at the damsite also cannot be avoided and its replacement will be an additional project cost.

(h) Other comments

Further environmental and aesthetic damage will be incurred by forest clearance for the power transmission lines; the extent of this cannot be assessed until the alignment of the trace is determined.

(5) Conclusion

It is considered that the environmental consequences in terms of the loss of 8 km2 (800 hectares or 4.0% of the total forest)) or more of valuable and irreplaceable indigenous forest should be sufficient to place this particular proposal on a relatively low priority level. Alternatives which inflict less environmental damage should be given more attention and a higher priority.

11.2.3 Oldorko Damsite

(1) Purpose of the dam

This is a multi-purpose dam with a principal objective of electric power generation; secondary objectives are to supply water to Kajiado District and to irrigate parts of the lower Ewaso Ngiro river basin. These objectives are achieved by storage of surplus water during the rainy season and its distribution during the dry season; thus water redistribution is mainly though not entirely temporal rather than geographical. A 12 km long headrace tunnel leads from the dam to the power house.

(2) Basic details of the dam

Principal Features of Oldorko Reservoir.

Dam Elevation (m)	Height (m)	Area (m2x106)	Volume (m3x106)
1250	0	0	0
1260	10	0.36	0.9
1272	22	11.27	119.5
1280	30	19.42	198.6
1300	50	51.15	904.2

Max. length = 10 km; max. width = 6 km Drawdown: 28 m.
Live storage volume: 785 m3x106 (=310% mean annual inflow)
FSL = 1300 m
Height: 55 m
Volume: 8.43 m3x106
Design discharge: 18 m3/sec.
Average river discharge: 8.0 m3/sec

Source:Acres 1987, KNPDP 1986-2006.

(3) Water quality

Few data on water quality are available for the Ewaso Ngiro South river; these data are summarized in TableN11.4 These data do not indicate any reason to suppose problems for the development of the river for power. The elevated concentration of sodium in relation to calcium and magnesium suggests that sodium absorption ratios should be calculated when more recent data are available to assess the likely impact on irrigation. The quantity of dissolved solids is low by inference from the conductivity levels though considerable seasonal variation is indicated. The concentration of iron is on the high side for water supply.

During the aerial reconnaissance the water appeared to be very brown and turbid indicating a high silt load. This situation will worsen in the wet season. Organic foam was observed in swirl-pools below the damsite but the source of this foam could not be determined; it is more likely to be of natural origin rather than man-made. Evaporation of water from the reservoirs at both Leshota and Oldorko may be sufficiently substantial to affect the water quality by evaporative concentration. Storage alone under the high ambient temperatures of this area will also result in some degradation and the reservoirs are likely to become stratified and water quality in the river downstream will be affected depending upon the depth of the off-take structure in relation to the thermocline.

(4) Results of the IEE and aerial reconnaissance

(a) Land use

i) Vegetation, cultivation and livestock

At the Oldorko damsite the vegetation was generally light scrub and bush with few mature trees. The reservoir area has thicker scrub with much bare red soil visible between bushes; major trees only occur in the immediate river valley and between the river and the escarpment where large trees are dense in some places. Selective clearance will be necessary to avoid serious water quality problems and eutrophication.

In the northern sector of the flood zone where the river meanders extensively are large areas of tall mature flat-topped Acacia about 10-12 metres tall. Here also goats and sheep were observed in small numbers and animal tracks and pathways were visible through areas of bare red soil. The scrub and trees were very green after some recent rain and did not appear stressed; no grass was in evidence.

In the middle reservoir region there are denser areas of Acacia and some signs of overgrazing. These signs were prominent especially around a waterhole which had an extensive area of degraded land around it about 0.5 to 0.75 km wide; this illustrates one example of the adverse effects of providing water in ASAL areas.

No signs of cultivation were observed anywhere in the flood zone or elsewhere. The entire area is Maasai grazing land and although at the time of this survey very few stock animals were seen this is undoubtedly a seasonal effect and stock densities will be considerably higher at other times of the year.

ii) Settlements and other structures

In the northern sector of the reservoir there are two large Maasai bomas, both recently occupied and comprising two sets of manyattas, one with 24 huts, the other with 12-14 huts. Signs of 'overgrazing' were evident for a considerable distance around these bomas; a number of very large abandoned bomas also exist in this area indicating this is a seasonal stopping place for the Maasai on migration.

iii) National Park or Reserve or forest

There are no National parks, reserves or forests within this project area.

(b) Compensation, relocation and resettlement

i) Land, crops and buildings

Compensation for the 50 km2 of land taken by the project will be due to the Maasai belonging to the group ranches affected by project implementation; no cultivation is carried out in this area so crop compensation will not be required. Compensation for dwellings will be minimal though one or possibly two cattle dips in the flood zone will have to be rebuilt.

ii) Problems of relocation site

This could be a significant problem in view of the already existing land conflicts between the different Maasai clans within the group ranch areas. If the reservoir affects one clan particularly heavily finding alternative grazing land for their relocation may pose difficulties.

(c) Bush clearance

Extensive bush clearance will not be necessary. Some selective clearance of larger trees and areas of dense bush will be required in a few areas but overall site preparation of this nature should not be a major problem.

(d) Aquatic weeds

No aquatic weeds were seen in the river above or below the damsite so the possibility of weed problems is not ranked very high.

(e) Downstream user conflicts

i) Power bores

The power production cycle is continuous and power bores will not be produced under normal operating conditions.

ii) Water shortages

Since the Oldorko reservoir in conjunction with the Leshota reservoir will partially regulate the river, water resources should be more evenly distributed throughout the year. However, storage and regulation may bring their own side-effects in the form of water losses due to evaporation and to adverse effects on the swamp lands in the river delta region around Shombole. Storage, as noted above may also degrade water quality if prolonged.

iii) Evaporation

Evaporation from the reservoirs and its impact on dry season river flows needs to be assessed critically; especially if the project also includes proposals for irrigation and water transfer to Kajiado below the dams both of which will quantitatively reduce the volume of water entering the swamps at Shombole.

According to present assessments evaporation from the two Ewaso Ngiro reservoirs will be a significant problem resulting in the loss of the equivalent of about 2.54 m3/sec from the reservoir surface at Oldorko and a further 1.0 m3/sec from Leshota. This order of loss must be viewed against a mean low flow of 2.8 m3/sec for 75% of the year. Thus the combined loss from Oldorko and Leshota will exceed the mean low flow by 0.75 m3/sec during the dry season. The river will then be kept flowing only by the regulated discharge from the power house at Oldorko. The location of the proposed off-take for irrigation and water supply is unknown as is the volume of water to be abstracted for these purposes; it thus presently impossible to evaluate the impact of these consumptive abstractions on the ecology of the river below Oldorko. It can be reliably assessed, however, that in the presence of these two proposed developments the impacts on the river, the swamp at Shombole and the Maasai will be very significant.

iv) Swamp desiccation

If regulation of the river reduces flooding and the recharging of the Shombole swamp and evaporation from the dams reduces the total volume of water further this important dry weather refuge which provides both water and forage for the Maasai and their livestock may be seriously threatened. This danger is apparently highlighted in the KPC Feasibility Study on developments within the Ewaso Ngiro catchment. There may also be additional adverse effects on Lake Natron and its delta fishery but the significance of this impact has not been assessed and although this area is said to be fished by Luo fishermen but no evidence of such activity was observed.

v) Water quality reduction

As noted above storage of water in reservoirs, especially those subject to high temperature and prolonged stratification inevitably results in some reduction in water quality. So although the sediment load will be reduced the quantity of organic suspended solids in the form of plant and animal plankton will increase. Evaporation will also, to some unquantified extent, increase the salinity of the water. It is

uncertain whether these impacts will materially affect the utilization of the water.

(f) Upstream user impacts on project

The only significant potential source of pollution upstream of the damsite is the town of Narok; it is unlikely, however, that any effluent entering the river from this source will significantly impact water quality in the reservoirs. It is expected that any such effluent will be degraded by natural processes in the 30-40 kilometres of river between Narok and the reservoirs. The larger impact will in any event be experienced by the Leshota reservoir which will act as a buffer between Narok and Oldorko.

(g) Health aspects

i) Tsetse fly

This fly which transmits trypanosomiasis (sleeping sickness) is present in the southern reaches of the Ewaso Ngiro but it is uncertain if it is equally abundant in the reservoir areas to the north. Fortunately in Kenya this fly does not transmit human sleeping sickness but its painful bite could be a nuisance problem during construction and post-construction operations.

ii) Mosquitoes and malaria

It has been confirmed that seasonal malaria is rife in this area and that resistance to chloroquin is common. So, although it is unlikely that the project will increase the incidence of malaria in this area, malaria will adversely impact the project via health hazards to the work force both during construction and operations.

iii) Schistosomiasis

This vector-borne disease is also 'rife' in the Ewaso Ngiro South catchment and the Oldorko and Leshota reservoirs are thus very likely to become colonized by the snail intermediate hosts. As with malaria its uncertain if the situation 'with-project' will be any worse than that 'without-project'. However, this debilitating disease will, none-the-less poses a health hazard for construction workers and operations personnel; in addition it will represent a major constraint on the safe development of irrigation in the lower Ewaso Ngiro River.

(h) Project impact mitigation

i) Social conflict

A development seen as most likely to cause problems results from the current rumours that "30,000 Kikuyu are to be imported as irrigation farmers into the area"; these irrigators and their cultivation will displace the already crowded Maasai from their dry season grazing lands and this will probably lead to 'serious' land use and ownership conflicts according to researchers presently working in the lower Ewaso Ngiro area. It is recommended that means to pre-empt and mitigate this potential conflict should be investigated.

ii) Compensation flows

Attention should also be given to the provision of compensation flow in the river below the dam where the section of river by-passed by the penstock is confined to a very narrow gorge containing riverine forest, flow should be provided to maintain river ecology at all times and especially during the dry season when the volume of water required and diverted for power generation exceeds the natural inflow of the river.

11.2.4 Mwachi Damsite

(1) Purpose of the dam

To store surplus water from the rainy season to maintain flows in the Mwachi river to maintain the supply of water to Mombasa through the dry season.

(2) Basic details

Elevation (m)	Dam height (m)	Reservoir area (km2)
30.0	0	0
30.5	0.5	0.34
45.7	15.7	1.10
61.0	31.0	1.90
76.2	46.2	3.20
84.0	54.2	4.70 = HWL
91.4	61.4	6.35

HWL = EL 84.0 m; LWL = EL 66.6 m; Drawdown = 17.4 m.
Max. length = km; max. width = km.

(3) Water quality

Published reports indicate that the water entering the reservoir may be slightly organically polluted and that further deterioration is to be expected during storage as is the case at Pemba.

(4) Results of the IEE and aerial reconnaissance

(a) Land use

i) Vegetation and cultivation

A substantial amount of natural scrub, bush and forest vegetation, especially along the incised slopes of bends in the river, will be inundated by the reservoir. Bush clearance will be a very necessary part of project implementation. Without clearance and removal the quality of the water stored in the reservoir will deteriorate substantially and greatly increase the difficulties and costs of water treatment. This deterioration results from the decay of the submerged vegetation which causes deoxygenation of the water and eutrophication; the latter leading to the development of unwanted algal blooms with attendant further problems for water treatment and supply. Very little of the inundation area is under intensive cultivation, what there is, is generally at subsistence level.

ii) Settlements and other structures

No settlements apart from a few scattered low-cost traditional houses with makuti roofing and mud walls or other man-made structures appear to exist in the inundation area.

iii) National Park, Reserve or forest

The Mwachi dam and reservoir does not impinge on any national parks or reserves. However, much of the riverine vegetation, especially that along the immediate river course appears to be dense and valuable indigenous forest and must be considered a conservation loss if it is flooded. Further study of the ecological and conservation value of these forest areas is recommended.

(b) Compensation, relocation and resettlement

i) Land, crops and buildings

Some degree of compensation will be required for land, crops and buildings in the project area but this is assessed to be required only on a very small scale.

ii) Problems of relocation site

A potentially greater problem will be the identification and acquisition of suitable and acceptable land for resettlement of those families dispossessed by project implementation. The problem looks less severe than at the Pemba, Thwake or Yatta damsites.

(c) Bush clearance

As noted above (a(i)), to maintain the quality of the water in the reservoir excessive vegetation in the flood zone must be felled and removed; the logic for this is discussed in Chapter N4.

(d) Aquatic weeds

The presence of aquatic weeds, and especially free-floating species is usually detrimental to reservoir management because of the adverse impact on water quality. Some aquatic weeds are prevalent in the Mwachi River and completely cover the surface in some areas. This is obviously a seasonal event and such vegetation will be destroyed during periods of high water discharge. Although it was impossible to accurately identify the dominant species from the air it appeared to be a rooted macrophyte belonging to the genus *Potamogeton.* This, and any other rooted weeds will inevitably colonize the perimeter of the reservoir with unpredictable but adverse consequences. The impact of free-floating weeds such as *Salvinia, Pistia* or *Eichhornia* would, on the other hand be much more serious and of greater concern but these were not seen on this survey. It is recommended that the identity of this weed is firmly established in further phase of project development. This same weed also occurs in the Pemba and Rare rivers.

(e) Downstream user conflicts

i) Power bores and water shortages

Since this dam does not produce power the problem of power bores is absent; so to is the threat of water deprivation to downstream users. People living downstream should in fact benefit from the maintenance

of flow in the river during the dry season a time when this seasonal river is normally dry.

ii) River fisheries

Several fish traps were noted across the river below the damsite within the mangrove zone. The livelihood of the fishermen operating these traps may be affected by project implementation but it is not possible at this stage to assess the degree of impact or whether it will be beneficial or detrimental.

There will be some impact also on the ecology of the mangrove swamp into which the river flows; this is expected to be minimal but should be investigated further.

iii) Water quality reduction

Storage of water in reservoirs almost inevitably results in some deterioration in water quality. This is especially so if the water is organically enriched and maintains a high water temperature. Published reports point to a possible risk of eutrophication (nutrient enrichment) because of organic matter entering the river from communities living upstream. The magnitude of this problem in the Mwachi cannot be assessed without additional water quality studies. It should be noted, however, this problem will be further exacerbated if bush clearance in the flood zone is not carried out effectively as noted above.

(f) Upstream user impacts on project

Although few people apparently live in the upstream catchment previous reports suggest some organic pollution of the river results from inflows of wastewater originating upstream of the reservoir area. The possible extent of this impact requires assessment through monitoring of chemical and biological water quality parameters in the Mwachi river .

(g) Impacts on other developments or projects

As far as could be seen from the air no other projects or significant structures exist in the inundation area.

(h) Project impact mitigation

From this initial examination little needs to be proposed by way of mitigating the few generally mild adverse impacts of this project.

(i) Other comments

It is to be noted that the water associated disease schistosomiasis (bilharzia) is prevalent in this area and there may be concern that the existence of such a large body of water will cause an unacceptable increase in the incidence of the disease. Whether or not the incidence will be increase above the 'without project' level by project implementation is not known; a more detailed assessment is recommended.

11.2.5 Ndarugu Damsite

(1) Purpose of the dam

This dam and reservoir are proposed for similar purposes as the larger Munyu dam, though the emphasis is changed, namely:-

(a) Nairobi water supply,
(b) augmentation of water supply to Mombasa and the coastal region,
(c) irrigation development in the middle reaches of the Athi River.

(2) Basic details of the dam

The Ndarugu reservoir is formed by the damming of two tributary rivers, the Ndarugu and the Komu and will have an area of 17.5 km2 at normal top water level of 1450 masl, and will drawdown by a maximum of 12.7m.

(3) Water quality and eutrophication

Water quality data are given in Tables N11.5 and N11.6. From a chemical point of view the water appears to be suitable for water supply purposes after appropriate treatment, testing for irrigation suitability should be carried out. There are discrepancies in the data which need clarification; these include BOD and COD results from both rivers which show large variations; these differences may result from the time of sampling and further testing is needed; the high concentration of sodium should be checked. The levels of ammonia, nitrate and phosphate are on the high side and may result in some eutrophication of the reservoir; this also requires further investigation. No data are available on the bacteriological quality of the water.

(4) Results of the IEE

A short aerial survey was conducted over the Komu and Ndarugu valleys from which the following observations were made.

(a) Land use

i. *Komu River*: the river valley bottom is wide and open, but the river is much smaller than the Nairobi River. There is dense vegetation and many mature *Acacia* trees along the banks. The river is seasonal and was not flowing a short distance above the confluence with the Athi. There is extensive maize cultivation accompanied by low cost housing (tin roof type/stone wall type), but there is much new construction under way. The whole area well settled divided into plots with well marked boundaries. These semi-urban estates are well served by murram roads. As noted above this river receives the final effluent from the Thika oxidation ponds.

ii. *Ndarugu River*: by comparison with the Komu valley the Ndarugu is relatively under-populated and uncultivated with a mixture of thick vegetation and mature trees. There were indications of livestock activity and nearer the Athi confluence cultivation and settlement increases in the valley bottom where a few scattered houses exist in the probable flood area. Overall the main but not overwhelming problem here would appear to be bush clearance and not resettlement of population. However, if the development of the dam is delayed for a number of years this situation may well change.

(b) Population, resettlement and compensation

The development of the Ndarugu damsite will require the relocation and resettlement of an unknown, but substantial number of people with associated compensation for property and crops. The identification of suitable resettlement sites may prove difficult within the Nairobi area.

(c) Bush clearance

In the upper Ndarugu especially, but also in the Komu to a lesser extent bush clearance will be necessary to avoid eutrophication of the reservoir. The extent of clearance needs further assessment.

(d) Other environmental aspects

i) Future water quality

Although water quality of the Ndarugu and Komu rivers is presently quite good, future development of urban centres and especially Thika, as well as agriculture and industry in conjunction with other land use changes in the upper catchment around the Aberdare foothills in Kiambu, may well alter this situation for the worse. This possibility

requires monitoring if the future value of the Ndarugu reservoir is not to be impaired.

ii) Compensation flow

Sufficient water must remain in the river below the dam to maintain the ecology of the river ecosystem and to provide water for downstream users. Maintenance of dry season base flows is especially important to avoid health hazards from stagnant water in the river.

iii) Other considerations

Two electric power lines cross the probable location of the reservoir and will need re-routing.

No other observations were made indicating further negative environmental impacts.

11.2.6 Pemba Damsite

(1) Purpose of the dam

This is a water supply reservoir designed to store surplus water from the rainy season to maintain flows in the Pemba river and the supply of water to Mombasa through the dry season.

(2) Basic details

Elevation (m)	Dam height (m)	Reservoir area (km2)
57.9	0	0
61.0	3.1	0.05
76.2	18.3	0.30
91.4	33.5	1.05
106.7	48.8	3.30
121.9	64.0	7.30 = HWL

Max. length = 6.5 km; max. width = 2 km.

(3) Water quality

Published reports indicate that the water is very turbid and that there is "a great possibility of eutrophication in the reservoir resulting in growth of algae and plankton". This is noted since it may affect the odour and taste of the water even after water treatment. No analytical data are available at present.

(4) Results of the IEE and aerial reconnaissance

(a) Land use

i) Vegetation and cultivation

A substantial amount of natural scrub, bush and forest vegetation will be inundated by the reservoir. Bush clearance will be a necessary part of project implementation to protect water stored in the reservoir from serious quality deterioration caused by the decay of the submerged vegetation. Decay can lead to deoxygenation of the water and eutrophication; the latter leading to the development of unwanted algal blooms with attendant problems for water treatment and supply. Very little of the inundation area is under cultivation, what there is, is subsistence level.

ii) Settlements and other structures

No settlements exist in the inundation area though there are a few scattered low-cost traditional houses with makuti roofing and mud walls. The only significant structure seen in the flood area is a small dam and associated modern-style houses in the mid to upper zone of the reservoir site.

iii) National Park or reserve or forest

Although the Shimba Hill National Reserve is close by the proposed reservoir area it is not thought that there will be any intrusion into this reserve by the project. However, much of the riverine vegetation, especially that along the immediate river course is dense indigenous forest and must be considered a conservation loss if it is flooded.

(b) Compensation, relocation and resettlement

i) Land, crops and buildings

Some degree of compensation will be required for land, crops and buildings in the project area but this is assessed as small scale.

ii) Problems of relocation site

A potentially greater problem will be the identification and acquisition of suitable and acceptable land for resettlement of those families dispossessed by project implementation.

(c) Bush clearance

As noted in (i) above to maintain the quality of the water in the reservoir excessive vegetation in the flood zone must be felled and removed; the logic for this is discussed in Chapter N4.

(d) Aquatic weeds

The presence of aquatic weeds, and especially free-floating species is usually detrimental to reservoir management because of the adverse impact on water quality. Some aquatic weeds are prevalent in the Pemba River and completely cover the surface over large areas of the river upstream of the existing small dam mentioned above. Although it was impossible to identify the dominant species from the air it is probably a rooted macrophyte belonging to the genus *Potamogeton*; some smaller patches of water lily (*Nymphaea*) were also observed. These weeds will almost inevitably colonize the perimeter of the reservoir with presently unpredictable but adverse consequences. The impact of free-floating weeds such as *Salvinia*, *Pistia* or *Eichhornia* would, on the other hand be much more serious and of greater concern. It is recommended that the identity of this weed is established in further phase of project development. This same weed also occurs in the Mwachi and Rare rivers.

(e) Downstream user conflicts

i) Power bores and water shortages

Since this dam does not produce power the problem of power bores is absent; so to is the threat of water deprivation to downstream users. People living downstream should in fact benefit from the maintenance of flow in the river during the dry season a time when this river is normally dry. There will be some impact on the mangrove swamp into which the river flows but this is expected to be minimal but should be investigated further.

ii) Water quality reduction

Storage of water in reservoirs almost inevitably results in some deterioration in water quality. This is especially so if the water is organically enriched and maintains a high water temperature. Published reports on the Pemba River point to a risk of eutrophication (nutrient enrichment) because of organic matter entering the river from semi-urban communities living upstream. This problem will be exacerbated if bush clearance in the flood zone is not carried out effectively as noted above. Since water from the Pemba reservoir will be mixed with the very high quality water brought from Mzima

Springs, the Pemba water should be maintained at the best practical quality.

(f) Upstream user impacts on project

Although few people apparently live in the upstream catchment previous reports indicate some organic pollution from wastewater originating upstream of the reservoir area. The extent of this impact requires assessment through monitoring of water quality for chemical and biological parameters.

(g) Impacts on other developments or projects

An existing water pipeline running from the water works at Marere to Mombasa will be inundated for approximately two kilometres by the reservoir. The re-routing of this pipeline will probably be necessary if the Pemba dam is constructed.

(h) Project impact mitigation

From this initial examination little needs to be proposed by way of mitigating the adverse impacts of this project. However, some environmental enhancement may be achieved if the reservoir is made more accessible to the public and it can be turned into a local or tourist amenity in conjunction with the existing forest areas. At some locations near the damsite are possible sites for tourist lodges or other facilities which would benefit the area.

(i) Other comments

It is to be noted that the water associated disease schistosomiasis (bilharzia) is prevalent in Kwale District and there may be concern that the existence of such a large body of water will cause an unacceptable increase in the incidence of the disease. Whether or not the incidence will be increase above the 'without project' level by project implementation is not known; a more detailed assessment is recommended.

11.2.7 Rare River Damsite

(1) Purpose of the dam

To store water transferred from the Athi-Sabaki River via a canal during the rainy season for supply to Mombasa and its hinter-land during the dry season. This will convert the Rare from a seasonal to a perennial river.

(2) Basic details

Elevation (m)	Dam height (m)	Reservoir area (km2)
73.2	0	0
76.2	3.0	0.01
83.8	10.6	2.00
		3.50

(3) Water quality

Published reports indicate that barytes (barium) and galena (lead) mineral deposits are mined in the vicinity of Vitengeni, upstream of the proposed reservoir site; it is feared that wash-water and tailings from the mines will pollute the water in the reservoir. The presence of toxic lead compounds in drinking water is an unacceptable health hazard and the concentration of lead in the river water must be assessed in due course.

No further water quality data are available to date.

(4) Results of the IEE and aerial reconnaissance

(a) Land use

i) Vegetation and cultivation

There is little evidence of cultivation within the intended reservoir area and natural vegetation is only thick in the immediate river valley especially along the outer incised wall of the valley; here bush and semi-forest occurs. Some selected clearance of bush and woodland will be necessary in limited areas. Much of the land away from the river is only lightly covered with bush and large areas of bare or almost bare soil are visible.

ii) Settlements and other structures

There are very few signs of settlement or housing within the presumed flood zone; some traditional makuti roofed, mud walled houses are present and fewer tin roofed dwellings.

iii) National Park, Reserve or forest

The Arabuko-Sokoke Forest lies to the east of the reservoir area but the flood zone does not appear to extend this far and impacts on the forest areas are assessed as negligible.

(b) **Compensation, relocation and resettlement**

i) Land, crops and buildings

As noted above very little human habitation or cultivation exists within the proposed reservoir area and consequently compensation and relocation problems will be minimal though not entirely absent.

ii) Problems of relocation site

The low population density in the area suggests that finding alternative land for displaced families may not be difficult; this contention needs confirmation, however.

(c) **Bush clearance**

A limited programme of bush clearance will be necessary especially in the immediate vicinity of the river and on the steep river banks on incised bends.

(d) **Aquatic weeds**

In the river above the damsite areas of the river were extensively covered with the aquatic weed tentative identified as *Potamogeton* spp. This is a rooted macrophyte which is probably decimated during periods of high discharge and recolonizes the river during the dry season. It will probably form a fringe around the reservoir but will not tolerate desiccation and may therefore be eliminated by fluctuations in water level. The presence of the more obnoxious free-floating weeds such as *Salvinia* and *Pistia* was not observed.

(e) **Downstream user conflicts**

i) Power bores and water shortages

Since the reservoir is designed to store water transferred from the Athi-Sabaki River, water supply in the Rare River should be improved and extended over time. Attention, however, should be given to ensuring that that not all the diverted water goes for supply to Mombasa and that maintenance flow is provided during the natural flow periods of the year to maintain the ecology of Kilifi Creek.

ii) Water quality reduction

The storage of water in reservoirs in hot climates generally leads to some deterioration in water quality either through evaporative concentration of the dissolved materials in the water, or through the growth of algae and aquatic weeds. The degree to which this is likely to happens depends on the retention time of the water in the reservoir, the water circulation system of the reservoir and the concentration of plant nutrients (mainly nitrate and phosphate) in the water. Insufficient data are available for the Rare River to make a further assessment. In contrast water quality will be marginally improved as silt sediments out in the reservoir prior to transfer to the water treatment works for purification.

(f) Upstream user impacts on project

From the aerial reconnaissance no particular sources of adverse impacts on the reservoir were seen; attention is drawn to the presence of lead and barium salt mines upstream of the reservoir and that the possible impact of polluted wastewater from these mines requires further assessment.

(g) Project impact mitigation

None of the impacts noted in this IEE require specific mitigation providing the results of analyses of river water taken below the mineral mines at Vitengeni do not indicate unacceptably high levels of lead in the water. If lead is present in excess than measures must be taken to prevent wastewater from the mines entering the river.

11.3 Notes on Other Selected Damsites (29 Damsites)

11.3.1 Schemes in Lake Victoria basin

(1) Amala damsite

This is a small dam less than 2km2 designed solely for water supply. It impinges on the edge of the East Mau Forest therefore a forest reserve is involved and also tree and bush clearance. Population density in the area should be minimal or absent. Water quality should not be a problem and no other adverse impacts are apparent at this stage.

(2) Bunyunyu damsite

This 1.82 km2 water supply reservoir lies in a generally heavily populated area of the country but appears to occupy an upland valley swamp. If this is the case then few people will be living inside the inundation area, and little cultivation is to

be expected. Water quality may be impaired slightly by the swamp with a low pH and possibly moderate to high levels of some metals including iron and manganese. No water quality data are available for this location.

(3) Itare damsite

This 1.14 km2 reservoir is for water supply to Nakuru town which will require inter-basin transfer will lie almost entirely within the South Western Mau Nature Reserve which will have obvious negative ecological impacts, assuming that the forest is still intact. No other problems are apparent based on the information available.

(4) Londiani damsite

This medium size (4.5 km^2) water supply reservoir lies on the boundary of the Tinderet Forest but does not appear to encroach into the forest. Land use in the area according to the available maps seems to be mainly farms and ranches; and may therefore have a moderately high population level. No other impacts are apparent.

(5) Moiben damsite

The purpose of this dam is to supply water to Eldoret and Iten plus a pumped supply for irrigation of the upper Nzoia. The reservoir area is about 4 km^2 at FSL (2014 masl). Drawdown will be approximately 32 meters which will reduce the area to under 0.5 km2. The map indicates low population density and land use mainly scrub and scattered trees; this situation may have changed significantly since publication of the map and needs checking. One road, the C630 will be covered by the reservoir for about 3 kilometres and will need re-routing. The upstream catchment appears to be free from potential sources of pollution. Water quality data (see Table N11.7) indicate no obvious problems for supply.

(6) Mukulusi damsite

The reservoir will inundate an area of about 2.3 km^2. The area contains some cultivated lands and housings, and further a part of the reservoir area extends into Kakamega Forest area. The inundation of forest seems to be a major issue in this scheme.

(7) Kibos damsite

The damsite forms a narrow steep gorge and the reservoir is also in relatively steep area. However, there may be some land uses in the reservoir area, which should be subject to further survey. A major issue will be the impact to downstream water uses, since the water is taken and transferred for water supply. Compensation flow should be assured.

River reach downstream from the proposed damsite has a very steep gradient. A mini-hydropower scheme may be possible depending on the layout of the plan for water supply.

(8) Sondu/Miriu damsite

The proposed dam creates only a small pond just enough for daily flow regulation for power generation and no social compensation nor ecological issues are foreseen. Main issues needing due attention will be decrease of low flow in the Sondu river downstream reaches and power bore in the tailrace channel downstream from the powerhouse.

11.3.2 Schemes in Rift Valley basin

(1) Kimwarer damsite

This small reservoir is designed for water supply, power generation and irrigation. Available, but old, maps indicate that the 1.4 km^2 reservoir will impinge on several forests and forest blocks, mainly the Tingwa Hill and Kipkabus forests. It is not known if these forests remain intact today. The KVDA Report (1991) contains references in the budget for forest clearance at the damsite. Some communities may become isolated on ridges between long arms of the reservoir and some will lose their land though much of the valley bottom appears to be marsh according to the map. One or more rural roads will be disrupted. According to the KVDA Report (1991) the reservoir will dry up in 6 out of 20 years which reduces its utility as a water supply.

(2) Narok damsite

This is a 2.4 km2 water supply reservoir sited a few kilometres to the N-N-W of Narok town at the extreme edge of the Ol Pusimoru Forest. According to the maps a small portion of this forest may be inundated if it has not been cleared in recent years. The same map indicates little habitation of the area but this location has experienced considerable population growth and the extent of population relocation associated with this dam requires investigation. No main roads or other structures are shown on the map. Water quality should not be a problem.

(3) Upper Narok damsite

This damsite is located upstream of the Narok damsite mentioned in (2) above. The two schemes are deemed as alternatives mutually. Environmental aspects of this damsite is almost identical to those described for (2) above. This damsite is at a more deeper part of the Ol Pusimoru Forest.

(4) Chemususu damsite

The damsite is located at the southern edge of the Lembus Forest area, where some forest clearance will be required. It appears that there would be no other serious problems.

(5) Kirandich damsite

No serious problems are foreseen except that the construction of dam/access road and the impoundment of reservoir will require the clearance of some forest trees and scrubs.

11.3.3 Schemes in Athi River basin

(1) Ikiwe damsite

This is a small 2.1 km2 water supply reservoir, 5-7 kilometres to the ESE of Machakos. In a dry bush area but may be well populated. The reservoir may block passage along roads from north to south of the area. No other impacts can be identified.

(2) Kiteta damsite

The Kiteta dam is a small 1.2 km2 water supply reservoir sited in dry bush land. The dam appears to inundate a small area of the Utunun Forest, but it is probable that this forest no longer exists in the flood zone. Population in the catchment above the dam appears moderately dense and impacts from this source on the reservoir need investigation. No other significant impacts are obvious.

(3) Upper Athi damsite

Little relevant information is available concerning this damsite. It will be small 1.1 km2 at full supply level, drawdown will be 10 m, which will expose 0.7 km2 of reservoir bottom. It is situated on the Mbagathi River along the southern boundary of the Nairobi National Park and is intended for pumped water supply to Athi River township. The precise location of the dam and reservoir will greatly influence the extent of environmental impacts of the project.

Potential impacts, both beneficial and detrimental, are possible. Inundation of riverine vegetation and associated habitats and possible disruption of migration routes into the Nairobi Park are likely. The reservoir will act as a very large water hole which has both good and bad points. The reservoir has a drawdown zone of approximately 0.7 km2 and this may be unsightly and the exposed sediments may give rise to unpleasant odour. Construction impacts will be significant and

unavoidable. Any development with impacts on such an important National Park should proceed with caution following adequate study.

(4) Ruiru-A damsite

This damsite is located on the Ruiru river some 2 km downstream of the existing Ruiru dam. In view of a fact that no major environmental issues are reported in the existing dam, the same would be expected for this proposed dam. The reservoir will inundate only a small area of some 90 ha. However, since the area is in high potential area, land acquisition and resettlement will require careful planing to avoid the arise of the issues.

(5) Kikuyu damsite

Although the reservoir is not large (about 1 km^2 in area), the land acquisition and resettlement will still be a major issue to be managed since the area is in the vicinity of highly populated area. A potential environmental concern is that the development of this dam may cause an important on the flow of Nairobi river which is the main river flowing through the capital.

(6) Yatta damsite

This damsite will pose problems of relocation of displaced people, since the area is generally heavily settled and intensively cultivated. Other than land acquisition and resettlement issues, the economic loss due to production foregone in agricultures shall also be evaluated properly.

(7) Ruaka (Kiambaa) damsite

The proposed damsite and reservoir area are intensively cultivated in both river valley bottom and on slopes. The same problems as described for (6) above are foreseen, though the submerged area is small (about 30 ha).

11.3.4 Schemes in Tana River basin

(1) Low Grand Falls damsite

This is a large (67 km2) run-of-river continuous (presumed) power generation dam; therefore, no river section will be by-passed, and power bores will not be a hazard. Because of the large area inundated further investigations of population density and land use are essential though this is not a highly populated region of the country. No serious adverse impacts are anticipated from diseases associated with this development.

The retention time of the dam is approximately two months and so water quality changes due to storage should be minimal. Water quality in the Upper Tana is good and should cause no problems. Inundation of several kilometres of river bank and possibly riverine forest are a potential adverse impact but as far as can be seen from available maps there should be no impacts on forest resources of any kind with the possible exception of riverine vegetation noted above.

It is possible that several social and economic benefits will accrue from this development including - the provision of a readily accessible source of water for domestic and livestock use; in addition the dam will provide a route across the Tana river for traffic, and a productive fishery can be expected to develop in the reservoir. Hopefully, rural power and water supply will be distributed to the immediate area as a major contribution to rural development.

(2) Mutonga damsite

This is a similar but smaller (11 km2) development to Low Grand Falls and shares many of the same benefits and deficits. Population and land use will require evaluation and also the extent of inundation of riverine forest. Mutonga reservoir will have an enormously long shoreline which will make the reservoir vulnerable to land use changes in the immediate catchment area. To some extent these impacts will be mitigated by the very rapid water exchange expected in the reservoir; this should occur almost weekly. Problems of water quality changes due to storage, therefore, should be insignificant. As far as can be seen from the available maps there are no impacts on forest resources of any kind with the possible exception of riverine vegetation as noted above.

(3) Thiba damsite

This small water supply reservoir extends to 1.2 km^2 and examination of the available maps does not indicate any obvious adverse environmental impacts arising from this proposal.

(4) Masabet damsite

Masabet Damsite is located about 5.0 km downstream of the town of Kericho. The dam is small with about 0.6 km^2 of reservoir area at FSL (1,839 m) and it is planned entirely for water supply to Kericho and adjacent areas. As indicated on the topo-map of 1:50,000 scale ,only a small area of the tea plantation at the right side of the reservoir along the Kitoi River will be inundated. No other impact is apparent.

(5) Waseges damsite

This damsite was proposed by the water resouces study for the Regional Development Plan for the Kerio Valley Basin in 1982. The 2.0 km^2 reservoir is

for water supply to the sub-basin 2EC which will require interbasin transfer .As shown on the topo-map, the reservoir area has only a small population and land use is minimal with mainly scrub and some scattered trees.

As the result of water transfer from subbasin 2EB to subbasin 2EC , there will be a lowering of water level at Lake Bogoria which will give some impacts on the ecosystem in both subbasins, including flamingoes inhabiting the Lake Bogoria National Park.

(6) Perkerra damsite

This damsite is about 10 km upstream of a damsite proposed by the Regional Development Plan for the Kerio valley Basin in 1982. The 1.13 km^2 reservoir is planned for water supply to the Molo River Basin (2EG). As shown on topo-map the population is smal and land use is minimal with mainly scrub and some scattered trees in the reservoir area . One road, the D350,will be inundated for less than 1.0 km and will need to be relocated.

(7) Chania-B damsite

Although both the damsite and reservoir area are situated in relatively steep gorges, there would still be land acquisition and resettlement problems since the area belongs to heavily settled area. A major issue will be the possible conflict of water use, since the Chania river is already used for existing water supply and also foreseen to serve future water supply schemes in both upstream and downstream areas.

11.3.5 Schemes in Ewaso Ngiro North River basin

(1) Rumuruti damsite

The damsite is located within the Rumuruti Forest area. Forest clearance will be necessary at the damsite and in reservoir area, but otherwise no serious problems have been foreseen.

(2) Nyahururu damsite

The proposed damsite is relatively close to habited area. It is presumed that the construction work will involve some land acquisition and resettlement issues, though the quantities will not be large. Attention should be required for reservoir water quality and health issues, since the reservoir is in the heavily settled area and receives some effluents from the catchment where is also populated.

N12. INITIAL ENVIRONMENTAL EXAMINATIONS OF SHORT-LISTED IRRIGATION SCHEMES.

12.1 General Issues

Environmental impacts of irrigation schemes result from two principal sources: those resulting from site location and those resulting from management strategies and practices. At present little information relating to the eighteen short-listed projects is available concerning the latter category, the initial environmental examinations reports (IEE's) here are based, therefore, mainly on location related impacts.

It has not been possible to carry out more detailed IEE's as illustrated in Table N12.1 which is based on the Asian Development Bank format; such studies can be conducted at a later stage of project planning when more details on management plans, and especially information on agro-chemical use and methods of application are available and the project list has been shortened by further screening. The present reports, therefore, are preliminary but have attempted to identify the most likely impacts. They should not be considered as certain or guaranteed; neither should the list of impacts be regarded as definitive since more may be revealed as studies continue.

All irrigation projects on the short-list will have some degree of impact on the people presently inhabiting the proposed project area. Not all will be adversely affected, and hopefully a majority will benefit. However, all will be affected in some way. An initial assessment has been carried out on the probable numbers of people so affected; this assessment is based on several assumptions which must be clearly understood. These assumptions are as follows:-

(a) hat the population projections are correct,

(b) that the project will be developed to its full design area,

(c) that the population is evenly distributed within the locations affected by the project,

(d) that the area of the scheme is distributed among the affected locations in proportion to the area of these locations.

In terms of population relocation, should this prove necessary, the availability of land for resettlement will be a decisive factor and the ease of finding such land will in part depend upon the areal proportion of the locations taken over by the project. Estimates of the percentage of location land taken by the various projects are included on Table N12.2. These percentages range from <1% in Tana Delta and Turkwel to over 73% at Mwea.

The results of this assessment of population impacts are given in Table N12.2 and are not specifically commented on in the following notes. In the notes below only the most probable negative impacts are mentioned; others are entered on Table N12.3.

12.2 IEE's of Specific Schemes

Reference to Table N12.3 should be made to supplement these notes on individual projects.

12.2.1 Arrow scheme

This irrigation development is part of a combined scheme including hydropower production. The construction of the dam for hydropower has now been down rated and the irrigation scheme may, therefore, not now go ahead.

The Kerio Valley Development Authority Feasibility Study Report indicates that the hydropower dam would reduce flows in the lower course of the Arror and this will negatively affect a complex network of existing traditional water conveyance furrows which would become permanently dry. This will badly affect people in the Kerio Valley who depend on the furrows for irrigation, domestic water supply and livestock water. The environmental impacts of the actual Arror scheme appear to be minimal but further investigations are recommended especially to ensure the protection of any ASAL key production areas which may be affected.

12.2.2 Kano plains scheme

The principal negative environmental impact of this scheme is identified as the effects of the return water on the Winam Gulf. The return water will be enriched with nutrients; may also contain pesticides and herbicides; have a low or zero oxygen content and have a high BOD.

To mitigate the impacts of this poor quality return water on the Gulf it is recommended that the return water is drained into the Nyando swamp where natural tertiary treatment will remove much of the nutrient from the water. The return water flow should be dispersed in the swamp and not channelled through to allow maximum absorption of dissolved matter. This use of the swamp will probably cause it to grow in size and invade Nyakach Bay to some extent; this is regarded as the lesser of two evils.

Since it may take some years for this scheme to develop efforts should be made now to conserve and protect the Nyando swamplands from 'development' or reclamation for other land use purposes thereby ensuring their survival to perform this valuable and vital water clarification role.

12.2.3 Kanzalu scheme

This is a paddy rice scheme and therefore the possibility exists of introducing schistosomiasis and increasing the existing incidence of malaria. The adverse impacts of sediment on the scheme are another possible problem.

12.2.4 Kibwezi Extension scheme

No particular problems are identified here other than those presented by the high silt load in Athi-Sabaki river water.

12.2.5 Kimira scheme

Similar problems as with the Kano Plains scheme; the difference here is the lack of natural swamps to clean up the return water which will enter Kendu Bay with uncertain, but adverse water quality implications. The creation of an artificial swamp area to provide the necessary treatment might be considered as a mitigation measure.

12.2.6. Kunati scheme

Insufficient information is available to make a meaningful assessment at this time.

12.2.7 Lower Ewaso Ngiro scheme

There are several important and potentially significant adverse impacts of this proposal as follows, for further details see Chapter N9, Part I, of the main report on Environmental Conservation:-

(a) The possible desiccation of the Shompole swamps which are believed to be an ASAL key production area which sustains the local nomads through the dry season.

(b) Excision of 10,000 hectares of grazing land.

(c) Possible social conflicts resulting from land use changes.

(d) Impacts of existing diseases, malaria, schistosomiasis and sleeping sickness on the project developers and their livestock.

(e) Pressure on fuel wood resources.

(f) The location of the project between two of the most saline lakes in the world suggests that soil conditions in this area may be unsuitable for agriculture of any kind.

12.2.8 Lower Kuja scheme

Some adverse impacts related to water quality are a possibility here. The inflowing water comes from an area where the mining of heavy metals has been conducted in the past and this may have impacts on the scheme. Analyses for heavy metals should be carried out to clarify this situation.

The return water from the scheme will drain directly into Karungu Bay of Lake Victoria. This will probably not result in significant pollution so long as lake shore currents disperse the inflow otherwise localized pollution may occur.

12.2.9 Lower Nzoia-Bunyala scheme

No major problems foreseen here. Return water will pass directly into Lake Victoria but currents and dilution should prevent the build up of pollution problems.

12.2.10 Rupigazi scheme

No known problems. Sprinkler irrigation requires higher quality water especially in regards to sediment and salinity but no data are available.

12.2.11 Mwea extension scheme

No obvious problems apart from the high population density in the locations affected; nearly 43,000 people are projected to be living in the project area by 1995. Otherwise impacts here will be similar to the original scheme area.

12.2.12 Sabaki extension scheme

Problems here may include the impacts of return water on the ecology of the Sabaki estuary and Malindi Bay; the sediment load from the Sabaki river on the furrow system and the extent of forest clearance which may be necessary. Forest cover in the project area is unknown but it may include parts of the Arabuko-Sokoke Forest; this needs to be confirmed.

12.2.13 Tana Delta scheme

Potential impacts include:

(a) Return water impacts on the lower Tana River and the inshore coastal region are a potential problem depending on the extent of agro-chemical use on the scheme.

(b) The degree of flood protection works will affect the ecology of the floodplain and Tana estuary both of which depend on regular seasonal flooding. Floodplain and inshore fisheries will also suffer. The development or extension of water related diseases is also an important consideration in this area.

12.2.14 Taita Taveta scheme

Although water quality data for the Lumi River are not available there is some question as to the suitability of this water from a salinity point of view. The effects of return water on Lake Jipe are unpredictable but the extensive papyrus swamps around the lake may provide protection against pollution. The extent of water loss to Lake Jipe and the effects on lake level are also unknown.

12.2.15 Thanatu scheme

No relevant data are available. Nearly 5,000 people will be living in the project area by 1995 according to recent projections.

12.2.16 Turkwel scheme

Several points can be raised concerning this proposal;

(a) It is probable that ASAL key production areas are targeted for development here; if this is the case then the proposal should be reconsidered. This should be done in the light of the performance of existing Turkwel irrigation schemes which according to one report have a particularly poor record of production and suffered large cost over-runs. This same report questioned the whole concept of trying to develop irrigation in ASAL areas, a view which the present author supports.

(b) The extent of water loss and quality reduction in the scheme and the impacts on downstream users need detailed evaluation before further consideration is given to this project.

(c) The probable impact on fuel wood resources by project inhabitants should also be given further study.

(d) This scheme lies down river from the Turkwel Hydropower dam; the reliability of water for irrigation should be assessed in detail to ensure adequate flows for irrigation and maintenance of the river ecology and supply to downstream users.

12.2.17 Upper Nzoia scheme

The only foreseeable problem here is the impact on population; estimates indicate that over 15,000 people will be living in the area by the year 1995.

12.2.18 Yala Swamp scheme

(a) The destruction (reclamation) of 70 km2 of the Yala Swamp is required to implement this project which in itself may be a major ecological loss. Further study is recommended.

(b) If the project goes ahead the return water should be filtered through the remaining swamp to reduce the pollution load on Lake Victoria as much as possible.

(c) It should also be assessed whether the scheme will adversely affect the hydrology and ecology of lakes Kanyaboli and Sare, both of which contain fish species endemic to Lake Victoria but which are now endangered by over-fishing and are uncommon or absent from the Winam Gulf. These fish include once commercially important species of 'tilapia'.

TABLES

Table N11.1 An environmental checklist for hydropower development schemes.

1. **Environmental effects due to project location**
   - (1) Resettlement and compensation
   - (2) Encroachment into river catchments
   - (3) Encroachment into National Parks and Forest Reserves
   - (4) Impairment of historic and cultural artifacts and sites
   - (5) Catchment erosion and siltation
   - (6) Impairment of navigation
   - (7) Effects on surface and groundwater hydrology
   - (8) Effects on migrating fish
   - (9) Inundation of mineral resources
   - (10) Other adverse inundation effects
   - (11) Improved access across river via the dam wall
   - (12) Impaired passage across reservoir away from the dam site

2. **Problems from oversights in planning and design**
   - (1) Road erosion
   - (2) Pre-impoundment reservoir site preparation
   - (3) Water rights conflicts

3. **Problems during construction stage**
   - (1) Erosion control and silt runoff
   - (2) Other construction stage hazards
     - a. workers safety
     - b. sanitation of construction camp
     - c. water-related and faecal-oral diseases
     - d. dust, noise, fumes etc.
     - e. social pressures on local communities

4. **Problems resulting from deficiencies in project operations**
   - (1) Downstream flow variations and bore hazard
   - (2) Reduction in downstream fishery yield
   - (3) Delta fishery impacts
   - (4) Downstream erosion
   - (5) Downstream water quality
   - (6) Lack of reservoir management
   - (7) Eutrophication and aquatic weeds
   - (8) Disease vector problems
   - (9) Reservoir bank stability
   - (10) Operation monitoring

5. **Potential environmental enhancement measures**
   - (1) Reservoir fishery management
   - (2) Drawdown agriculture
   - (3) Downstream community water supply
   - (4) Downstream aquaculture
   - (5) Forestry and wildlife reserves
   - (6) Tourism and recreation

6. **Additional considerations for hydropower projects**
   - (1) Design options
   - (2) Characteristics and environmental impacts of design options

Table N11.2 Summary of IEE results for Potential Damsites (1/2)

Name of damsite	Compensation required for			Relocation settlement	National Parks Forests	Aquatic weeds	Bush/scrub clearance	Health/ safety hazards	Water quality problems	Water use conflicts	NOTES
	Land	Crops	Housing								
Amala	==	==	==	==	*F	==	**	==	==	==	
Bunyunyu	*	*	*	*	==	==	/	/	*	==	(1)
Itare	*	==	==	==	**F	==	**	==	==	==	
Londiani	*	*	*	*	==	==	/	/	==	/	
Magwagwa	**	**	**	(****)	==	/	**	**B	==	*	(2)
Moiben	*	*	*	*	==	==	*	==	==	==	
Nandi Forest (dam)	==	==	==	==	(****)F	==	(****)	==	==	==	(3)
Nandi Forest (weir)	==	==	==	==	*F	==	*	==	==	==	
Masabet	==	*	==	==	==	==	*	==	==	==	
Perkerra	==	==	==	==	==	==	*	==	==	==	
Waseges	==	==	==	==	==	==	*	==	==	***	
Kimwarer	/	/	/	*	*F	/	/	/	/	/	
Malewa	**	**	**	**	==	==	*	==	==	(****)	
Narok	/	/	/	/	*F?	/	*?	/	/	/	
Oldorko	*	==	*	**	==	==	**	***M,S&T	==	(****)	(4)
Ikiwe	==	==	==	*	==	==	==	==	==	==	
Kiteta	==	==	==	*	*F	/	*	==	==	==	
Mwachi	*	*	*	*	==	*	**	?*	==	==	
Ndarugu	**	*	*	**	==	/	*	==	**	==	
Pemba	*	==	*	*	==	*	*	?*S	==	==	
Rare	*	==	*	*	==	*	*	?*S	**	==	
Upper Athi	==	==	==	==	(****)P	==	**	==	/	/	(5)
Low Grand Falls	*	*	*	*	*F?	==	*	/	==	==	(5)
Mutonga	*	*	*	*	*F?	==	*	/	==	==	(5)
Thiba	==	==	==	==	==	==	==	==	==	==	

(****) = the most significant impact
*** = high impact
** = moderate impact
* = low impact
== = no significant impact anticipated
/ = unknown or not assessed
B,M,S,T = power bores, malaria, schistosomiasis & trypanosomiasis respectively
P,F = park, forest respectively

NOTES:
(1) Swamp water may reduce water quality.
(2) Power bore flows will occur in the river below the dam, where the tailrace re-enters the river downstream. Compensation flows necessary in the river below the dam in dry season.
(3) A small water treatment works will be inundated by the reservoir near the dam site.
(3) Tinderet Forest; heavy metals; possible international repercussions.
(4) Possible intrusion into ASAL key production area by the associated irrigation scheme.
(5) Possible impacts on riverine forests.

Table N11.2 Summary of IEE results for Potential Damsites (2/2)

Name of damsite	Compensation required for			Relocation settlement	National Parks Forests	Aquatic weeds	Bush/scrub clearance	Health/ safety hazards	Water quality problems	Water use conflicts	NOTES
	Land	Crops	Housing								
(Schemes supplementally examined)											
Mulubisi	*	*	*	*	*	/	==	==	==	==	
Kibos	*	*	*	*	==	==	==	==	==	*	
Upper Narok	/	/	/	/	*F	/	*	/	/	/	
Ruiru-A	**	**	**	**	==	==	==	==	==	*	
Kikuyu	**	**	**	**	==	==	==	==	==	==	
Yatta	***	***	**	**	==	==	==	==	==	*	
Chania-B	**	**	**	*	==	==	==	==	==	***	
Rumuruti	==	==	==	==	*	/	==	==	==	=	
Nyahururu	**	**	**	*	==	*	*	*	*	==	
Sondu/Miriu	==	==	==	==	==	==	==	==	==	**	(1), (2)
Chemususu	==	==	==	==	*	==	*	==	==	==	(2)
Kirandich	==	==	==	==	==	==	*	==	==	==	(2)
Ruaka (Kiambaa)	**	***	**	**	==	==	==	*	*	*	(2)

(****) = the most significant impact * = low impact
*** = high impact == = no significant impact anticipated
** = moderate impact / = unknown or not assessed
B,M,S,T = power bores, malaria, schistosomiasis & trypanosomiasis respectively P,F = park, forest respectively

(1) Water transfer to Kano Plain irrigation
(2) Schemes committed for implementation

Table N11.3 Principal Features of Potential Damsites (1/2)
(in order of Sub-basin code No.)

Item No.	Potential Damsites	Sub-basin Code	River (damsite)	Catchment Area (Km2)	Study Stage	Purpose	Reservoir Water Level & Storage Capacity								Dam				Variation of Reservoir Area by Drawdown (Km2)	Re-marks
							H.W.L. (F.S.L.) (El.m)	L.W.L. (El.m)	Dead Storage (MCM)	Active Storage (MCM) /1	Gross Storage (MCM)	Surface Area (FSL) (Km2)	Yield (m3/s)	Yield (m3/day)	Dam Crest (El.m)	Dam Height (m) /2	Embankment Volume (1000m3)	Construction Cost (1000 US$)		
1	Moiben	1BA	Moiben	188	D/D	W	2,361.6	2,337.1	1.22	18.38	19.60	1.37	0.68	58,666	2,36.6	42	414	14,720	2.9	Under D/D
2*	Mukulusi	1EA	Mukulusi	341	M/P	W	1,510.1	1,508.5	11.60	5.39	16.99	2.27	1.10	95,040	1,515.1	8	21	960	0.8	small dam
3	Nandi Forest	1FD	Yala	1,339	M/P	W	-	-	-	-	-	-	0.45	38,880	-	weir	-	-	-	Run-of-river
4	Londiani	1GC	Kipchorian	71	M/P	W	2,325.6	2,297.2	1.60	49.30	50.90	4.36	0.47	40,608	2,330.6	50	1,720	54,550	4.1	
5	Kibos	1HA	Kibos	179	M/P	W	1,482.1	1,471.6	2.20	4.93	7.13	0.68	0.95	82,080	1,487.1	39	700	23,840	0.3	
6	Itare	1JA	Itare	185	M/P	W	2,400.5	2,379.7	1.11	12.48	13.59	0.97	1.73	149,472	2,405.5	35	623	21,430	0.9	
7	Sondu/Miriu	1JA	Sondu	3,360	D/D	P,I	-	-	-	-	-	-	-	-	-	weir	-	5,200	-	Run-of-river
8	Masabet	1JC	Timbili	138	M/P	W	1,839.04	1,820.3	0.83	8.32	9.14	0.56	1.00	86,400	1,844.0	31	510	20,400	0.35	
9	Magwagwa	1JG	Sondu	3,160	F/S	P,I	1,665.0	1,603.0	107.00	701.00	808.00	23.49	-	-	1,670.0	110	4,388	169,700	20.6	
10	Bunyunyu	1KB	Kuja	120	M/P	W	1,834.3	1,832.7	3.40	1.34	4.74	2.43	0.61	52,704	1,837.3	16	18	4,280	1.0	
11	Amala	1LB1	Amala	475	M/P	W	2,186.15	2,170.70	0.59	4.75	5.34	0.42	1.25	108,000	2,191.2	34	480	19,680	0.32	
12	Kimwarer	2CB	Kimwarer	136	Pre-F/S	W	2,443.64	2,429.12	6.26	12.83	19.8	1.41	0.90	77,760	2,448.6	59	1,380	53,130	0.87	
13	Waseges	2CC	Waseges	433	M/P	W	1,418.19	1,406.35	12.99	16.62	29.61	1.97	0.60	51,840	1,423.2	48	1,080	44,820	0.86	
14	Chemususu	2ED	Perkerra	63	D/D	W	2,336.5	2,315.5	1.51	9.44	10.95	0.82	0.41	35,000	2,340.0	45	757	20,200	0.6	
15	Perkerra	2EE	Perkerra	501	M/P	W	1,558.52	1,554.46	15.03	2.68	17.71	1.13	0.21	18,144	1,563.5	43	860	28,638	0.21	
16	Kirandich	2EH	Kirandich	28	D/D	W	1,774.4	1,756.5	0.75	3.25	4.52	0.28	0.13	11,000	1,3780.0	50	420	20,000	0.2	
17	Malewa	2GB	Malewa	635	F/S	W	2,149.0	2,123.5	15.88	55.82	71.70	3.32	1.37	118,714	2,154.0	80	1,170	47,630	2.1	
18	Upper Narok	2KA	Ewaso Narok	516	M/P	W	1,9485.5	1,975.5	3.10	6.99	10.09	0.79	1.20	103,680	1,988.5	29	368	13,190	0.6	
19	Narok	2KA	Ewaso Narok	633	M/P	W	1,910.08	1,892.24	3.80	20.64	24.44	2.42	1.20	103,680	1,915.1	42	1,110	45,621	1.81	
20	Oldorko	2KB	E.Ngiro S.	5,696	Pre-F/S	P,I,W	1,300.0	1,272.0	71.20	885.22	956.42	51.15	-	-	1,305.0	55	4,480	121,620	39.7	

Notes: Marked "*" shows a damsite newly identified in this Study.
Purpose, W = water supply, I = irrigation, P = hydroelectric power.
Study stage, M/P = mater plan, Pre-F/S = prefeasibility study, F/S = feasibility study

/1 Active storage = (required storage capacity for w/s) + (reservoir evaporation loss)
/2 Dam height above reverbed

Source: Sectoral Report H.

Table N11.3 Principal Features of Potential Damsites (2/2)
(in order of Sub-basin code No.)

Item No.	Potential Damsites	Sub-basin Code	River (damsite)	Catchment Area (Km2)	Study Stage	Purpose	Reservoir Water Level & Storage Capacity								Dam				Variation of Reservoir Area by Drawdown (Km2)	Re-marks
							H.W.L. (F.S.L.) (El.m)	L.W.L. (El.m)	Dead Storage (MCM)	Active Storage (MCM) /1	Gross Storage (MCM)	Surface Area (FSL) (Km2)	Yield (m3/s)	Yield (m3/day)	Dam Crest (El.m)	Dam Height (m) /2	Embankment Volume (1000m3)	Construction Cost (1000 US$)		
21	Upper Athi	3AA	Athi	400	Pre-F/S	W	1,551.7	1,542.9	3.00	7.30	10.30	1.12	0.30	25,920	1,554.7	26	171	6,520	0.7	
22	Ruaka (Kiambaa)	3BA	Ruaka	100	D/D	W	1,755.7	1,747.7	0.60	2.07	2.67	0.29	0.12	10,000	1,758.7	18	120	4,710	01.2	
23	Kikuyu	3BA	Nairobi	81	M/P	W	2,006.6	1,989.9	0.49	10.50	10.99	1.06	0.25	21,600	2,009.6	25	221	8,250	0.8	
24*	Ruiru	202	Ruiru	202	M/P	W	1,898.9	1,855.8	1.21	17.83	19.04	0.87	0.35	30,240	1,903.9	69	1,528	48,920	0.7	
25	Ndarugu	3CB	Ndarugu	360	M/P	W,I	1,451.3	1,429.8	9.27	214.95	224.22	18.76	6.10	527,040	1,456.3	36	1,302	42,230	9.7	
26	Ikiwe	3EA	Ikiwe	373	M/P	W	1,357.23	1,351.23	18.65	8.68	27.33	2.01	0.40	34,560	1,362.2	39	760	26,296	0.49	
27	Kiteta	3EB	Ngaa	72	Pre-F/S	W	1,207.39	1,202.73	3.60	3.95	7.55	1.15	0.10	8,640	1,210.4	24	380	17,328	0.48	
28	Yatta	3FB	Athi	20,000	M/P	I	782.1	764.2	100.00	280.20	380.20	25.61	13.50	1,166,400	787.1	52	4,988	145,240	16.0	
29	Rare	3LA	Rare	6,246	F/S	W	91.1	82.5	6.00	31.27	37.27	5.51	0.50	43,200	94.1	21	502	35,120	2.2	Off-stream
30	Mwachi	3MB	Mwachi	7,497	M/P	W	85.6	39.5	8.00	105.00	113.00	5.26	2.75	237,600	90.6	77	3,217	97,010	0.6	
31	Pemba	3MC	Pemba	866	M/P	W	-	-	-	-	-	-	0.23	19,872	-	weir	-	1,100	0.9	Run-of-river
32	Chania-B	4CA	Chania	338	M/P	W,I	1,790.6	1,720.6	2.03	48.99	51.02	1.50	1.3	112,320	1,795.6	101	3,816	113,530	1.3	
33	Thiba	4DA	Thiba	173	F/S	I	1,380.0	1,359.0	1.30	16.73	18.03	1.22	-	-	1,385.0	35	1,200	22,200	0.9	
34	Mutonga	4FA	Tana	15,329	Pre-F/S	P	550.0	542.0	268.26	87.81	356.07	1,090	-	-	554.0	42	870	117,940	5.1	
35	LowGrand Falls	4FB	Tana	17,459	Pre-F/S	P	512.0	500.0	742.01	857.78	1,599.79	67.20	-	-	516.0	9	5,820	242,260	22.3	
36	Rumuruti	5AA	Ewaso Narok	673	Pre-F/S	W	2,012.8	2,010.4	2.00	0.95	2.95	0.63	0.03	2,592	2,015.8	1	109	4,310	0.2	
37	Nyahururu	5AA	Nyahururu	29	M/P	W	2,400.0	2,380.9	0.17	10.23	10.40	1.16	0.26	22,464	2,403.0	20	72	2,940	1.1	

Notes: Marked "*" shows a damsite newly identified in this Study.
Purpose, W = water supply, I = irrigation, P = hydroelectric power.
Study stage, M/P = mater plan, Pre-F/S = prefeasibility study, F/S = feasibility study

/1 Active storage = (required storage capacity for w/s) + (reservoir evaporation loss)
/2 Dam height above reverbed

Source: Sectoral Report H.

Table N11.4 Water Quality of the Ewaso Ngiro (South) River.

Parameter	Unit	Date of sampling								
		03-09 1982	13-01 1983	08-09 1983	04-11 1983	06-03 1984	08-05 1987	26-08 1987	15-12 1987	11-04 1988
pH	–	6.2	6.8	6.9	7.3	7.4	7.0	6.4	6.2	6.4
Turbidity	–	21	12	20	5	5	44	18	21	22
Colour	–	70	–	–	15	60	5	10	40	–
Conductivity	uS/cm	66	90	52	80	120	154	280	162	15
Iron	mg/l	–	2.0	–	–	–	3.2	1.6	–	1.6
Manganese	mg/l	–	0.1	4.0	–	–	0.2	0.1	–	–
Calcium	mg/l	3.0	1.8	1.0	4.8	[10.0]	0.8	2.2	4.0	1.8
Magnesium	mg/l	0.6	1.8	–	0.5	3.9	1.0	0.8	2.0	[18.0]
Sodium	mg/l	–	–	–	–	–	26.0	27.0	22.0	–
Total hardness	mg/l	12	24	14	14	42	20	16	18	[177]
Total alkalinity	mg/l		58	26	36	46	60	74	50	60
Chloride	mg/l	[55]	3	3	7	8	7	6	[70]	4
Fluoride	mg/l	0	0	0	2	–	0	0	0	0
Sulphate	mg/l	0.2	0.5	–	0.8	–	1.2	1.2	0.6	0.3
Phosphate	mg/l	–	–	–	–	0.1	0.1	0.1	0	–
TDS	mg/l	44	54	[312]	48	72	92	168	97	92

[ ] = doubtful results
Source: MOWD database.

Table N11.5 Water quality of the Ndarugu Dam Tributaries, 1983.

Parameter	Unit	Komu River				Ndarugu River			
		1	2	3	4	1	2	3	4
pH	–	7.2	6.9	7.6	7.5	6.7	8.1	7.4	7.1
Colour	oHazen	70	75	–	–	180	145	–	–
Turbidity	FTU	50	63	–	–	110	92	–	–
BOD5	mg/l	100	630	0.7	8.9	5	100	4.0	–
COD	mg/l	84	182	30	30	4	12	70	190
Conductivity	uS/cm	250	165	–	–	47	63	–	–
Total hardness	mg/l	55	33	14	52	12	32	30	80
Calcium hardness	mg/l	34	24	–	–	16	28	–	–
Total alkalinity	mg/l	112	83	80	103	23	32	45	21
Total solids	mg/l	470	384	–	–	328	202	–	–
TSS	mg/l	134	112	–	–	168	46	–	–
TDS	mg/l	–	–	18	18	–	–	42	114
Calcium	mg/l	34	24	42	5	16	28	29	33
Iron	mg/l	0.2	1.2	–	–	0.4	0.4	–	–
Magnesium	mg/l	31.0	17.0	11.4	20.1	8.0	14.0	7.7	5.0
Manganese	mg/l	–	–	0.0	2.0	–	–	0.0	0.0
Potassium	mg/l	–	–	47.8	58.4	–	–	22.2	21.8
Sodium	mg/l	–	–	116	178	–	–	68	29
Copper	mg/l	–	–	0.2	0.0	–	–	0.0	0.2
Lead	mg/l	–	–	0.0	0.0	–	–	0.0	0.0
Zinc	mg/l	–	–	2.6	0.8	–	–	1.8	1.4
Chloride	mg/l	61	56	20	10	33	22	13	–
Fluoride	mg/l	0.97	0.97	0.77	0.85	0.76	0.78	0.43	–
Nitrite	mg/l	0.001	0.014	–	–	0.005	0.080	–	–
Nitrate	mg/l	0.94	0.30	–	–	0.83	0.55	–	–
Total ammonia	mg/l	6.20	–	–	–	3.50	2.60	–	–
Phosphate	mg/l	–	–	0.2	0.5	–	–	0.1	0.1
Grease	mg/l	0.30	0.17	–	–	–	–	–	–

Legend

Komu 1.....at Munyu
Komu 2.....at Athi River
Komu 3.....at Thika Road
Komu 4.....at Munyu

Ndarugu 1....at Komu
Ndarugu 2....at Thika Road bridge
Ndarugu 3....at Munyu
Ndarugu 4....at Thika Road bridge

Note: Sample numbers 1 & 2 from each river were analysed by the Industrial Research Consultanct Unit, Faculty of Engineering, University of Nairobi.samples 3 & 4 were analysed at the MOWD laboratory.

Source: Ref. G24; Annex 2.

Table N11.6 Water Quality of the Ndarugu River Station 3 CA 2.

Parameter	Unit	Date of sampling							
		13-10 1982	28-02 1986	12-06 1986	11-06 1986	31-07 1986	14-01 1987	15-03 1988	MEAN
pH	–	7.2	7.8	6.6	6.0	6.4	7.3	6.9	6.9
Turbidity	–	–	31	72	140	53	43	15	59
Colour	–	–	–	200	400	100	175	50	185
Conductivity	uS/cm	74	155	150	46	60	80	166	104
Iron	mg/l	6.8	–	4.7	10.5	3.4	4.8	0.1	5.1
Manganese	mg/l	0.50	–	0.17	0.42	0.16	0.35	0.10	0.28
Calcium	mg/l	3.0	–	1.9	0.1	0.9	0.8	7.3	2.3
Magnesium	mg/l	2.2	–	1.6	0.3	0.9	1.0	2.9	1.5
Sodium	mg/l	12	–	18	5	7	7	14	11
Potassium	mg/l	–	–	45.0	1.5	1.0	2.2	3.8	10.7
Total hardness	mg/l	12	30	26	6	8	16	30	18
Total alkalinity	mg/l	36	52	38	11	18	28	42	32
Chloride	mg/l	6.6	8.0	5.6	5.6	7.1	7.0	8.0	6.8
Fluoride	mg/l	–	0.70	0.44	0.30	0.24	0.26	0.34	0.38
Nitrate	mg/l	–	0.02	0.07	0.05	0.06	0.08	–	0.06
Sulphate	mg/l	–	0.3	0.3	3.6	–	0.3	1.3	1.2
Phosphate	mg/l	0.02	–	0.01	0.01	0.06	0.01	0.01	0.02
TDS	mg/l	49	93	90	28	36	48	100	63

Source: MOWD Pollution Control Unit.

Table N11.7 Water Quality of the Moiben Dam Tributaries, 1985-86.

Parameter	Unit	Chebeinet -Moiben	River Chebeinet	Moiben River	
		23-10-85	16-01-86	21-02-86	21-03-86
pH	---	7.8	7.9	7.5	7.9
Colour	mg Pt/l	--	40	15	35
PV N/80, 4 hour	mg/l	--	1.4	2.9	6.5
Conductivity	uS/cm	100	47	15	15
Aluminium	mg/l	--	0.10	0.05	(T)
Iron	mg/l	--	0.55	0.16	0.35
Manganese	mg/l	0.10	0.00	0.00	0.05
Calcium	mg/l	15.2	17.6	24.0	24.0
Magnesium	mg/l	2.0	6.8	4.2	6.6
Sodium	mg/l	7.8	7.4	4.6	3.2
Potassium	mg/l	3.8	2.4	2.9	3.0
Silica	mg/l	17	20	20	(T)
Total hardness	mg/l CaCO3	48	72	78	88
Total alkalinity	mg/l CaCO3	86	110	115	101
Chloride	mg/l	22	22	29	38
Fluoride	mg/l	0.000	0.042	0.020	0.180
Nitrate	mg/l	--	(T)	0.00	0.00
Nitrite	mg/l	0.012	(T)	0.000	0.000
TDS	mg/l	--	135	154	59
COD (2 hour)	mg/l	12	0	0	24

(T) = trace.
-- = no data.
Source: Ref. K72. Eldoret Water Supply - Phase II, 1986.

Table N12.1 An Environmental Checklist for Irrigation Schemes.

Actions affecting environmental resources and values

(a) **Environmental effects due to project location**
- (1) Encroachment into forests/swamplands
- (2) Impediment of movement of livestock and wildlife
- (3) Impairment of historic/cultural artifacts
- (4) Conflicts in water supply rights
- (5) Regional flooding/drainage hazards

(b) **Problems from oversights in planning and design**
- (1) Watershed erosion
- (2) Downstream water quality problems
- (3) Suitability of water supply quality for irrigation
- (4) Overpumping of groundwater
- (5) Adequacy of drainage planning
- (6) Land tenure problems
- (7) Farmer credit limitations
- (8) Feasibility of cooperatives
- (9) Feasibility of water users associations
- (10) Disruption of existing farmer cooperative systems
- (11) Use of agricultural chemicals
- (12) Selection of pesticides
- (13) Land use conflicts
- (14) Inequalities in water distribution
- (15) Canal maintenance
- (16) Passageways
- (17) Scouring hazards

(c) **Problems during construction stage**
- (1) Erosion control
- (2) Other construction stage hazards
- (3) Monitoring during construction

(d) **Problems resulting from deficiencies in operations**
- (1) Inadequate O&M
- (2) Adverse soil modifications
- (3) Changes in groundwater hydrology
- (4) Water-oriented disease hazards
- (5) Toxic chemical hazards
- (6) Fertilizer runoff hazards
- (7) Operations monitoring
- (8) Aquaculture water supply

(e) **Realization of enhancement potentials**
- (1) Community water supply and sanitation in service area
- (2) Aquaculture in service area

(f) **Overall environmental review criteria**
- (1) Unwarranted losses of precious resources
- (2) Unwarranted acceleration of resource use for short-term gain
- (3) Adversly effect the national energy and foreign exchange situation
- (4) Unwarranted hazards to endangered species
- (5) Undesirable migration to urban centres
- (6) Increase the affluent/poor divide

Table N12.2 Population density projections in short-listed irrigation scheme locations, 1990-2010.

Name of scheme	Location	Area of Location (km2)	Irrigated area (ha)	Project as % of location area	Estimated size of population affected		
					1990	1995	2010
1 Arror	Arror	104	1,340	3.0	50	56	57
	Mon	347			15	17	17
				Total	65	73	74
2 Kano Plains	North Nyakach	166	26,150	30.0	14,065	14,512	12,524
	West Nyakach	66			5,075	5,254	4,517
	N-E Kano	223			17,209	17,809	15,341
	S-E Kano	254			16,057	16,818	15,372
	N-W Kano	76			7,752	8,026	6,908
	S-W Kano	88			5623	5808	4990
				Total	65,781	68,227	59,652
3 Kanzalu	Mbiumi	146	4,055	27.8	8,364	9,632	13,763
4 Kibwezi extension	Ngwata	884	13,200	7.7	3,196	3,740	5,304
	Mtito Andei	833			3,905	4,672	7,232
				Total	7,101	8,412	12,536
5 Kimira	Central Karachuonyo	117	2,000	17.0	7,100	8,360	12,820
6 Kunati	Mwonge	38	1,050	27.6	2,888	3,339	4,746
7 Lower Ewaso Ngiro	Magadi	1,110	10,000	9.0	1,000	1,400	4,100
8 Lower Kuja	North Kadem	201	1,900	3.5	824	959	1,385
	South Kadem	338			1,856	2,142	3,130
				Total	2,680	3,101	4,515
9 Lower Nzoia/Bunyala	East Bunyala	19	10,480	27.6	3,552	4,009	5,330
	South Bunyala	97			5,046	5,714	7,556
	North Samia	121			9,457	10,656	14,519
	South Samia	143			8,983	10,126	13,711
				Total	27,038	30,505	41,116
10 Lower Rubigazi	S. Mbeti	178	1,800	5.5	563	669	1,009
	Murinduko	151			971	1,137	1,685
				Total	1,534	1,806	2,694
11 Mwea extension	Mutithi	40	2,900	72.5	36,163	42,949	67,019
12 Sabaki extension	Dagamra	67	3,000	21.6	1,392	1,624	2,349
	Garisha	72			1,116	1,287	1,876
				Total	2,508	2,911	4,225
13 Tana Delta	Bilisa	11,003	12,000	0.9	102	204	204
	Salama	633			83	100	159
	Witu	1,279			71	178	534
				Total	256	482	897
14 Taita Taveta	Taveta	532	3,780	7.1	2,722	3,175	4,612
15 Thanantu	Thangatha	168	2,520	10.1	2,720	3,145	4,454
	Mbeu	81			1,460	1,689	2,394
				Total	4,180	4,834	6,848
16 Turkwel	Lorengippi	2,102	600	0.1	9	9	6
	Kalapata	2,021			20	20	17
				Total	30	30	24
17 Upper Nzoia	Ndalu	185	7,550	40.8	13,213	15,327	22,726
18 Yala swamp	Usonga	98	7,000	35.9	5,210	6,054	8,870
	South Bunyala	97			6,577	7,447	9,848
				Total	11,787	13,501	18,718

Table N12.3 Tentative summary of impacts of proposed irrigation schemes.

Potential impact	Scheme number number and name																	
	1 Arror	2 Kano	3 Kanzalu	4 Kibwezi	5 Kimira	6 Kunati	7 S.Ewaso	8 Kuja	9 Bunyala	10 Rubigaz	11 Mwea X	12 Sabaki	13 Tana D	14 Taita	15 Thanan	16 Turkwel	17 L.Nzoia	18 Yala
Population impacts (1)																		
- numbers affected (1995)	73	68,227	9,632	8,412	8,360	3,339	1,400	3,101	30,505	1,806	42,949	2,911	482	3,175	4,834	30	5,327	13,501
- % of location area affected	3.0	30.0	27.8	7.7	17.0	27.6	9.0	3.5	27.6	5.5	72.5	21.6	0.9	7.1	10.1	0.1	40.8	35.9
Disease aspects																		
- Introduction of new diseases	/		++		/					/	++		/	+		+		
- Impacts of existing diseases	/	++			++		++	++	+	/	++		++					
- Agro-chemical hazards													++					
Downstream impacts																		
- on water volume	+		+	+			++					+	+	+		++		
- on water quality	+	++		+	++		/	++	+	/	+	+	++					
In flow water quality																		
- chemistry	/	/	/		/			++						++				
- sediments		/	+	+	/		+	/		+		++	+					
Soil quality							++	/	/		/							
ASAL key production area impacts	+	/			/		++	/	/	/	/	/	/			++		
Fuel wood demand		+					++									++		
Other impacts (see Notes)													Arabuko Sokoke Forest	L.Jipe (2)		L.Turk -ana(3)		++(4)

++ = probable impact
\+ = possible impact
/ = probably no impact
blank = unknown

Notes:
(1) See notes on assumptions in main text.
(2) Uncertain water quality and lake level impacts.
(3) Reduced water inflow affecting lake level.
(4) Swamp clearance-reclamation.