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FEEDER ROAD TECHNICAL ANALYSIS

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3.4. FEEDER ROAD TECHNICAL ANALYSIS

3.4.1. Objectives of the IDP Feeder Roads Component

The construction of feeder roads is an important step towards establishing the infrastructure that is essential to profitable perimeters. The objective of this component is to provide access to the project perimeters for input deliveries and produce marketing.

The IDP plans for financing feeder roads include constructing 136 km of feeder roads in Mauritania to link the Gouraye and Kaedi perimeters to the main routes, and conducting a feasibility study for the construction of the Kayes to Diboli Road in Mali. In Senegal, 51 km of feeder roads have been identified for financing under another USAID bilateral project.

3.4.2. The Problem

The lack of passable roads in the IDP zones is a serious impediment to all development activities. Target villages* on Senegal River banks can only be reached by poorly maintained tracks that are flooded during the rainy season. Transport needs will derive primarily from the movement of agricultural produce and inputs in and between the five zones identified by the IDP.

By studying aerial photos, river hydrographs, rainfall maps, observation, field trips, and site surveys, IDP planners have been able to evaluate transportation problems during the different seasons of the year throughout the river basin. The evaluation noted that all three countries and regions on both banks face the same problems of transport, with minor variations.

In all three countries, a road considered to be the "main route" (the most direct and shortest) links villages located on the levee at the edges of the river. This road generally cuts the backwaters and small streams near the deepest points at their confluence with the Senegal river and well into the flood plain.

The IDP study was conducted in an area lying between the 600 mm and 800mm isohyetes, or a 700 mm mean rainfall in a semi-desertic zone. Overland runoff is intense after heavy rain and streams show a oued regime; that is, very heavy flooding occurs in this area, immediately following rains but diminishing rapidly, particularly upstream, away from the Senegal. At the beginning of the rainy season, during the months of May and June, when the river level is low, roads are occasionally cut off by rains.

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* See "Perimeter Location Map" - Appendix A, page 1.

As the river begins to flood, around mid-July, the influent streams become permanently flooded, cutting off the main route and making necessary to go upstream to cross the influent above the flooded zone. The stream bed generally takes two to three days to dry off after the rain stops, provided that basins (former meanders) are not inundated by the river flood or runoff water.

According to the site surveys, many villages are totally isolated for a three to four month period between July and November, during which they are accessible only by pirogue. Areas where influent streams enter the river are generally flat and characterized by slow percolation, thus increasing the length of time these areas remain impassable.

3.4.3. Existing Road Networks Servicing the SRB

3.4.3.1. Mauritania

The Mauritanian road network consists of 7,800 km of which 1,100 km are paved; 600 km are improved earth roads; and 6,100 km are unimproved dirt tracks. This network is linked to four main axes:

1. A north-south 1,850 km road from Rosso on the Senegal River to Atar, of which 459 km are paved;

2. An unpaved road from Rosso to Nema;

3. A center axis from Nouakchott to Nema; and,

4. A central unpaved road linking Boghé to Aleg and Tidjikja. (See Map §2 General Layout of Roads in Upper Valley Senegal).

Traffic will increase in the near future, with the execution of the medium-scale irrigation schemes in Boghé and in the Gorgol area where the GIRM plans to complete 1) the M'Bout to Kaedi road to be constructed in the context of the Fourth Development Plan; 2) the M'Bout to Selibabi road, to be constructed with UNSO/USAID financing; and 3) the Selibabi to Gouraye road, to be constructed with USAID financing.

IDP planners have taken note of the necessity to link Maghama to Desili and Harr, as well as Lougéré. Viewed from aerial photos, these roads seem to be accessible year round. These trails, as well as the trails between Harr and Selibaby, are recommended for upgrading with IDP financing. The feeder road network to be rehabilitated and or constructed under the IDP is discussed under Section 3.4.4.2. of this report.

3.4.3.2. Senegal

Senegal has over 8,000 km of roads of which 2,800 km are paved in addition to approximately 5,000 km of tracks. The two axes of interest to this project are the National Route Number 2, which goes from Dakar to Bakel, and National Route Number 1, which links Dakar to Tambacounda. NR §2 is asphalted up Fadiria. The remaining 45 km segment to Bakel is scheduled for completion in 1983. A 2 km stretch of the Bakel to Nahé road on the Malian border, linking Bakel to Bema, is in poor condition due to insufficient drainage structures. The GOS has set forth plans for paving the Tambacounda - Nahé portion of the road, which is already asphalted from Dakar to Tambacounda. The feasibility of the completion of this road is examined in the Sixth Development Plan of Senegal.

3.4.3.3. Mali

Mali's road network totals 15,200 km, of which 1,600 km are paved, 3,300 km are all weather roads, and 10,300 km are dirt roads and tracks which are impassable during the rainy season.

The Kayes region has no transport system to speak of. To open access to the Kayes region perimeters, construction of a Kayes to Diboli axis is being considered under the IDP.

3.4.4. Engineering Aspects

3.4.4.1. Introduction

The IDP Feeder Roads program will focus on improving tracks with alignments, drainage, stream crossing structures, and wearing courses of selected reinforcement materials.

The area under consideration has only slight relief. The main obstacles to transportation are water spreading over increasingly larger areas towards the river and flooding during the rainy season. The areas, flooded during a three to four month period of the year, are all situated in close proximity and parallel to the river. They are former river beds or depressions in which runoff accumulates during the rains. These agricultural alluvial areas, whether flooded or not, are generally loams or clay, which are useless for road foundations and require select fill embankments and bridges.

To overcome these obstacles, the feeder road routing strategy has involved constructing roads on neighboring hills above flood levels and perpendicular to the river to link villages. Alignments have been carefully chosen to minimize fills. On either side of the flood plain, higher ground provides the best site for high main roads. Soils have less clay

content and thus are less sensitive to water, and porous laterite and quartzite construction materials are abundant. Another advantage of this strategy is that it allows for crossing the streams in a reach with oued-type regime using submersible fords. This is a much less expensive solution than constructing bridges. Water for road construction can be drawn from the river or from neighboring ponds less than 15 km from the construction site.

The strategy for road alignments outlined above was based on a number of factors including the length of roads to be constructed and the presence of obstacles such as streams, flood zones, and rocky hills that require expensive construction work to overcome; for example, constructing a concrete bridge over a small stream could be more costly than 30 km length of rural road. However, it is important to regard these proposals --made on the basis of aerial photography and site visits with no topographic survey-- as feasibility level considerations, and not as a construction design, especially for areas in the flood plain.

3.4.4.2. Site Description

A. Mali

Upstream from Ambédédi, National Route Number 1 (RN 1) from Kayes to Diamou to Bafoulabé follows the left bank of the river and passes near the perimeters. Although this road is in very poor condition, it will not be repaired under the IDP. This road segment is part of the Dakar - Kayes - (Manantali) - Bamako Road and will experience much heavier traffic than a "feeder" road" of the type proposed for this project could withstand.

Repair of national routes and construction of feeder roads in Mali will be financed by other projects. IDP provided a feasibility level analysis for the feeder roads below, but at the GOM request will finance a feasibility study for improving RN 1 between Kayes and the Senegal border of Diboli, instead of the feeder roads.

	Length of Roads (in km)	Perimeters serviced[a] (in ha)
- RN 1 - Daramane - Gakoura[b]	12	256
- RN 1 - Saboukou	14	150
	26	406

(a) Existing and projected perimeters.

(b) Right bank of Gakoura will be serviced by pirogue from the left bank.

- RN 1 - Daramane - Gakoura

On the basis of the aerial photo study and site survey during the dry season, the engineer could not tell the water levels during flooding in the depressions parallel to the river between Gakoura and RN 1. It seemed prudent to connect Gakoura to Daramane through Somone, which is accessible during the dry season, since the Gakoura - Djani road has all-weather access and villages would be no longer isolated.

Nevertheless, it will be successful to establish a stream crossing between Daramane and Somone. This should be designed prior to construction, to be situated above flood level. By the time construction is underway, the maximum flood water level in the basin between Gakoura and RN 1 will be known. It is important to point out that if a passage for RN 1 over oued Sekoundekole is not built, the construction work outlined above will be of limited use, as RN 1 is not an all-weather road.

During the rainy season, water regularly cuts off the section of RN 1 leading into Senegal up to Kouloumbo near the railway bridge and on the Falémé.

B. Senegal

The proposed feeder roads (to be funded under other USAID bilateral assistance and not under the IDP) are as follows, all running from RN 2 in the interior towards the river and villages:

	Length of Roads	Perimeters Serviced[1/]
- RN 2 - Balou - Aroundou - Sébou	14	304
- RN 2 - Yaféra	14	100
- RN 2 - Koungani	7	77
- RN 2 - Moudiéri - Gandé - Galaldi	16	91
	---	---
	51	572

The proposed routing is self-explanatory, except perhaps the choice of Bondji - Moudiéri - Galaldi - Gandé over Tianato - Dembankané - Gandé - Galaldi. An aerial photo study and site visit revealed that the two roads are the same length, but establishing an alignment through Dembankane means constructing a large structure of some 20 meters in the flood plain, requiring a bridge. For this reason, we have selected the alignment through Moudiéri, where investment costs are lower. The other argument in favor of the Moudiéri alternative is that the village is much larger than Dembankane.

1/ Existing and proposed perimeters.

C. Mauritania

The general strategy proposed for the Gouraye sector is to route perimeter traffic towards RN 5 which will be constructed to serve Sélibaby, the administrative and commercial center for the Guidimaka region. Sélibabi must have access to either the M'Bout-Kaédi road to be constructed under the Fourth Plan, or to M'Bout-El Moudéré or the Bouly-Ould Yenge-Kankossa-El Moudéré roads proposed in the UNSO/USAID program. RN 5 should also be extended from Sélibabi to Gouraye.

	Length of Roads	Perimeters Serviced[1/]
- Upstream Network:		
RN 5 Diaguila - Moulessimon Diogountourou - Solou - Khabou	74	713
- Downstream Network:		
Woumpou - Lougéré - Sagné - Bedinké	62	459
	---	---
	136	1,171

The upstream network between Khabou - Guidimaki and Gouraye is constructed on hills in the interior (0 to 9 km from the river) above the floods and crossing system and is accessible most of the year. RN 5 - Diaguili: The 14 km junction between RN 5 and Diaguili is routed to pass through Boutanda (approx. 10 km) rather than directly through Gouraye-Diaguili, for the following reasons (as can be seen on aerial photos Nos. 504-134, 504-135 and 504-136 at 1:50,000 of Teledyne Geotronics).

West of Diaguili, the 4 km long flood plain of the oued Touna is inundated, either by the Senegal River or runoff in the stream itself, with a watershed of over 1,000 km². The oued Touna in this reach can only be crossed by a major bridge. These problems are encountered just 2-1/2 km west of Diaguili.

Even if all these obstacles could be overcome, a rocky pass on the way to Gouraye would be expensive to construct. Moreover, building a road through the 7 km long chain of rocky hills running north-south into Gouraye would be prohibitively expensive, as there is no pass along the river bank. At present all vehicles take a detour to the North. For the downstream network of Woumpou-Lougéré, the road east of the flood plain must cross the oued Niorde with a watershed of over 1500 km². Based on maps and aerial photos, the best place to cross between Harr and Sagne appears to be the site we have marked.

It will be necessary to verify that this site is not reached by Senegal flood waters and that soils and flow of the oued Niorde Wadi will allow construction of at least two large fords. Hydrological, topographical

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1/ Existing and proposed perimeters.

and construction work may indicate that only one ford is necessary. The rest of the road alignment showns no significant problems.

For Lougéré - Fimbo - Paliba, the road alignment remains east of the flood plain at the foot of the hills. Two transversal roads are planned at the start from Louguère towards Sagne, for 5 km and from Toulel to Wali and Bédinké- Sintiane for 12.5 km. These will not be all-weather roads.

The oued Desili, with a watershed of about 200 km^3, will be crossed by one or two fords; the dimensions of these fords can only be fixed after hydrologic and topographic studies are completed, however.

For Fimbo-Paliba to Maghama, it would appear more attractive to construct the Fimbo-Paliba - Maghama road (9 km) than the Woumpou-Louguère road as the first would service Maghama, the largest commercial center in the region and furnish access to Regional Road 7 Maghama - Kaédi. The flood plain of the oued Garfa, a basin watershed of several thousands of km^2, has a maximum width of 3 km near Maghama. Based on aerial photos Nos. 503-263 and 503-264, it would require at least five or six large fords. Moreover, hydrologic and topographic studies could impose a 3 km ford or confirm that flood duration would be too lengthy to be acceptable even for feeder roads.

When the engineer crossed this oued in March, the trail was still humid and the flood recession sorgho crop had been planted less than a month earlier. Following field visits, the northern linkage was dropped. This would have been much more expensive than the Woumpou - Lougéré road, as well as the segment from Lougéré to Desili, Harr and Sélibabi. Because the 20 hectare perimeter proposed for Liradji is not serviced by road, this linkage would have required construction of 25 km of feeder road.

Road conditions are no better in the Kaedi sector than in Gouraye. However, because Kaedi was only included rather late in the IDP design, no study was made of possible feeder roads. If funds become available during the life of the project for additional roads in Mauritania, the Irrigation Engineer in Kaedi could select sites on the basis of aerial photos and field visits, using the criteria developed in this analysis. Construction could be scheduled to coincide with the other road building in the interest of cost-efficiency. It is a fact that routings are likely to be difficult and costs high in the wide flood plain, where abundant hills, fords, or structures will be required to allow year round access to the villages on the river bank.

3.4.4.3. Design Standards

3.4.4.3.1. Criteria

Current road traffic is light, estimated at a maximum of no more than 25 vehicles per day, most of them light cars. However, trucks

with a 13-ton axle load can be expected. In any event, climatic factors such as wind, rain and drought play a more significant role than traffic in road design. There is little relief in the area. Terrain is relatively flat, and the wearing surface will generally be at natural ground level with runoff flowing over it.

In areas with signs of surface water concentration and gullying, 300 mm culverts will be built on an average of one per km; in areas of even greater water concentration, 600 mm culverts would be placed on an average of one per two kms. Inverts will be at the level of the ground or at the bottom of the gully. To protect the pipes from heavy damage by heavy traffic and to insure that runoff does not detour the culverts, we will place at least 0.50 mm of fill over a stretch estimated at 20 percent of total road length. Local fill will be bulldozed into place and compacted at a six mm width to allow trucks to pass. In an area where erosion from surface runoff is active, fill will largely consist of erodible gravel and sandy loams. Fill will require a protective wearing course, as will some portions of roadbed at ground level. The length of this laterite or quartzite wearing course is estimated at 60 percent of total length, 4 mm wide by 0.15 mm thick.

These materials can be found within a radius of 5 km. Since they are located in areas where mean annual rainfall is low, around 700 mm, their plasticity index could reach 20. Optimum Proctor Ratio will be 60 to 95%; embankment slopes will be five horizontal for two vertical.

The embankment shown in Figure 1, Appendix B, is based on the criteria mentioned above. Figure 2, Appendix B, shows the proposed fords for larger water courses.

Life expectancy of such roads should be 10 years, with light but regular maintenance.

3.4.4.3.2. Environmental Issues

Feeder roads located should be designed and constructed to minimize any negative impact on the environment. Although the new roads will increase traffic levels, vehicles will remain on prepared roadbeds, thus reducing the tearing up of ground and cutting down the dust caused by heavy vehicles traveling over dust trails. Feeder roads are to be designed and laid out to impede water flow as little as possible. Note that there may be a concentration of runoff by embankments running across the slopes, significant enough to provoke erosion.

Construction will inevitably engender some dust and noise; however, since it will take place largely during the dry season, streams will not be polluted. The first rainfalls will absorb some suspended matter, but little more than after a normal dry season of vehicles circulating on a series of parallel tracks. Borrow pits and spoil dumps will be smoothed by bulldozer or grader blading, although vegetation growth will be slow in the dry climate. Soils in the higher lying lands near the roads are sufficiently permeable so that runoff water will not accumulate in borrow pits to cause health hazards.

3.4.4.4. Construction Costs

Costs calculations are based on the criteria cited above and for duty free unit price in Senegal (August 1981).

3.4.4.4.1. Mali

Average Cost per kilometer (of Road Constructed) : 60% with laterite wearing course and 20% on fill (1981).

(in Malian Francs)

	Volume	Unit	Application %	Unit Cost FCFA	Total Cost FCFA
Clearing/Stripping	10,000	M²	100	45	450,000
Preparation compact sub-base in situ	18,000	M²	100	150	1,200,000
Place fill, bulldozer, compaction	3,000	M³	20	800	480,000
Laterite base, compaction	635	M³	60	2,000	762,000
Transport of laterite	635x5	M³ xkm.	60	125	238,125
Longitudinal ditches (embankmt. sections)	1,000	ml	20	300	60,000
Lateral discharge ditches " "	100	ml	20	800	16,000
Culverts Ø 300 . . . " "	20	ml	20	4,975	19,900
Small structures Ø 600 " "	5	ml	100	40,000	200,000
			Sub total:		3,426,025
Contractor set-up at 1.7%					58,242
			Sub total:		3,484,267
Topography search for best passage in flood zones, place markers, alignment of curves (based on aerial photos at 1:50,000) L.S/km			100	80,000	80,000
			T o t a l :		3,564,267

/ 3,56 MF CFA per KM /

Ford (1981)

2.92m long structure				
Hand excavation	9,052	M³	800	7,242
Rubble masonry	3,429	M³	33,000	113,157
Pipes Ø 400	16	lm	5,000	80,000
Concrete, 150 kg	5,972	M³	45,000	268,740
Rockfill	5,84	M³	16,000	93,440
			Sub total:	562,579
Contractor set-up at 1.7%				9,564
			T o t a l:	572,143

/ 0,196 MF CFA per Linear Meter /

Access (two/crossing) (1981)				
Hand excavation	11.76	M³	800	9,408
Rubble masonry	4.8	M³	33,000	158,400
Concrete 150 kg	4.45	M³	45,000	200,250
Rockfill	17.76	M³	16,000	284,160
			Sub total:	652,218
Constructor set-up at 1.7%				11,088
			T o t a l	663,306

3.4.4.4.2. Estimation of Construction Costs

A. Mali

	Volume	Unit	Unit Cost MF/CFA	Total Costs MF/CFA	Total Costs 000$ ($1 = 300 CFA)
Roads					
1. RN-1 Sobouko	14	km	3.56	49.8	166
Fords x 10m	20	lm	0.196	3.9	13
Access	2	u	0.663	1.3	4
			Subtotal:	55.0	183
2. RN-1 Daramane-Gakoura	12	km	3.56	42.7	142
Total	26	km	2 Fords	97.7	325
Updated to 1982 (inflation at 10%/year):				107.5	358

107,500 FCFA 358,000 dollars or 2,150,000 Malian Francs.

B. Senegal

1. RN-2 Moudiéri to Gandé-Galaldi	16	km	3.56	57.0	190
2. RN-2 Koungani	7	km	3.56	24.9	83
3. RN-2 Yaféra	14	km	3.56	49.8	166
4. RN-2 Balou	14	km	3.56	49.8	166
	51	km		181.5	605

Updated to 1982 (inflation at 10%/year):

200,000 FCFA or $666,000

C. Mauritania

(in CFA Francs)

Roads				
1. RN-5 - Diaguili-Moulessimou-Diogountourou-Solou				
- Khabou Guidimaki	74 km	3.56 x 1.7	447.8	1,493
7 Fords x 6m	42 lm	0.196 x 1.7	14.0	47
7 accesses	7 u	0.663 x 1.7	7.9	26
		Sub - Total	469.7	1,566
2. Woumpou-Lougéré	13.5 km	3.56 x 1.7	81.7	272
2(100 meter)Fords	200 lm	0.196 x 1.7	66.6	222
2 accesses	2 u	0.663 x 1.7	2.3	8
			150.6	502
3. Sagné-Lougéré	5 km	3.56 x 1.7	30.3	101
4. Toulel-Lougéré	14 km	3.56 x 1.7	84.7	282
5. Sintiane-Bédinké -Wali-Toulel	12.5 km	3.56 x 1.7	75.7	252
6. Fimbo-Paliba-Toulel	17 km	3.56 x 1.7	102.9	343
2 Fords x 100 m	200 ml	0.196 x 1.7	66.6	222
2 access bridges	2 u	0.663 x 1.7	2.3	8
			262.5	1,208
Total	136 km + 11 Fords		982.8	3,275
Updated to 1982 (inflation at 10%/yr):			1,081.0	3,603

NOTE: Costs Ratio for Three Countries

The above costs reflect the Senegalese construction market since it is the most active. A survey conducted in Mali, at the Regional Directorate for Public Works, has confirmed that this work, duty-free, would cost the same in Mali as in Senegal. The visit to Nouakchott revealed that construction costs in Mauritania would be double those of Senegal.

In the absence of an established system for feeder road construction (i.e. by force account or under contract), the maintenance cost of dirt roads have been used to establish a ratio.

In March 1982, the cost of dirt roads was estimated at 545,200 FCFA/km in Mauritania 1/. This cost was updated at 14 percent/year, 8,000 UM x 1,175-15 months in Mauritania, and 316,075 FCFA/km in Senegal 2/. This means a multiplying factor of 1.7 for the cost of work in Mauritania, to be applied to the costs as calculated for Senegal or Mali.

3.4.5. Alternative Transport System

3.4.5.1. Access to National Routes

The feasibility of the feeder road system proposed above depends on several factors beyond the scope of the IDP, namely: in Mali and Mauritania, the feeder roads proposed are virtually useless unless the national highways into which they are designed to feed are in fact built, and unless a minimum of maintenance is assured.

As an alternative to feeder roads, rail transport could be considered in Mali, but the small volume of goods to be handled at sites spaced at considerable distances poses considerable problems. It may be possible to bulk loads at existing stations. Air transport is prohibitively expensive. A discussion of river transport appears later.

3.4.5.1.1. Mali

Unless the Malian Government constructs RN 1 (Nahé to Kayes) and the Regional Route Kayes to Diamou, a minimum of 100 km, plus the Senegal junction of around 30 km, the country will have little or no alternative means of transporting goods to and from the perimeters, despite the proximity of the railway. To serve the four easternmost perimeters, a feeder road could be built parallel to RN 1 to link these perimeters to the railway station at Ambidédi, where produce could be bulked for rail shipment. This road, which would be some 23 km long, does not seem a feasible solution, given the specifications of our feeder roads and the state of RN 1. All traffic on RN 1 would detour to this feeder road, as is the case already in Moussala and Walinekane; the investment would be lost in a single season. Furthermore, this strategy would require that a bridge be constructed over the oued Sekoundekole, which is quite wide.

1/ BCEOM/SONADER Transport System Report.

2/ GOS, Directorate for Material and Road Maintenance - Report from Louis Berger International (1980-1981).

Given its distance from highway and railroad, feeder roads are the only feasible option for the portion of road from Ambidédi - Maloum. If a feeder road were built to serve the perimeters, it would certainly be used for national traffic and destroyed quickly. If specifications were to be adapted to traffic conditions, the investment, at least at the regional level, would no longer be economical. Finally, building railroad depots every five km or so to collect agricultural produce does not seem feasible.

Before or after construction of the Manantali Dam, the Senegal River could not withstand heavy freight traffic to Kayes in any but a few reaches without a heavy development investment. Between Bakel and Kayes, approximately six rock sills four to six km long dot the river, one of them eight km long. (Norbert Beyrard Study, 1974 and LDE Navigability Study 19).

3.4.5.1.2. Senegal

Feeder road construction (financed by other USAID bilateral assistance and not under the IDP) does not seem to present any problems, as construction of National Highway Two is almost completed.

3.4.5.1.3. Mauritania

The best possible sites have been tentatively identified for feeder roads to link the proposed perimeters in Gouraye and Kaédi to commercial centers or major transport routes. The design strategy is to facilitate the movement of goods, inputs and produce to and from Sélibabi, the commercial and administrative center of the Guidimaka Region if the RN-5 Sélibabi Gouraye is constructed; then the major portion of traffic and merchandise could go through Sélibabi. If these conditions are not fulfilled, the best course of action would be to divert traffic that presently crosses the river to Bakel and Senegal, on RN-2 in Senegal towards Rosso, St. Louis, and Dakar.

This goal might be accomplished by the following means:

1. Completing the segment of RN-5 Boutanda to Gouraye as a reinforced feeder road for approximately 16 km (relocating a portion of the road to the west of the present alignment to take it out of a stream bed).

2. Repairing the existing ferry so that the river could be crossed between Bakel and Gouraye in all seasons.

An advantage of this solution is that it would allow all traffic to pass through Gouraye, which is the governmental administrative center and the Operational Center for SONADER. A customs control post could easily be installed there.

International traffic would increase if the river crossings at Diaguili-Koungani and Diogountourou-Aroundou were improved. All weather roads could serve these villages. Finally, a feeder road could be built in Senegal from RN-2 to the large villages of Yerma, across from Woumpou and Wali. Looking at the 1/200,000 map, it is difficult to envision all-weather roads, however, as this is a major flood plain.

3.4.5.2. River Traffic

During the flood, when it is most needed, the river remains an important means of communication. Although travel along the river is slower and sometimes less fuel efficient than by road, riverbank villages are not isolated; mechanics can be called upon to make emergency visits, and supplies such as fuel can be delivered.

In low water, from November or December until July, a series of bars restrict travel along the river. This will no longer be a constraint after 1989, when releases from Manantali will maintain a minimum flow of 300 m^3/s, corresponding to raising minimum flow level at Bakel by 2.5. meters. Heavy barge traffic will be limited particularly above Bakel,however, until extensive and costly river work improvements are made. River posts will have to be constructed or repaired in order to handle heavy loads.

3.4.6. Implementation Plan

3.4.6.1. Road Construction

The figures presented for the cost of road construction in Section 3.4.7. are an adequate estimate for contracting purposes, including mobilization and contractor supervision. The figures are also included the topographical work necessary for the layout and stakeout, which can be performed either by the staff of the Public Works Service of the Ministry of Equipment or under contract. The USAID/Mauritania engineer will determine which is most appropriate means of completing the first construction design.

For Senegal the construction will not be financed under the IDP but through other bilateral USAID funding, so it is not discussed further. Because there are no significant streams to be crossed, design and construction could begin as soon as financing is secured.

For Mauritania, construction of the feeder roads poses some difficult problems. Because there are several streams to be crossed, the choices of crossing site and drainage capacity must be made with care. Private sector contracting capacity in the country is limited, as are the construction capacities of GIRM official services. However, a construction crew of UNSO (expatriate engineers and mechanics with national staff) are in the midst of contructing roads, using equipment furnished to GIRM by UNEP. It is proposed

that, upon completion of the UNSO road in 1983, the same system be employed to complete work to Sélibabi and continue to Gouraye. This work would be funded through bilateral USAID - GIRM financing, with USAID essentially replacing UNSO. The road would be expected to be completed in March 1985. This strategy would lend a certain continuity to the construction process in that the UNEP equipment, far from the end of its useful life, could continue to be exploited, and the USAID-financed construction team's contract could be extended for the construction of the 136 km of feeder roads proposed for Gouraye.

3.4.6.2. Road Maintenance

Maintenance in general, and road maintenance in particular, have presented a continuing problem for Mali and Mauritania. Public works administrations lack the financial resources or equipment, and trained personnel to perform basic maintenance on major roads, much less for small agricultural feeder roads.

The proposed roads will require at least minimal maintenance if their anticipated useful life of 10 years is to be realized. Before the rains, in June, culverts will have to be inspected and cleaned of any obstructions to flow, and lateral drainage ditches will have to be cleaned; this operation should be repeated after any particularly heavy rain. Following the rains, in November, any damages will have to be repaired, particularly erosion of the laterite or compacted sub-base, to keep potholes from expanding, which can occur rapidly under even light traffic. This process should begin the year after construction is completed and be continuous thereafter.

The design chosen for the feeder roads allows for this work to be done manually, although hand compactors will be less effective than properly supervised mechanical compactors with controlled water use.

Several alternatives were considered for road maintenance:

1. The villages to be served by the road could contract to undertake the maintenance of the roads by negotiating with the authorities before construction. Villages would receive the necessary tools, such as wheel-barrows, shovels, picks, and hand compactors, which would be included in the construction cost of the road. This system would provide an incentive to villagers to furnish their own labor to keep roads in good condition. This proposal was not pursued.

2. The administration of Public Works could be charged with the responsibility for maintenance, but this would require that the regional sub-centers be reinforced (or created) with the necessary equipment and budget.

3. The RDA's could be charged with the maintenance of agricultural feeder roads to the villages in which there are perimeters and which they visit regularly. This added function would require budgetary support, however, and could cause administrative problems.

The second option was chosen as the most viable, especially since under the Mauritania Rural Roads Project the regional office of the Public Works Service in Selibabi is being strengthened. This office will be charged with maintenance of RN 5 from M'Bout to Sélibabi to Gouraye and of the feeder roads in the Gouraye Sector. To assure proper maintenance, IDP will provide operating support to this office for two years following construction of the feeder roads. Annual maintenance costs are estimated to be $200 per kilometer or $27,200 for the 136 km constructed by the project.

3.4.7. The Kayes-Diboli Road Feasibility Study

3.4.7.1. Introduction

Originally, USAID designed a feeder roads program for 26 kilometers of low volume feeder roads in Mali to connect village perimeters to National Highway No. 1 (RN 1). After reviewing this program, however, the Government of Mali requested, and USAID concurred, that financing for these feeder roads should be used instead to complete the feasibility studies for RN 1 from Kayes to the Senegal border at Diboli, approximately 96 km. The existing RN 1 runs along the left bank of the river close to all the perimeters upstream from Ambidedi (see Appendix D Plans No. 1 and 2). It is little more than a track battered by heavy trucks and seldom repaired or maintained by the Public Works subdivision in Kayes.

Upgrading this road is the number one transportation development priority for the Kayes region. The feeder roads identified for the project will be of little value unless RN 1 is suitably upgraded. In light of this fact, USAID has recommended that the project finance the feasibility study for upgrading the werternmost section of RN 1. The Mission has already funded and carried out the feasibility study for the eastern section from Kayes to Nioro du Sahel (250 km).

The feasibility study for the Kayes-Diboli road can be presented to potential donors to appeal for funding through the OMVS Consultative Committee. The project's objectives are as follows:

1. To provide a reliable, all-weather transport link in the northwestern part of the First Region of the Republic of Mali to render the area more accessible to rural development programs and social services.

2. To encourage commerce and overall development of the project region by reducing the cost of transporting people and goods.

3. To improve the construction and maintenance capacity of the Malian Ministry of Transport and Public Works with respect to the project road.

3.4.7.2. Project Description

The Kayes-Diboli Road Feasibility Study will include the following components:

1. Design and blueprints for the construction of 96 km of all-weather road from the city of Kayes to the town of Diboli on the Senegalese border, for the construction of several small bridges in the vicinity of Kayes, and one larger bridge at the border over the Falémé River.

2. Presentation of the Study and Plans as a package to secure financing.

3. Development and implementation of a program to ensure the maintenance of the road, in conjunction with existing and planned national road maintenance programs supported by the World Bank.

4. Development of a strategy for financing road maintenance.

5. Provision of equiment, training for both equipment and road maintenance, and construction of required shops and facilities for the upkeep of roadway maintenance equipment (in conjunction with existing and planned national maintenance programs).

3.4.7.3. Scope of Work

The Contractor designated by USAID will carry out the study and submit a detailed report to USAID and the Government of the Republic of Mali (GOM) on the technical, economic, financial, social and environmental feasibility of the project. GOM personnel should cooperate and assist the consultant in preparing the report, but the contractor will be solely responsible for its contents.

3.4.7.3.1. Economic Analysis

The consultant will prepare a complete economic analysis, computing road user cost savings and value added to development projects in the area by the road. This analysis will be vital to the full assessment of the potential beneficial impact of the road on the inhabitants of the area. USAID has already completed a preliminary economic feasibility study based on the analysis of projected road user cost savings. (See Reference 1). This analysis will involve the following tasks:

1. Collecting basic information essential to the measurement of the economic and social benefits of the proposed project on area development.

2. Projecting user cost savings, based on an analysis of the composition and characteristics of current and projected traffic flows. The projection should include the following:

a) a review of area transport activity, indicating how reduced operating costs would affect project zones and who would accrue the benefits;

b) a review of the costs of moving goods and people between centers of economic activity;

c) a profile of primary and secondary local beneficiaries;

d) an account of projected savings to the economy in time and vehicle operation and maintenance costs.

3. Projecting rural development benefits (value added analysis). The consultant will examine production, marketing, and transport constraints to the area's rural development programs to ascertain the importance of the proposed road to the achievement of increased agricultural production goals and other rural development objectives. The analysis would project increases in agricultural production flowing from construction of the road. Analyzing the impact of the road on the development of the area will require judging its potential effects on the following factors (inter alia):

a) agronomic and hydrological potential;

b) agricultural technology employed;

c) availability of extension services;

d) availability of fertilizers, insecticides, and other farm inputs;

e) availability of agricultural credit;

f) marketing structures;

g) transportation services (including an examination of the extent to which the road ties into GOM national and regional road priorities);

h) storage capacity;

i) prices of agricultural inputs and outputs;

j) farmer income and distribution of anticipated agricultural benefits.

4. Looking at non agricultural benefits of the project such as the impact of all-weather access to markets on non agricultural economic activity and on cottage industries, handicrafts, and tourism.

5. Projecting the potential savings in cost of providing essential government services to population centers near the road.

6. Presenting qualitative benefits and costs that may be difficult to quantify in a format suitable for decision making using modern techniques (e.g., value balance sheet, decision matrix, etc.). These benefits and costs should include those associated with:

a) expanded educational opportunities for school-age children and adults and possibly greater attendance rates as a result of easier all-weather access to schools;

b) easier access to health facilities;

c) greater likelihood of involvement in community development activities.

7. Modifying the financial costs developed in accordance with Section III.B.11 below to reflect the economic costs of the project to the national economy.

8. Conducting an internal rate of return analysis, identifying all assumptions used as well as a sensitivity analysis showing the effect of changes in major assumptions on the results obtained.

3.4.7.3.2. Technical Analysis

The consultant's responsibilities will include the following:

1. To cooperate with the GOM in developing the geometric and structural design criteria, construction standards, and loading standards for the project road; forecasting traffic volumes to the year 2000; and recommending ways of meeting project objectives in the most economic manner. The design standards chosen for the road and bridges should be based on projected traffic volumes and axle load estimates, climatic conditions, and GOM maintenance capabilities.

2. To evaluate alternative alignments and select the most appropriate one based on available studies, maps, aerial photographs, reconnaissance field surveys, order-of-magnitude cost estimates, the preliminary socio-economic analysis, and the environmental assessment. The consultant should also consider ongoing and proposed development projects in the area, recommend the route alignment judged most satisfactory, and then meet with officials of the GOM and USAID/Bamako, who will review and discuss the recommendations with the consultant and approve the selection. Once the alignment is approved, the contractor will carry out the tasks described below.

3. To cite and discuss in the report any agreed major departures of the alignment from the existing road.

4. To prepare a preliminary engineering design of the road and bridges for the purpose of estimating construction costs.

5. To review soils and analyses of construction materials available from the GOM or other sources, and to carry out any additional soils investigations and tests necessary to devise a construction cost estimate; to investigate the availability and determine the location of quantities of select material for surfacing; and to select construction materials and methodology appropriate to local customs, preference, availability, and cost.

6. To assess Mali's accessibility in terms of its suitability for the importance of equipment and materials by the construction contractor; to note present limitations to such access to assess the cost of providing solutions to these limitations and to include this cost in the construction cost estimate.

7. To establish typical criteria for stream crossings and water transfers and examine the adequacy and number of existing drainage structures; to prepare a budgetary cost estimate for each structure and to include it in the total construction cost.

8. To establish design criteria for bridge loading; to prepare prototype designs and sketches for new bridges that may be necessary, including details on span lengths, types of superstructures, and types of substructures; to prepare cost estimates for bridges on a total lineal or total area basis. The consultant should review and evaluate complex structures on a case-by-case basis and include these cost estimates in the total construction cost estimate.

9. To investigate construction techniques that rely on a good mix of labor, simple tools and equipment, and conventional construction machinery; to determine the availability of local and foreign contractors as well as the capability of local contractors; to review the possibility of GOM force account construction or a combination of contractor and force account; to determine whether it would be feasible from a cost, management, and time point of view to use labor-based force account construction for portions of the road for training purposes in conjunction with a capital intensive construction contact; to submit an economic study recommending and supporting either the relative capital or labor mix strategy.

10. To develop a plan for project execution, including a plan for final engineering design, supervision of construction, and construction. The construction phase of the plan should be broken down to show the sequence of major construction operations, methods of control, equipment and personnel needs, logistic requirements, and other items. The consultant should also prepare a time schedule of major operations, including design, procurement, mobilization, and construction. The consultant should consider the alternative of incrementally designing portions of the road as construction progresses as first priority and make recommendations on how this scheme could be accomplished.

11. To prepare a cost estimate for the final engineering design, construction, and construction supervision of the proposed road and bridges; include a sensitivity analysis indicating the influence on the cost estimate of variable or indeterminate cost elements; to give an estimate of the probable percentage of accuracy of the cost estimate; to provide two cost estimates, based on:

-- the cost of goods and services of AID Geographic Code 941 source and orign (U.S. and Selected Less Developed Countries), except for locally available materials and labor, which should be used to the maximum extent possible;

-- the international bidding for the construction work. The cost estimate should be broken down into the foreign exchange and local cost components and should not include local taxes.

Because full financing for the road may not be immediately available, the cost estimates for the proposed road should be subdivided into lengths suitable for separate financing and phasing of construction. An estimate should be included of the additional mobilization and demobilization costs that constructing the road in phases would entail.

3.4.7.3.3. Social Soundness Analysis

The consultant wil be expected to carry out the following tasks:

1. To analyze the socio-cultural feasibility and impact of the project, describing existing social patterns and how the road would affect them and looking at how the project population might perceive project benefits. The analysis should assess the appropriateness of proposed project plans.

2. To recommend steps for minimizing potential adverse social effects of the project.

3. To project the impact of the road on the spread effect of ongoing or planned rural development activities in the area.

4. To examine the project's benefit incidence, with particular attention to benefits to the rural poor.

5. To examine potential changes in employment patterns and economic activity.

6. To examine the impact of the road on migration patterns.

3.4.7.3.4. Environmental Assessment

The consultant should prepare an environmental assessment based upon the Initial Environmental Examination completed by AID, which should meet the requirements of Federal Procurement Regulations, Title 22, Chapter II, Part 216, Section 216.5, published in the Federal Register of June 30, 1976. This assessment should focus on examining the potentially significant impact the project could have on the social environment, and should be prepared in conjunction with the social soundness analysis.

3.4.7.3.5. Financial Analysis

The consultant will be responsible for the following:

1. To provide a disbursement schedule for the project, in both U.S. dollars and Malian Francs, including the final engineering design, construction, and guarantee period of the construction contract.

2. To project and itemize recurrent expenditures of the GOM for project road and bridge maintenance over a 20-year period, following the expiration of the contractor's guarantee; to examine available information on road maintenance financing requirements for roads under construction and planned with other donor financing and for the ongoing GOM road maintenance program; to compare the total of these costs with the current and projected levels of the GOM Road Fund and discuss the impact of recurrent expenditures for maintenance of the road on the level of funding to be required in the Road Fund over the next 20 years.

3. To discuss with USAID/Mali the GOM and the World Bank alternative means of ensuring the availability of funds to meet requirements for maintenance of the project road, including financing through tariff schedules; to make specific recommendations to GOM on the financing of required road maintenance; to recommend financial plan.

3.4.7.3.6. Road Maintenance, GOM Administrative and Staffing Requirements, Depot and Equipment Requirements

The consultant's responsibilities will be as follows:

1. To examine the physical, organizational, financial, and professional capacity of the Ministry of Transportation and Public Works (MTPW) for road maintenance in Mali, in coordination with ongoing World Bank road maintenance project, with particular attention to the First Region and all road maintenance offices in the project zone.

2. To evaluate the capacity of the MTPW to:

- supervise construction of the project road by local or foreign contractors;

- maintain the project road along with the entire national road network.

3. To identify any additional manpower, training, equipment, and facility requirements of the MTPW to ensure proper maintenance of the project road.

4. If appropriate, to recommend a training program including formal in-country training, training abroad for higher professional skills, and on the job training during the construction phase.

5. To estimate the numbers of personnel, time, and cost of the recommended training program.

6. To recommend technical assistance demmed essential to the successful project implementation during design, construction, and interim maintenance activities.

7. To recommend administrative measures to ensure a viable maintenance program for the project road.

8. To review, in coordination with the World Bank program, the adequacy and location of existing maintenance depots in the area for consideration by GOM and the World Bank.

9. To estimate the construction cost of any proposed depots.

10. To prepare a list of shop equipment and tools for the maintenance depots and an initial inventory of spare parts for equipment maintenance.

11. To outline road maintenance requirements for the project road, prepare a road maintenance schedule, and recommend a road maintenance program in coordination with the World Bank.

3.4.7.3.7. Reports and Consultation

1. The Consultant should arrange for his or her project director, the civil engineer, and the chief economist to meet with certain AID officials within a certain time frame, as follows:

a) Prior to leaving for Mali, they should set aside a day to meet with representatives of the Office of Development Resources, Bureau for Africa, AID/Washington.

b) Upon their arrival in Bamako, they should meet with representatives of the USAID Mission and REDSO/WA over a two-day period; in addition they should consult intermittently with the USAID/IDP engineer and project officer for this project.

2. No later than six weeks after arrival in Mali, the consultant's project director should request a meeting with officials of the GOM and USAID/Bamako to review the Consultant's recommendation on road alignment and to make the final selection.

3. A week after the alignment is finalized and approved by USAID and the GOM, the project director should submit a short report in three copies indicating the degree of progress made on the feasibility study, the names and periods of time spent by various members in the field, and any problems encountered that could result in a delay in the completion of the study or the inability to obtain any required data.

4. Within 120 days after the project director's arrival in Mali, the consultant should forward 20 copies of the typed draft of the feasibility study to USAID/Mali (15 in English, 5 in French). Five copies (in English) should also be submitted to the Office of Development Resources, Office of Engineering, Bureau for Africa, AID/Washington.

5. Within 25 days of receipt of the draft report, AID should forward comments from the various interested parties to the consultant, who should complete and deliver to the Office of Development Resources, Bureau for Africa, AID/Washington, 35 copies of the final report (25 in English and 10 in French) no later than 30 days after receiving these comments.

The following format for the draft and final report should serve as a guideline to the consultant in presenting data, analysis, and recommendations, but is not intended to be restrictive. The full report should be completed in both English and French, with the English version considered as priority.

Part I — Project Summary and Recommendations

a) Project goal and purpose. Description of the project including engineering design, construction, construction supervision, training, technical assistance, maintenance provisions, and all other elements.

b) Recommendations. Estimated project cost, recommended implementation procedures, and any other recommendations.

c) Summary of Findings. Summary of conclusions reached from the consultant's data collection and analyses.

Part II — Project Background and Detailed Description

a) Background. Project goal and purpose, developmental problems ot which the project is addressed, and a summary of any prior studies done of the project.

b) Detailed Description. An expansion of the summary description in Part I a) above, including technical details of the project components.

Part III Project Analyses

a) Quantitative and qualitative assessment of the benefits of the project to the economy of Mali in general and to the First Region, with special reference to benefits for the rural poor. This section should include a calculation of the project's internal rate of return in accordance with Section A (Economic Analysis) above.

b) Technical Analysis. Result of the consultant's technical analysis, as set forth in the statement of work, including a detailed description and justification for any changes in the project in terms of road alignment, road standards, or any alternatives to project elements that may, in the consultant's judgment, better serve the project's objectives. The project cost estimate should be broken down by component cost and should include allowances for contingencies and cost escalation due to local inflation and cost increases for imported materials and services. For a guide to preparing a cost estimate, consult AID publication "Cost Estimating Methods".

c) Social Analysis. A discussion of the effects of the project on the population served, as set forth in the statement of work.

Part IV Environmental Assessment

This section of the report should be prepared in a separate volume, covering the work requirements included in the statement of work. We suggest the following format:

1. Project Description: Background Information

   a. Reason for the Project

      i. Background

      ii. Project goals

   b. Description of the Project Area Environment

2. Description of the Project Area Environment

   a. Natural environment

   b. Human environment

3. Probable Environment Impact of Project Implementation

   a. Impact on population increase or decrease

   b. Impact on increasing agricultural production

   c. Impact on increasing livestock production

   d. Impact on improving health facilities

   e. Impact on improving educational opportunities

   f. Impact on cultural traditions and patterns

   g. Impact on employment patterns and opportunities

   h. Impact on general economic activity.

4. Relationship of proposed action to land use plans, policies, and controls.

5. Unavoidable Adverse Environment Impact.

6. Alternative to the proposed action (if significant negative impacts are discovered).

7. Irreversible and irretrievable commitment of resources.

8. Bibliography.

<u>Part V</u> <u>Financial Analysis</u>

a) A disbursement schedule for final engineering design and construction, and any necessary training and technical assistance and maintenance equipment.

b) An analysis of recurring costs for maintenance and their effect on the national budget and the budget of the Ministry of Transport and Public Works, along with recommendations for financing road maintenance.

c) All pertinent financial tables required in AID project paper preparation as identified in AID Handbook III.

<u>Part VI</u> <u>Implementation and Evaluation Plans</u>

a) Detailed plan and time schedule for constructing the road, indicating the number and type of supportive administrative and technical specialists required for

implementation of the project and the duration of their respective assignments, phased ordering of equipment and spare parts, etc.

b) Analysis of GOM capacity to oversee project implementation and to maintain the road once it is built. Specific recommendations in relation to the World Bank's Road Maintenance projects for training, technical assistance, and equipment and construction to strengthen the MTPW should be given in this section.

c) Detailed program for maintenance of the project road.

d) Evaluation Plan. This section should outline recommendations for a "before-after" type evaluation designed to assess the effects of the project road on the rural population. It should be carried out as an integral part of the project. In addition, a schedule for evaluation of project progress during implementation should be outlined.

3.4.7.3.8. Level of Effort

A. 24 person months of professional services are required in the specialties listed below. Potential contractors are invited to make their own estimates, but the team proposed must include expertise in:

- Project Management
- Civil Engineering (Roads)
- Structural Engineering (Bridges)
- Soils and Materials Engineering
- Equipment
- Financial Planning
- Transportation Economics
- Rural Development Economics
- Social Anthropology
- Environmental Science.

B. Staffing Requirements

The following presents the qualifications for team members.

1) Project Director. Significant prior experience with feasibility studies of the type required for this project. Educational and professional background in project design, economics and/or engineering. Fluency in French. (S3/R3 or better).

2) Civil Engineer (Roads). Thorough familiarity with all aspects of design, construction, and maintenance of rural roads, especially in semi-arid environments. Prior experience in developing countries, preferably in Africa. Ability to work in French. (S2/R2 minimum).

3) Structural Engineer. Thorough knowledge of all aspects of small bridge design for relatively low-volume rural roads. French capability desired but not necessary.

4) Soils and Materials Engineer. Thorough knowledge of road construction materials and expertise in soils analysis, especially tropical soil groups. Experience in road construction materials reconnaissance and in road and bridge foundation studies. Ability to work in French. (S2/R2).

5) Equipment Specialist. Expertise in selection, repair and maintenance of heavy equipment, especially road maintenance equipment. Ability to work in French. (S2/R2).

6) Cost Estimator. Experience in all aspects of preliminary cost estimation and financial planning for construction project implementation. Ability to work in French. (S2/R2)

7) Transportation Economist. Significant educational and professional background in economic data collection and analysis, especially related to assessment of rural road projects in developing countries (preferably in West Africa). Up-to-date working knowledge of both quantitative and qualitative approaches to project analysis. Ability to work in French. (SR/R2 minimum).

8) Rural Development Economist. Up-to-date working knowledge of both quantitative and qualitative approaches to analysis of rural development projects and recent experience in their application. Ability to devise relatively innovative methods of assessing potential economic benefits of rural development projects to rural populations. Ability to work in French. (S2/R2 minimum).

9) Social Anthropologist. West African specialist with experience in the Sahel. Familiarity with social-soundness analysis and environmental impact assessment. Ability to work in French. (S2/R2 minimum).

10) Environmentalist. Significant experience in environmental impact assessment of overseas development projects, preferably in Africa, especially in analysis of changes in factors potentially affecting the social encironment. Ability to work in French. (S2/R2).

3.4.7.3.9. Selection Criteria

The following criteria, listed below in order of importance, will be used to evaluate proposals:

1. The quality of the professional personnel proposed, in line with the requirements set forth in Section V above, as evidenced by their educational background and actual experience in developing countries, especially in West Africa.

2. Actual experience with similar studies in developing countries, including demonstrated capability to carry out environmental assessments.

3. Proposed methodology and details of technical response.

Appendix A.

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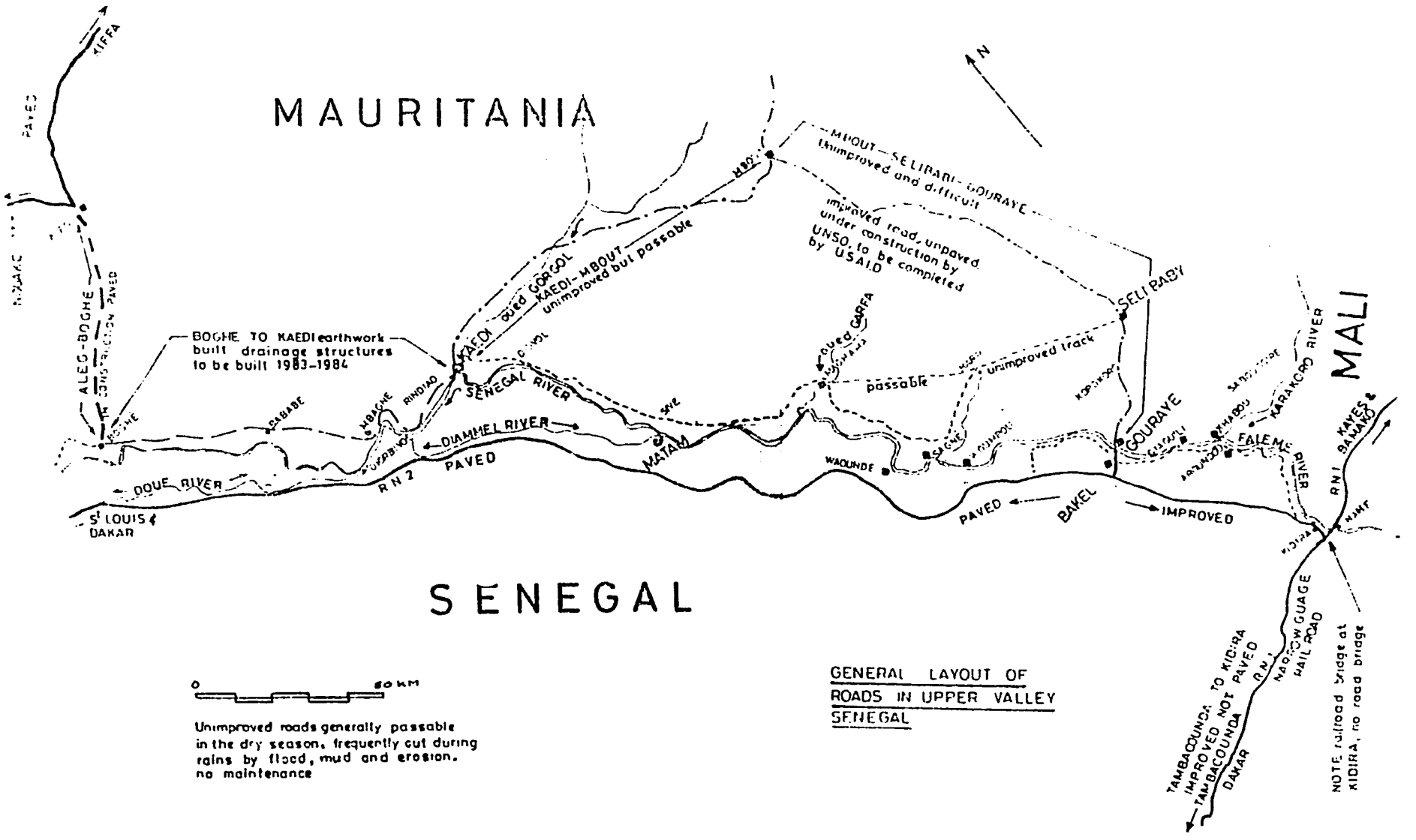
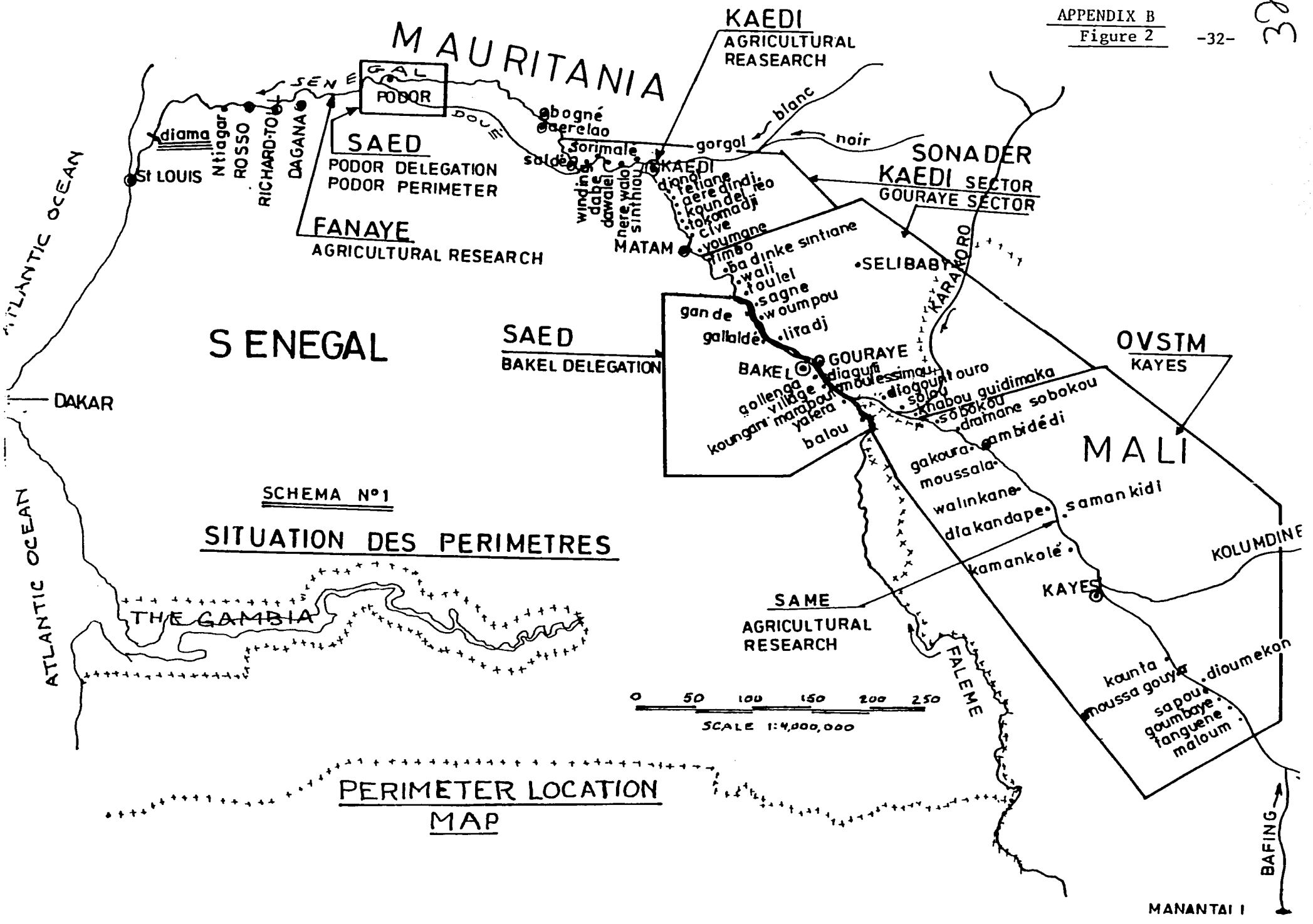
Figure 1



GENERAL LAYOUT OF ROADS IN UPPER VALLEY SENEGAL

APPENDIX B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SONADER
KAEDI SECTOR
GOURAYE SECTOR
SAED
BAKEL DELEGATION
OVSTM
KAYES
SAME
AGRICULTURAL RESEARCH
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SENEGAL
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ATLANTIC OCEAN
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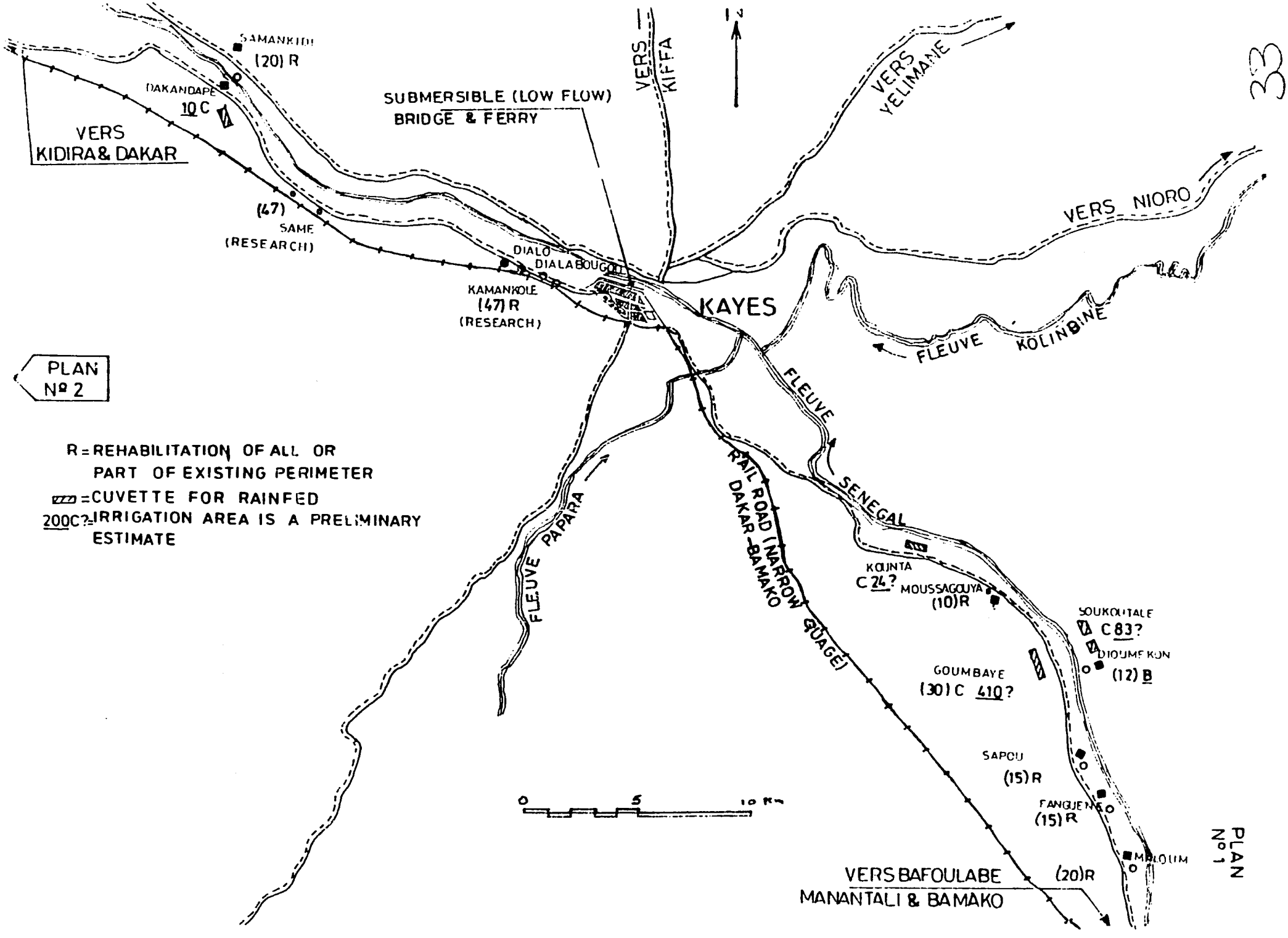
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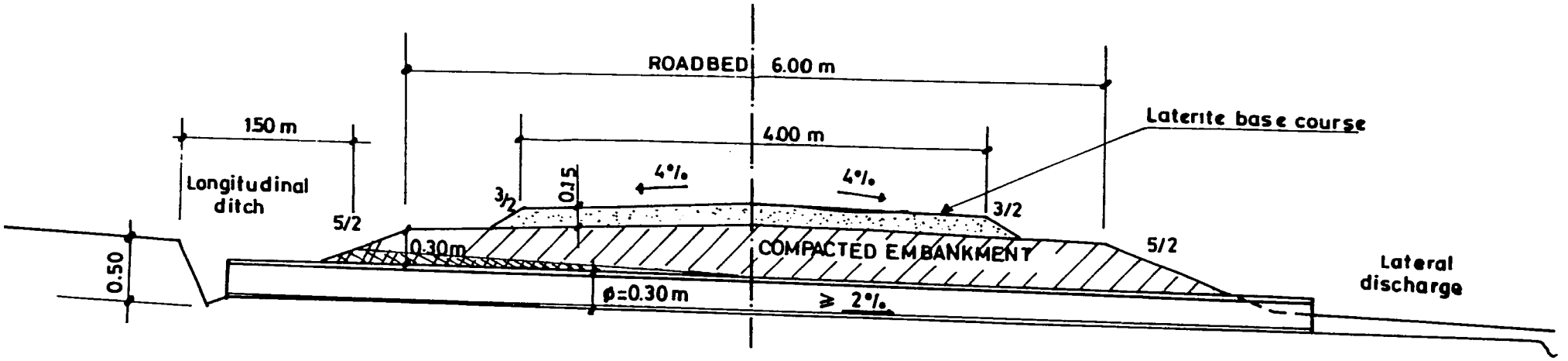
VERS
KIDIRA & DAKAR
(47)
SAME
(RESEARCH)
SUBMERSIBLE (LOW FLOW)
BRIDGE & FERRY
VERS
KIFFA
VERS
YELIMANE
VERS NIORO
DIALO
DIALABOUGOU
KAMANKOLE
(47) R
(RESEARCH)
KAYES
FLEUVE KOLINBINE
FLEUVE
SENEGAL
FLEUVE PAPARA
RAIL ROAD (NARROW
DAKAR-BAMAKO
GUAGE)
KOUNTA
C 24?
MOUSSAGOUYA
(10) R
SOUKOUTALE
C 83?
DIOUMEKON
(12) B
GOUMBAYE
(30) C 410?
SAPOU
(15) R
FANGUENE
(15) R
MALOUM
VERS BAFOULABE
MANANTALI & BAMAKO
(20) R
0 5 10 Km
PLAN
Nº 2
R = REHABILITATION OF ALL OR
PART OF EXISTING PERIMETER
= CUVETTE FOR RAINFED
200C? = IRRIGATION AREA IS A PRELIMINARY
ESTIMATE
PLAN
Nº 1

APPENDIX C. - Figure 1

FEEDER ROADS-CROSS SECTION



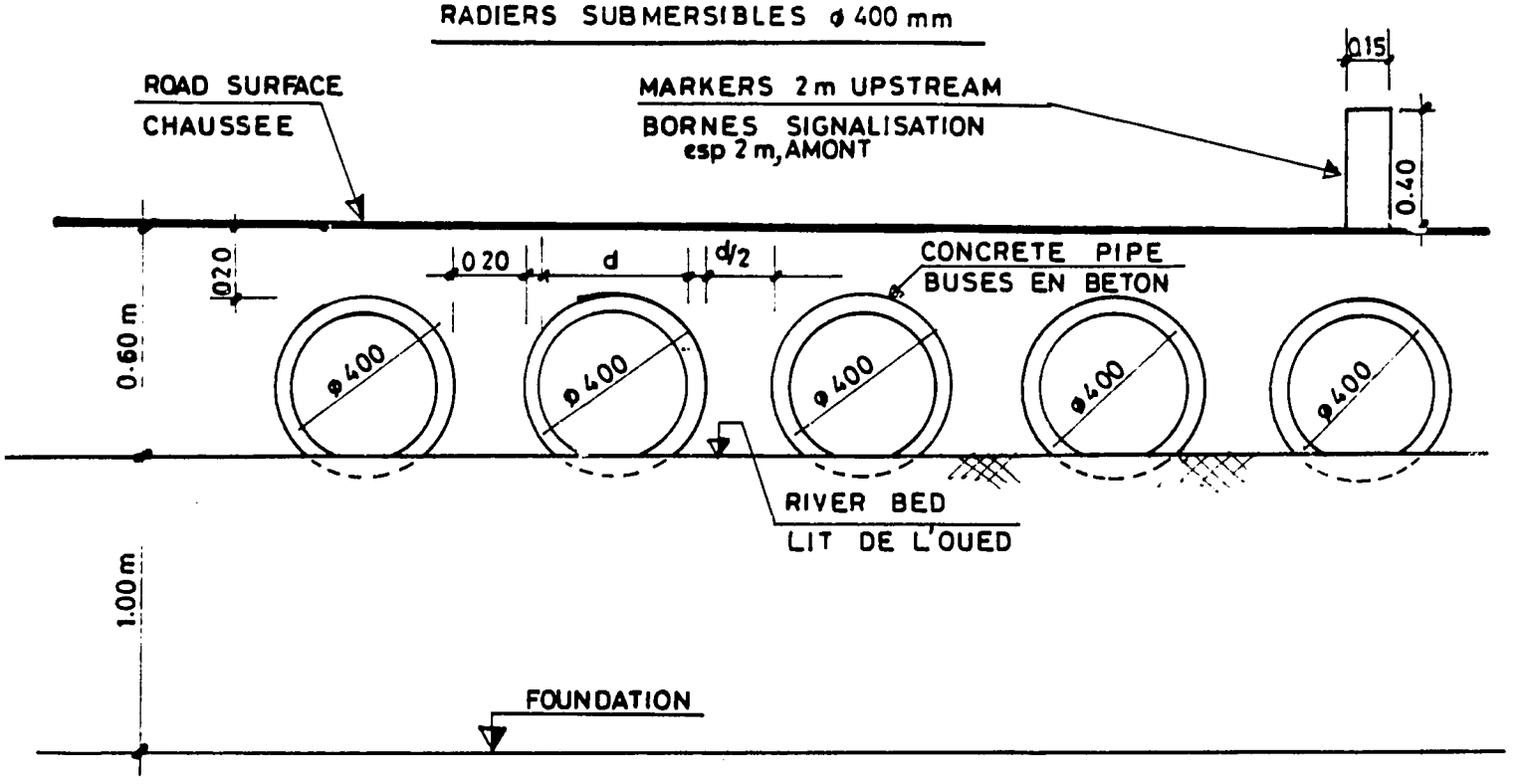
Application	Volume	Unit	
100%	X 10.000	m²/km	Clear and remove top soil
100%	X 8.000	m²/km	Prepare and compact roadbed
20%	X 3.000	m³/km	Place fill (buldozer) compact
60%	X 635	m³/km	Laterite base course, compacted
20%	X 1.000	m/km	Longitudinal ditch
20%	X 100	m/km	Lateral discharge ditch
20%	X 20	m/km	Culvert, Ø 300 mm
100%	X 5	m/km	Drainage structures, Ø 600 mm

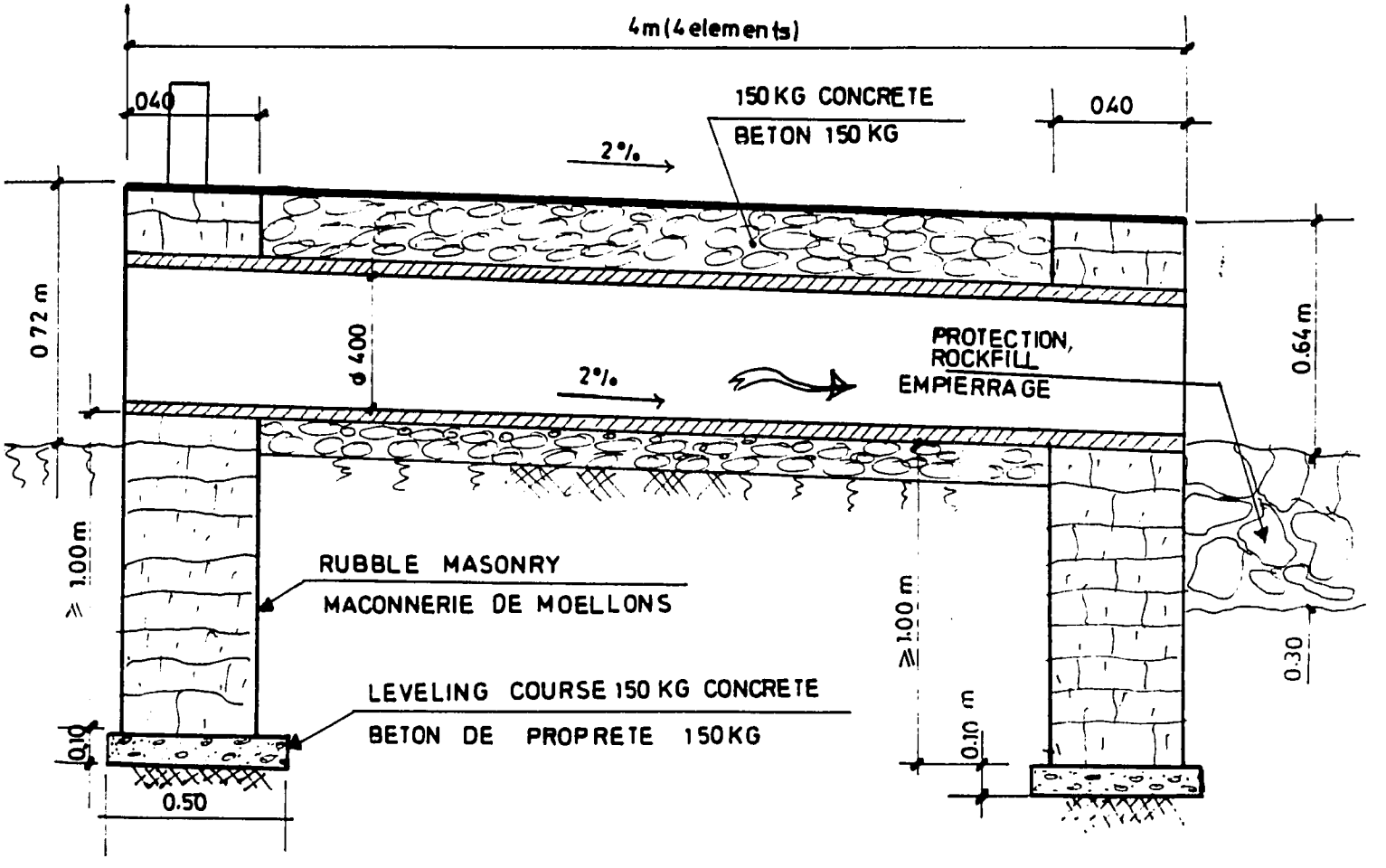
34

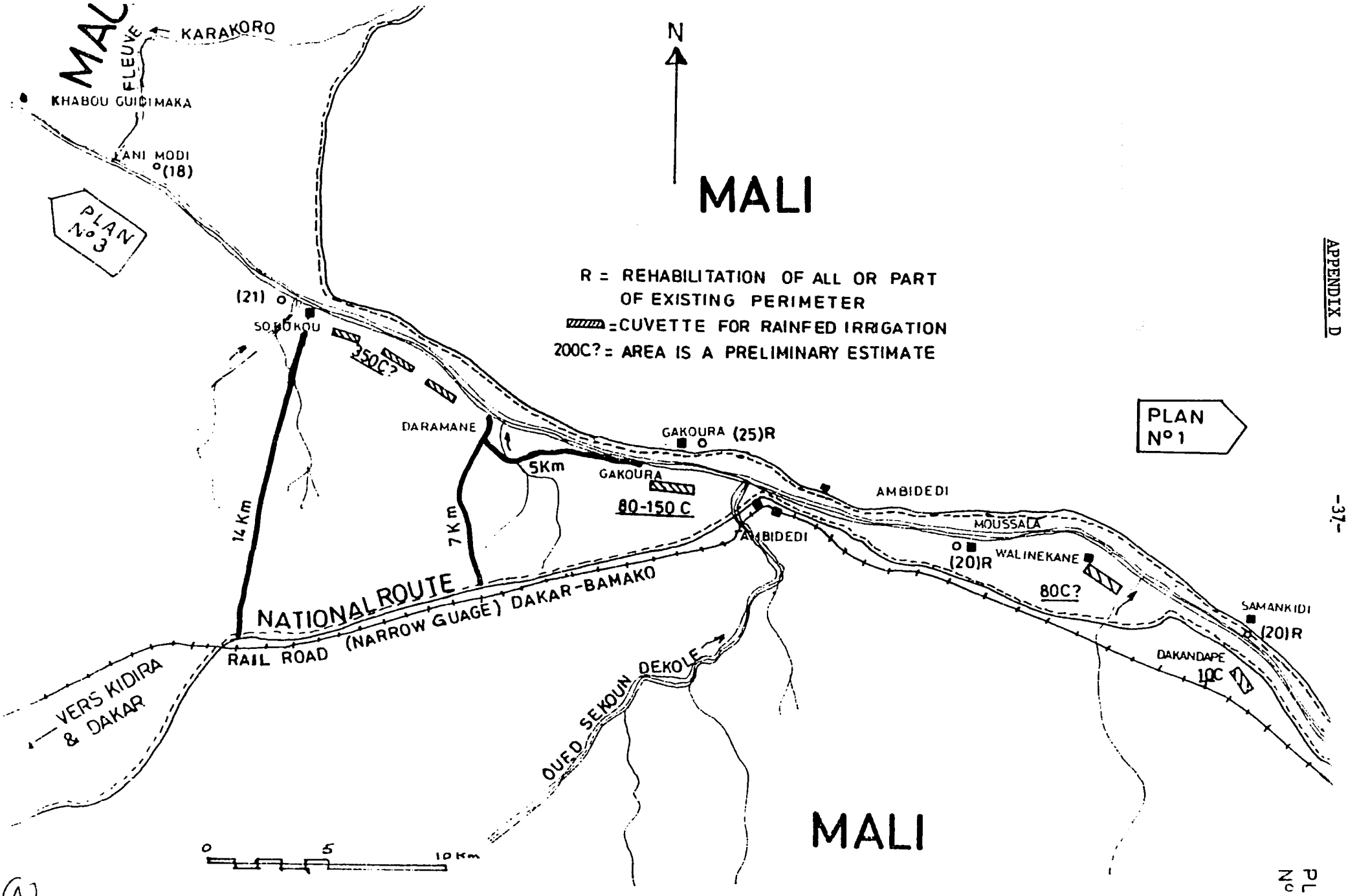
APPENDIX C - Figure 2

SUBMERSIBLE FORDS ø 400mm

RADIERS SUBMERSIBLES ø 400 mm

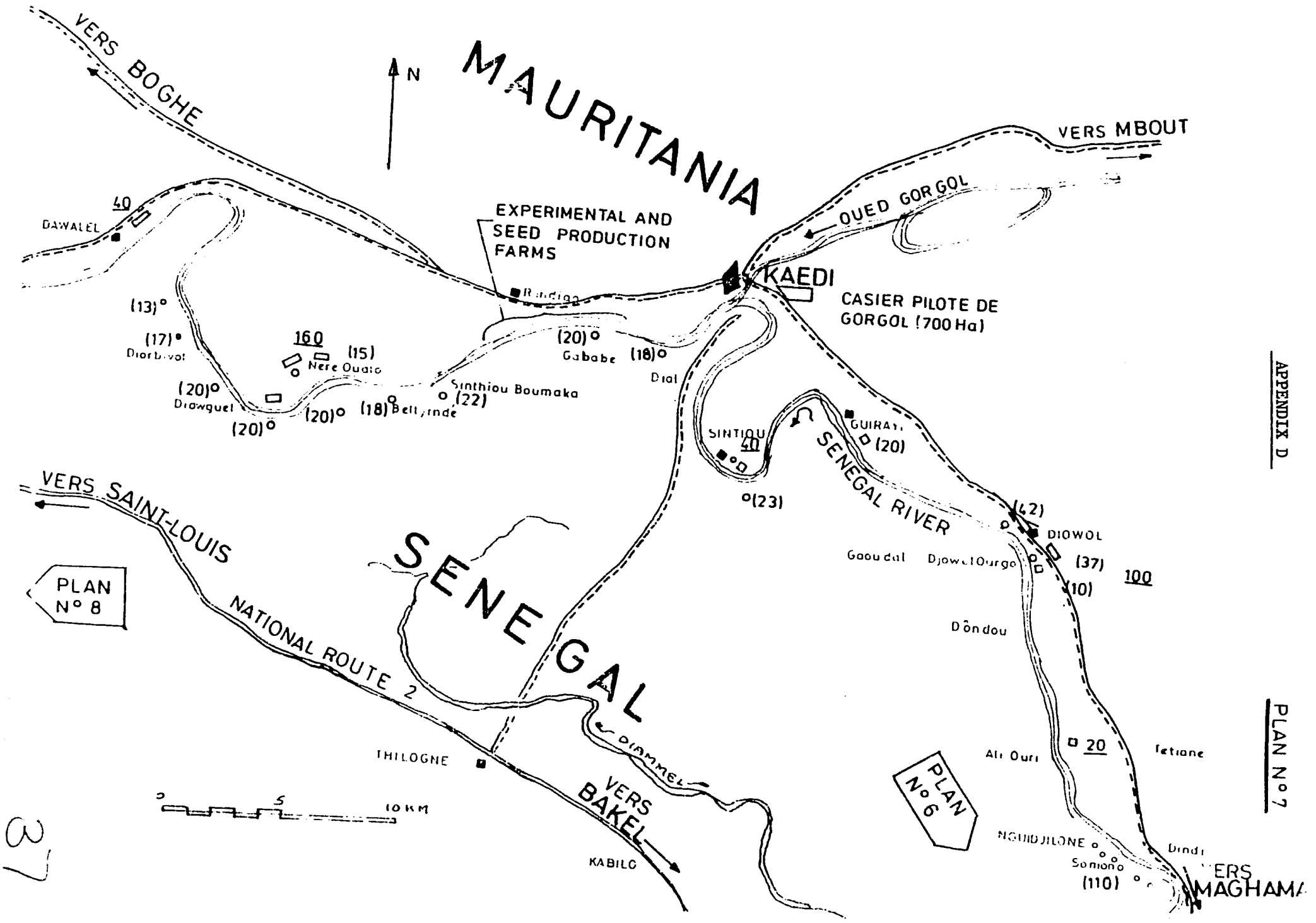




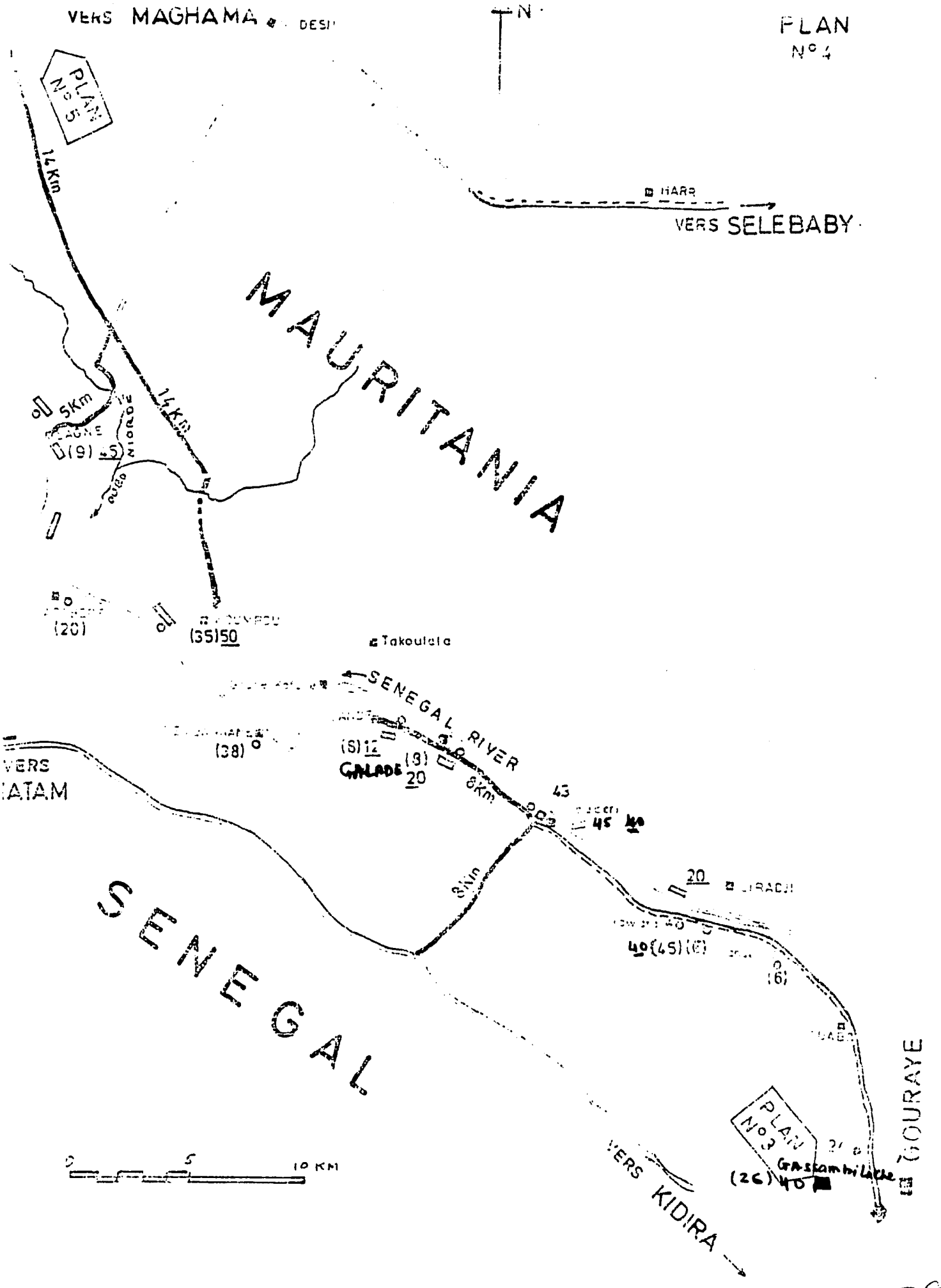

MAL
FLEUVE
KARAKORO
KHABOU GUICIMAKA
LANI MODI
(18)
PLAN No 3
N
MALI
R = REHABILITATION OF ALL OR PART OF EXISTING PERIMETER
=CUVETTE FOR RAINFED IRRIGATION
200C? = AREA IS A PRELIMINARY ESTIMATE
(21)
SOBOKOU
350C?
DARAMANE
5Km
GAKOURA (25)R
GAKOURA
80-150 C
PLAN No 1
AMBIDEDI
MOUSSALA
(20)R
WALINEKANE
80C?
SAMANKIDI
(20)R
DAKANDAPE
10C
14 Km
7 Km
NATIONAL ROUTE
RAIL ROAD (NARROW GUAGE) DAKAR-BAMAKO
VERS KIDIRA & DAKAR
OUED SEKOUN DEKOLE
0
5
10 Km
MALI

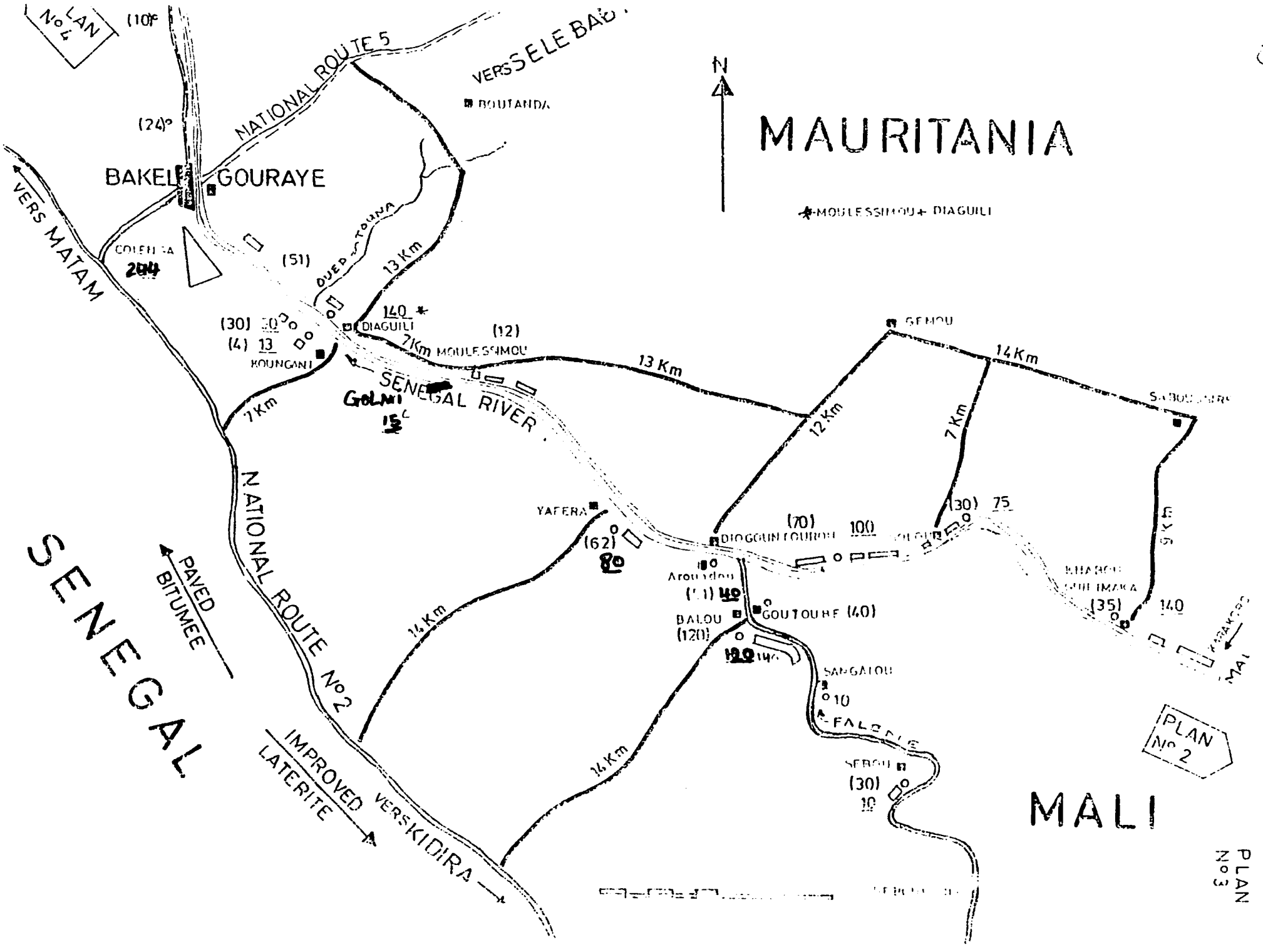
PLAN No 2

26


MAURITANIA
N
VERS BOGHE
VERS MBOUT
OUED GORGOL
EXPERIMENTAL AND SEED PRODUCTION FARMS
KAEDI
CASIER PILOTE DE GORGOL (700 Ha)
DAWALEL
40
(13)
(17)
Diorbivol
160
(15)
Nere Ouaio
(20)
Diawguel
(20)
(20)
(18)
Bellyinde
Sinthiou Boumaka
(22)
(20)
Gababe
(18)
Dial
SINTIOU
40
(23)
GUIRAYI
(20)
SENEGAL RIVER
(42)
DIOWOL
(37)
(10)
100
Gaoudal
Djowol Ourgo
Dôndou
SENEGAL
VERS SAINT-LOUIS
NATIONAL ROUTE 2
PLAN N° 8
THILOGNE
DIAMMEL
VERS BAKEL
KABILO
0
5
10 KM
PLAN N° 6
Ali Ouri
20
Tetiane
NGUIDJILONE
Somono
(110)
Dindi
VERS MAGHAMA
PLAN N° 7

3


VERS MAGHAMA
N
PLAN
N° 4
PLAN N° 5
14 Km
HARR
VERS SELEBABY
MAURITANIA
5Km
14Km
(9) 45
(20)
(35)50
Takoulela
SENEGAL RIVER
(38)
(8) 12
GALADE
(9)
20
8Km
43
45 40
VERS
MATAM
8Km
20
LIRADJI
40(45)(6)
(6)
SENEGAL
PLAN N° 3
GASSAMBI Lake
(26) 40
GOURAYE
VERS KIDIRA
0
5
10 KM


PLAN No 4
(10)
(24)
NATIONAL ROUTE 5
VERS SELEBABI
BOUTANDA
N
MAURITANIA
MOULESSIMOU
DIAGUILI
BAKEL
GOURAYE
VERS MATAM
COLENTA
204
(51)
OUED TOUNA
13 Km
140
(30) 50
(4) 13
KOUNGANI
DIAGUILI
7Km
(12)
MOULESSIMOU
13 Km
SENEGAL RIVER
GOLMI
15
7Km
NATIONAL ROUTE No 2
SENEGAL
PAVED BITUMEE
IMPROVED LATERITE
VERS KIDIRA
YAFERA
(62)
80
14 Km
14 Km
GEMOU
14 Km
12 Km
7 Km
(70)
100
DIOGOUN LOUROU
Aroudou
(11) 40
BALOU
(120)
120
GOUTOUBE (40)
SANGALOU
10
FALEMME
SEBOU
(30)
10
(30) 75
(35)
140
MALI
PLAN No 2
PLAN No 3

39

Table

I. Senegal

A. Bakel	Existing Perimeters	Ha. to be Upgraded	New Perimeters (gross ha.)	
Gandé	8	8	(ext.)	12
Galladé	8	8	(1)	20
Moudery	45	28	(2)	40
Diawara	46	20	(2)	40
Yellingara	7	-		-
Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
Nayé	9	-		-
Guitta	15	-		-
Senédébou	18	-		-
Total Bakel	611	281		714
B. Podor				
Podor-Sector C1	-	-		330
Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
Fondé As	20	-		50
Dado	-	-		50
Guia	-	-		50
Doué	20	-		50
Goumel	-	-		50
Kodité	18	-		50
Total Podor	58	-		1,063
Total Senegal	669	281		1,777

Table

I. Senegal

A. Bakel	Existing Perimeters	Ha. to be Upgraded	New Perimeters (gross ha.)	
Gandé	8	8	(ext.)	12
Galladé	8	8	(1)	20
Moudery	45	28	(2)	40
Diawara	46	20	(2)	40
Yellingara	7	-		-
Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
Nayé	9	-		-
Guitta	15	-		-
Senédébou	18	-		-
Total Bakel	611	281		714
B. Podor				
Podor-Sector C1	-	-		330
Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
Fondé As	20	-		50
Dado	-	-		50
Guia	-	-		50
Doué	20	-		50
Goumel	-	-		50
Kodité	18	-		50
Total Podor	58	-		1,063
Total Senegal	669	281		1,777

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Yellingara	7	-		-
Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
Nayé	9	-		-
Guitta	15	-		-
Senédébou	18	-		-
Total Bakel	611	281		714
B. Podor				
Podor-Sector C1	-	-		330
Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
Fondé As	20	-		50
Dado	-	-		50
Guia	-	-		50
Doué	20	-		50
Goumel	-	-		50
Kodité	18	-		50
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Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
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Guitta	15	-		-
Senédébou	18	-		-
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Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
Fondé As	20	-		50
Dado	-	-		50
Guia	-	-		50
Doué	20	-		50
Goumel	-	-		50
Kodité	18	-		50
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Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
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Fondé As	20	-		50
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Manael	8	-	-
Tuabou	12	-	-
Gassambilakhé	26	26	(2) 40
Collenga-Bakel	--	-	244
Kounghani-Marabout	4	4	(ext) 13
Kounghani-Village	30	30	(2) 30
Golmy-Marabout	5	-	-
Golmy-Village	-	-	(1) 15
Yafera	62	62	(4) 80
Aroundou-Emigré	10	-	-
Aroundou-Village	49	20	(2) 40
Ballou	109	-	(6) 120
Sebou	30	30	-
Debekhoule	20	20	(1) 20
Djimbe	15	15	-
Dialiquel	10	10	-
Sinthiou-Dialiquel	7	-	-
Ouro-Imadou	10	-	-
Seling	15	-	-
Kidira	33	-	-
Nayé	9	-	-
Guitta	15	-	-
Senédébou	18	-	-
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B. Podor			
Podor-Sector C1	-	-	330
Podor-Sector M1	-	-	240
Podor-Sector C2	-	-	193
Fondé As	20	-	50
Dado	-	-	50
Guia	-	-	50
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Aroundou-Emigré	10	-		-
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Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
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Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
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Guia	-	-		50
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Golmy-Village	-	-	(1)	15
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Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
Nayé	9	-		-
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Podor-Sector C2	-	-		193
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Dado	-	-		50
Guia	-	-		50
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Goumel	-	-		50
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Yellingara	7	-	-
Manael	8	-	-
Tuabou	12	-	-
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Collenga-Bakel	--	-	244
Kounghani-Marabout	4	4	(ext) 13
Kounghani-Village	30	30	(2) 30
Golmy-Marabout	5	-	-
Golmy-Village	-	-	(1) 15
Yafera	62	62	(4) 80
Aroundou-Emigré	10	-	-
Aroundou-Village	49	20	(2) 40
Ballou	109	-	(6) 120
Sebou	30	30	-
Debekhoule	20	20	(1) 20
Djimbe	15	15	-
Dialiquel	10	10	-
Sinthiou-Dialiquel	7	-	-
Ouro-Imadou	10	-	-
Seling	15	-	-
Kidira	33	-	-
Nayé	9	-	-
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B. Podor			
Podor-Sector C1	-	-	330
Podor-Sector M1	-	-	240
Podor-Sector C2	-	-	193
Fondé As	20	-	50
Dado	-	-	50
Guia	-	-	50
Doué	20	-	50
Goumel	-	-	50
Kodité	18	-	50
Total Podor	58	-	1,063
Total Senegal	669	281	1,777

Table

I. Senegal

A. Bakel	Existing Perimeters	Ha. to be Upgraded	New Perimeters (gross ha.)	
Gandé	8	8	(ext.)	12
Galladé	8	8	(1)	20
Moudery	45	28	(2)	40
Diawara	46	20	(2)	40
Yellingara	7	-		-
Manael	8	-		-
Tuabou	12	-		-
Gassambilakhé	26	26	(2)	40
Collenga-Bakel	--	-		244
Kounghani-Marabout	4	4	(ext)	13
Kounghani-Village	30	30	(2)	30
Golmy-Marabout	5	-		-
Golmy-Village	-	-	(1)	15
Yafera	62	62	(4)	80
Aroundou-Emigré	10	-		-
Aroundou-Village	49	20	(2)	40
Ballou	109	-	(6)	120
Sebou	30	30		-
Debekhoule	20	20	(1)	20
Djimbe	15	15		-
Dialiquel	10	10		-
Sinthiou-Dialiquel	7	-		-
Ouro-Imadou	10	-		-
Seling	15	-		-
Kidira	33	-		-
Nayé	9	-		-
Guitta	15	-		-
Senédébou	18	-		-
Total Bakel	611	281		714
B. Podor				
Podor-Sector C1	-	-		330
Podor-Sector M1	-	-		240
Podor-Sector C2	-	-		193
Fondé As	20	-		50
Dado	-	-		50
Guia	-	-		50
Doué	20	-		50
Goumel	-	-		50
Kodité	18	-		50
Total Podor	58	-		1,063
Total Senegal	669	281		1,777

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