Appendices

Appendix A BOQ

A.1 BOQ List

Table A.1: BOQ of Civil Works (Road)

Work Category	Description	Unit	Rate (USD)	BRT Estimated Quantity	BRT Amount (USD)	Remarks
EARTH WORK	Clearing and Grubbing	m2	0.73	354,900.56	257,394	
	Cutting	m3	17.15	232,222.81	3,983,704	
	Filling	m3	13.97	110,600.83	1,545,221	
	Sub Total				5,790,000	
SUBBASE AND BASE	BRT					
	Asphaltic Base Course	m2	20.00	131,748.63	2,634,973	t=12.5cm
	Cement Stabilization	m3	40.56	41,264.23	1,673,877	t=30cm
	Existing Road Widening					
	Asphaltic Base Course	m2	17.00	194,043.41	3,298,738	t=10cm
	Cement Stabilization	m3	40.56	47,067.61	1,909,290	t=22.5cm
	Side Walk					
	Asphaltic Base Course	m2	17.00	79,722.72	1,355,286	t=10cm
	Median					
	Cement Stabilization	m3	40.56	546.00	22,148	t=10cm
	BRT Station					
	Cement Stabilization	m3	40.56	143.00	5,800	t=10cm
	Road Pavement of BRT Station and Intersections					
	Cement Stabilization	m3	40.56	3,441.59	139,608	t=15cm
	Sub Total				11,040,000	
SURFACING	BRT					
	Asphaltic Wearing Course	m2	18.24	132,705.62	2,420,641	t=4cm
	Tack Coat	m2	0.63	132,432.90	83,010	0.5 l/m2
	Existing Road Widening					
	Asphaltic Wearing Course	m2	18.24	196,015.70	3,575,461	t=4cm
	Tack Coat	m2	0.63	195,816.14	122,739	0.5 l/m2
	Sidewalk					
	Asphaltic Wearing Course	m2	13.68	82,904.96	1,134,182	t=3cm
	Tack Coat	m2	0.63	84,186.19	52,768	0.5 l/m2
	Median					
	Concrete Slab	m3	134.67	273.90	36,886	t=5cm
	BRT Station					
	Concrete Slab	m3	134.67	71.50	9,629	t=5cm
	Road Pavement of BRT Station and Intersections					
	Concrete Slab	m3	134.67	5,735.99	772,465	t=25cm
	Sub Total				8,210,000	
REMOVAL WORK	Breaking of Existing Road Pavement	m3	55.95	40,101.87	2,243,724	
	Sub Total				2,240,000	
DRAINAGE	Pipe Culvert (D=600mm)	m	260.90	1,581.00	412,482	Road Crossing Pipe Culvert
	Sub Total				410,000	
STRUCTURE	Bridge	L/S	450,000.00	1.00	450,000	Bridge Length: 12m
	Curve Block	m	33.07	61,374.00	2,029,774	
	Sub Total				2,480,000	
RELOCATION	Utilities	L/S	380,000.00	1.00	380,000	
	Street Lightning	No.	2,914.64	567.00	1,652,603	
					0	
	Sub Total				2,030,000	
OTHERS	Road Marking					
	White Line	m	1.36	46,493.00	63,034	150mm wide
	Yellow Line	m	1.36	17,900.00	24,268	150mm wide
	Lettering and Symbols	m2	19.53	3,005.75	58,702	
	BRT Road Stud	No.	12.00	2,343.00	28,116	
	Sub Total				170,000	
Civil Works (Road) Cost (Net)					32,370,000	
MISCELLANEOUS EXPENSES	20 % of Construction Cost Sub Total	L/S			6,474,000	
Civil Works (Road) Cost (Gross)					38,844,000	

Table A.2: BOQ of BRT Facilities

Work Category	Description	Unit	Rate (USD)	BRT Estimated Quantity	BRT Amount (USD)	Remarks
STATION STRUCTURE	Width: 2.0 m	No.	9.00	41,000.00	369,000	
	Width: 3.5 m	No.	7.00	71,800.00	502,600	
	Sub Total				872,000	
BUS BAY STRUCTURE	T3 (Zimpeto Terminal)					
	BRT	m2	250.00	3,000.00	750,000	
	Feeder Bus	m2	250.00	2,600.00	650,000	
	T2 (Missao Roque Terminal)					
	BRT	m2	250.00	2,000.00	500,000	
	Feeder Bus 1	m2	250.00	300.00	75,000	
	Feeder Bus 2	m2	250.00	840.00	210,000	
	T1 (Maputo Station Terminal)					
	BRT	m2	250.00	2,300.00	575,000	
	Feeder Bus	m2	250.00	2,200.00	550,000	
	Sub Total				3,310,000	
BUILDINGS	T3 (Zimpeto Terminal)					
	Repair and Maintenance	m2	330.00	1,200.00	396,000	
	Office	m2	660.00	600.00	396,000	
	Waiting Room	m2	330.00	600.00	198,000	
	T1 (Maputo Station Terminal)					
	Repair and Maintenance	m2	330.00	420.00	138,600	
	Office	m2	660.00	1,200.00	792,000	
	Waiting Room	m2	330.00	280.00	92,400	
	Sub Total				2,013,000	
SPECIAL FACILITIES	T3 (Zimpeto Terminal)					
	Car Wash	No.	200,000.00	1.00	200,000	
	Filling Station	No.	1,000,000.00	1.00	1,000,000	
	T1 (Maputo Station Terminal)					
	Car Wash	No.	200,000.00	1.00	200,000	
	Filling Station	No.	1,000,000.00	1.00	1,000,000	
	Sub Total				2,400,000	
CIVIL WORKS	T3 (Zimpeto Terminal)	m2	7,150,000.00	1.00	7,150,000	
	T2 (Missao Roque Terminal)	m2	1,050,000.00	1.00	1,050,000	
	T1 (Maputo Station Terminal)	m2	5,970,000.00	1.00	5,970,000	
	Sub Total				14,170,000	
OTHERS	Permissions and Authorizations	L/S	15,000.00	1.00	15,000	
	Sub Total				15,000	
BRT Facilities Cost (Net)					22,780,000	
MISCELLANEOUS EXPENSES	20 % of Construction Cost Sub Total	L/S			4,556,000	
BRT Facilities Cost (Gross)					27,336,000	

Table A.3: BOQ of Bus Fleet

Work Category	Description	Unit	Rate (USD)	BRT Estimated Quantity	BRT Amount (USD)	Remarks
BUS FLEET	Base	No.	280,000.00	30.00	8,400,000	
	Spares	No.	280,000.00	4.00	1,120,000	
	Sub Total				9,520,000	
	5 % of Sub Total Cost (Import Duty)	L/S			476,000	
	1 % of Sub Total Cost (Import Costs)	L/S			95,200	
	Sub Total				571,000	
Bus Fleet Cost					10,091,000	

Appendix B Economic Evaluation

B.1 Introduction

B.1.1 Purpose

This Appendix outlines the approach and assumptions adopted and the results from the economic evaluation of the status quo transport development “Scenario A” set out in the Master Plan volume versus the proposed N1 BRT scheme “Scenario A+N1 BRT.”

B.1.2 Structure

Subsequent Sections of this appendix are structured as follows:

- Section B.2 discusses the preferred transport network scenario
- Section B.3 introduces and outlines the approach taken to economic evaluation of the preferred scenario
- Section B.4 describes how parameters were defined for economic analysis
- Section B.5 presents project cost data
- Section B.6 presents transport modelling results, as interpreted for purposes of this economic analysis
- Section B.7 shows the economic evaluation results
- Section B.8 presents the results of sensitivity analysis

B.2 Land Use Scenario and Transport Network

The Land Use scenario selected as part of the Master Plan was scenario “C”, which assumed that there would be development intensification along key transit corridors.

The transport network being tested comprises Phase II of BRT construction, which is studied in this pre-F/S volume, consisting of the North and South Sections as seen in Figure B.1. In this economic analysis, it is assumed that both the North and South Sections will be completed by the end of 2009.

Source: JICA Project Team

Figure B.1: Bus Rapid Transit Network Being Tested

B.3 Economic Analysis Methodology

The economic analysis is predicated upon comparing a "Scenario A+N1 BRT" case against a "Scenario A" case. The difference between cases is the N1 BRT that is studied in this pre-F/S. The outline methodology can be described as follows:

1) Based upon transport model outputs (Section B.6) and parameters for economic evaluation (Section B.4), benefit streams are calculated until 2035 and estimated by year.
2) Cost streams are also calculated by year (Section B.5).
3) The resultant cost and benefit streams are then combined in order to perform discounted cashflow analysis (DCF) to derive scheme Net Present Value (NPV) at a discount rate of 12%, the Economic Internal Rate of Return (EIRR), as set out in Section B.7. A sensitivity analysis is also performed, as set out in Section B.8.

B.4 Parameters for Interpretation of Transport Model Outputs

B.4.1 Value of Time

The Value of Time (VOT) was estimated based upon:

- Per capita GDP in the Study Area
- Price inflation to 2013
- Growth estimated in GDP per capita,
- Data from the Household Interview Survey (HIS)

As per materials presented at the 3rd Steering Committee, based upon data from INE and projections made by MPD and the JICA Project Team, per capita GDP in Maputo City and Maputo Province was as shown in Table B.1, in 2009 prices. Given that Matola, Marracuene and Boane are within Greater Maputo, it was assumed that their income level would be higher. Hence for these areas, GDP per capita was taken to be midway between Maputo Province as a whole and Maputo City.

Table B.1: GDP Per Capita in MT in 2009 prices

	Year			
Location	**2012**	**2018**	**2025**	**2035**
Maputo City	48,062	67,272	95,221	132,346
Maputo Province	28,448	34,671	44,612	55,008
Boane, Matola, Marracuene	38,255	50,972	69,917	93,677

Source: INE, MPD, JICA Project Team

Price inflation estimates from the IMF and the CIA Factbook were used to convert these figures into 2012 prices. These price inflation estimates are shown in Table B.2.

Table B.2: Price Inflation Estimates

	Year				Compound
	2009	**2010**	**2011**	**2012**	**2009–2012**
IMF	3.3%	12.7%			
CIA Factbook	3.3%	13.5%	10.4%		
Say	3.3%	13.1%	10.4%	10.4%	42.4%

Source: IMF, CIA, JICA Project Team

Based on the data in Table B.1 and Table B.2, GDP per capita was then specified in 2013 prices. Furthermore, based upon planning data, 55% of the population in the study area lived in Maputo City, with 45% residing in Boane, Matola or Marracuene. And according to HIS data, 57% of trips were made by Maputo residents, as opposed to 43% made by residents of Boane, Matola and Marracuene. An average of these proportions were used to derive a weighted average GDP per capita: 56% based upon Maputo City and 44% for the other locations. This then gave GDP per capita estimates, in 2013 prices, as shown in Table B.3.

It was then assumed that the average work year for study area residents was 2,000 hours (equivalent to 50 weeks of 40 hours each). Dividing GDP per capita by 2,000 then gave an economic estimate of the value of work-related time (i.e. commutes to or from work, plus trips on employers' business). In line with standard practice, half of this value was adopted for non-work trips. According to HIS data, 51% of trips were associated with work, as shown in Table B.4. The resultant VOT's adopted by year, in 2012 prices, are shown in Table B.5 (data given for modeled years only).

Table B.3: GDP Per Capita in Study Area as a Whole (2013 Prices)

	Year			
Location	**2012**	**2018**	**2025**	**2035**
MT	62,241	85,496	119,609	164,037
USD	2,058	2,826	3,954	5,423

Source: JICA Project Team

Table B.4: Selected Trip Purpose Splits from HIS

Purpose	% of Trips
To Work	22.2%
On Business	6.6%
From Work *	22.2%
All work/ business related	51.0%
Non-work/business related	49.0%

Source: JICA Project Team
Note: * From Work taken to be the same as To Work

Table B.5: Value of Time in 2013 Prices for the Study Area as a Whole

	Year			
	2012	**2018**	**2020**	**2035**
VOT (MT/hour)	23.50	32.27	35.52	61.92
VOT (USD/hour)	0.78	1.07	1.17	2.05

Source: JICA Project Team

B.4.2 Vehicle Operating Costs

Vehicle operating costs (VOC) were estimated based upon the UK Department for Transport's WebTAG advisory guidance, which covers the build-up of VOC for urban transport models and also upon the World Bank's HDM model, by vehicle type.

Data on individual cost elements were, however, collected locally by the JICA Project Team.

The approach adopted is summarized as follows:

- Take local values for typical vehicle purchase costs (second-hand imported cars being more typical than new cars in Maputo, for example), vehicle life, km's operated per year to estimate depreciation; this also taking account of a trend towards smaller-engined cars in Maputo.
- Use fuel consumption values for urban transport from WebTAG in the first instance, but then adjust for the roughness of roads in Maputo (using IRI=4 as an overall roughness factor for Maputo's roads in the future).
- Input costs of tires and oil and estimation of cost per km.
- Account for depreciation costs.
- For commercial vehicles, estimate crew costs and overheads based upon operating patterns (in the case of buses, separate operating patterns and km operated per year under the "Scenario A" and "Scenario A+N1 BRT" scenarios).

Equations were defined for each vehicle type in the following form:

$$VOC\ per\ km = A + B.V + C.V^2 + D.V^3 + E/V$$

Where: V= velocity (kph); and,
A, B, C, D and E are parameters

Data were then converted into vehicle categories to match those classes assigned in the transport model, according to the surveyed vehicle mix. The resultant values for A, B, C, D and E are as shown in Table B.6.

Table B.6: VOC's (MT per Vehicle-km)

Vehicle Type	Parameter				
	A	B	C	D	E
Car	9.244878	-0.19565	0.00222	-7.1E-06	0
Minibus	8.351372	-0.10286	0.000751	-2.8E-06	200.921
Bus	32.71849	-0.7208	0.010412	-4.6E-05	371.7483
Truck	36.16736	-0.96461	0.013833	-6.1E-05	231.4679
BRT	43.93283	-1.08119	0.015618	-6.9E-05	393.3116

Source: JICA Project Team

B.4.3 Emissions

Emissions of CO_2 and NO_x were estimated on a per-vehicle km basis according to speed, using an equation form similar to that used for VOC, though without the *"E"* term. Parameters from the Japanese Ministry of Land, Infrastructure and Transport were adopted, with relationships specified for small vehicles (i.e. cars) and large vehicles (trucks, buses, BRT). The A, B, C and D parameters are shown in Table B.7.

Table B.7: CO_2 and NO_x Emissions by Vehicle-km According to Speed

	Grams of Carbon per vehicle-km		Grams of NOx per vehicle-km	
Parameter	Small Vehicles	Large Vehicles	Small Vehicles	Large Vehicles
A	1.377142857	3.025714286	0.004435714	0.042357143
B	-0.047454185	-0.078176768	-0.000113286	-0.000401151
C	0.000768182	0.001108009	1.65584E-06	-4.42857E-06
D	-4.11616E-06	-5.05051E-06	-6.31313E-09	8.05556E-08

Source: Japanese Ministry of Land, Infrastructure and Transport

Both CO_2 and NO_x figures are used in the environmental assessment. For the economic assessment, the cost of carbon emissions are monetized on the basis of USD 5.20 per metric ton of CO_2 in 2012 (equivalent to recent prices on European exchanges), increasing to USD 23.00 per metric ton of CO_2 in 2035 (equal to the all-time high on the European exchanges for emissions trading).

B.4.4 PCU Factors and Vehicle Occupancies

The transport model assumed passenger car unit (PCU) equivalent factors of 1.0 for cars, 2.0 for bus (incorporating large buses and various sizes of minibus and chapas) and 2.5 for trucks.

From the surveys conducted at screenlines, average occupancies were shown to be: 12 passengers per chapa (including caixa aberta and minibus) and 63 per bus. Therefore, modeled passenger flows were converted into vehicle flows for the purposes of economic analysis based upon these occupancy levels. However, 110% of these figures were assumed for peak hour occupancies (where crush loading is commonplace) and 75% in off-peak periods. For BRT, although the vehicle capacity is 160 persons, 120 was assumed (or 120 × 110% = 132 in the peak; and, 120 × 75% = 90 in the off-peak).

B.4.5 Vehicle Speeds

The JICA STRADA transport model assumes the same speed for all vehicle types on a link. Therefore, as part of the processing of model outputs, trucks were assumed to be 10% slower than cars, chapas 20% slower than cars, and TPM buses 25% slower than cars (to take into account of the need to weave in and out of traffic to set-down and pick-up passengers). As BRT will be on a segregated right-of-way, BRT speeds are unchanged from the JICA STRADA outputs.

In addition, so as to prevent unrealistically low speeds on certain links distorting VOC or VOT calculations, minimum and maximum speed constraints were also set by vehicle type.

B.4.6 Waiting Times

Public transport routes were coded into the JICA STRADA model on the basis of envisaged services per day. However, STRADA interprets these frequencies on a per-hour basis. As such, the model does not directly output meaningful waiting times. Therefore, as part of the post-STRADA processing of model data, waiting times were added based on:

- The revised frequency calculated from the number of vehicles per hour in peak and off-peak periods, based on assumptions set out in Section B.4.4, subject to:
  - A minimum waiting time, also taking account of ticketing time (two minutes and three minutes in peak and off-peak, respectively, for bus and chapa; two minutes in peak and off-peak for BRT); and,
  - A maximum waiting time, being ten minutes for chapa, fifteen for TPM and five for BRT in the peak; and fifteen, twenty and five minutes, respectively, in the off-peak.

B.4.7 Annualization Factors

In order to convert modeled day metrics into annual metrics, a factor of 330 was used. This was estimated as follows:

- 52 × 2 = 110 weekend days per year
- 12 × 1 = 12 holidays per year (i.e., one per month)
- Apply a factor of 1.00 for non-holiday weekdays
- Apply a factor of 0.8 for Saturdays
- Apply a factor of 0.6 for Sundays and holidays
- This gives 329, which was rounded to 330

B.5 Project Cost Data

Not all costs shown in the financial analysis were included in the economic analysis directly. Vehicle fleet purchase and operating costs for road-running vehicles were modeled as part of VOC including those costs of the BRT fleet to be procured in the project. However, infrastructure design and construction, capability development, and maintenance costs have been included. These costs were obtained from the financial analysis, and were converted to economic costs.

A shadow price conversion factor of 0.85 was applied to infrastructure-related costs (i.e. infrastructure design & construction; and, maintenance). This factor was obtained following review of a number of other development agency studies undertaken in Mozambique in recent years.

In addition, when undertaking economic analysis a time horizon is set for evaluation, in this case 2035. However, certain infrastructures may have a design life beyond this horizon. As such, a residual value is placed on the remaining value of the infrastructure at the end of the evaluation period. So in 2036 a proportion of certain costs is deducted, relating to such residual valuation. The economic costs included in the analysis are shown in Table B.8.

Table B.8: Economic Costs of the Project by Year (USD thousands)

Year	Infrastructure Design & Construction	Capacity Building	Maintenance	Total
2014	3,063	500		3,563
2015	2,466	500		2,966
2016	2,959	500		3,459
2017	2,466	500		2,966
2018	28,393	1,000		29,393
2019	27,860	1,000		28,860
2020 to 2035			47	47
2036 (residuals)	(39,670)			(39,670)

Source: JICA Project Team

B.6 Transport Model Outputs

Although transport model runs were originally prepared for 2018 as well, given an assumed opening for the N1 BRT project in 2020, only transport model runs for 2020 and 2035 were considered.

Table B.9 and Table B.10 compare daily passenger hours, vehicle-km, average speeds and public transport boardings in the Scenario A and Scenario A+N1 BRT cases (i.e,. without and with the Phase II BRT), by mode for 2020 and 2035. Similarly, Table B.11 and Table B.12 compare daily vehicle operating costs and emissions in 2020 and 2035.

Table B.9: Daily Passenger Hours, Vehicle-km, Speeds and Boardings in 2020

	Scenario A	Scenario A+N1 BRT	Diff.	% Change
Passenger Hours by Mode (per Day)				
Car	504,500	509,209	4,709	1%
Truck	54,070	53,910	(159)	0%
Chapa	791,094	752,994	(38,100)	-5%
TPM Bus	451,980	391,781	(60,199)	-13%
Ferry	5,590	5,590	(1)	0%
LRT	22,467	25,857	3,389	15%
BRT	30,768	137,085	106,317	346%
BRT Feeder	4,396	13,708	9,311	212%
Walk	13,522	23,514	9,992	74%
Total	**1,878,386**	**1,913,646**	**35,260**	**2%**
Vehicle-km by Mode (per Day)				
Car	6,786,088	6,797,561	11,474	0%
Truck	653,487	653,849	362	0%
Chapa	3,935,916	3,785,513	(150,404)	(4%)
TPM Bus	302,538	276,625	(25,913)	(9%)
Ferry	505	505	0	0%
LRT	977	1,010	33	3%
BRT	3,984	22,131	18,148	456%
BRT Feeder	33	224	190	571%
Walk	--	--	--	--
Total	**11,683,528**	**11,537,417**	**(146,111)**	**(1%)**
Public Transport Boardings per Day				
Car	n/a	n/a	n/a	n/a
Truck	n/a	n/a	n/a	n/a
Chapa	2,316,236	2,161,194	(155,042)	(7%)
TPM Bus	1,025,353	950,681	(74,672)	(7%)
Ferry	41,517	41,518	1	0%
LRT	40,360	47,376	7,016	17%
BRT	45,944	168,167	122,223	266%
BRT Feeder	36,502	89,560	53,058	145%
Walk	--	--	--	--
Total	**3,505,912**	**3,458,496**	**(47,416)**	**(1%)**

Source: JICA Project Team

Table B.10: Daily Passenger Hours, Vehicle-km, Speeds and Boardings in 2035

	Scenario A	Scenario A+N1 BRT	Diff.	% Change
Passenger Hours by Mode (per Day)				
Car	1,139,252	1,149,981	10,729	1%
Truck	92,991	93,207	216	0%
Chapa	2,022,798	1,915,307	(107,491)	(5%)
TPM Bus	1,234,700	1,124,842	(109,858)	(9%)
Ferry	7,390	7,389	(1)	0%
LRT	33,671	37,105	3,434	10%
BRT	33,346	174,570	141,224	424%
BRT Feeder	3,568	14,280	10,712	300%
Walk	19,490	29,759	10,270	53%
Total	**4,587,204**	**4,546,439**	**(40,765)**	**(1%)**
Vehicle-km by Mode (per Day)				
Car	11,356,919	11,400,158	43,239	0%
Truck	736,427	739,848	3,422	0%
Chapa	6,693,892	6,453,132	(240,761)	(4%)
TPM Bus	506,013	480,331	(25,683)	(5%)
Ferry	771	771	0	0%
LRT	1,075	1,271	195	18%
BRT	4,139	26,453	22,314	539%
BRT Feeder	33	224	190	571%
Walk	n/a	n/a	n/a	n/a
Total	**19,299,269**	**19,102,186**	**(197,083)**	**(1%)**
Public Transport Boardings per Day				
Car	n/a	n/a	n/a	n/a
Truck	n/a	n/a	n/a	n/a
Chapa	3,746,032	3,513,841	(232,191)	(6%)
TPM Bus	1,578,551	1,512,742	(65,809)	(4%)
Ferry	62,070	62,078	8	0%
LRT	58,451	64,980	6,529	11%
BRT	44,745	191,343	146,598	328%
BRT Feeder	29,361	79,166	49,805	170%
Walk	--	--	--	--
Total	**5,519,210**	**5,424,150**	**-95,060**	**-2%**

Source: JICA Project Team

Table B.11: Daily Vehicle Operating Costs and Emissions in 2020

	Scenario A	Scenario A+N1 BRT	Diff.	% Change
Vehicle Operating Costs (MT per Day)				
Car	33,505,508	33,604,216	98,708	0%
Truck	16,507,364	16,475,910	(31,454	0%
Chapa	52,966,897	50,895,651	(2,071,247)	(4%)
TPM Bus	11,768,964	10,556,504	(1,212,460)	(10%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	189,520	1,054,358	864,838	456%
BRT Feeder	1,235	8,228	6,993	566%
Walk	n/a	n/a	n/a	n/a
Total	**114,939,488**	**112,594,867**	**(2,344,621)**	**(2%)**
CO_2 Emissions (grams of Carbon per Day)				
Car	3,544,006	3,558,245	14,239	0%
Truck	975,646	974,245	(1,401)	0%
Chapa	6,123,905	5,887,107	(236,798)	(4%)
TPM Bus	527,787	475,931	(51,856)	(10%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	7,420	41,259	33,839	456%
BRT Feeder	54	366	312	576%
Walk	n/a	n/a	n/a	n/a
Total	**11,178,818**	**10,937,153**	**(241,665)**	**(2%)**
NOx Emissions (grams of NOx per Day)				
Car	16,056	16,102	47	0%
Truck	17,265	17,241	(24	0%
Chapa	109,778	105,499	(4,279)	(4%)
TPM Bus	9,444	8,542	(902)	(10%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	132	735	603	456%
BRT Feeder	1	7	6	577%
Walk	n/a	n/a	n/a	n/a
Total	**152,675**	**148,125**	**(4,550)**	**(3%)**

Source: JICA Project Team

Table B.12: Daily Vehicle Operating Costs and Emissions in 2035

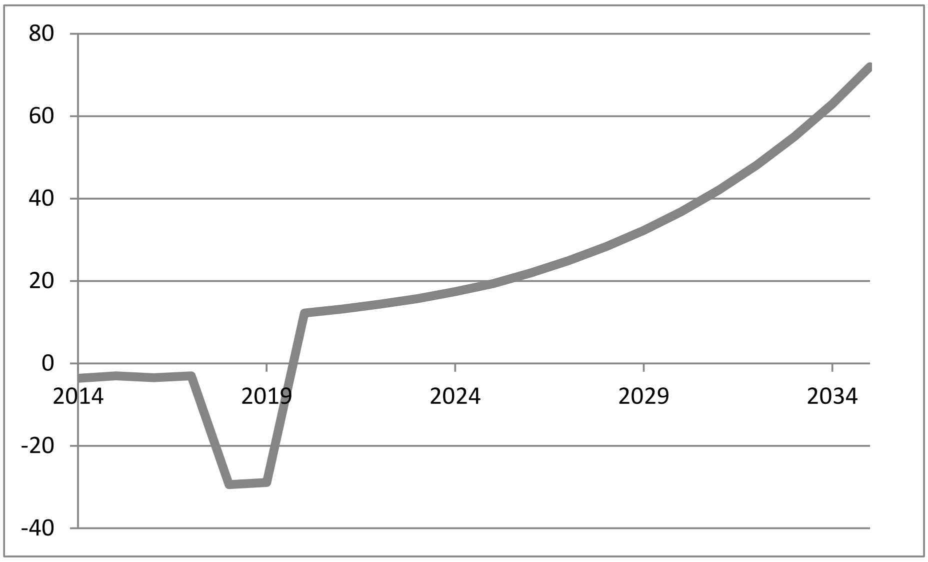
	Scenario A	Scenario A+N1 BRT	Diff.	% Change
Vehicle Operating Costs (MT per Day)				
Car	62,061,560	62,379,856	318,296	1%
Truck	23,692,072	23,748,478	56,406	0%
Chapa	117,703,139	113,964,887	(3,738,252)	(3%)
TPM Bus	24,570,071	22,843,668	(1,726,403)	(7%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	197,008	1,260,468	1,063,460	540%
BRT Feeder	1,235	9,373	8,138	659%
Walk	n/a	n/a	n/a	n/a
Total	**228,225,085**	**224,206,730**	**(4,018,356)**	**(2%)**
CO_2 Emissions (grams of Carbon per Day)				
Car	6,894,741	6,934,474	39,733	1%
Truck	1,280,675	1,283,859	3,183	0%
Chapa	11,860,012	11,450,565	(409,446)	(3%)
TPM Bus	988,646	927,370	(61,277)	(6%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	7,711	49,321	41,610	540%
BRT Feeder	54	401	347	641%
Walk	n/a	n/a	n/a	n/a
Total	**21,031,840**	**20,645,989**	**(385,851)**	**(2%)**
NOx Emissions (grams of NOx per Day)				
Car	29,069	29,212	143	0%
Truck	22,405	22,475	70	0%
Chapa	206,991	199,789	(7,202)	(3%)
TPM Bus	16,987	15,992	(995)	(6%)
Ferry	n/a	n/a	n/a	n/a
LRT	n/a	n/a	n/a	n/a
BRT	137	878	741	539%
BRT Feeder	1	7	6	624%
Walk	n/a	n/a	n/a	n/a
Total	**275,591**	**268,354**	**(7,237)**	**(3%)**

Source: JICA Project Team

B.7 Economic Evaluation Results

Daily transport model outputs were annualized using the factor 330, as described in Section B.4.7. Passenger time savings were monetized based upon the VOT (see B.4.1). For the economic assessment, the cost of carbon emissions are monetized on the basis of USD 5.20 per metric ton of CO_2 in 2012 (equivalent to recent prices on European exchanges), increasing to USD 23.00 per metric ton of CO_2 in 2035 (equal to the all-time high on the European exchanges for emissions trading). Interpolation was used to obtain benefit streams between 2020 and 2035.

These were then combined with project implementation and maintenance costs, as well as residuals (see Table B.8). Benefit and cost streams were thus obtained, shown in Figure B.2.



Source: JICA Project Team

Figure B.2: Net Benefit Streams by Year (USD million per annum)

Based upon these data, the results of economic analysis are calculated to be:

- Economic Internal Rate of Return (EIRR) = 21.5%
- Net Present Value (NPV) at a 12% discount rate = USD 47.32 million
- Benefit/Cost Ratio (BCR) = 2.23

In conclusion, the robust EIRR, positive NPV and favorable BCR support implementation of the BRT scheme as planned.

B.8 Sensitivity Analysis

Sensitivity analysis was performed, comprising three tests:

- Increasing initial costs by 10%
- Decreasing benefits by 10%
- A combination of the above two tests

The results are shown in Table B.13, showing that the scheme is still attractive even with a 10% increase in costs and 10% decrease in benefits.

Table B.13: Results of Sensitivity Analysis

Case	EIRR	NPV (USD million)	BCR
Base Case	21.5%	47.3	2.23
(1) Costs + 10%	20.2%	43.5	2.03
(2) Benefits – 10%	20.1%	38.7	2.01
Combination of (1) & (2)	18.8%	34.9	1.82

Source: JICA Project Team

Appendix C Baseline Description of Environment Factors

C.1 Baseline Description of Biophysical Conditions

C.1.1 Climate

The weather in Maputo City is tropical with moderate humidity. This region is distinguished by two seasons: the rainy season, which is hot and humid from November to March; and the dry season, which is cold and dry from May to September. April and October are transitional months between seasons.

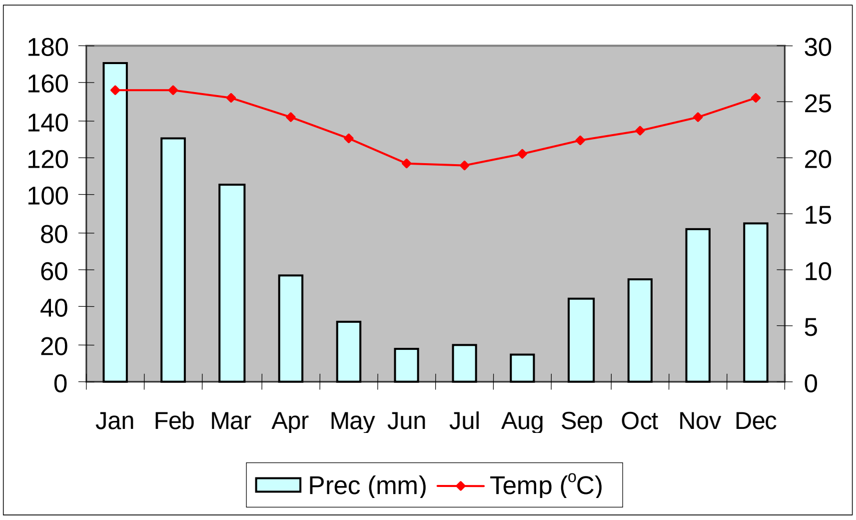
According to data from the Maputo Meteorological Station, the annual average precipitation in Maputo is 768 mm (but with significant inter-annual variation). The evapotranspiration is 1,109 mm per annum. The monthly precipitation is greater than the evapotranspiration only during four months of the year: December through March.

The average annual temperature is 22.9°C with a fairly low thermal semi-amplitude (3.45°C). February is the hottest month (26.0°C) and July is the coldest (19.1°C).

The wind system predominantly consists of winds from the south all year round, with the addition of winds from the north during the fresh period and from the northeast during the hot season. Thus, there are two periods with the following predominant average winds and velocities:

- April through August: winds from the south and north (13.3 km/h)
- September through March: winds from the south and northeast (km/h)

Figure C.1 presents the average monthly precipitation and temperature registered by the Maputo Meteorological station.



Source: INAM (National Institute of Meteorology)

Figure C.1: Average Monthly Precipitation and Temperature for Maputo (1989–2007)

C.1.2 Geology, Topography and Soils

Maputo City has been built on a coastal area sustained by dunes from the Tertiary and Quaternary Periods whose development is associated with events of regression (in combination with cold, dry climatic conditions) and transgression (in combination with hot, humid climatic conditions, the presence of sandy deposits and intensely intemperate weather).

According to the geological map for this region, Maputo City is known to have 12 stratigraphical units or formations with lithologic characteristics with specific color, level of consolidation, and specific granulometry (Table C.1).

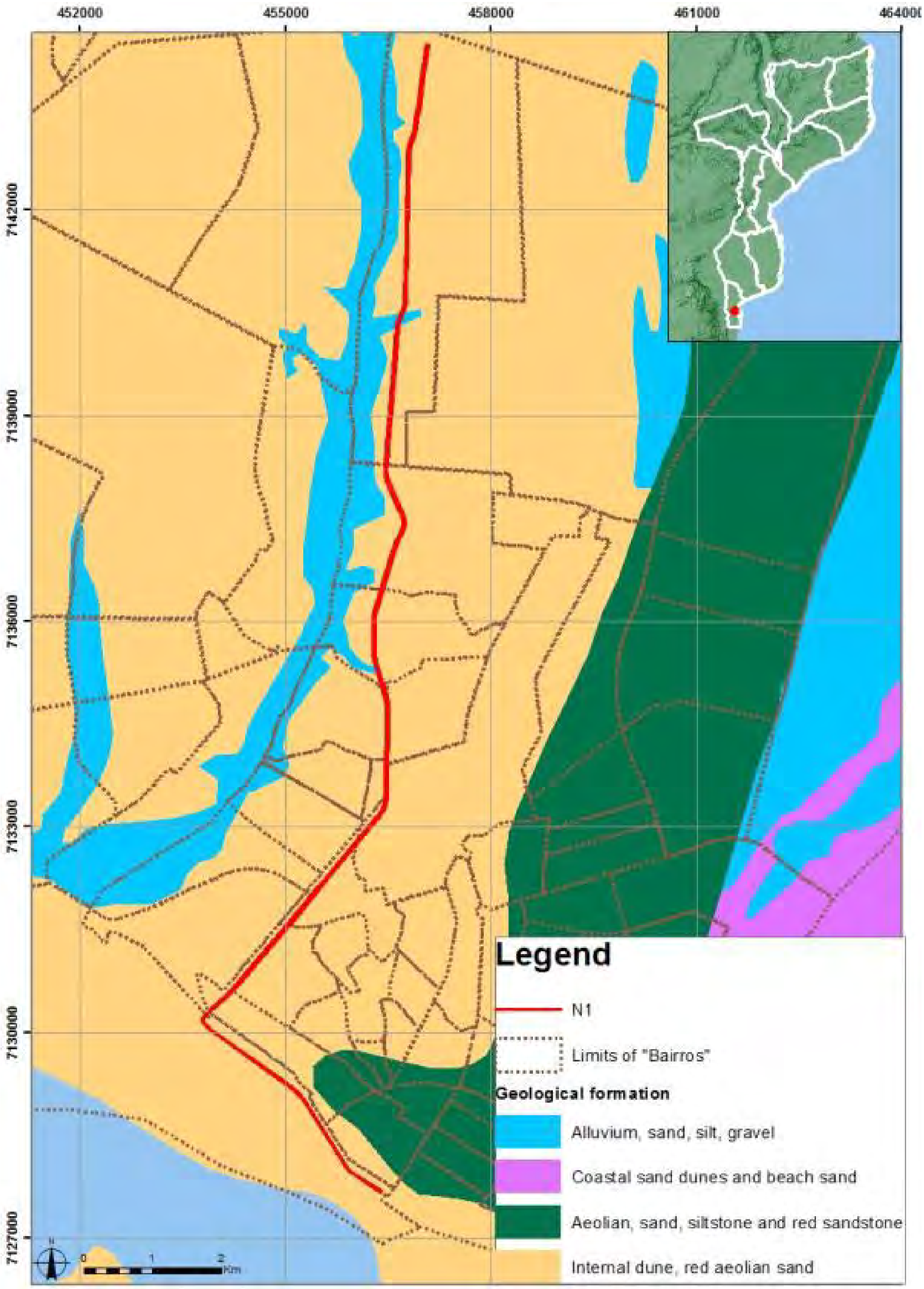
Table C.1: Characteristics of the Geological Units

Era	Period	Unit	Symbol	Descrption/Composition
Quaternary	Holocene	Deposits from the ocean beaches	Qm	White sands, mud and lama, in sections temporarily submerged.
		Aluvial deposits	Qa	Dark fluvial clays, with layers of carbonaceous material with marine influences.
		Deposits in dunes	Qi	White sands.
		Formation of Xefina	QXf	Costal dune sands and ilmenitie fossil sands .
		Costa do Sol	QCs	Arenite limestone.
	Pleistocene	Formation of Congolote	Qco	White, yellow and orange fine and coarse sands.
		Formation of Malhazine	Qma	Reddish, fine and coarse sands.
		Formation of Machava	QMc	Layers of arenous clay.
		Formation of Matola	QMt	Layers of arenous clay.
		Formation of Ponta Vermelha	TPv	Silty red sand with a gradual transition toward yellow arenite, and, in some locations, with a ferruginous crust.
Tertiary	Pliocene			
	Miocene	Formation of Santiago	Tsa	Argillaceous arenite, arenite limestone with *Ostrea cullata* in the upper part.
	Oligocene	Formation of Inharrime	TIn	Fine, silty argillaceous arenite impregnated with organic material and layers of arenite limestone.

Source: Momade et al., 1996, Enoque, 2011

For most of its alignment, the BRT will traverse an area called Congolote with a very short (178 m) portion in Machava, characteristically containing alluvium which outcrops in the hillsides of the Infulene Basin (Figure C.2).

The formation of Congolote comprises principally interior dunes composed of badly consolidated aeolian silica sands with brown, yellow, orange and whitish tones and with a medium to fine granulation. The dunes are located in the interior, not far from the current coastline, but are not part of the present system of dunes. In terms of composition, coarse to fine sands (with only 5% clay-silt) in aeolian deposits with a high silica content predominate the area. This formation contains intra-dune composites of red sands with a medium to fine granulation.



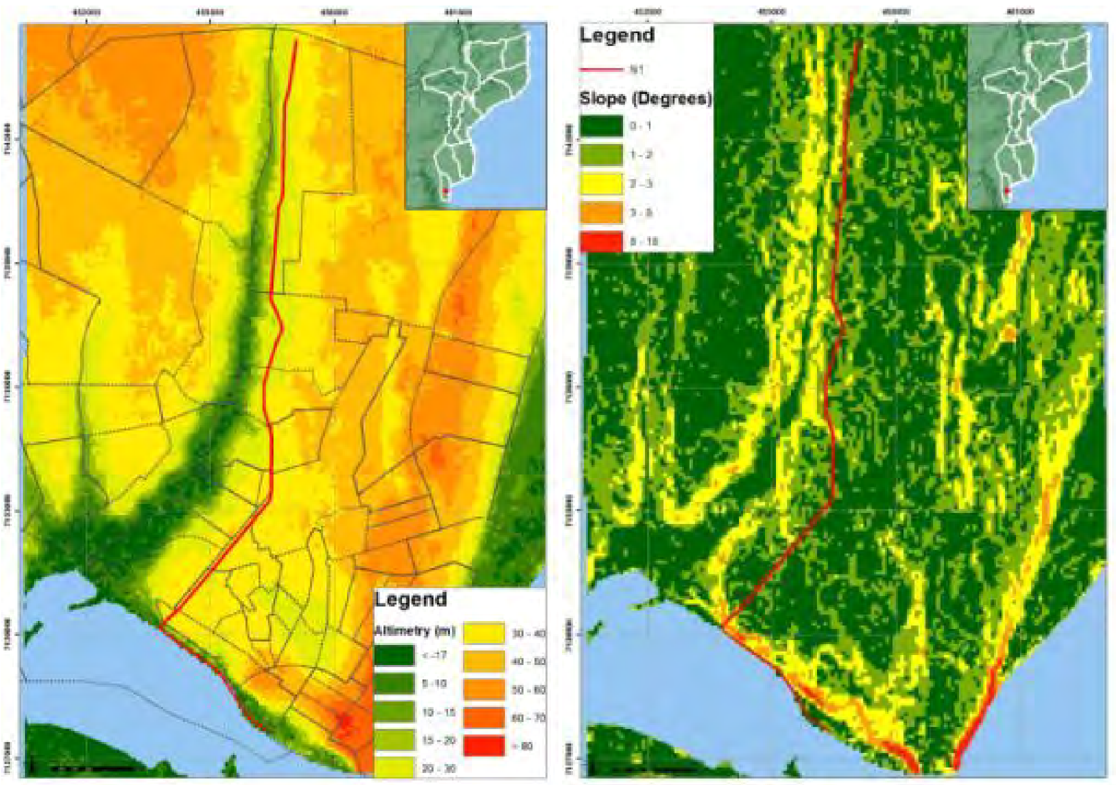
Source: Impacto

Figure C.2: Main Geological Formations in Maputo City and along the Proposed BRT Route

In terms of topography, Maputo City is characterized by a coastal plane to the east (with recent dunes and alluvium) that changes abruptly with a longitudinal escarpment running from north-northeast to south-southwest. To the west of the city, the Infulene River Valley creates conditions for a gradual decline, where there are various depressions with no natural exit. (Some of these depressions, together with the soil characteristics, are responsible for the flood events in the city.) Two principal tectonic faults, the Polana fault and the Infulene fault, are responsible, respectively, for the long hillside to the east of the city and for the Infulene River valley to the west. South of the city are hills 10 m to 50 m high with about a 20% decline, running along the interior band of Maputo estuary, leaving an extension between 100 m and 1,000 m wide of alluvium deposits between its base and the estuary. These are the typical characteristics of the hillside along Av. das Nações Unidas and the CFM housing (Pousada), as also in the Polana-Caniço and Ferroviário boroughs to the north.

Morphologically the following structures are recognized: (i) a coastal accumulation zone corresponding to the beach and ocean deposits; (ii) a coastal zone, inclined toward the ocean, with a maximum elevation of 8 m, consisting of dunes and alluvium; (iii) a 30 m to 50 m high platform, mildly inclined toward the west with fixed, degraded interior dunes and sand beds; and (iv) the Maputo hill, with a maximum elevation of 50 m to 60 m, that consists of a residual relief resistant to erosion, probably associated with neo-tectonic phenomena.

The Clube Ferroviário stretch in the south of Maputo City, where the southern end of the BRT N1 will be located, is at the base of the hillside along Av. das Nações Unidas and the CFM housing (Pousada), whereas the remaining stretch of the N1 up to Zimpeto will along the platform that is inclined to the west in the direction of the Infulene Valley (Figure C.3).



(a) **(b)**

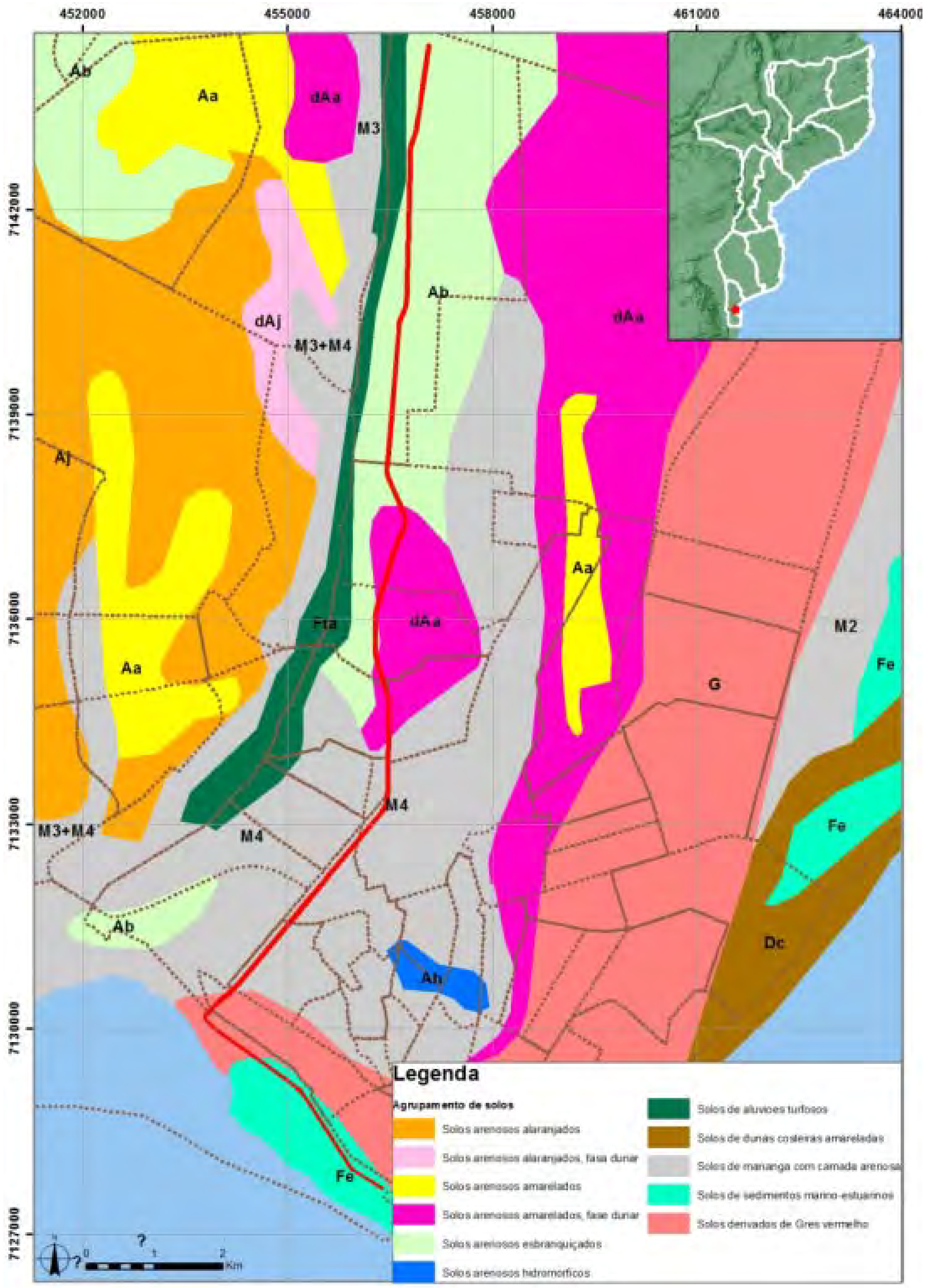
Source: Impacto

Figure C.3: Altimetry (a) and Slope (b) in the Maputo Region and along the Proposed BRT Route

The Maputo area mainly has the following types of soils:

- Mananga soils;
- Sandy soils of diverse types and colorations;
- Soils consisting of argillaceous alluvium;
- Soils consisting of marine and estuarial sediments; and
- Soils derived from red sandstone.

A description of the distribution of the different types of dominant soils in the region is presented in Figure C.4. A considerable portion of the industrial and residential region of Maputo sits on Mananga soils with moderate drainage. The same figure shows that the BRT route crosses soils consisting of marine-estuarial sediments along the stretch between the Maputo Estuary and the ex-Brigada Montada (about 2.7 km long), following the stretch over Mananga soils with a sandy layer (about 4.5 km long) and a final longer stretch (about 7.6 km long), ending in Zimpeto, over whitened sandy soils.



Source: Impacto

Figure C.4: Main Soil Type in Maputo Region and along the Proposed BRT Route

In general, Maputo's soils are susceptible to erosion due to the potential for dispersion allied to other factors such as topography, the use of soils (urbanization), the lack of drainage systems, and the rain pattern. Of special note are the sandy deposits in the Congolote Formation, which are very susceptible to erosion by surface water. In some zones there is also a high propensity for flooding because construction on these deposits has reduced the percolation area and the rate of infiltration thus causing an increase in surface-water runoff.

An example of a zone critically susceptible to erosion in the BRT area is near the hillside along the Avenida Organização das Nações Unidas. Here, erosion tends to form a ravine, generally in a straight path, on the hillside that has an angle of decline of about 25°. The problem was probably caused by the lack of a topical drainage system since one can observe the flow of water at the base of the hill. The problem was solved by installing gabions filled with rhyolite on the hillside. No other zones with erosion problems have been identified in the area directly affected by the BRT.

Especially vulnerable to floods in the area near the BRT are the boroughs of Luís Cabral, Chamanculo and Xipamanine and the residential area of Inhagóia (in this latter area the sandy layers of soil are on top of clay layers, which, allied with the topographical location, reduces the infiltration).

C.1.3 Hydrology and Ground Water

Surface Water

Near the project area is only one national river, the Infulene River. Located to the west of the proposed BRT alignment, this river constitutes the frontier between Maputo City and Matola. With a length of 20 km, 500 m average width, 130 km^2 of area, and a total discharge that varies between 0.2 and 0.7 m^3/s, Infulene River runs from north to south, parallel to National Highway N1. Its source is in the Marracuene District and its mouth is at the Espírito Santo estuary to the east of the N4 tollgate. This permanent river creates various swamps, and its drainage area floods during the rainy season. The downstream section of this river is a huge swamp that has been highly transformed by the installation of industries, salt-works, roads and the railway between Maputo and Machava. The upstream and downstream sections of the river have been altered by planting *Eucalyptus,* which can partially alter its hydrology.

Ground Water

In the Maputo City area, the aquiferous system consists of a superficial phreatic aquifer and a semi-confined, deeper aquifer, separated by a layer of semi-permeable sandy clay. The phreatic aquifer, with a width varying between 5 m and 20 m during the saturation period, consists of old sandy dunes, while the semi-confined aquifer varies between 20 m to 45 m wide and consists of sandstone (to the west) and limestone (to the east). The semi-confined aquifer is recharged by the overlying phreatic aquifer.

The aquiferous system occurs in a south-north sense, from Maputo City to the area north of Manhiça. In general, the pattern of water flow is from the west toward Infulene valley and toward the coast to the east. On the western side, the depths at which the aquifer occurs are, in general, rather shallow, about 1 m or 2 m (slightly deeper in the dry season). Given that the topography is quite regular, the subterranean water flows are slow or stagnant in some areas. However, on the eastern side, due to the steep topographical gradient, the flow is more pronounced and the potential for pollution of subterranean water is very high.

To the east, the phreatic aquifer discharges subterranean waters into Incomati Valley by way of springs or directly into the river. In the south, the phreatic aquifer discharges water into Infulene

Valley whereas, to the west, it replenishes the Matola River. It is not yet clear where the northern frontier of this aquifer is. The Infulene River seems to be the superficial drain for the aquifer but its influence is more limited (a few kilometres) and many boreholes in the valley suggest the continuity of the superficial aquifer below this river.

The semi-confined aquifer is limited to the east and south by waters from Maputo Bay and the Indian Ocean. To the east and southwest (up to the area around Matola River), the water is slightly saline.

C.1.4 Flora, Fauna, and Environmentally Sensitive Areas

Flora (Vegetation)

Within the study area, the land is mostly used for residential, industrial, commercial and farming areas (especially along the Infulene Basin). In this way, the plant cover reveals a strong human influence and is characterized, in general, by the disperse presence of different roads, housing and public spaces, with trees such as acacias, Australian pine, eucalyptus, pines, palms and fruit trees such as mangos, cashew, papaya, bananas and, in places, some gramineous plants of the *Urocholoa mossambicensis* species. As such, no endangered/rare/protected plant species are found in the study area.

Though occupying smaller areas, other natural habitats near the BRT route are tidal flood zones with sand and mud situated to the southwest of the BRT in the Clube Ferroviário at the beginning of N1 stretch of the BRT, mangrove forests at the mouth of Infulene River, and river vegetation along the river. By the Infulene River there are also various swamp areas colonized principally by bulrush (*Phragmithes australis*), with some water lilies (*Nimphea sp.*) and various grass species. The downstream section and the north of the river source have *Eucalyptus sp.* plantations.

The surrounding area along the proposed BRT N1 has some zones with notable vegetative cover, namely:

(i) The areas of the Zoological Garden and of the Equestrian Centre (*Centro Hípico*), in which medium and large vegetation is preserved, mostly non-native plants. In these areas, among many other species, there are red acacias, pines (*Araucaria* species), eucalyptus, palms, frangipanis (*Plumeria* species), mangos, bananas, pares, flamboyant, oleandro (*Nerium* species), bamboo, buganvíleas, encephalartos, and a variety of grasses and crawling vegetation (Figure C.5).


Source: JICA Project Team

Figure C.5: Vegetation at the Zoo (left: Eucalyptus, right: Frangipani)

(ii) The low area, with swampy characteristics, located in Zimpeto to the east of the Malhazine roundabout (Missão Roque), has vegetation that predominantly consists of *Phragmithes australis*. The outer portions of this area are, however, now mostly used for agriculture, with small tracts growing horticulture, cassava and fruit trees (Figure C.6).

Source: JICA Project Team

Figure C.6: Vegetation at the Swampy Area Close to Rotunda de Malhazine

(iii) The Malhazine Ecological Park (EcoPark): an old ammunitions magazine, or Area for Military Service, recently transformed into an Ecological Park, whose aim is to preserve nature and ecosystems as well as for to be for public use (Decree 20/2012). The EcoPark has 568 hectares in which there will be planned infrastructures for management, recreation, research, veterinary assistance, as well as leisure (including green spaces that should receive animal species representative of Mozambican fauna) and other commercial interests. According to Decree 20/2012, for a period of 18 months after its inception, the EcoPark will be managed by the Ministry of Coordination of Environmental Affairs (*Ministério para Coordenação da Acção Ambiental*, or MICOA). After this 18 month period it will be managed by the Municipality of Maputo.

(iv) A plantation of eucalyptus in the north end of the BRT N1 (Figure C.7).

Source: JICA Project Team

Figure C.7: Eucalyptus Plantation

Fauna

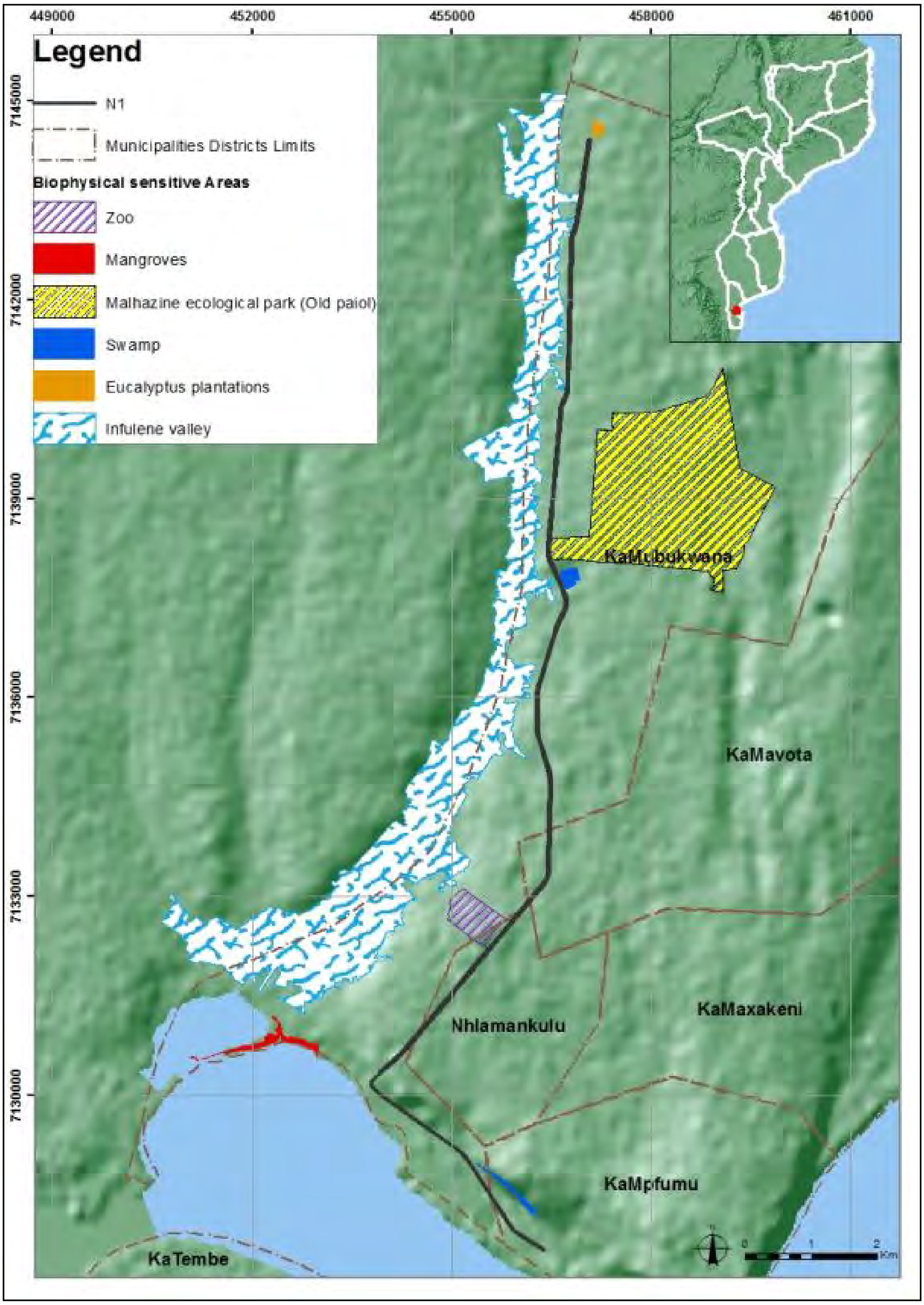
The area where the BRT project will be plemented is an urbanized area where the natural systems have been modified anthropologically. In such environments, due to the absence of locations appropriate for the habitat of local fauna, there only remain synanthropic animal species adapted to live in the company of humans, in or near homes, where they find shelter and food. Examples of these types are insects (mosquitoes, flies fleas, cockroaches, ants, bees, wasps), arachnids (spiders), small reptiles (lizards, geckos, chameleons), amphibians (frogs and toads), mammals (mice, bats) and birds (pigeons, doves, sparrows, crows).

West of the BRT, in the Infulene River, there are some species of fish, such as tilapia, frogs and various terrestrial and charadriiform birds (grey and red herons, cattle herons, small white herons and the hammerkop) are frequent along the river's banks. Small mammals that live along this river include domestic and bamboo mice.

Environmentally Important Areas

In the area surrounding the future BRT are five main environmentally sensitive zones (shown in Figure C.8). These zones are: (i) the Maputo Zoological Park and the Equestrian Centre, (ii) the swampy area near the Malhazine roundabout, (iii) the Malhazine Ecological Park, (iv) the eucalyptus plantation in the northern section of the BRT, and (v) the Infulene Valley.

These areas are chosen to be ecologically important because; (i) they are comparatively close to natural condition thus guaranteeing the effectiveness of the ecosystems' functions and processes (for example, the functions of regulation for maintaining the air quality and the production of nutrients or even genetic and ornamental resources), and (ii) they have cultural importance (as recreational areas or for sceneries important for the community).



Source: Impacto

Figure C.8: Environmentally Important Areas along the Proposed BRT Route

C.2 Baseline Description of Socioeconomic Conditions

C.2.1 Demography and Community Structure

The area proposed for the BRT project is in Maputo City, the province of Maputo, Mozambique's capital and major city, with an area of 347 km².

According to the 2007 Census, Maputo City has 1,094,628 inhabitants of which 532,578 are men and 562,058 are women, with a population density of 3,156.68 hab/km², and 221,428 households.

Administratively, Maputo City is divided into seven urban districts: Municipal District KaMpfumo (DU 1), Municipal District Nhlamankulu (DU 2), Municipal District KaMaxakeni (DU 3), Municipal District KaMavota (DU 4), Municipal District KaMubukwana (DU5), Municipal District Katembe (DU 6) and Municipal District Kanyaka (DU 7).

The project area includes Municipal Districts Nhlamankulu and KaMubukwana in Maputo City.

Municipal District Nhlamankulu includes the follows boroughs: Aeroporto A and B, Xipamanine, Minkadjuíne, Unidade 7, Chamanculo A, B, C and D, Malanga and Munhuana; Municipal District KaMubukwana now includes the boroughs of Magoanine, Malhazine Jardim, Luís Cabral, Inhagoia A and B, Nsalene, 25 de Junho A and B, Bagamoyo, George Dimitrov and Zimpeto (Figure C.9).

According to the 2007 Census (Table C.2), Municipal District Nhlamankulo has a total population 154,272 people, including 75,906 men and 78,366 women, while the Municipal District KaMubukwana has 290,775 people including 140,315 men and 150,460 women.

Source: Impacto

Figure C.9: Boroughs along the BRT Route

Table C.2: Administrative Divisions and Population

Municipal Districts	Population 2007 Census	Boroughs
Municipal District Nhlamankulu	154.272	Aeroporto A and B; Xipamanine; Minkadjuíne; Unidade 7; Chamanculo A, B, C and D; Malanga and Munhuana.
Municipal District KaMubukwana	290.775	Bagamoyo; George Dimitrov; Inhagoia A and B; Jardim, Luís Cabral; Magoanine; Malhazine; Nsalene; 25 de Junho A and B; and Zimpeto.

Source: Census 2007

C.2.2 Land Use

According to the latest land use plan for the city of Maputo, the project area is a mixture of residential, industrial, commercial and future expansion areas of the city. Figure C.10 below shows the different land uses of the project area as well future plans for some areas.

The project area consists of the urban and peri-urban area of Maputo City. The houses are mostly conventional. The zone also possesses various social and economic infrastructure such as schools and other educational establishments (such as the Faculty of Engineering, the Veterinary Faculty, of the Pedagogical University [UP]), hospital and health centers, the headquarters of some national institutions (such as the ANE, the Directorate for the 2nd Fiscal Borough in Bairro do Jardim, the Centre Canine Instruction, etc.), the main station for collective and semi-collective transportation (Junta), a cemetery, banks, warehouses, the premises for medium and large companies and factories, the National Warehouse for Medicines, formal and informal markets, stalls, the National Stadium, the Maputo Zoological Garden, the Maputo Equestrian Centre, the Malhazine Ammunition Magazine, the FADM Base, among others.

Source: Impacto

Figure C.10: Land Use Planning for Maputo City

C.2.3 Economic Activities

In the project area, there is commercial activity from both the formal and informal sectors. The formal sector corresponds to the establishments licensed for commercial activities. There are shops, warehouses and other types of commercial establishments, supermarkets, most notably the China Central and Pick 'n Pay, the Zimpeto wholesale market (Figure C.11), which has minimal associated infrastructure such as fencing, benches *(bancas)*, a secretariat, BIM bank, and public toilets. The Benfica, 25 de Junho, and other markets along the road have benches and stalls *(barracas)* with diverse products, concentrated along the N1 highway. These markets supply the population with basic products, agricultural products, clothing, construction materials, drinks, and cigarettes among other items.

Source: JICA Project Team

Figure C.11: Wholesale Market of Zimpeto

Informal commerce is an intense activity conducted throughout the project area, primarily by the roadside (Figure C.12), and at the road transport terminals along N1, by way of stalls, kiosks, small workshops (carpentry, metal works), as well as the sale of scrap from vehicles and as well as food products, drinks, poles, and furniture. These activities are conducted along the sides of the N1 highway. Many of these stalls and sales benches occupy N1's pedestrian area.

Source: JICA Project Team

Figure C.12: Informal Commerce

The study area also contains numerous industries, notably MODED, Licores de Moçambique, Luso Vinho, Ferro Moçambique, MABOR (not operational), INCOL, Camionagem de Moçambique, Fábrica de Chapas, Indústria Onda Lagoa, etc. Large construction companies – e.g., S&B Construções, Teixeira Duarte, and Opway Construções – are also present in the area, having set up work yards along N1.

C.2.4 Infrastructures and Public Facilities

The project alignment is primarily on National Highway N1, the principal link between the south and north of the country.

Along National Highway N1, which services the linkage axis in the stretch from the intersection of Av. de Moçambique and the Auto-Estrada (ex. Brigada Montada) up to Zimpeto, various social infrastructure predominate (industries, factories, warehouses for food products as well as construction materials), petrol stations, and the practice of formal and informal commerce.

Some fruit trees also exist in the project area, e.g., mafurra trees *(Trichilia emetica), Strychnos spinosa* (massaleiras), mangos, cashew, coconuts, acacia, etc.

At present time a pipeline is being installed on the ROW to transport natural gas on the stretch between Av. de Moçambique and Zimpeto. This pipe is being buried at 1 m deep along the N1.

Below is a list of the principal infrastructure encountered along N1.

Health Care Units

In general, according to the Profile for Maputo and the Summary of Strategies for PEN III, Adequate for Maputo City (n.d.), various diseases exist that are prevalent in Maputo City. In terms of prevalence and mortality, the most worrisome diseases are HIV/AIDS, tuberculosis, pneumonia, bronchitis, and gastrointestinal diseases.

As for the health services, the project area has one psychiatric hospital (Infulene), two health centres (Boa Vida and Bagamoyo), and also pharmacies, notably, the Farmácia da Luz, Farmácia Zabdiel, Farmácia África III, Farmácia Benfica, and Farmácia Luis Valente, among others.

Educational Institutions

- Pedagogical University (UP) Mathematics and Natural Science Faculties;
- National Institute of Distance Education/UP;
- Engineering Faculty, Engineering Laboratory of Mozambique, UEM;
- Veterinary Faculty, Institute of Agrarian Research of Mozambique,
- Directorate of Animal Science;
- Complete Primary School, Unit 2;
- Complete Secondary School Zedequias Manganhela;
- Infulene Primary School, Benfica;
- Professional Training Centre Limpers;
- UGC Secondary School;
- São Francisco Xavier do Benfica Community School;
- Middle Institute of Management and Finances; and
- Complete Primary School Ingrid Chawner.

Places for Religious Rituals

- Arco Íris Ministry;
- Universal Church of the Kingdom of God (2);
- Zimpeto Massjid Church;
- Church close to the Infulene Psychiatric Hospital;
- Missão Roque Catholic Church (São Francisco Xavier);
- Zimpeto Mosque; and
- Free Methodist Church of Mozambique – Temple.

<u>Petrol Stations</u>

Along the project area 10 petrol stations were identified, including:

- Petrol Station Petromoc;
- Petrol Station PB;
- Petrol Station Total;
- Petrol Station Tangerina – Galp; and
- Petrol Station Nkomazi.

<u>Pedestrian Flyovers</u>

- Bridge at intersection of Av. de Moçambique and the highway (ex. Brigada Montada);
- Pedestrian Flyover for the Lhanguene Cemetery;
- Bridge for the Bairro do Jardim below the railroad;
- Bridge at Avenida Joaquim Chissano;
- Pedestrian Flyover for the Zedequias Manganhela Secondary School;
- Pedestrian Flyover at Benfica; and
- Pedestrian Flyover for the Infulene Psychiatric Hospital.

Source: JICA Project Team

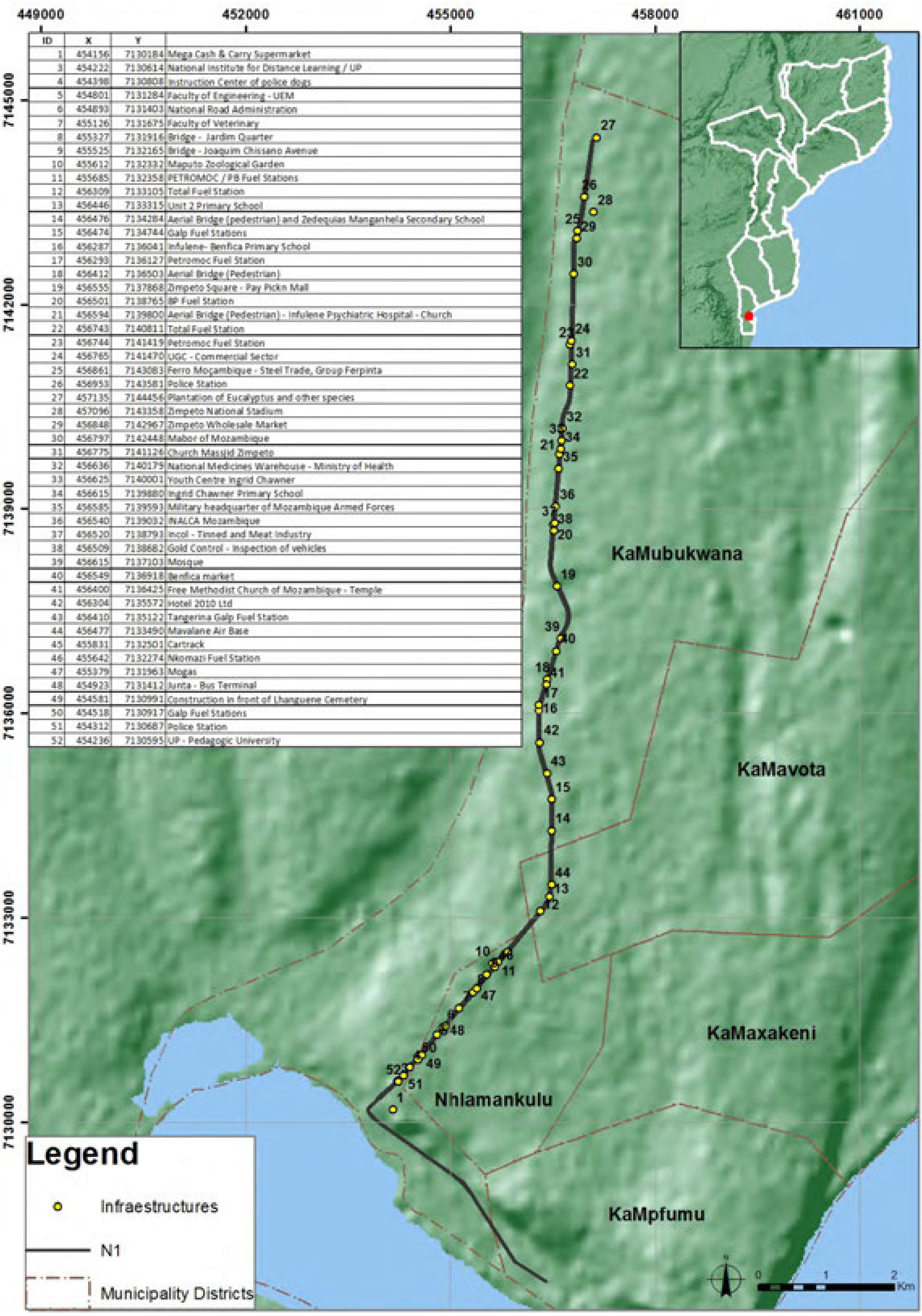
Figure C.13: Pedestrian Flyover

<u>Sacred Places</u>

The only sacred place identified is the Lhanguene Cemetery, the main city cemetery. The cemetery was recently closed because it had surpassed its capacity. Nevertheless, people observe daily burials there. It is also here that the city's only crematory exists.

Source: JICA Project Team

Figure C.14: Lhanguene Cemetery



ID	X	Y	
1	454156	7130184	Mega Cash & Carry Supermarket
3	454222	7130614	National Institute for Distance Learning / UP
4	454398	7130808	Instruction Center of police dogs
5	454801	7131284	Faculty of Engineering - UEM
6	454893	7131403	National Road Administration
7	455126	7131675	Faculty of Veterinary
8	455327	7131916	Bridge - Jardim Quarter
9	455525	7132165	Bridge - Joaquim Chissano Avenue
10	455612	7132332	Maputo Zoological Garden
11	455685	7132358	PETROMOC / PB Fuel Stations
12	456309	7133105	Total Fuel Station
13	456446	7133315	Unit 2 Primary School
14	456476	7134284	Aerial Bridge (pedestrian) and Zedequias Manganhela Secondary School
15	456474	7134744	Galp Fuel Stations
16	456287	7136041	Infulene- Benfica Primary School
17	456293	7136127	Petromoc Fuel Station
18	456412	7136503	Aerial Bridge (Pedestrian)
19	456555	7137868	Zimpeto Square - Pay Pickn Mall
20	456501	7138765	BP Fuel Station
21	456594	7139800	Aerial Bridge (Pedestrian) - Infulene Psychiatric Hospital - Church
22	456743	7140811	Total Fuel Station
23	456744	7141419	Petromoc Fuel Station
24	456765	7141470	UGC - Commercial Sector
25	456861	7143083	Ferro Moçambique - Steel Trade, Group Ferpinta
26	456953	7143581	Police Station
27	457135	7144456	Plantation of Eucalyptus and other species
28	457096	7143358	Zimpeto National Stadium
29	456848	7142967	Zimpeto Wholesale Market
30	456797	7142448	Mabor of Mozambique
31	456775	7141126	Church Massjid Zimpeto
32	456636	7140179	National Medicines Warehouse - Ministry of Health
33	456625	7140001	Youth Centre Ingrid Chawner
34	456615	7139880	Ingrid Chawner Primary School
35	456585	7139593	Military headquarter of Mozambique Armed Forces
36	456540	7139032	INALCA Mozambique
37	456520	7138793	Incol - Tinned and Meat Industry
38	456509	7138682	Gold Control - Inspection of vehicles
39	456615	7137103	Mosque
40	456549	7136918	Benfica market
41	456400	7136425	Free Methodist Church of Mozambique - Temple
42	456304	7135572	Hotel 2010 Ltd
43	456410	7135122	Tangerina Galp Fuel Station
44	456477	7133490	Mavalane Air Base
45	455831	7132501	Cartrack
46	455642	7132274	Nkomazi Fuel Station
47	455379	7131963	Mogas
48	454923	7131412	Junta - Bus Terminal
49	454581	7130991	Construction in front of Lhanguene Cemetery
50	454518	7130917	Galp Fuel Stations
51	454312	7130687	Police Station
52	454236	7130595	UP - Pedagogic University

Source: Impacto

Figure C.15: Location of Main Social Infrastructures along the Proposed BRT Route

C.2.5 Archaeological and Cultural Properties

No archaeological or cultural properties were found in the study area.

C.3 Baseline Description of Pollution

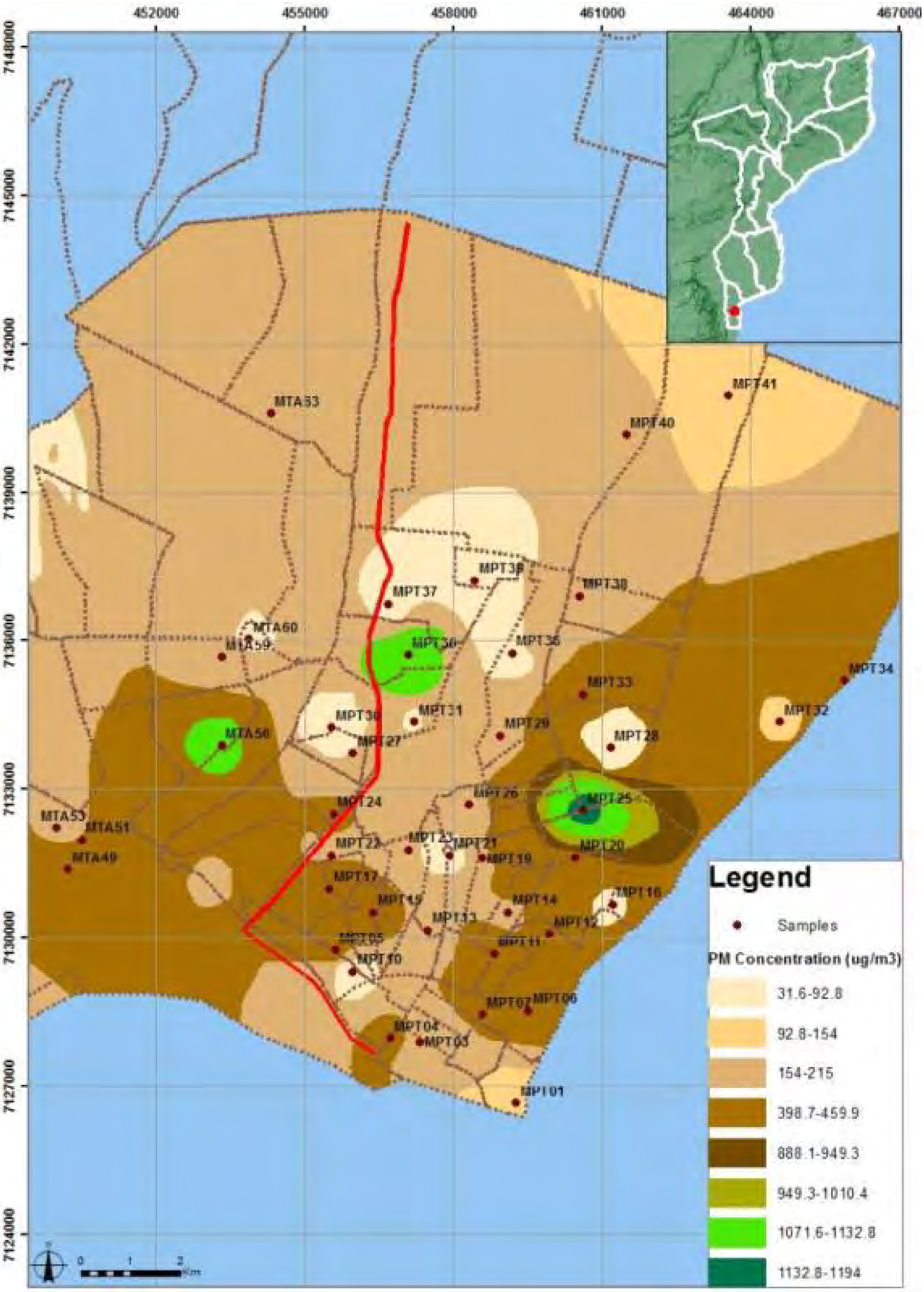
C.3.1 Air Quality

Maputo City is one of the most densely populated urbanized zones in Mozambique, with the presence of some industries and intense land and air traffic. Air quality is hugely affected by these conditions. The growing fleet of automobiles, the growing urban populations, industrial growth, and the demand for energy comprise the principal factors for concern about air pollution in a rapidly growing city such as Maputo.

The studies consulted point to the big growth in the fleet of motorized vehicles as the principal source of air pollution in the urban areas such as Maputo (Matos, 2009 and Magaia, n.d.). According to these studies, the automobile fleet in Mozambique grew from 185,392 vehicles in 2004 to 290,607 in 2008 – a growth of 57% in four years. Estimates show that in Maputo the pollutants most emitted by the automobile fleet are carbon dioxide (CO_2) followed by carbon monoxide (CO), and nitrogen oxides (NO_x). According to these estimates, in 2004, 501.277 tons of CO_2 and 10.028 tons of CO were emitted, of which 55% and 79%, respectively, were car emissions. Again, automobiles were identified as the principal causes for the emission of PM, copper (Cu), cadmium (Cd), chrome (Cr) and nickel (Ni).

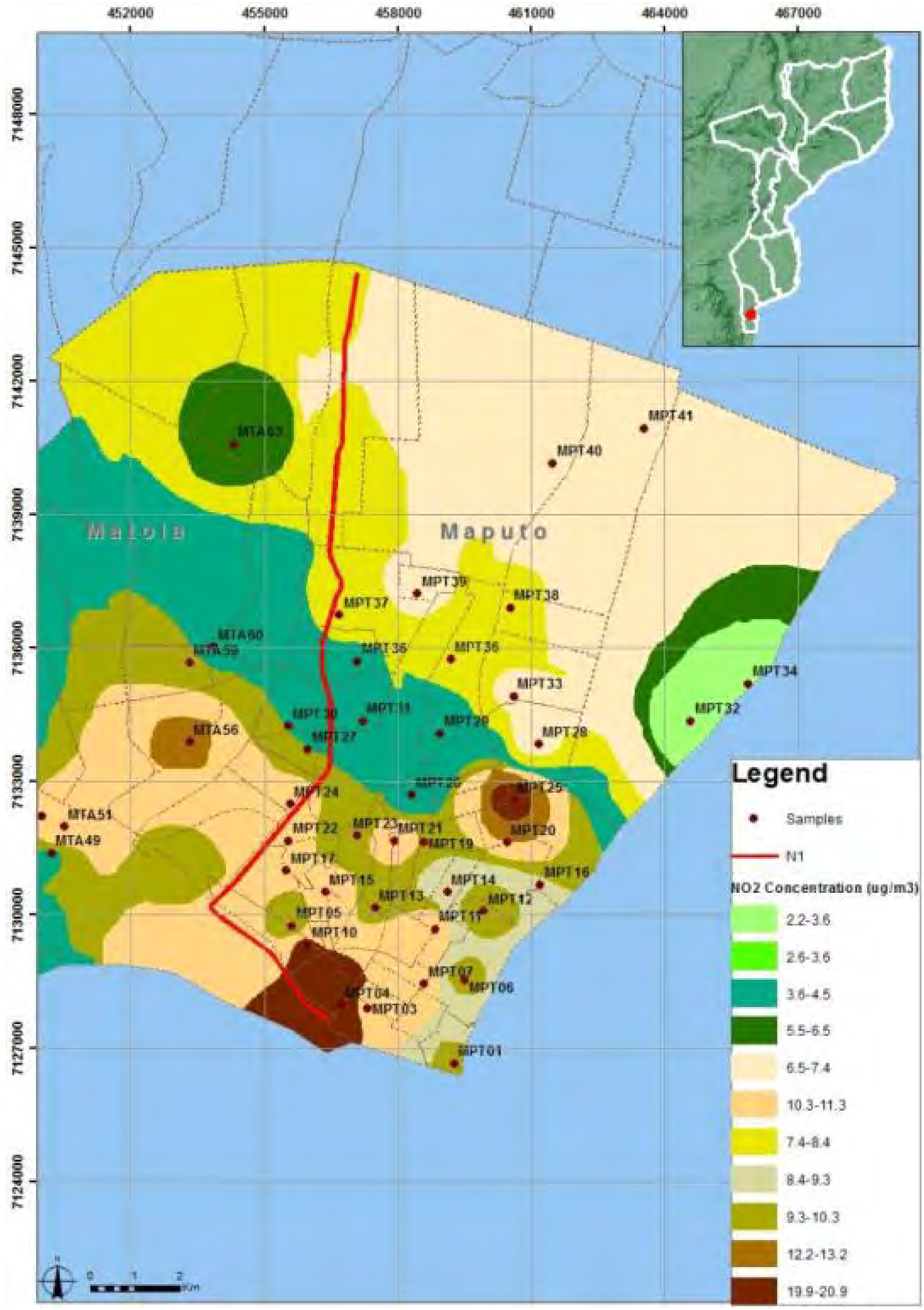
According to a study done in 2007 in Maputo and Matola cities, during two months (March to May), with the objectives of testing the methodology for Rapid Urban Air Quality Assessment (RUA) and taking an inventory of the atmospheric pollutants and their concentrations and dispersion, particulate matter (PM) comprised the most notable atmospheric pollutant followed by nitrogen oxide (NO_2). The concentrations of sulphur dioxide (SO_2) are lower (Figures C.16, C.17, C.18). As for distribution, the hot spots with the highest concentrations of PM and SO_2 identified in Maputo City were the markets and the bus stops for MPT15 at Xipamanine, MPT25 at Praça dos Combatentes, and MPT04 at Ferroviário da Baixa. The results of this study also demonstrate that the concentration of pollutants decreases, in Maputo City, from south to north, which is consistent with the fact that the majority of human activities that cause pollution in a city generally occur precisely in the city center. High concentrations of volatile organic compositions (VOCs) and fuel deposits (abundance of toluene, xylene, nonane) are registered in the bus stops and in the street intersections with large volumes of traffic (abundance of benzene).

According to the same study, Maputo City concentrates the main emissions of PM and NO_2, in comparison to Matola City, and it has many sources of dusts; and the re-suspension of these by traffic and wind can be the dominant emission processes for PM, though road traffic will be the main source of emissions of NO_2 and SO_2. To conclude, the concentrations of the identified pollutants were deemed fairly low though with a tendency to increase constantly since the fleet of vehicles continues to increase.



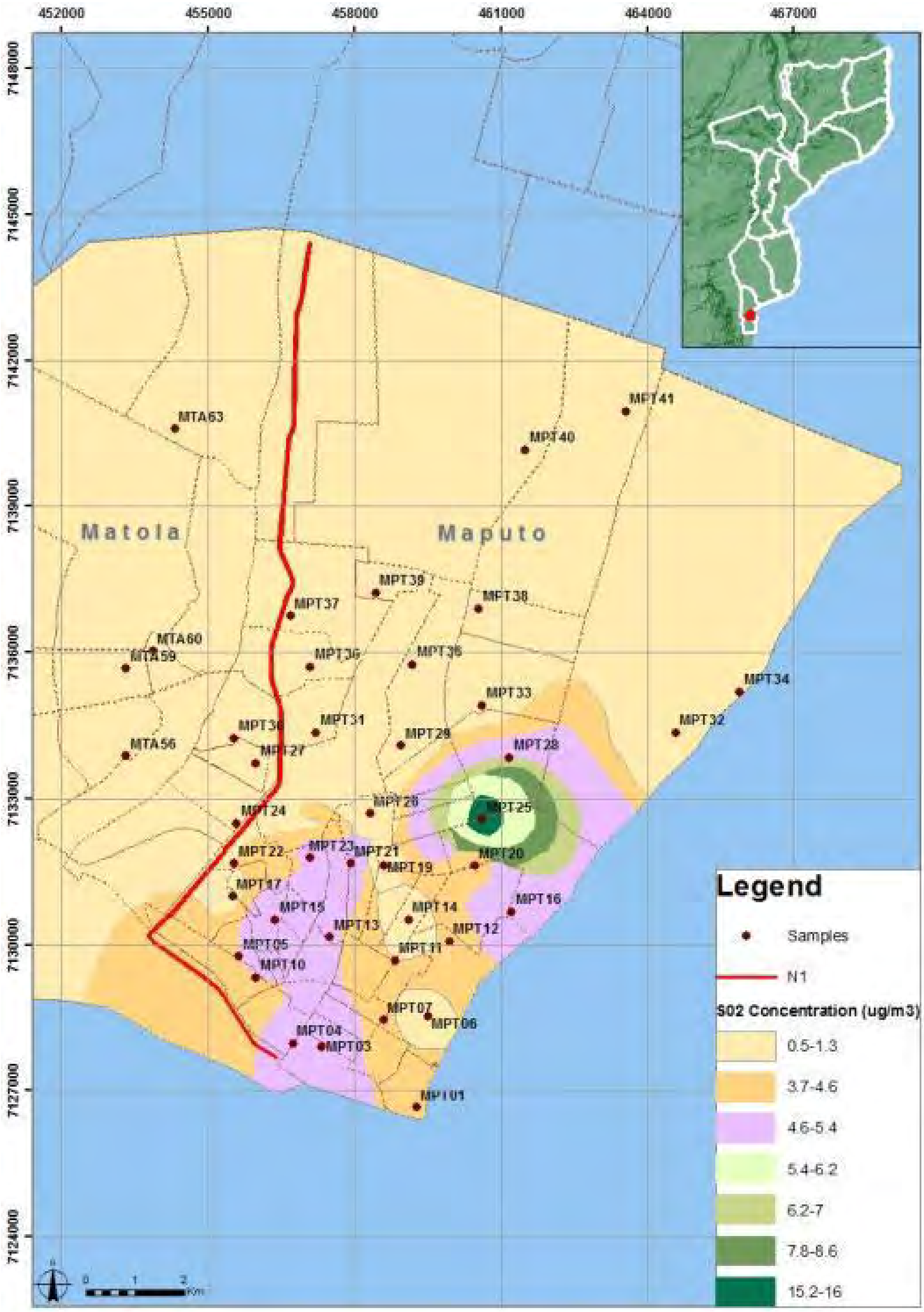
Source: Adapted from Cumbane et al.

Figure C.16: Concentration of Particulate Matter (PM), in Maputo City, around the BRT Route



Source: adapted from Cumbane et al.

Figure C.17: Concentration of NO_2, in Maputo City, around the BRT Route



Source: adapted from Cumbane et al.

Figure C.18: Concentration of SO_2, in Maputo City, around the BRT Route

According to the above figures, the future BRT will cross zones of the city with medium concentrations of PM, namely, in the zone of Ferroviário da Baixa, in the stretch between the intersection of N4 and Jardim Zoológico, and the stretch parallel to the Hulene trash dump. The stretch in the zone of Ferroviário da Baixa also has high concentrations of NO_2, while the stretch crossing the boroughs of Inhagóia, 25 de Junho and George Dimitro has medium concentrations of this pollutant. As for SO_2, medium concentrations are registered in the stretch between Ferroviário da Baixa and the intersection with N4.

The receptors most sensitive to the emission of pollutants along the current route (and the future BRT) are the innumerable pedestrians and drivers that circulate daily along N1, the residents in the different boroughs nearby the route, the hospitals, educational institutions, churches, cemetery, leisure or recreational locations, hotel or boarding accommodations, pharmacies, diverse banks and offices, markets, medical warehouses, and the center for laboratory exams.

C.3.2 Noise and Vibration

Effectively, N1 is one of the most traveled routes in the region, as it is the means of exit and entrance for all road traffic going from the south and coming from the center and north of the country. It also provides access to various peri-urban boroughs in Maputo City such as Zimpeto, Congolote, George Dimitrov, 25 de Junho, etc. As such, a significant level of noise is caused by traffic along N1.

The presence of the Maputo International Airport in the project area is also important because, since its recent amplification and modernization, the different international and domestic flights that leave resulted in an increase in the volume of air traffic and, consequently, in noise emissions from planes and auxiliary activities. According to an environmental audit in 2001 (John, 2001), the noise levels and emissions by the international fleet that use the airport are within the levels stipulated by the regulations for their destinations and are rigorously obeyed with the requirement that certificates are obtained attributing to this fact. However, for the domestic flights, there are no established standards and the noise levels and emissions are not monitored.

Recent wide-scope data about emissions and noise from road and air traffic in the area affected by the project should be evaluated. The description of receptors sensitive to noise should also be considered, but, right now, one can point to the more susceptible receptors, namely, the residents, hospitals and health centers, educational institutions, churches, and leisure and accommodation facilities.

C.3.3 Water Quality

Surface Water

The water from Infulene River is subject to a series of sources of pollutants. Its banks are densely populated and used to cultivate horticultural crops, especially in its middle section where sugarcane and bananas are also grown. Notably, here the use of pesticides, herbicides and animal manure as well as artificial fertilizers is great. Additionally, the drainage system in an open canal along Avenida Joaquim Chissano transports water from the boroughs of Maxaquene, Mavalane and others to Infulene River and finally to the sea.

The ARA-Sul, an independent organization for water management, controls the water quality of 12 hydrographical basins in the southern region, including Infulene River. The evaluation of the water quality is done by taking into account the standards and norms for the controlled parameters set by OMS in the Regulation about Standards of Environmental Quality and

Effluent Emissions and the Norms of the Inco-Maputo Accord, for the supply of water for domestic use, irrigation, industry and other purposes.

According to the results published by ARA-SUL (ARA-Sul, 2011a and 2011b) for the period from 2008 to 2011, the water's turbidity had, over the years, risen above the maximum permissible level and, at the river's mouth, was considered exceptionally bad. The levels of nitrates and, consequently, of ammonia, though within admissible values, have been high due to the use of fertilizers and the dumping of industrial effluents. Associated with these factors, which promote the processes of decomposition, the Infulene's waters also have low amounts of dissolved oxygen.

Underground Water

The principal potential risks for the quality of underground waters are the intrusion of saline water and the lack or deficient environmental sanitation. These dangers are associated especially with a growing city such as Maputo, where the current system of water supply, fed by the Umbelúzi River, does not satisfy the existing demand. This leads to the need to use underground water sources exploited by the private sector. It is estimated that, in the suburban area north of Maputo, 300 private operators use boreholes and wells to supply water to 150,000 people (Nhacume et al., 2011).

The high transmissivity of aquiferous sediments in some points allied to the drilling of wells without following basic rules for positioning, depth and cleaning of the perforation area are pointed to as the principal causes of the high potential for degradation of the underground water quality in Maputo.

A study conducted in 2004 (Muiuane 2004), analyzing indicators of the hygienic quality of underground water in diverse boroughs in Maputo, including 25 de Junho, Zimpeto, Magoanine and Aeroporto in the area near the future BRT, concluded that the concentrations of nitrates (more than 50 mg/l in most samples) and of pathogenic bacteria were extremely high. The principal causes of this contamination were reportedly the flow of water from many areas with small-scale subsistence agriculture practiced by local communities and the bad conditions for sanitation.

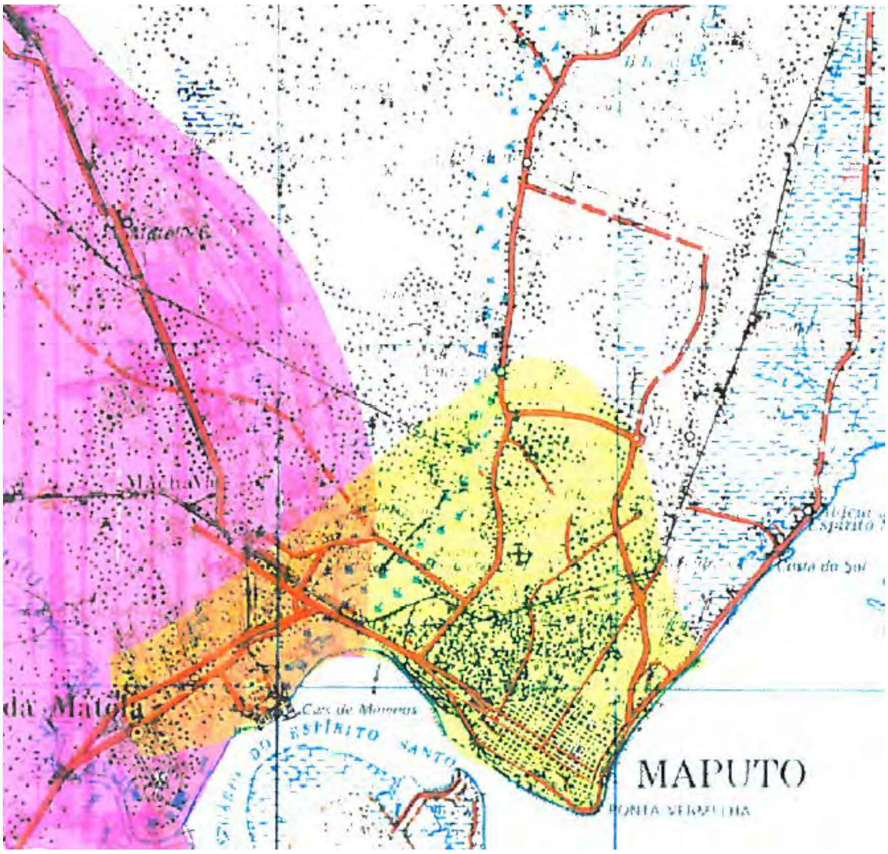
Another more recent study conducted by ARA-Sul to furnish a detailed description of the entire aquiferous system, to be used as a basis for the development and management of hydraulic resources in the Maputo Metropolitan Area, shows that, though most of the aquifer for this area would be adequate to produce potable water, three restrictions apply:

a. In the western part of the aquifer (along Matola River), the water is saline, especially during the dry season. In this region, water with CE > 2.000 µS/cm may not be used to supply potable water but may be used only for certain industrial applications;

b. In the oldest parts of the city, including the portion south of Laulane and Infulene Valley, subterranean water contains much nitrate (> 50 mg/l) and may not be used to produce potable water, but may be used only for certain industrial applications and irrigation; and

c. Bacteriological contamination is not limited to a specific zone since it is related to local factors such as the design of boreholes and the presence of latrines. Thus, all the wells in the urban zones are deemed vulnerable to fecal contamination.

Figure C.19 shows the zones identified as inappropriate for the production of potable water due to the high electrical conductivity and the high concentration of nitrates registered.



Source: Hidroconseil / WE Consult (2011)

Figure C.19: Zones Identified as Inappropriate for the Production of Potable Water due to the High Electrical Conductivity (Pink) and the High Concentration of Nitrates (Yellow)

C.3.4 Ground Subsidence

No ground subsidence episodes were observed in the area.

C.3.5 Offensive Odors

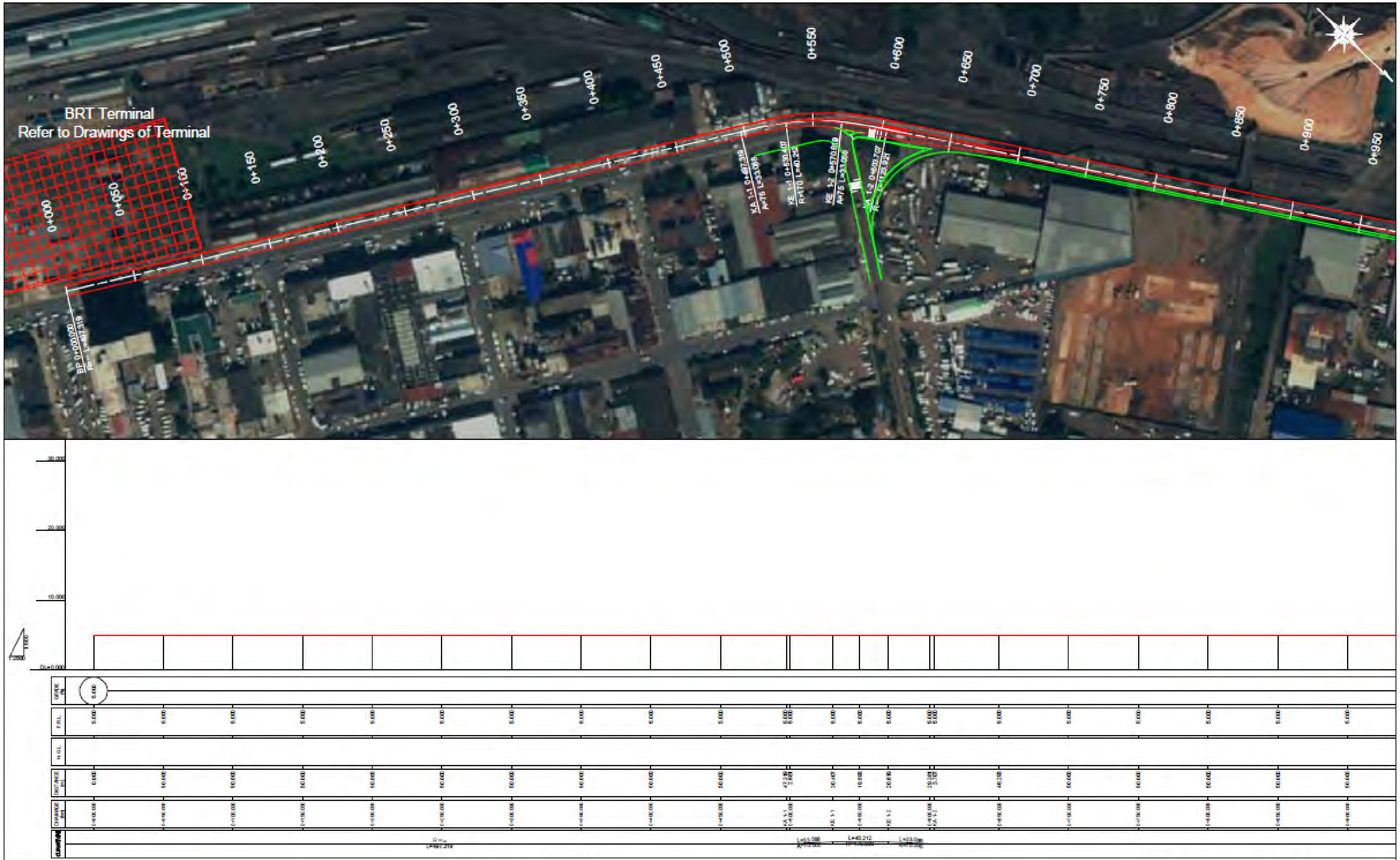
In the project area, sanitation is a problem, and offensive odors derived from bad sewage and stagnated water (during the rainy season predominantly) are very significant. Also offensive odors coming from the thousand of vehicles in obsolete conditions that use the N1 every day are strong.

Appendix D Drawings

List of Drawings

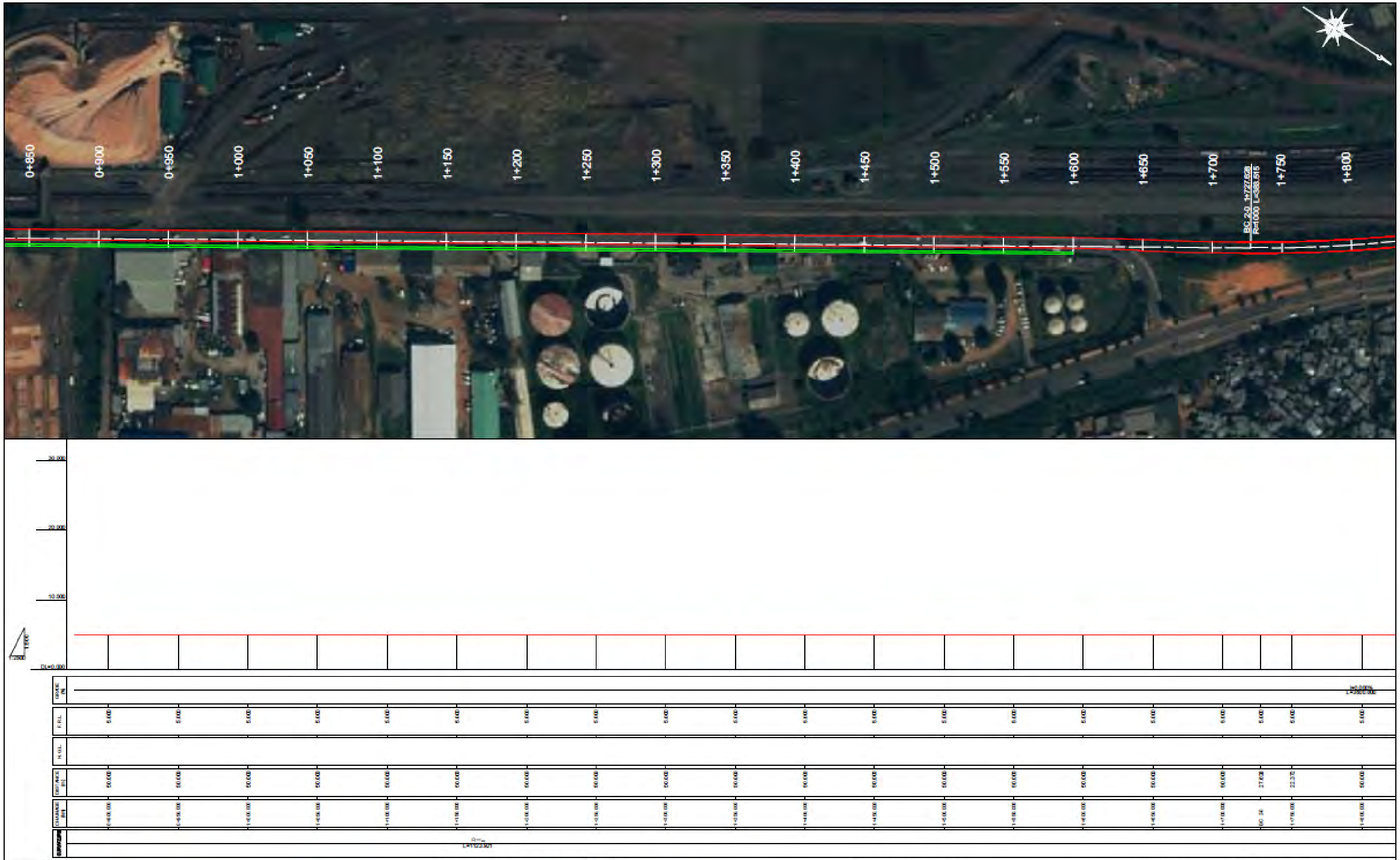
No.	Drawing Title	Drawing No.
1	Plan & Profile	PP-001 ~ 022
2	Typical Cross Section	TY-001 ~ 004
3	General Drawings of Intersections	INT-001 ~ 003
4	General Drawings of Bridge	BR-001
5	General Drawings of Bus Terminal and Station	BS-001 ~
6	N1 Bypass Route	1 ~ 3
7	25 Setembro Route	1

Note: The scale shown in these drawings shows printed scale in A3 size sheet.
All drawings are prepared by JICA Project Team.



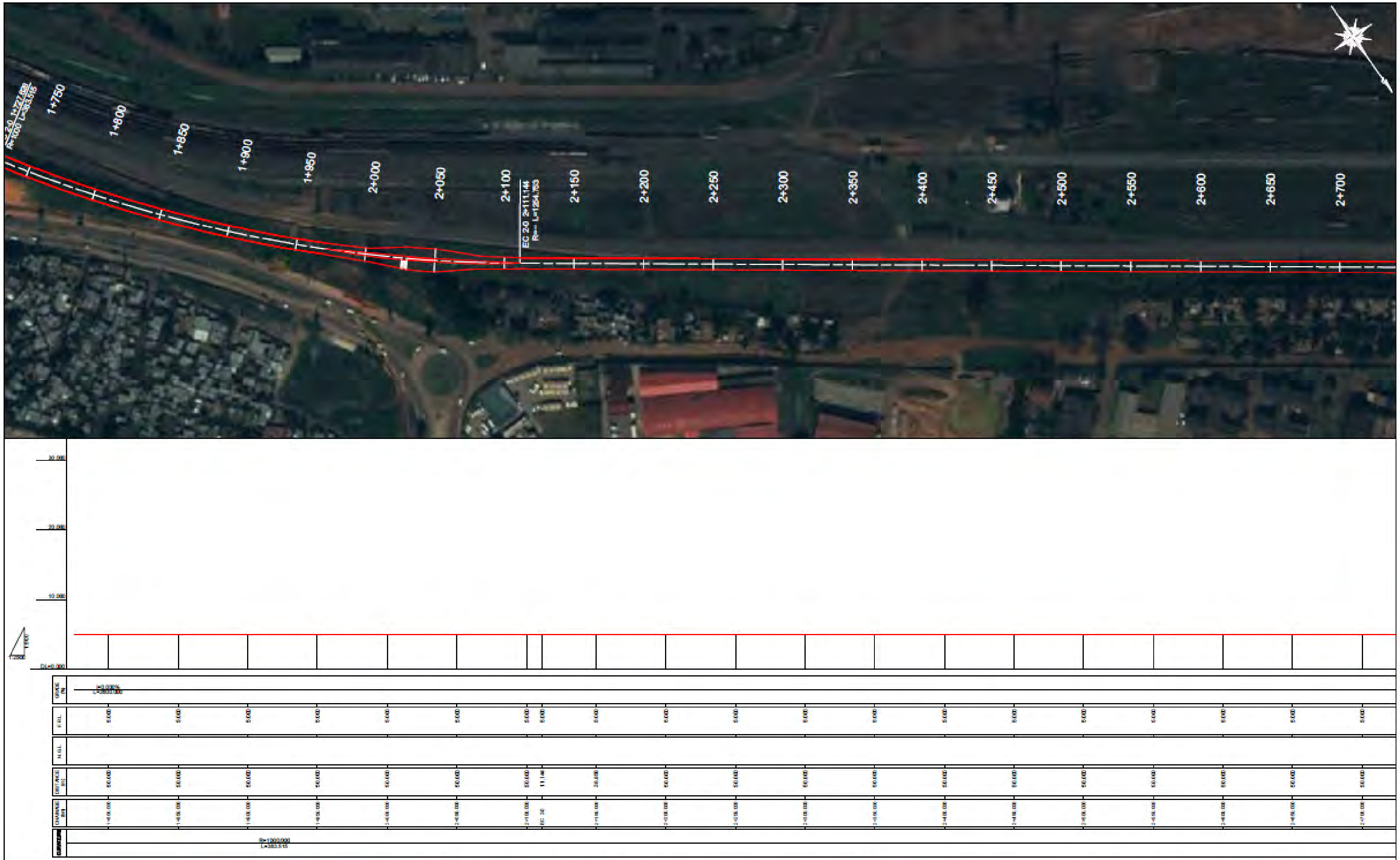
PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 0+000 TO STA. 0+900	H: 1:2500 V: 1:500	PP - 001

Figure D.1: Plan & Profile STA 0+000 to 0+900



	PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
JICA / PADECO / NIPPON KOEI	THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 0+900 TO STA. 1+800	H: 1:2500 V: 1:500	PP - 002

Figure D.2: Plan & Profile STA 0+900 to 1+800

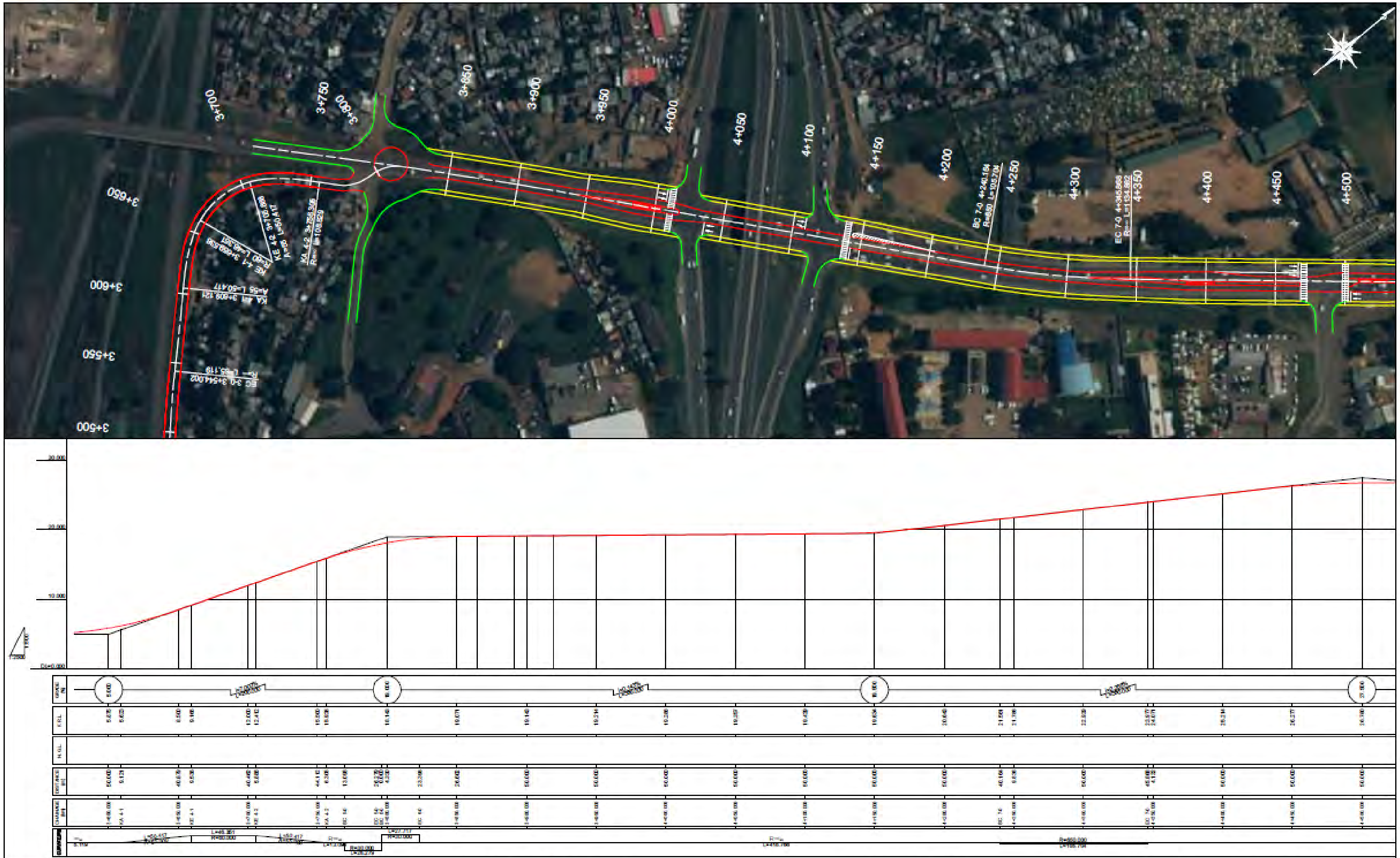


PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 1+800 TO STA. 2+700	H: 1:2500 V: 1:500	PP - 003

JICA PADECO NIPPON KOEI

Figure D.3: Plan & Profile STA 1+800 to 2+700

Figure D.4: Plan & Profile STA 2+700 to 3+600



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 3+600 TO STA. 4+500	H: 1:2500 V: 1:500	PP - 005

JICA · PADECO · NIPPON KOEI

Figure D.5: Plan & Profile STA 3+600 to 4+500

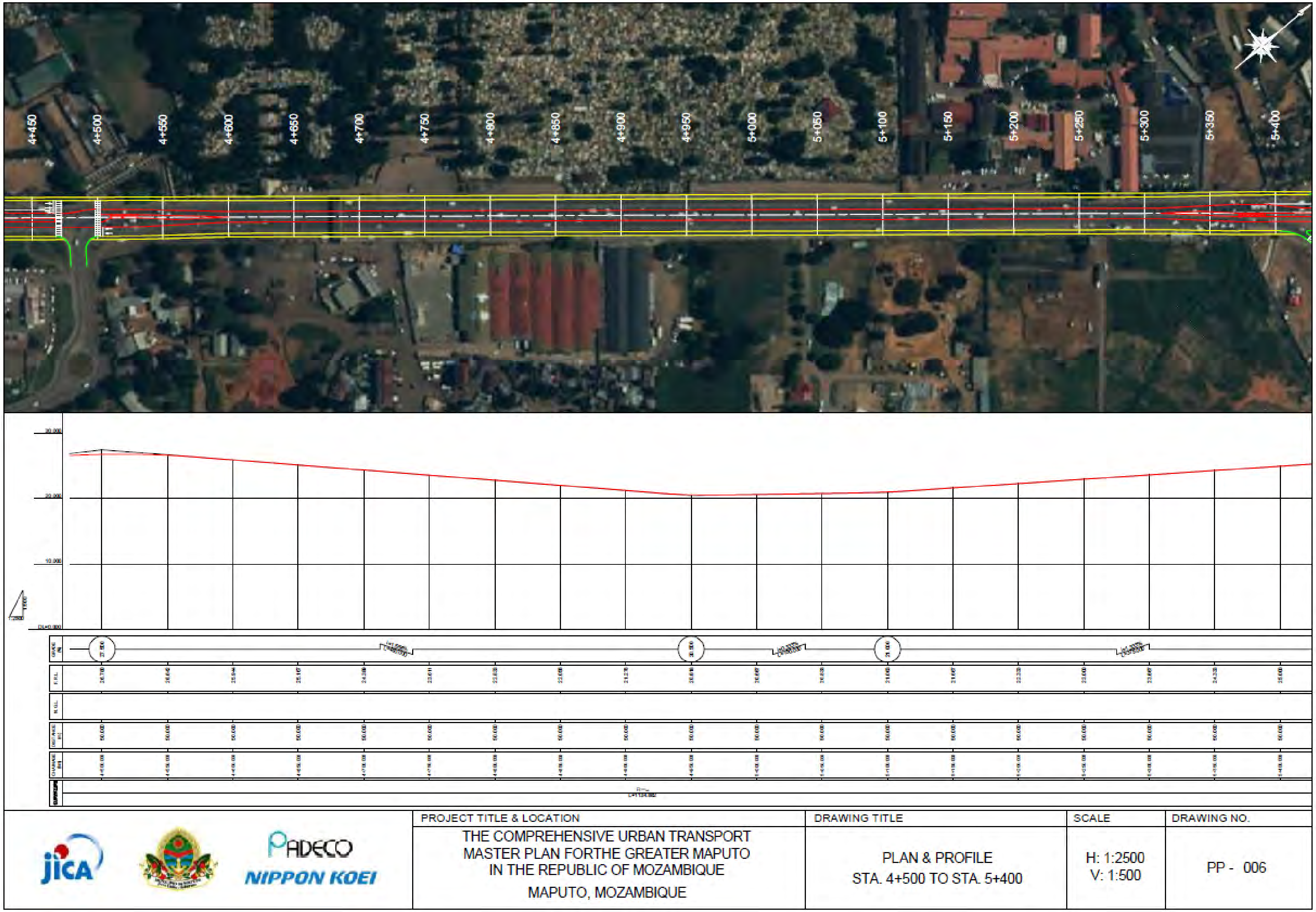
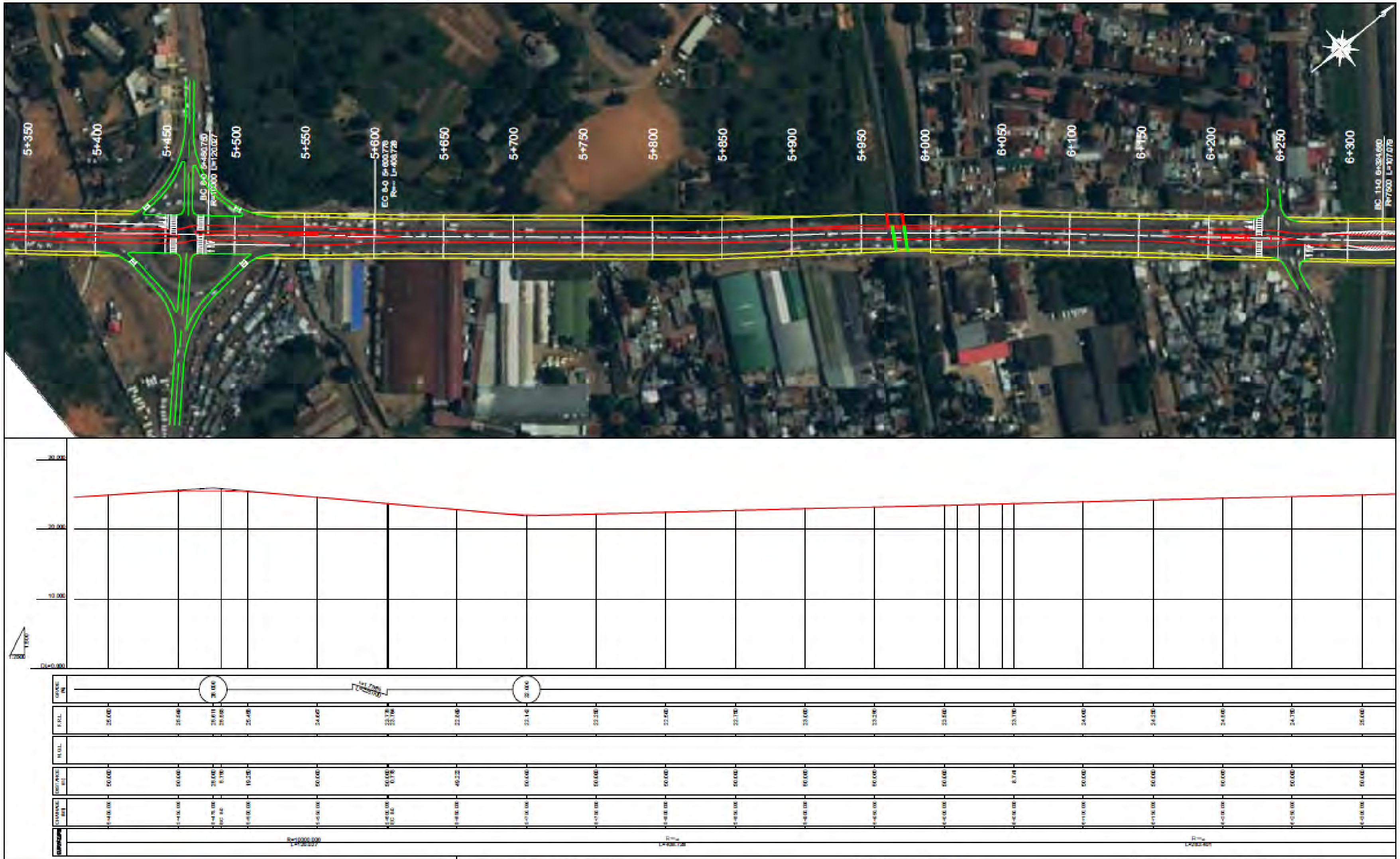


Figure D.6: Plan & Profile STA 4+500 to 5+400



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 5+400 TO STA. 6+300	H: 1:2500 V: 1:500	PP - 007

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Figure D.7: Plan & Profile STA 5+400 to 6+300

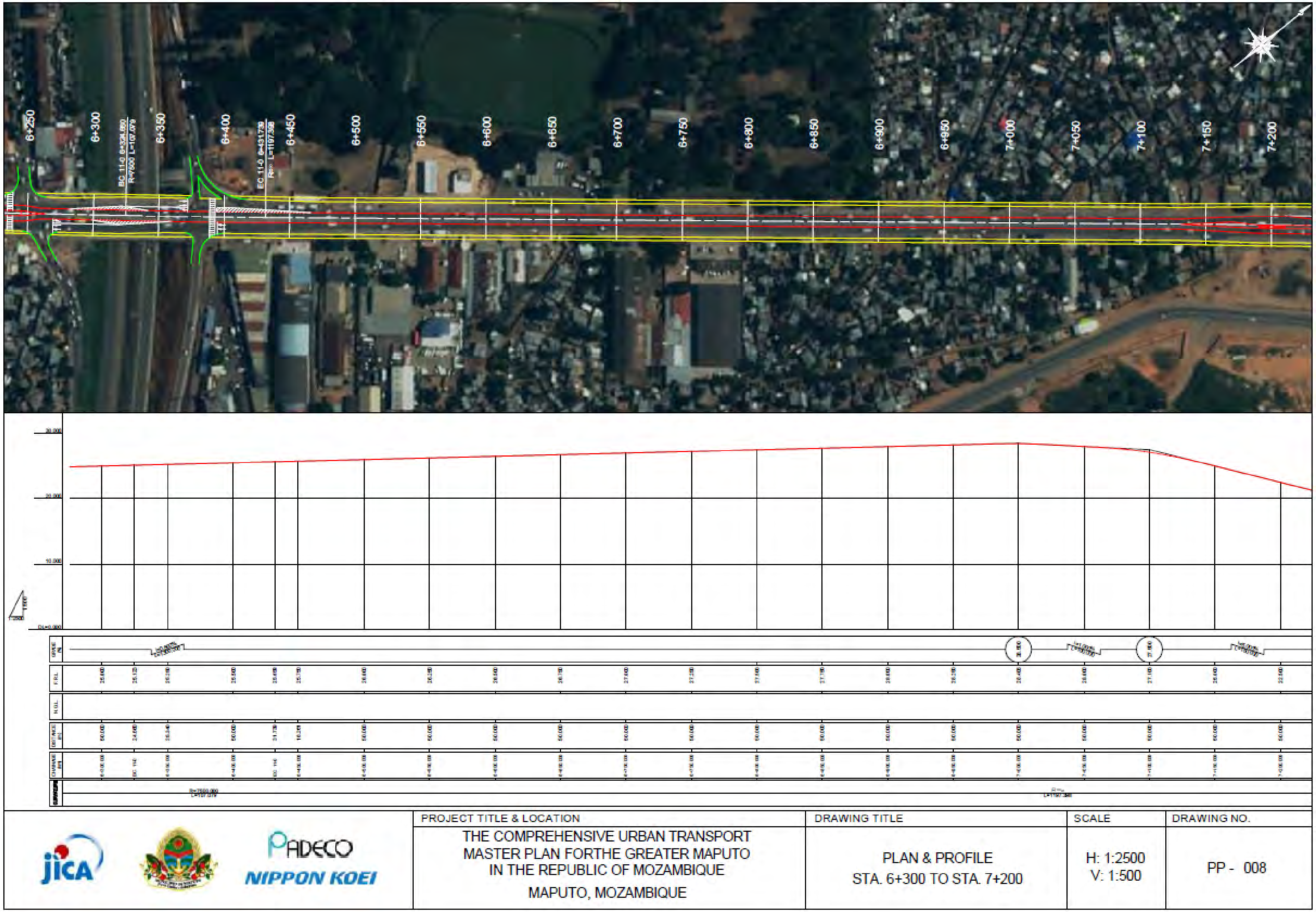
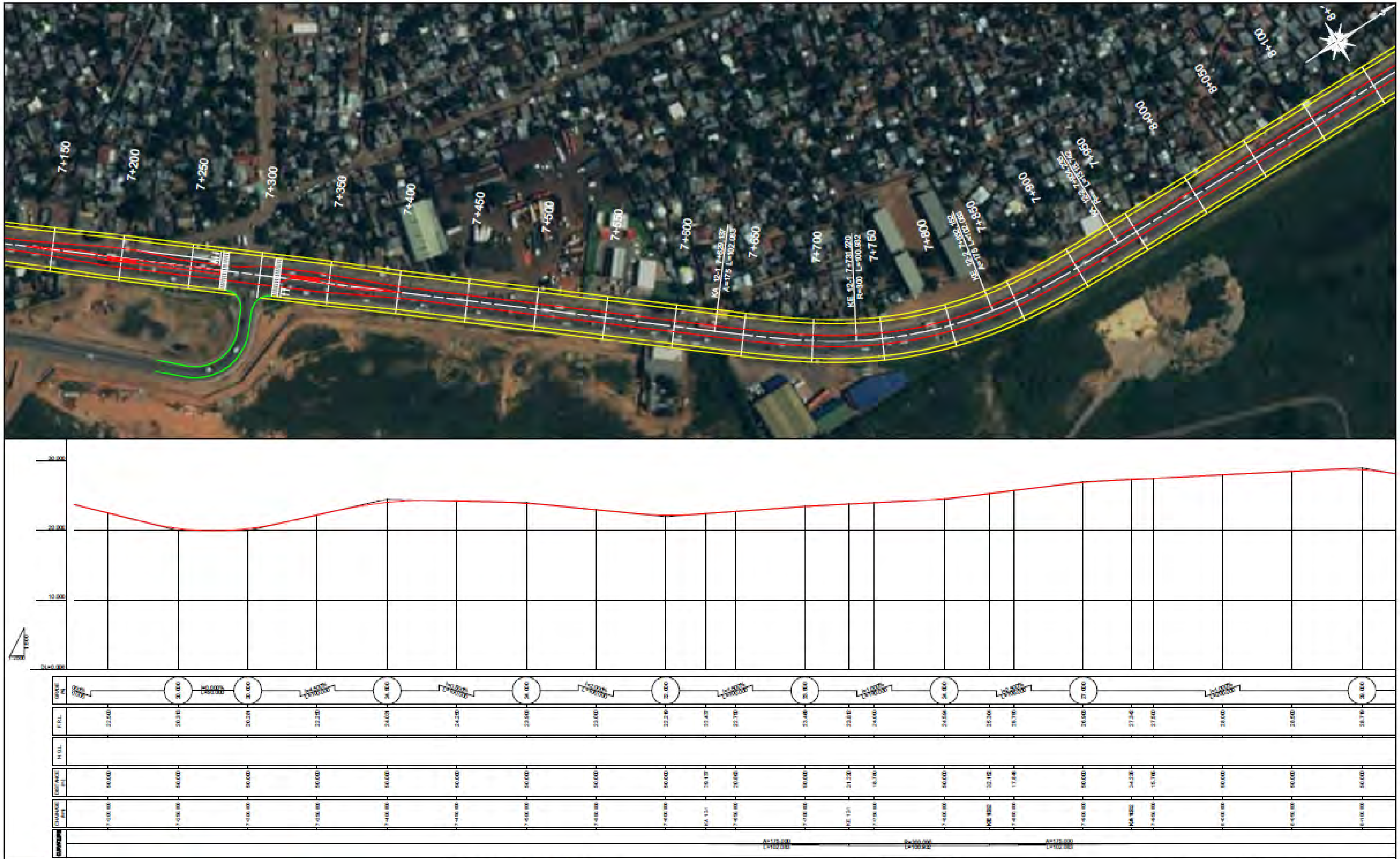


Figure D.8: Plan & Profile STA 6+300 to 7+200



PROJECT TITLE & LOCATION
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE
MAPUTO, MOZAMBIQUE

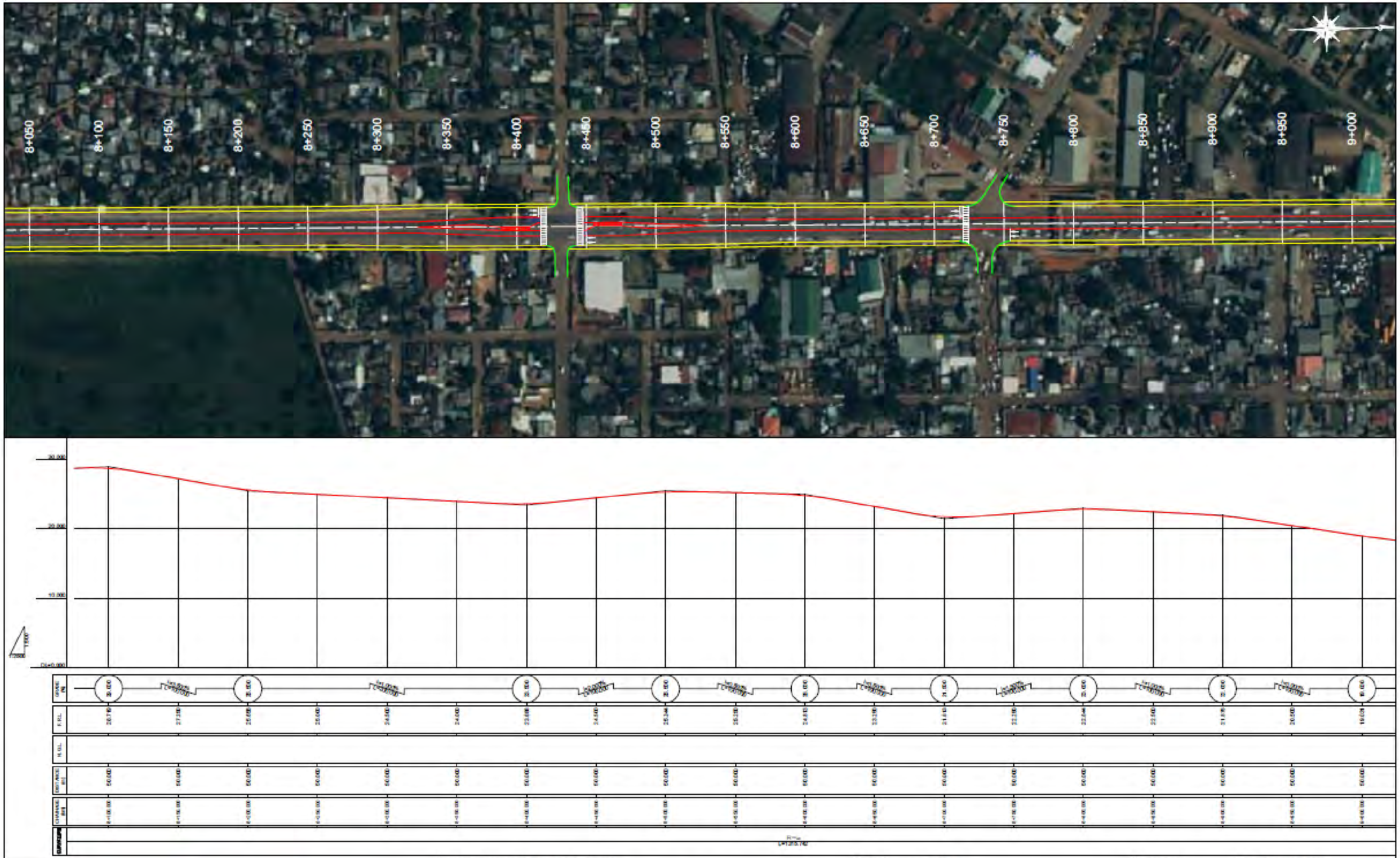
DRAWING TITLE
PLAN & PROFILE
STA. 7+200 TO STA. 8+100

SCALE
H: 1:2500
V: 1:500

DRAWING NO.
PP - 009

PADECO
NIPPON KOEI

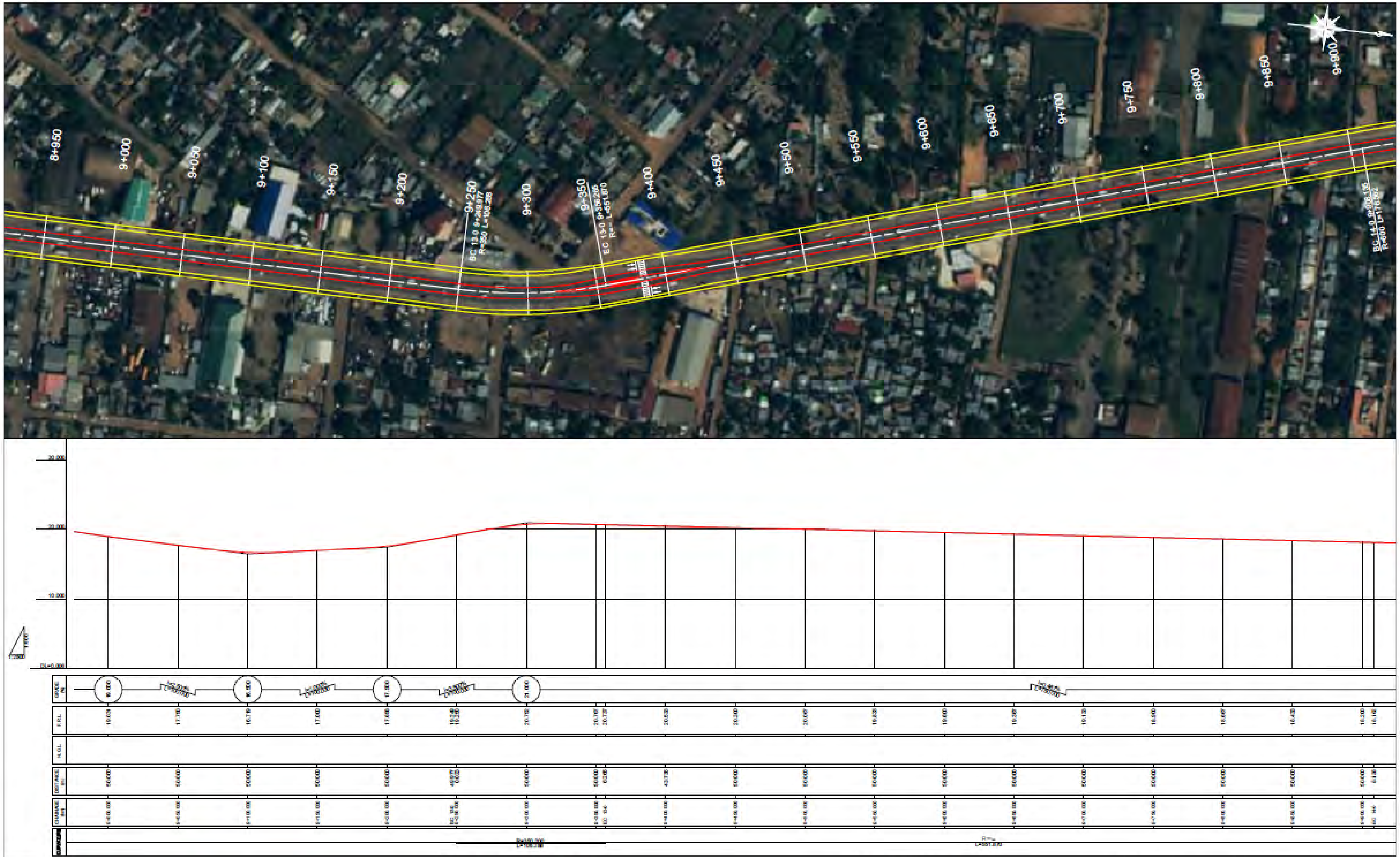
Figure D.9: Plan & Profile STA 7+200 to 8+100



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 8+100 TO STA. 9+000	H: 1:2500 V: 1:500	PP - 010

PADECO
NIPPON KOEI

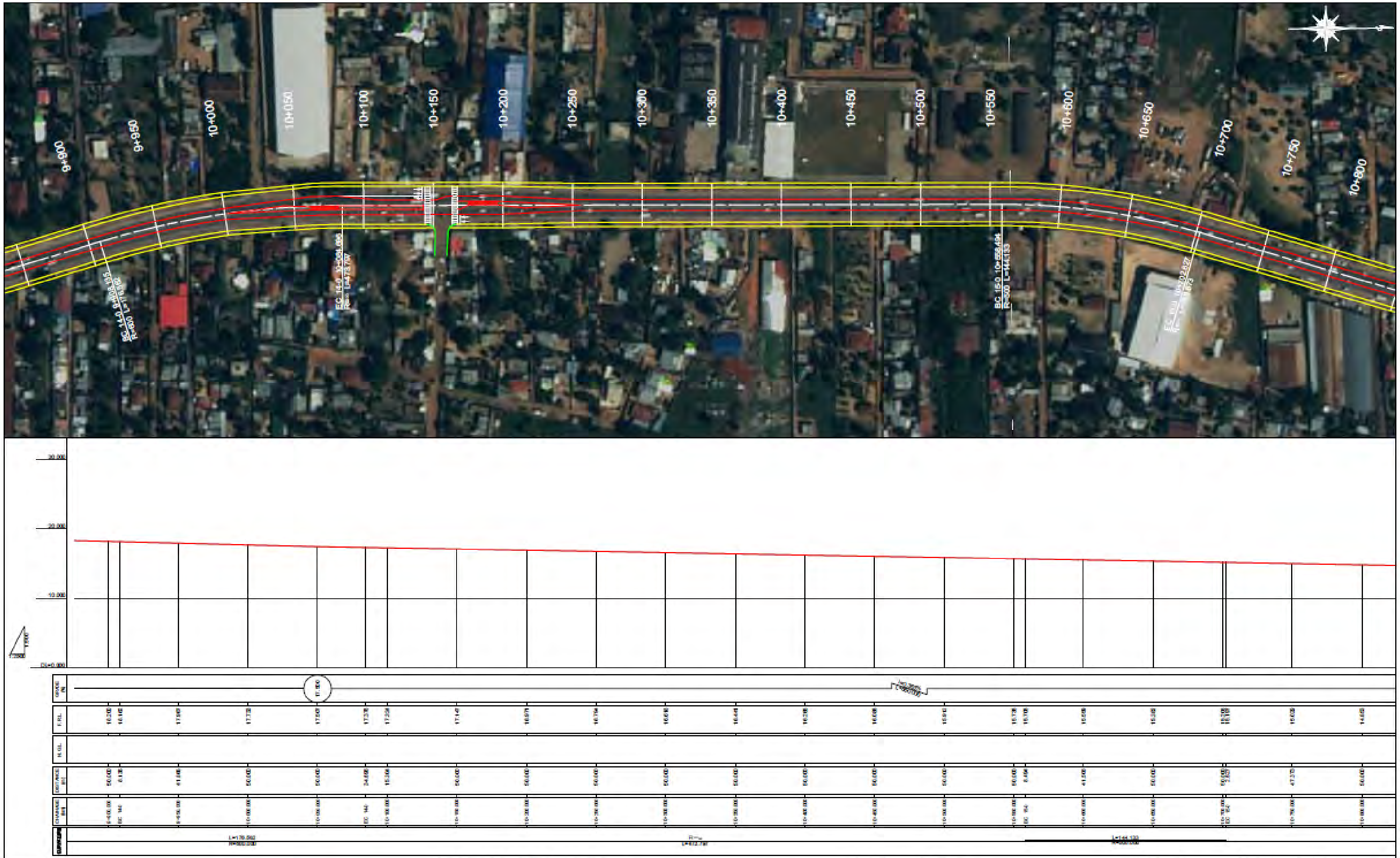
Figure D.10: Plan & Profile STA 8+100 to 9+000



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 9+000 TO STA. 9+900	H: 1:2500 V: 1:500	PP - 011

PADECO
NIPPON KOEI

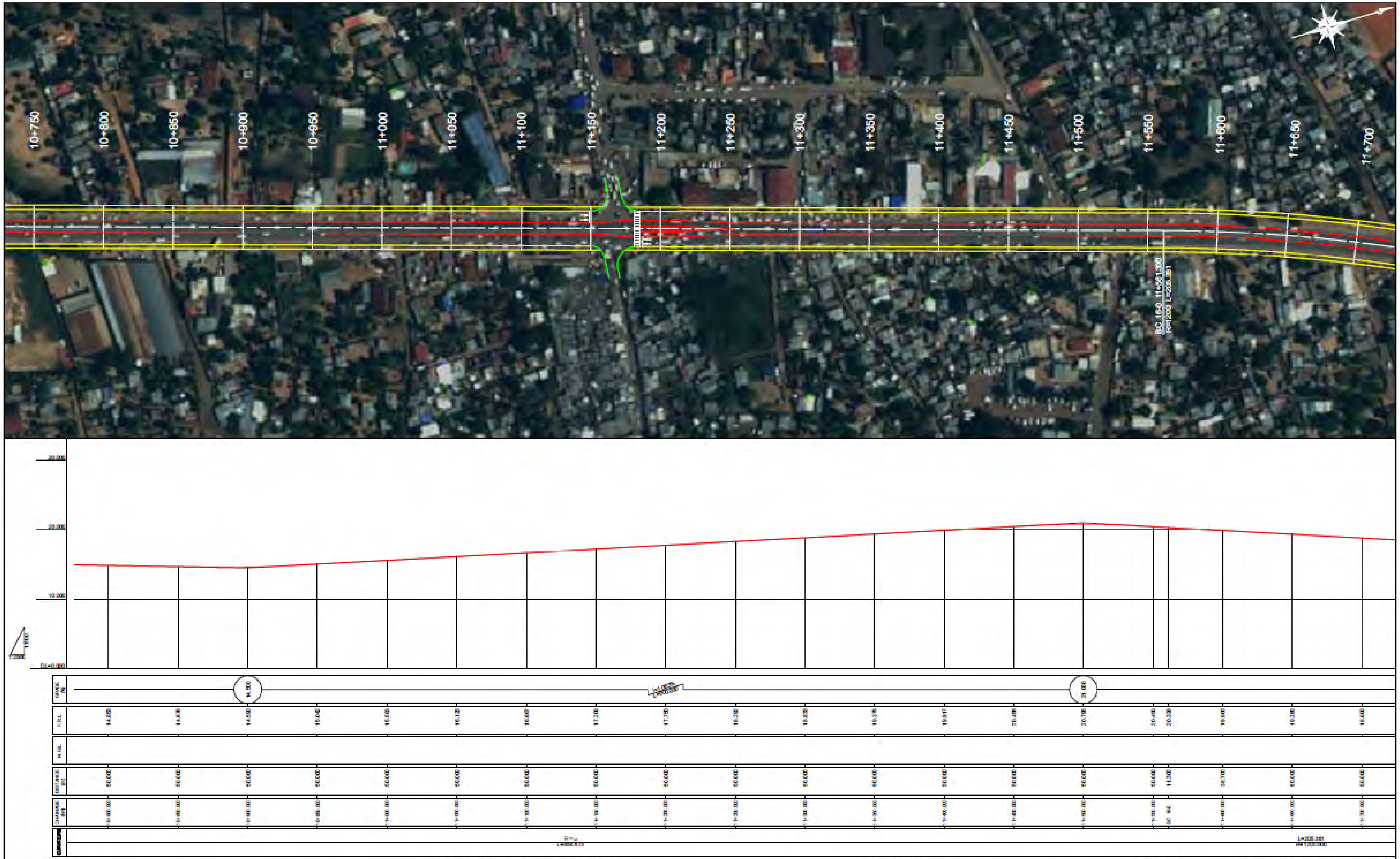
Figure D.11: Plan & Profile STA 9+000 to 9+900



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 9+900 TO STA. 10+800	H: 1:2500 V: 1:500	PP - 012

PADECO
NIPPON KOEI

Figure D.12: Plan & Profile STA 9+900 to 10+800



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 10+800 TO STA. 11+700	H: 1:2500 V: 1:500	PP - 013

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Figure D.13: Plan & Profile STA 10+800 to 11+700

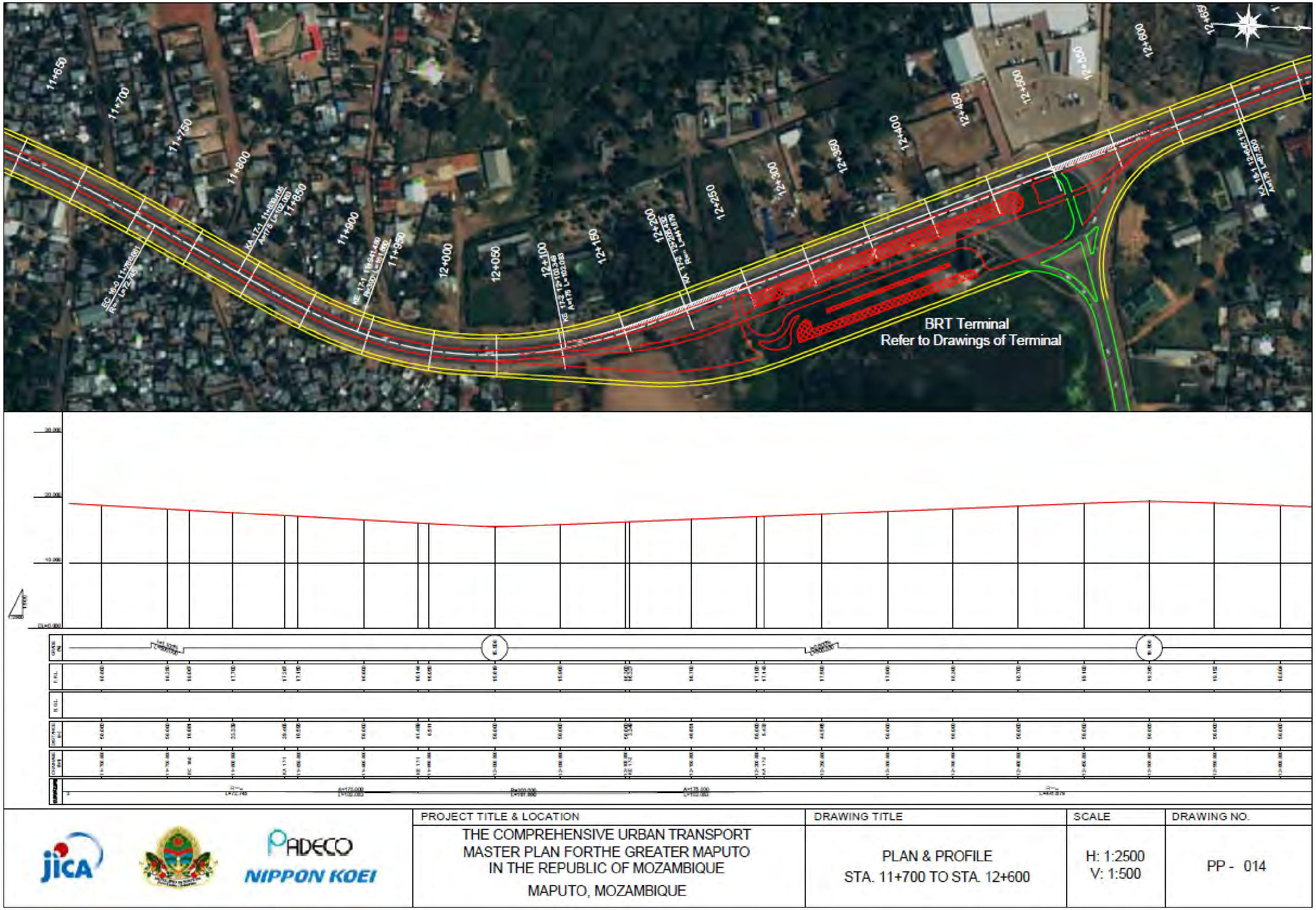
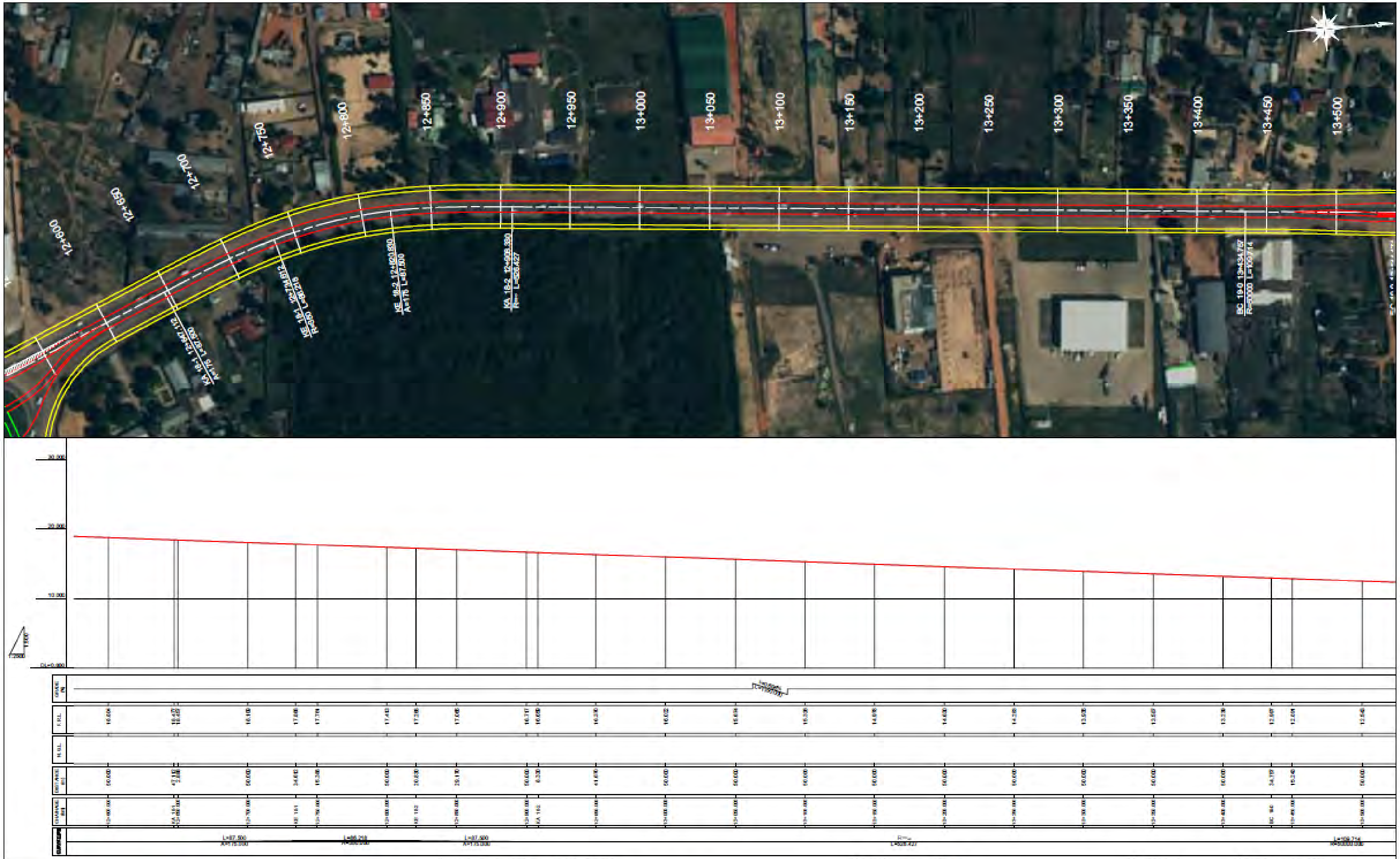


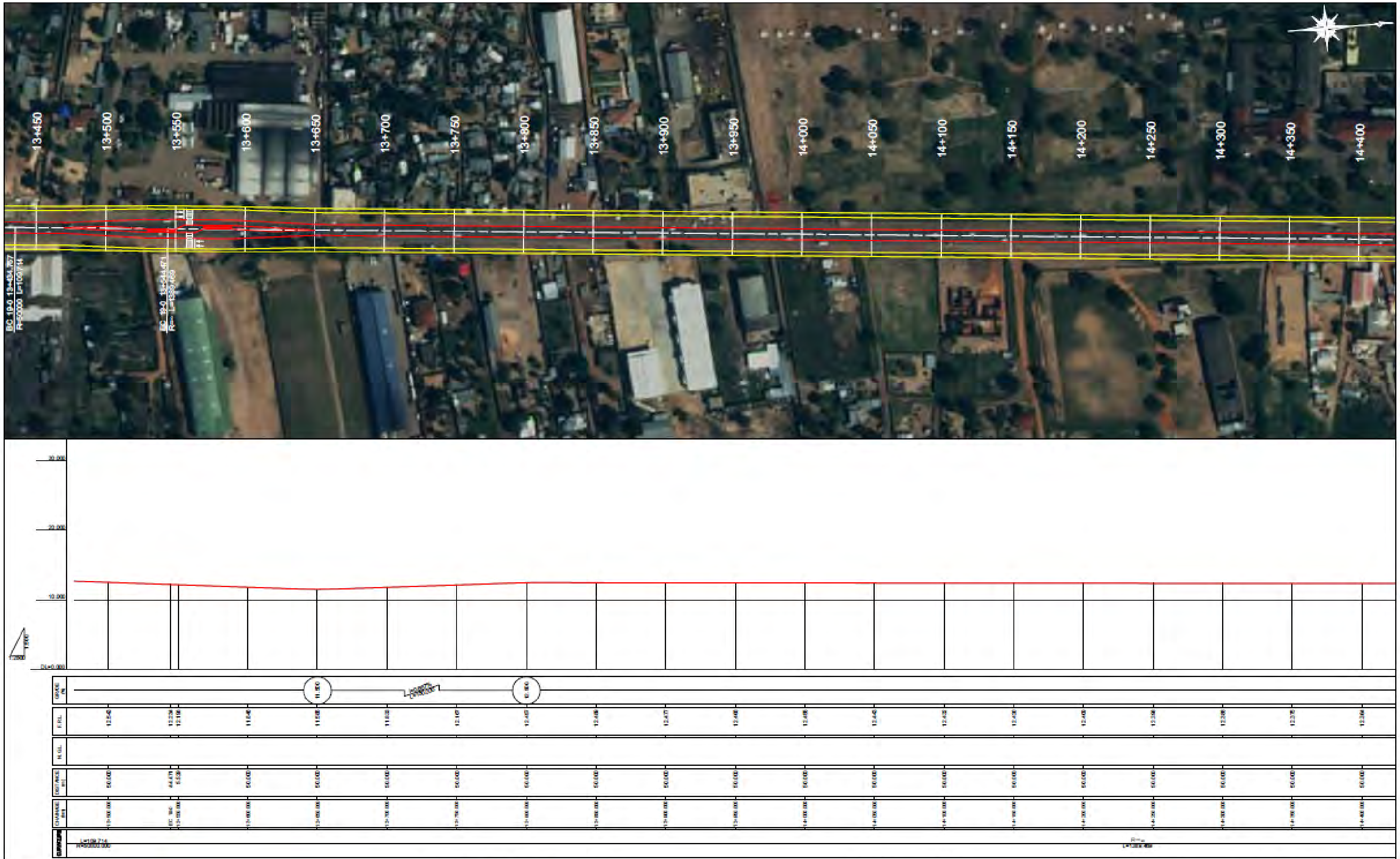
Figure D.14: Plan & Profile STA 11+700 to 12+600



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 12+600 TO STA. 13+500	H: 1:2500 V: 1:500	PP - 015

JICA PADECO NIPPON KOEI

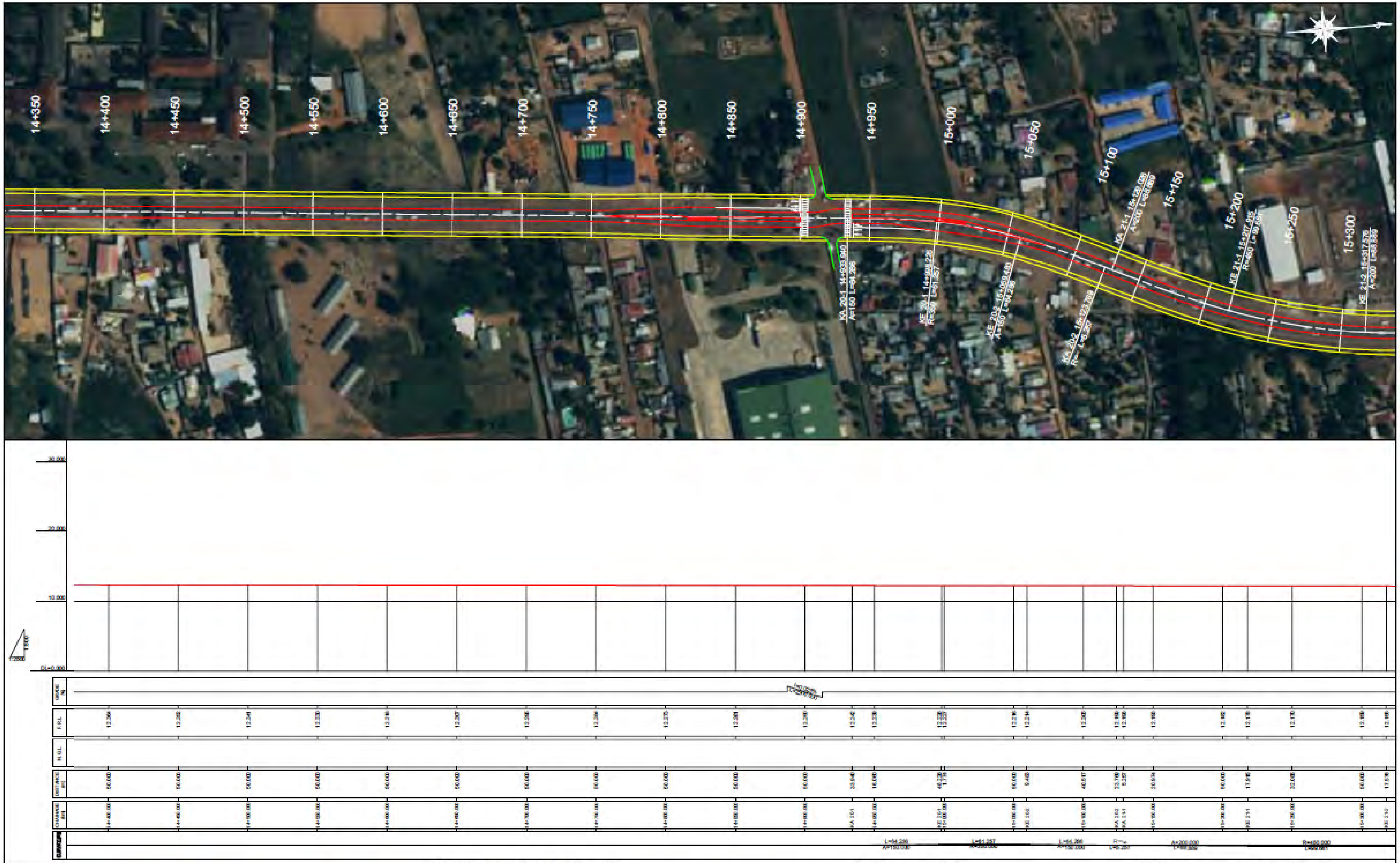
Figure D.15: Plan & Profile STA 12+600 to 13+500



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 13+500 TO STA. 14+400	H: 1:2500 V: 1:500	PP - 016

PADECO
NIPPON KOEI

Figure D.16: Plan & Profile STA 13+500 to 14+400



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 14+400 TO STA. 15+300	H: 1:2500 V: 1:500	PP - 017

Figure D.17: Plan & Profile STA 14+400 to 15+300

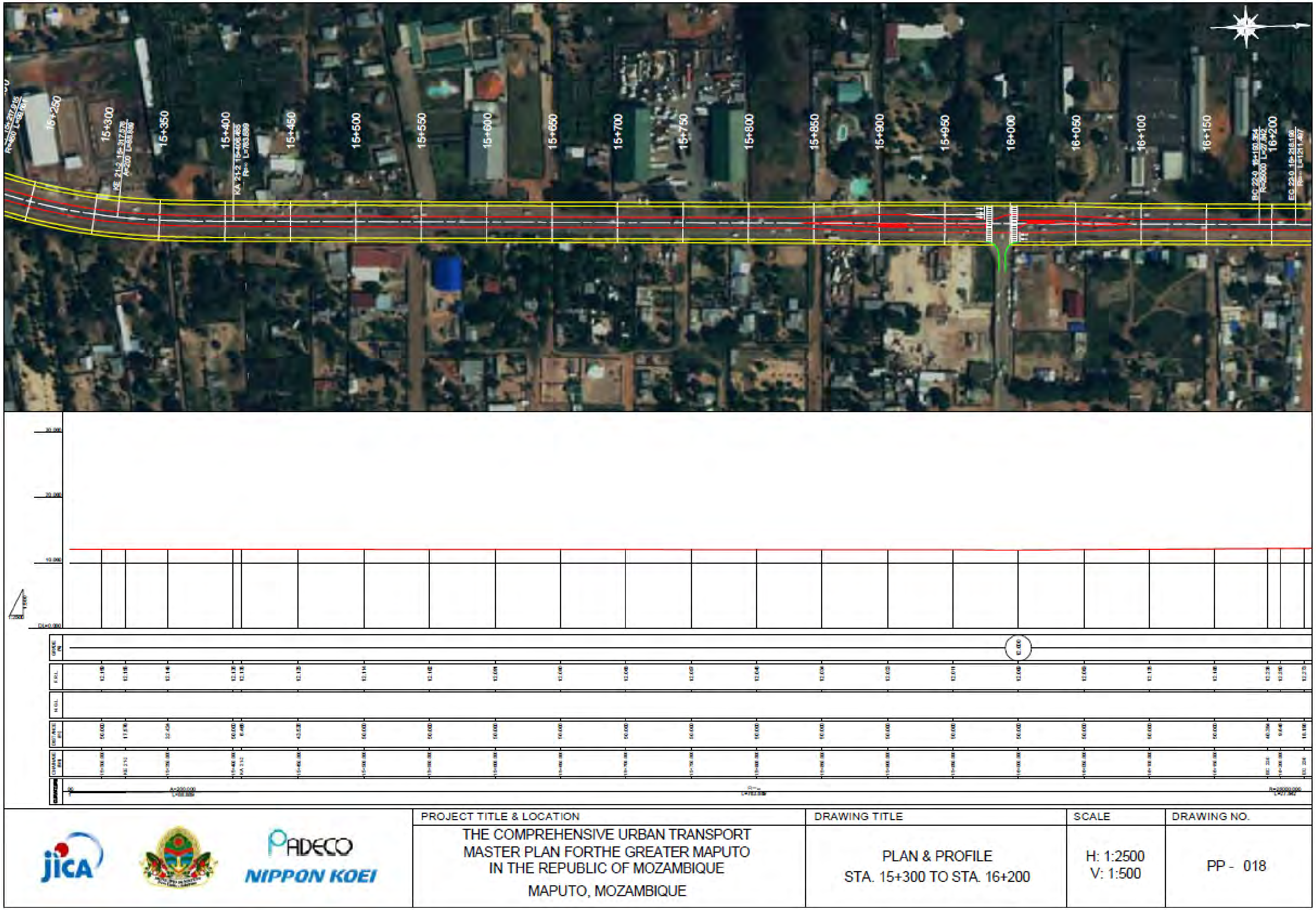
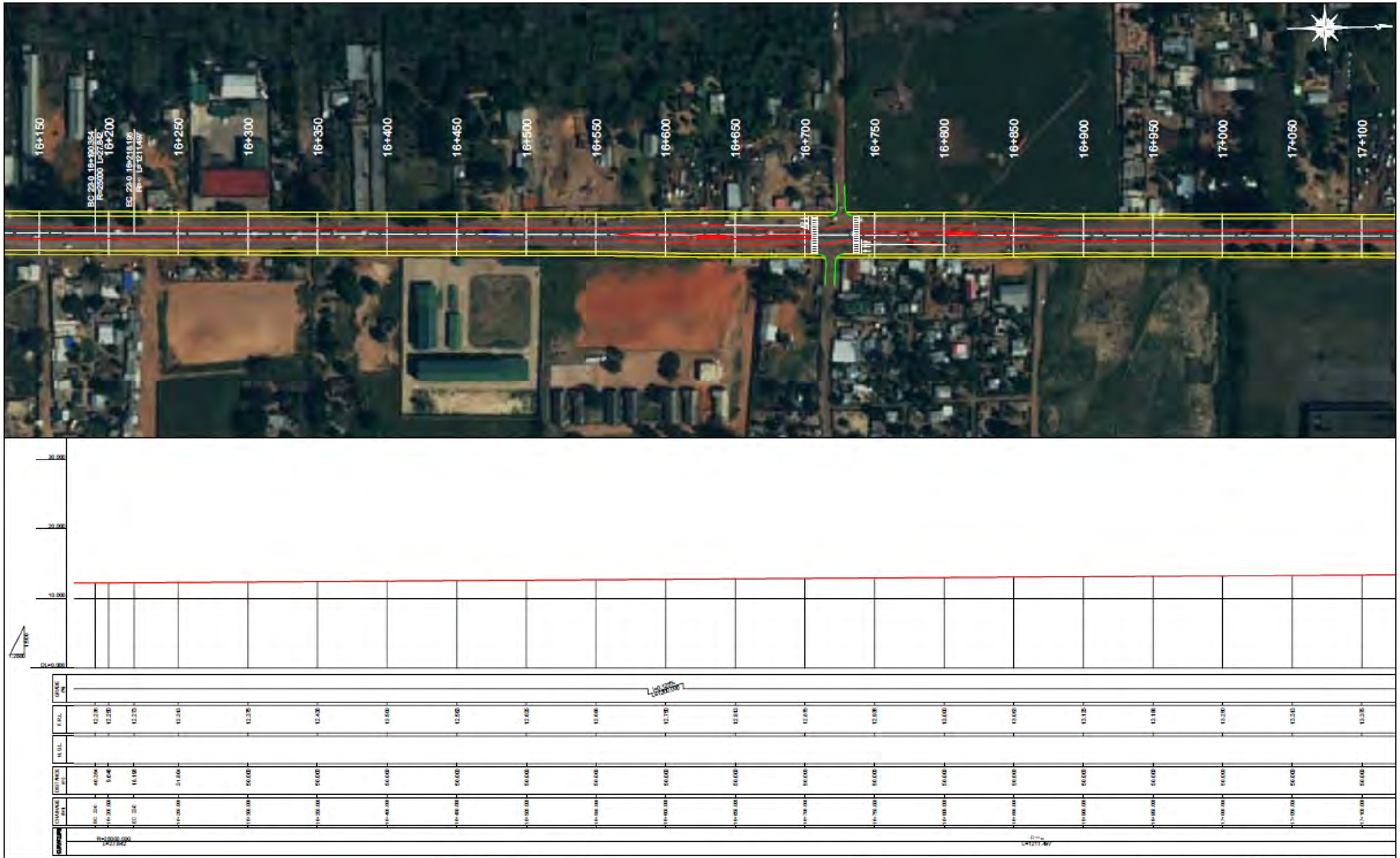


Figure D.18: Plan & Profile STA 15+300 to 16+200



PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 16+200 TO STA. 17+100	H: 1:2500 V: 1:500	PP - 019

JICA PADECO NIPPON KOEI

Figure D.19: Plan & Profile STA 16+200 to 17+100

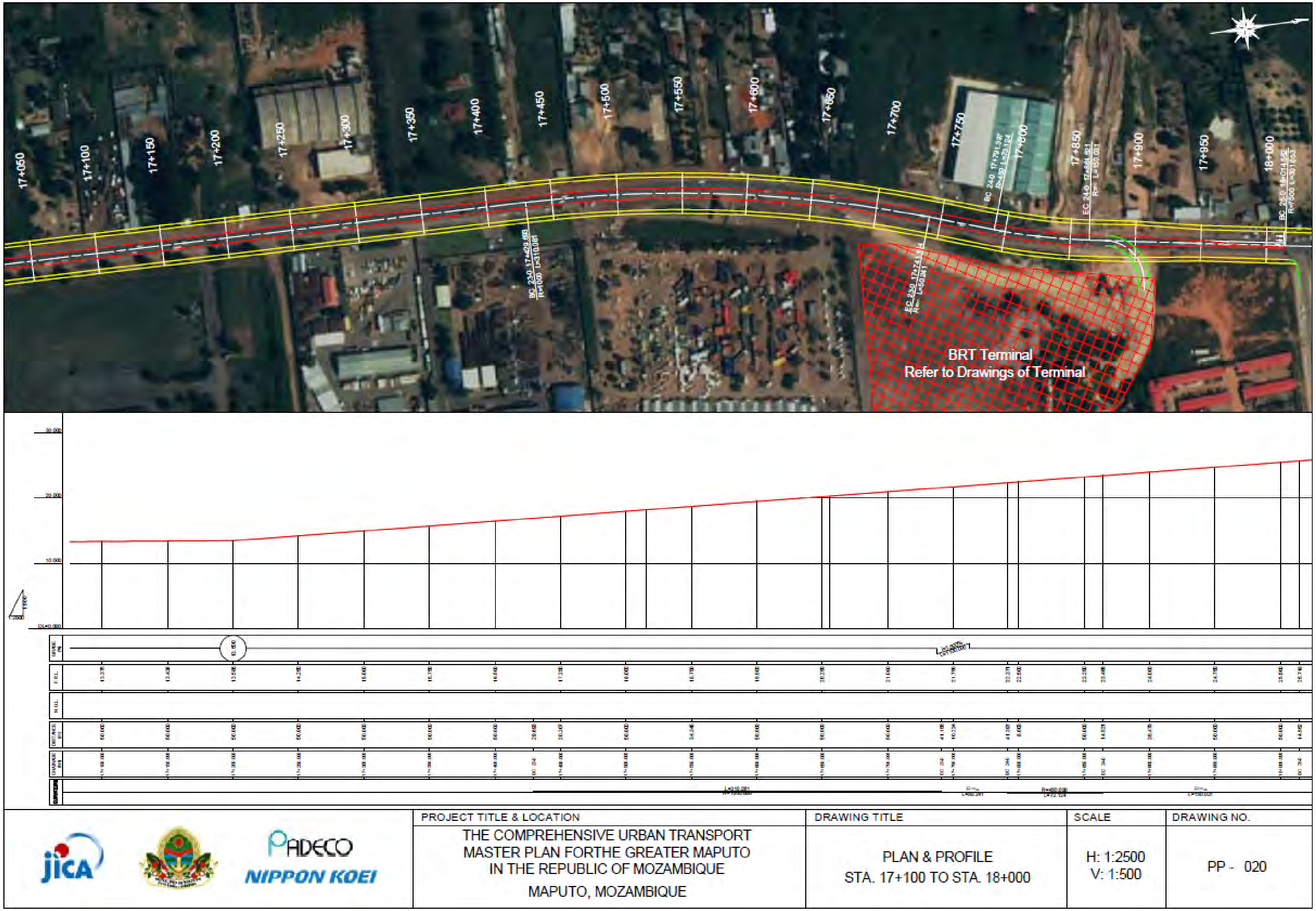
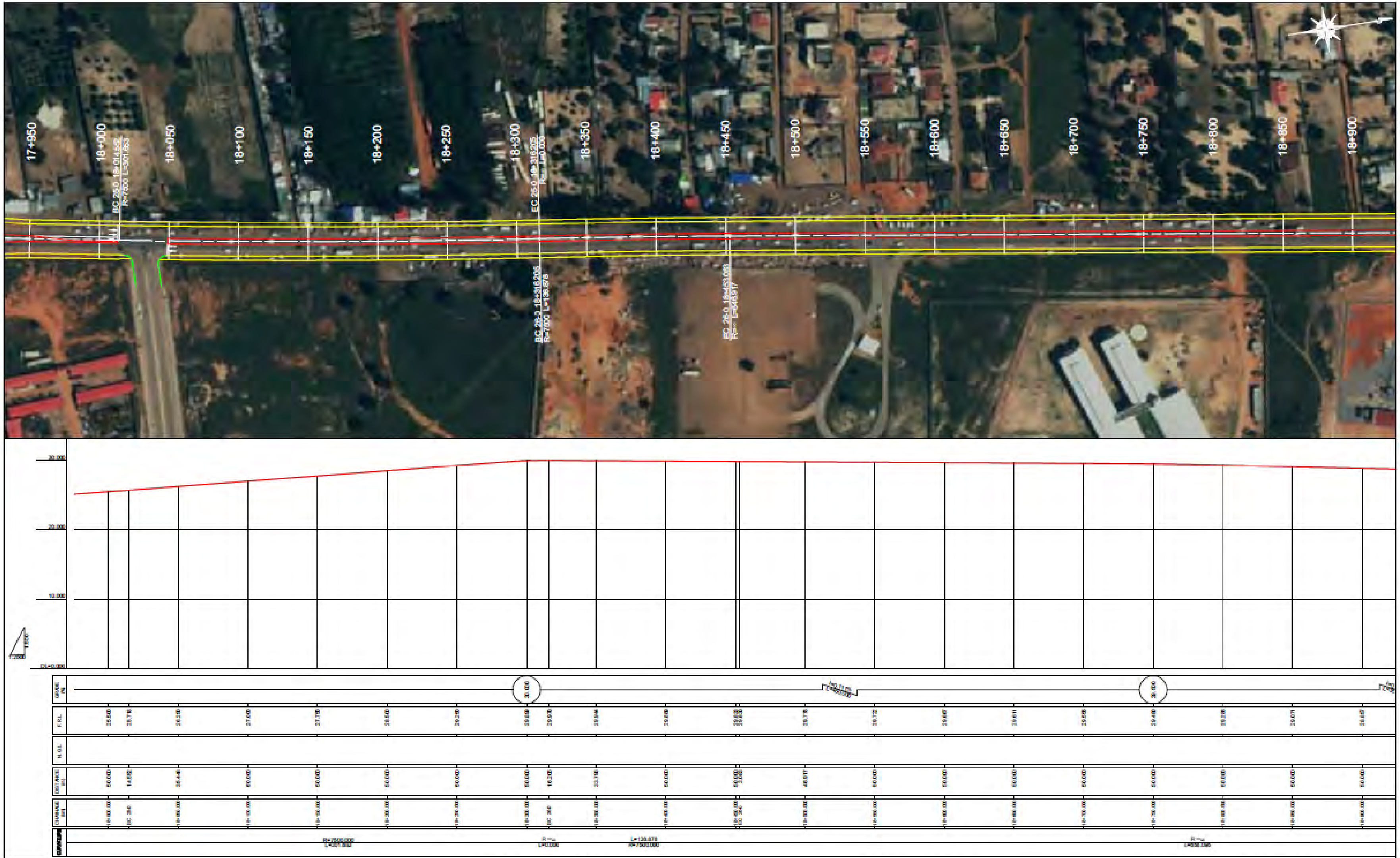


Figure D.20: Plan & Profile STA 17+100 to 18+000

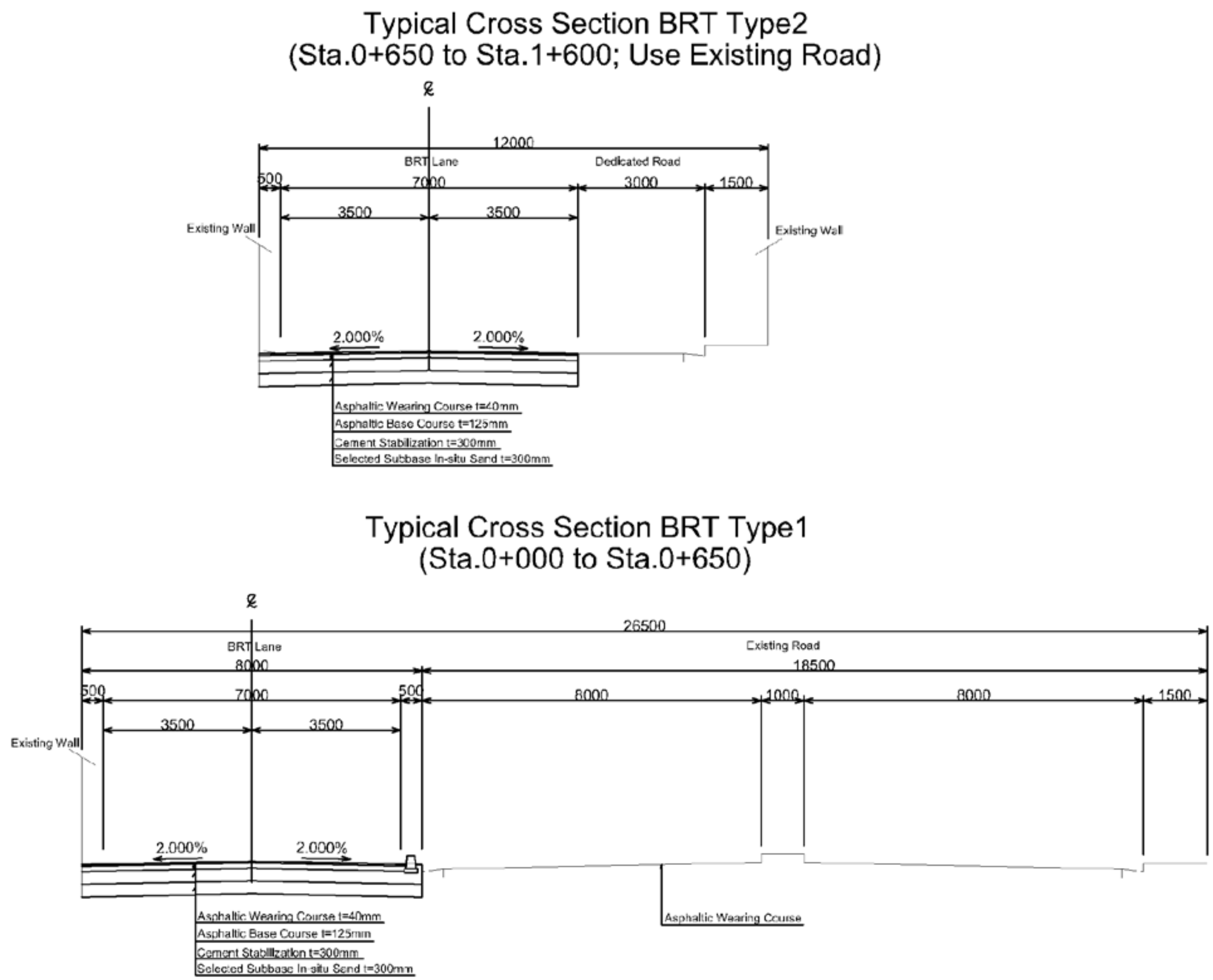


PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	PLAN & PROFILE STA. 18+000 TO STA. 18+900	H: 1:2500 V: 1:500	PP - 021

JICA PADECO NIPPON KOEI

Figure D.21: Plan & Profile STA 18+000 to 18+900

Figure D.22: Plan & Profile STA 18+900 to 19+100



	PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
JICA / PADECO / NIPPON KOEI	THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	TYPICAL CROSS SECTION (BRT Type 1,2)	1:100	TY - 001

Figure D.23: Typical Cross Section (BRT Section Type1, 2)

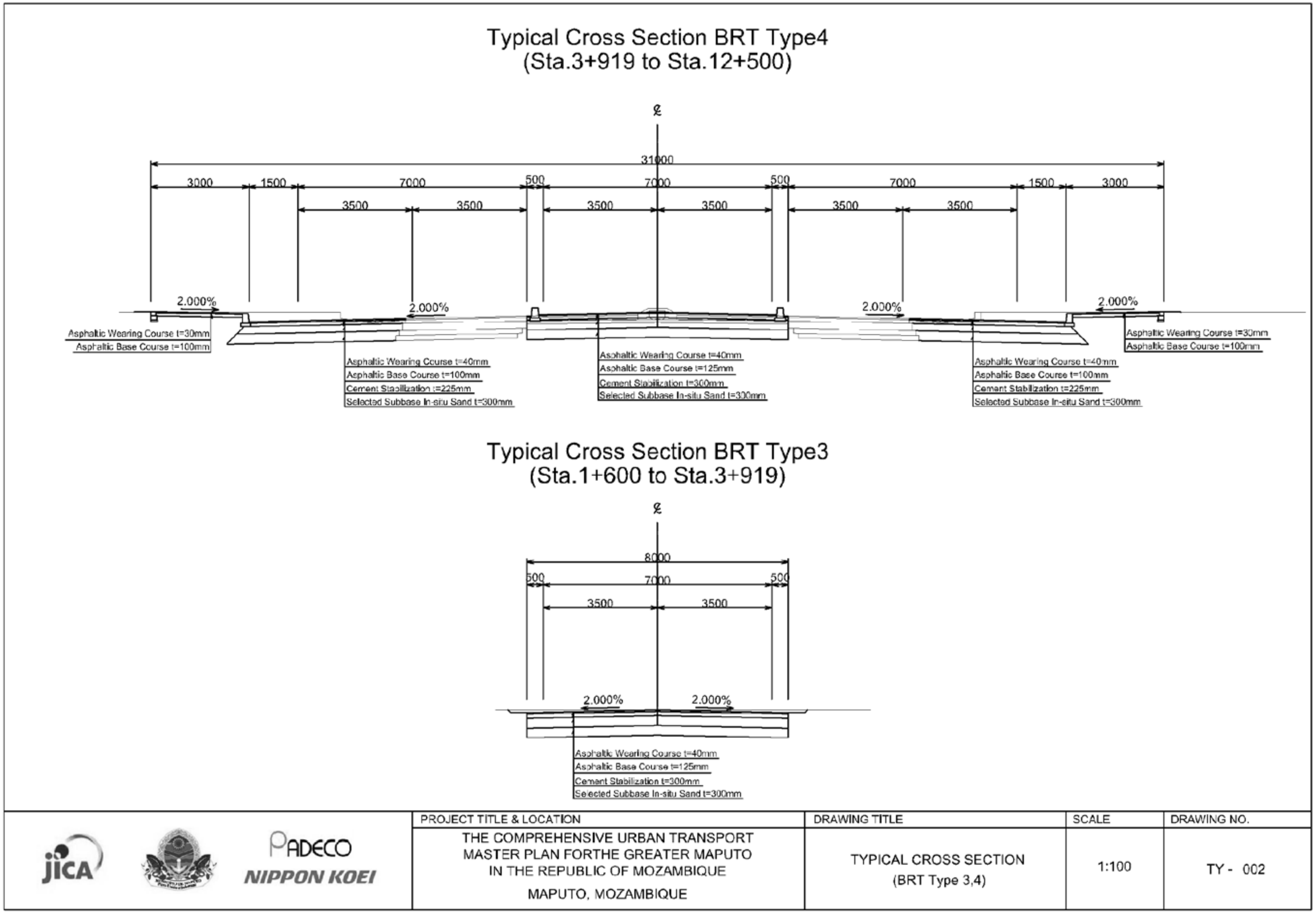


Figure D.24: Typical Cross Section (BRT Section Type3, 4)

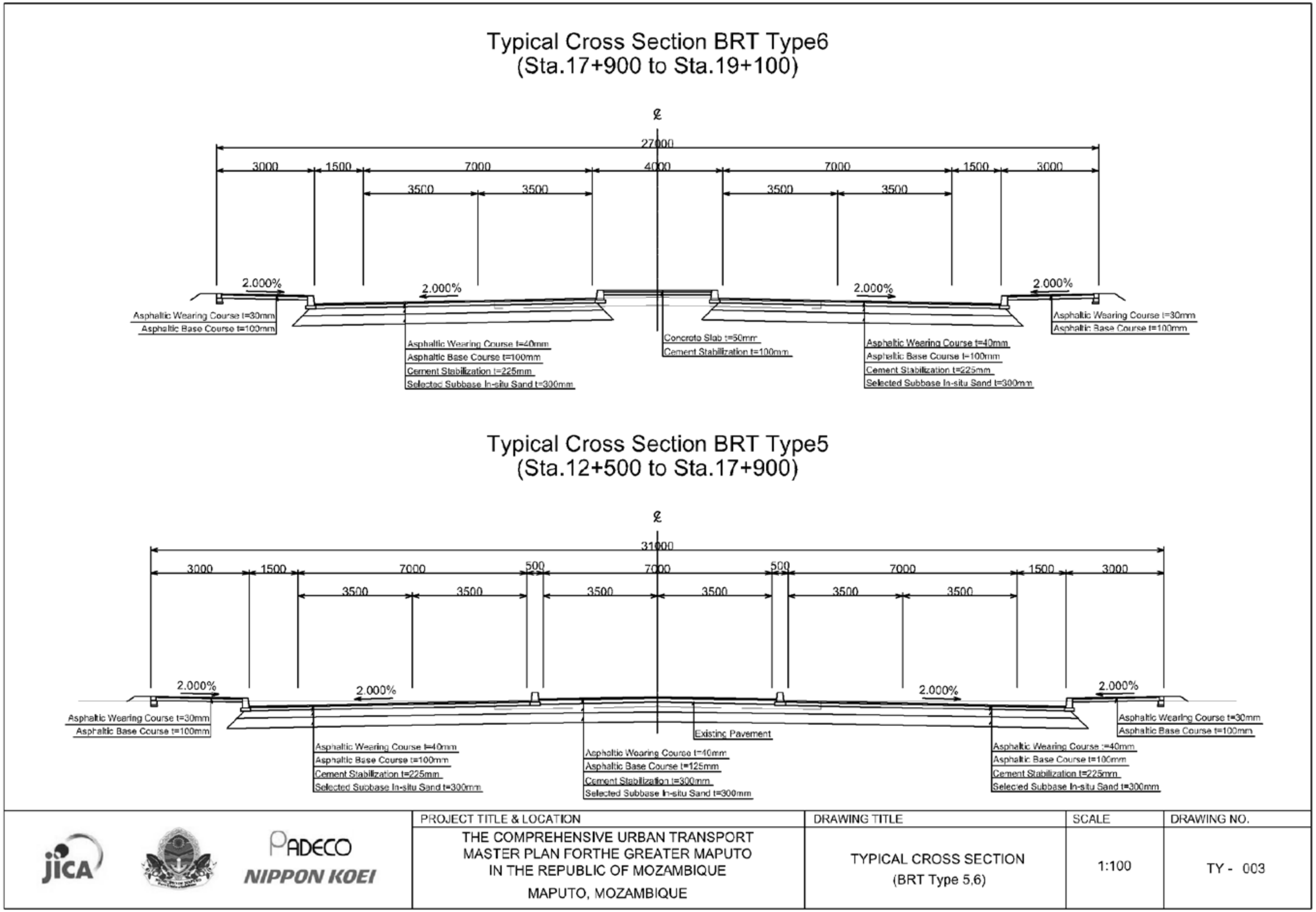


Figure D.25: Typical Cross Section (BRT Section Type5, 6)

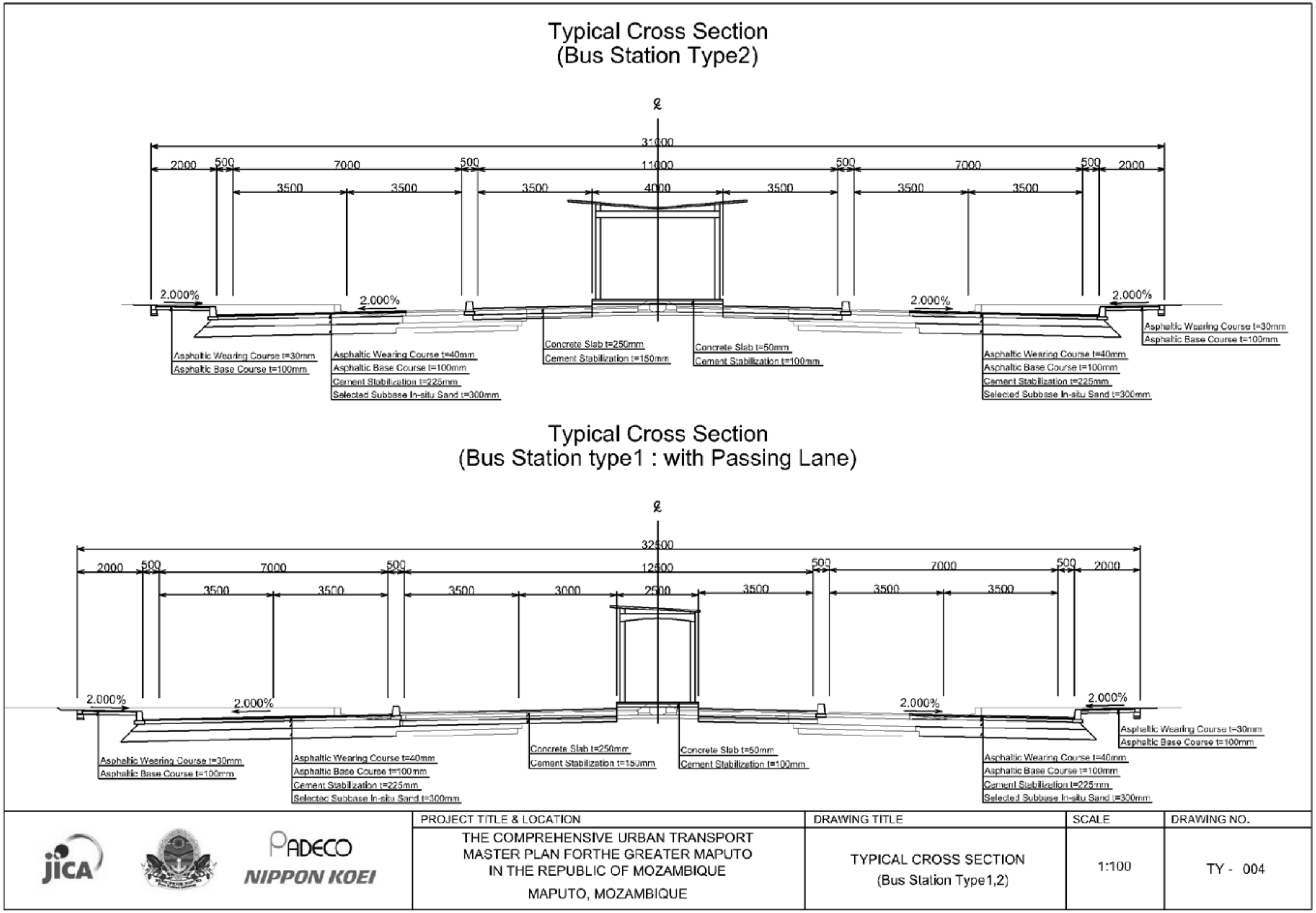
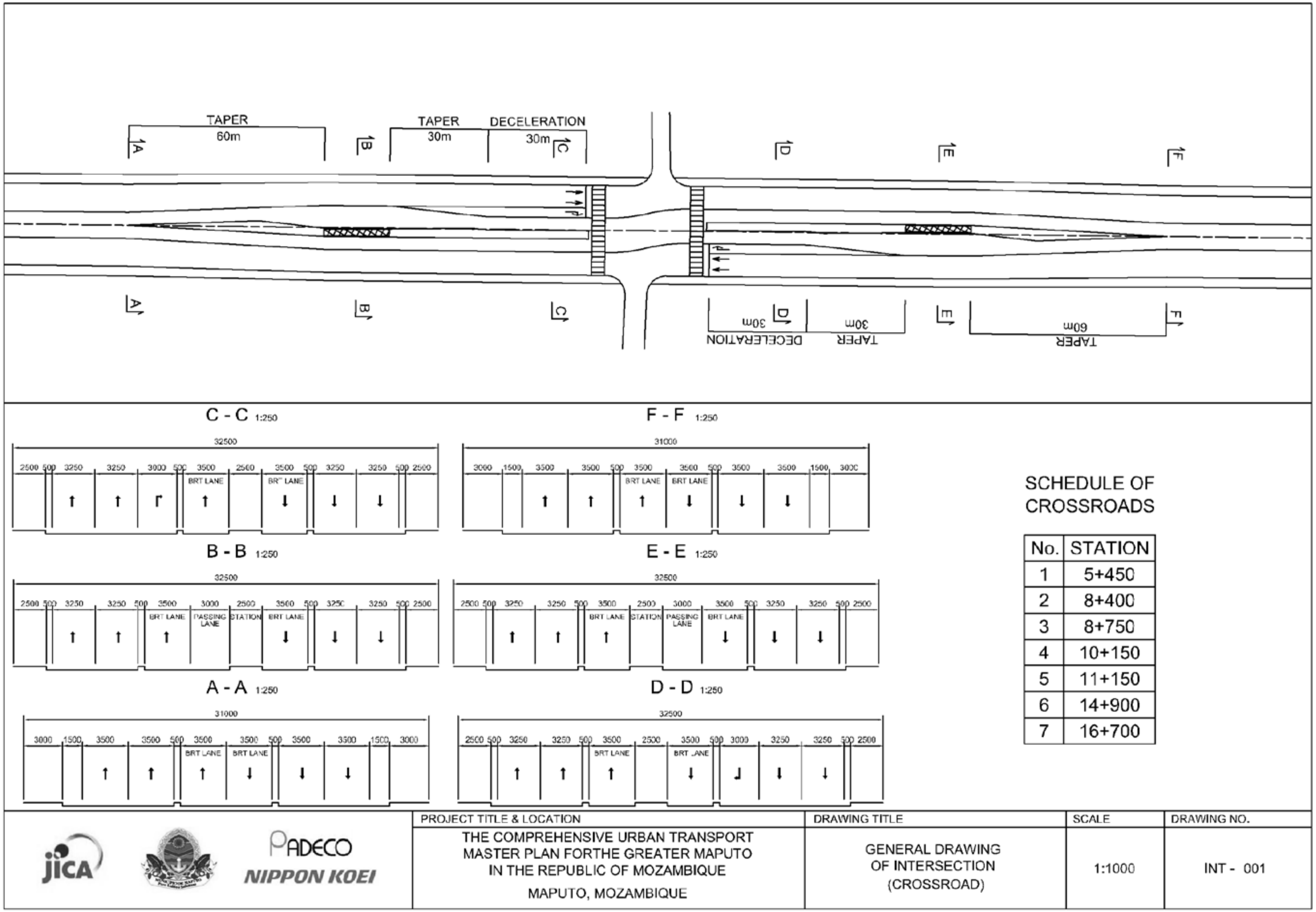


Figure D.26: Typical Cross Section (Bus Station Type1, 2)



SCHEDULE OF CROSSROADS

No.	STATION
1	5+450
2	8+400
3	8+750
4	10+150
5	11+150
6	14+900
7	16+700

Figure D.27: General Drawing of Intersection (Cross Road)

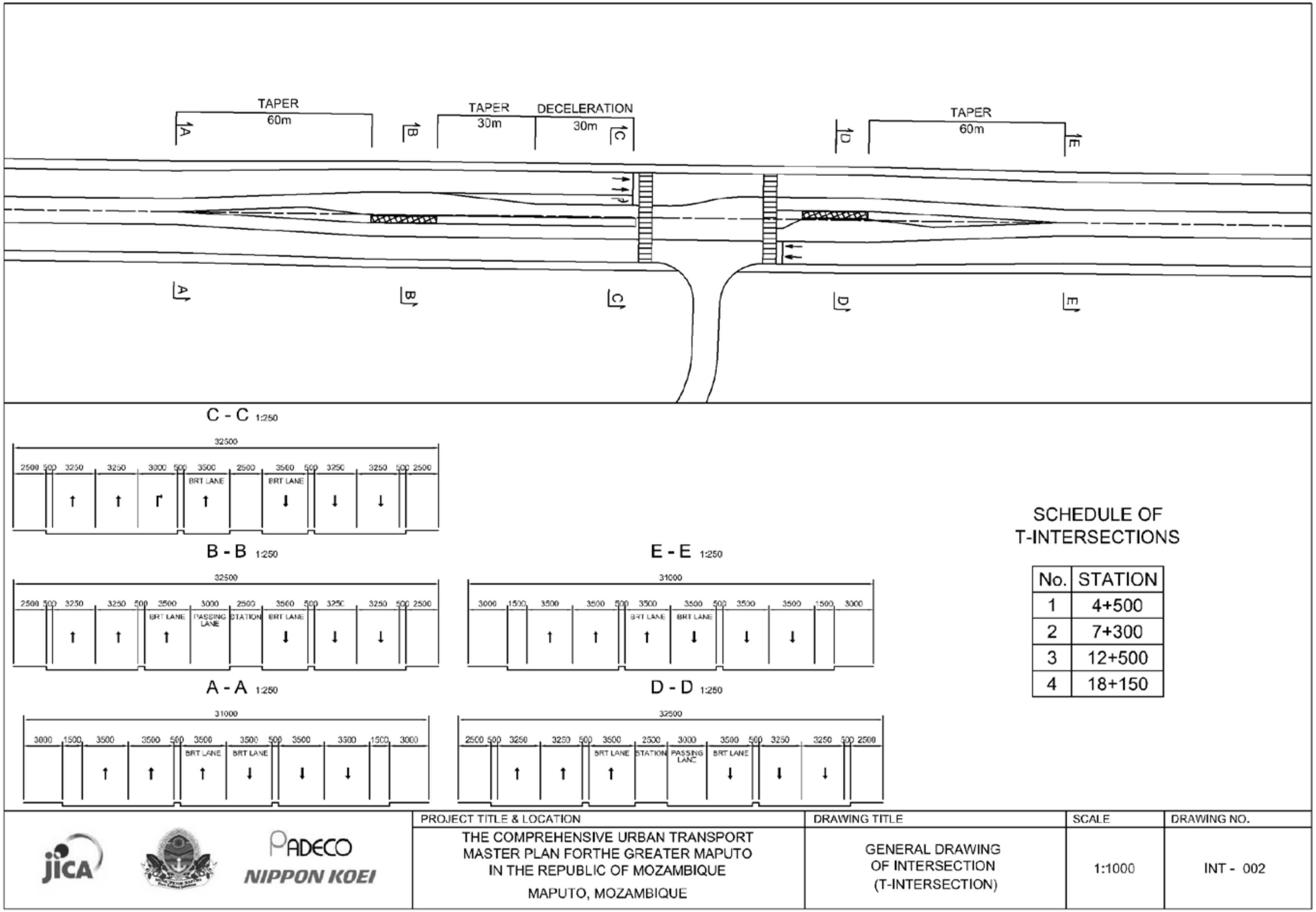
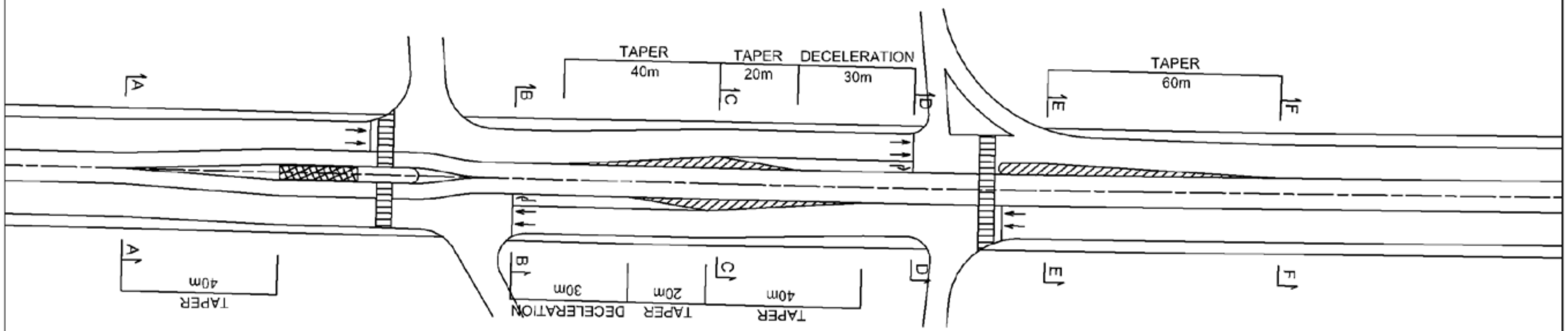
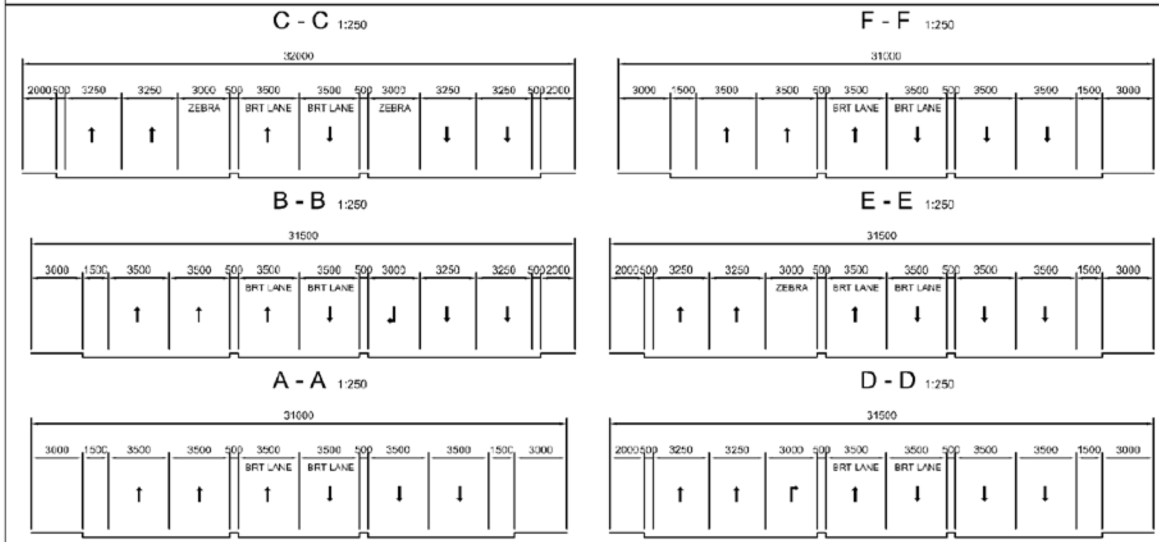


Figure D.28: General Drawing of Intersection (T-Intersection)





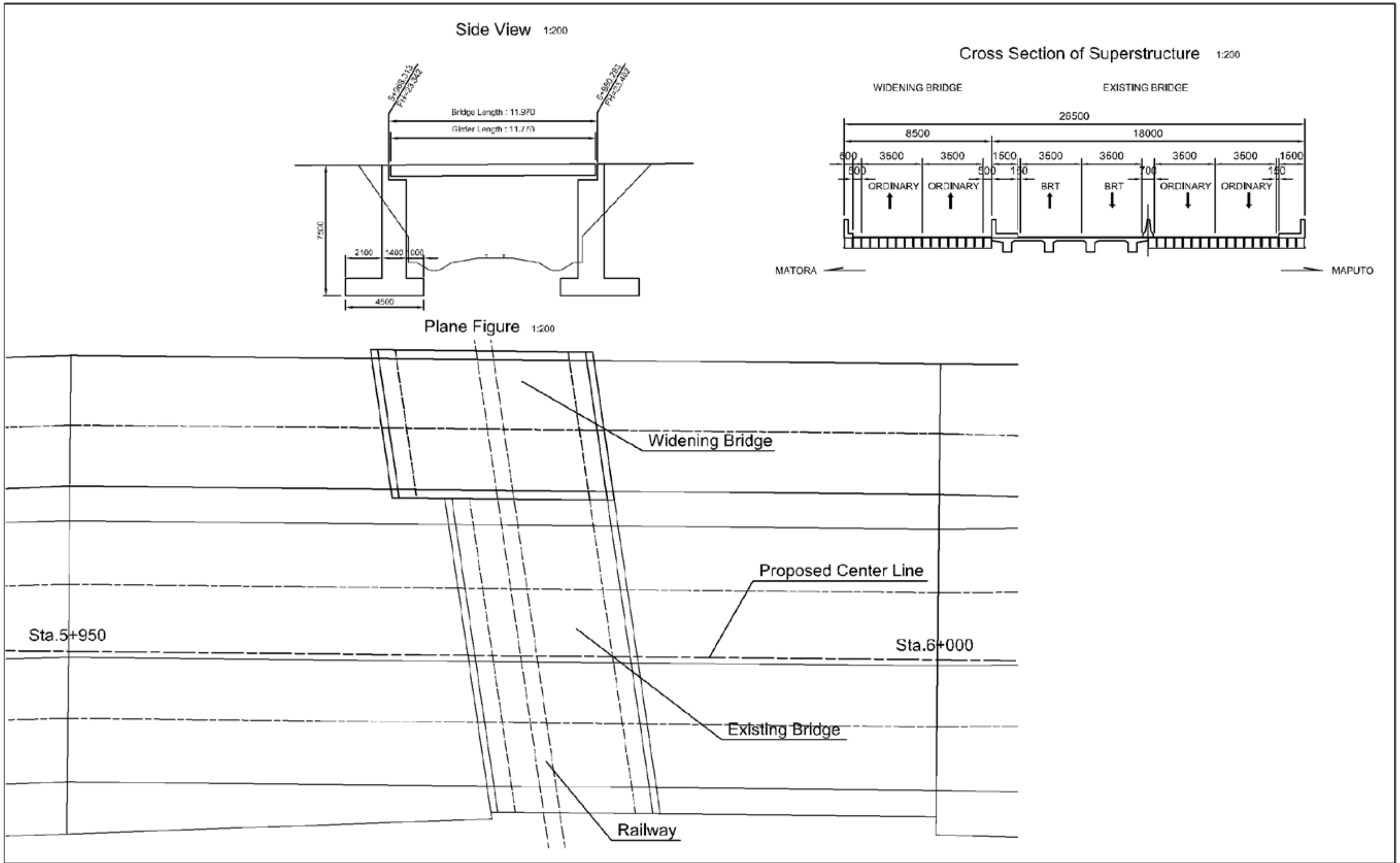
SCHEDULE OF
DIAMOND-INTERSECTIONS

No.	STATION
1	4+100
2	6+300

PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	GENERAL DRAWING OF INTERSECTION (DIAMOND-INTERSECTION)	1:1000	INT - 003

JICA PADECO NIPPON KOEI

Figure D.29: General Drawing of Intersection (Diamond-Intersection)



	PROJECT TITLE & LOCATION	DRAWING TITLE	SCALE	DRAWING NO.
JICA / PADECO / NIPPON KOEI	THE COMPREHENSIVE URBAN TRANSPORT MASTER PLAN FORTHE GREATER MAPUTO IN THE REPUBLIC OF MOZAMBIQUE MAPUTO, MOZAMBIQUE	GENERAL DRAWING OF BRIDGE	1:200	BR - 001

Figure D.30: General Drawing of Bridge

Figure D.31: N1 Bypass Route_1

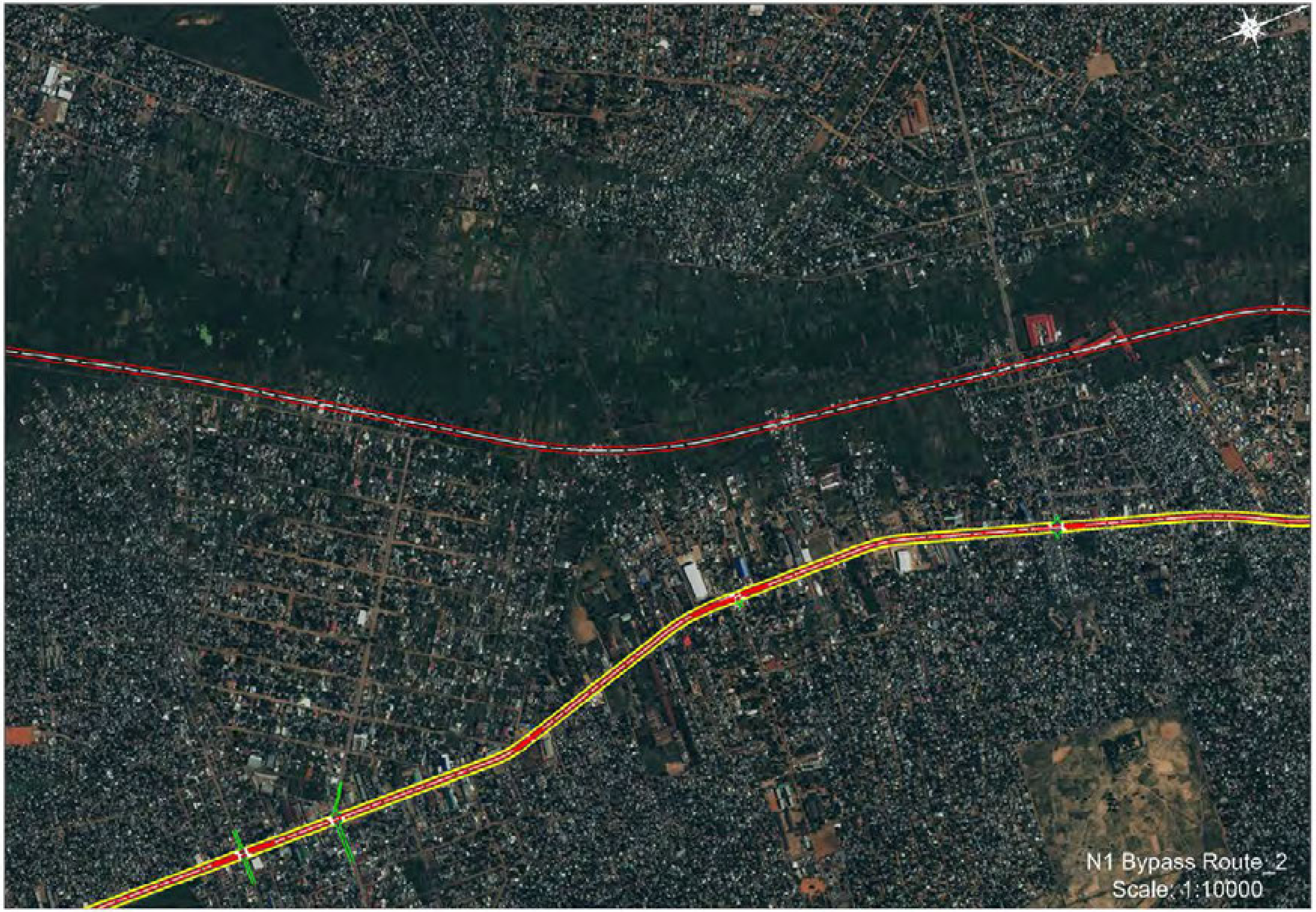


Figure D.32: N1 Bypass Route_2

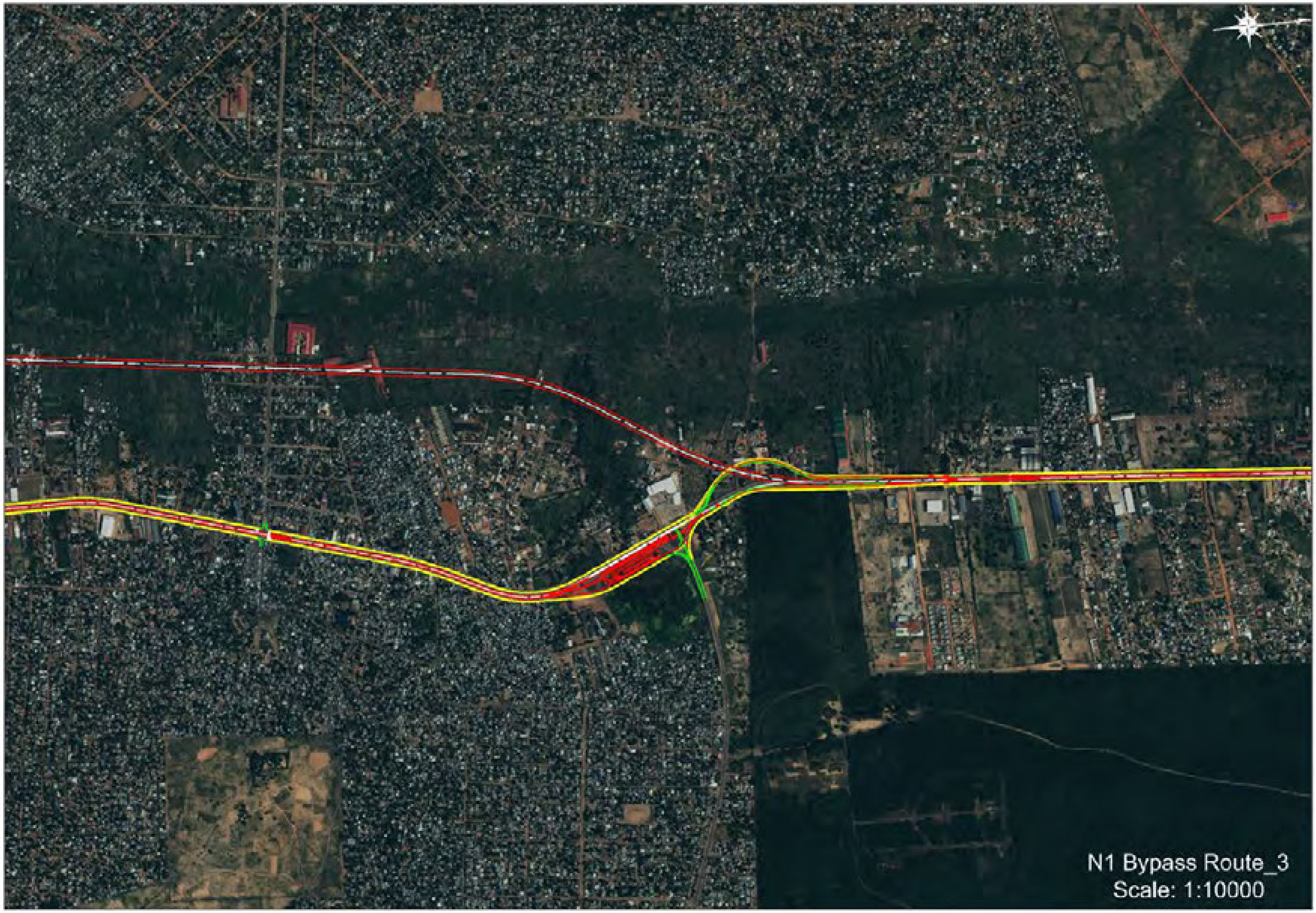


Figure D.33: N1 Bypass Route_3

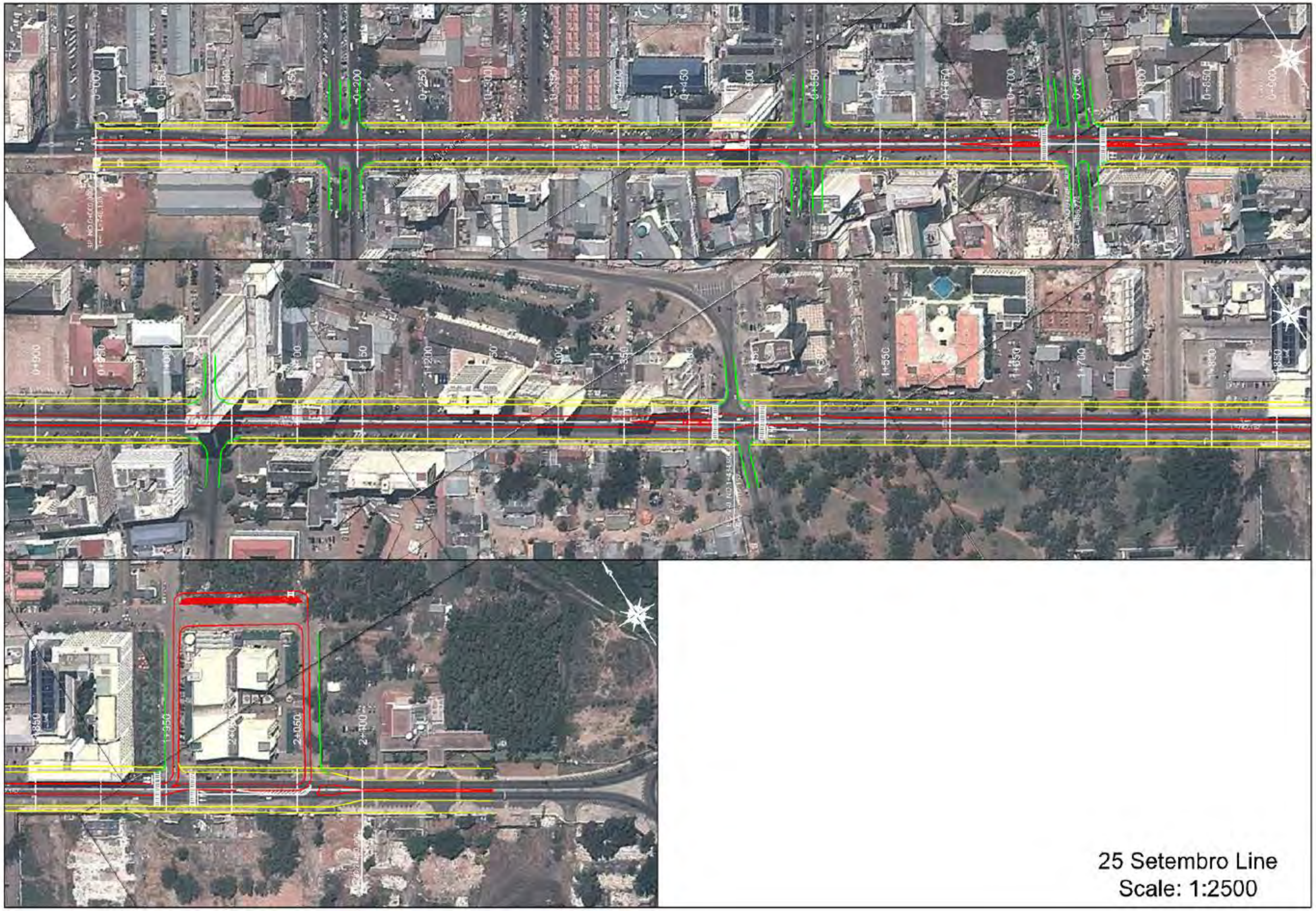


Figure D.34: 25 Setembro Route