ROADS AUTHORITY OF NAMIBIA
ROAD MANAGEMENT SYSTEM
(2011)
HDM-4 APPLICATION

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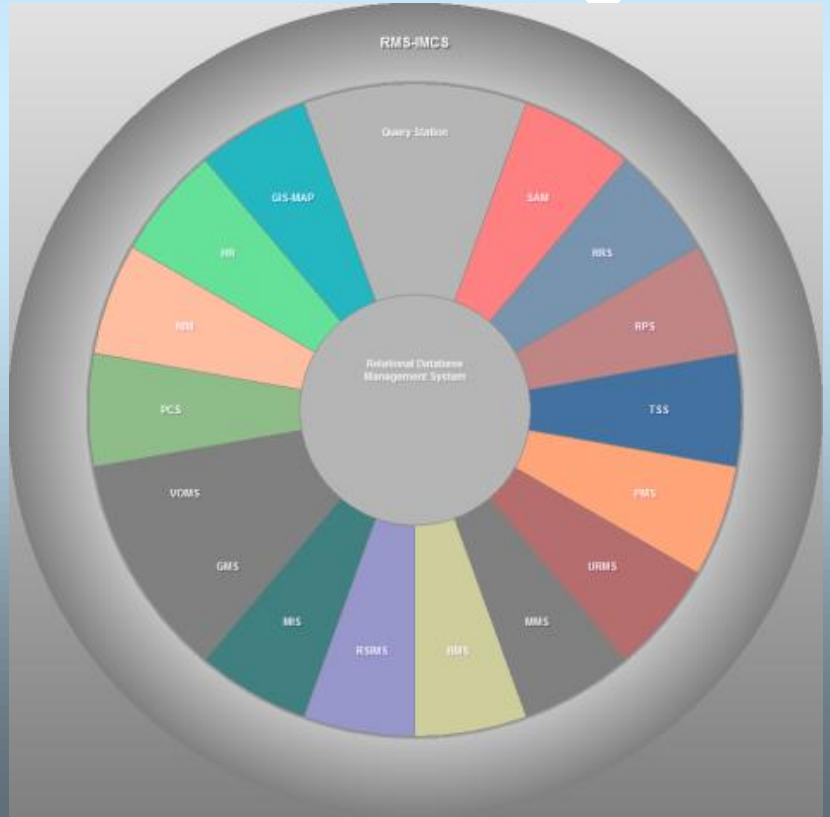
RMS Manager



SCOPE OF PRESENTATION

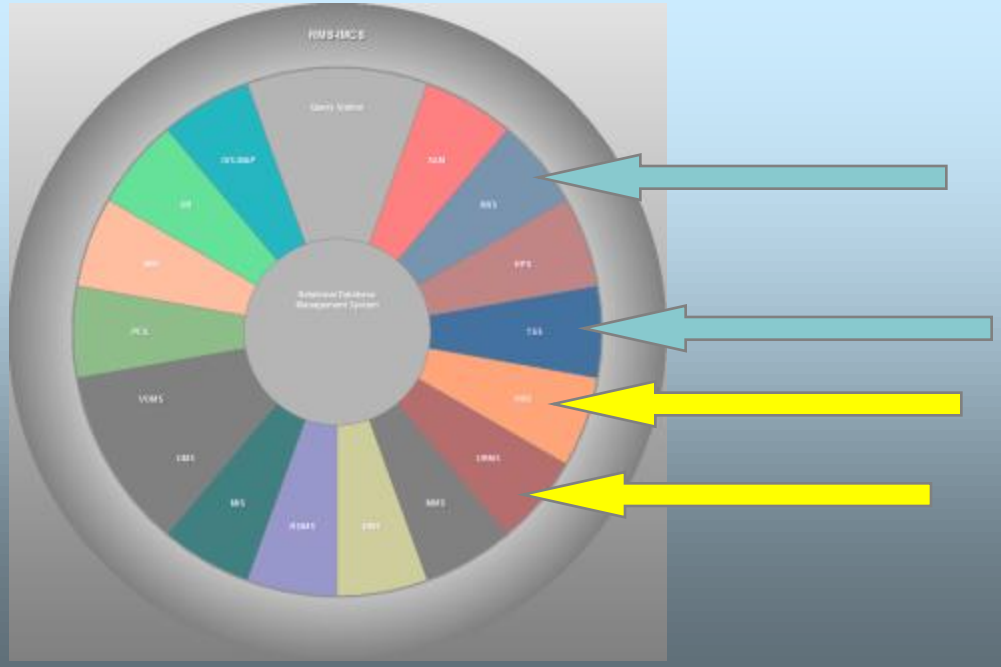
- **INTRODUCTION ON RMS OF NAMIBIA**
- **SUB-SYSTEMS AND RESULTS**
  - PAVEMENT MANAGEMENT SYSTEM
  - UNSEALED ROAD MANAGEMENT SYSTEM
  - NETWORK INTEGRATION MODULE AND HDM-4
- **RECOMMENDATIONS**

INTRODUCTION

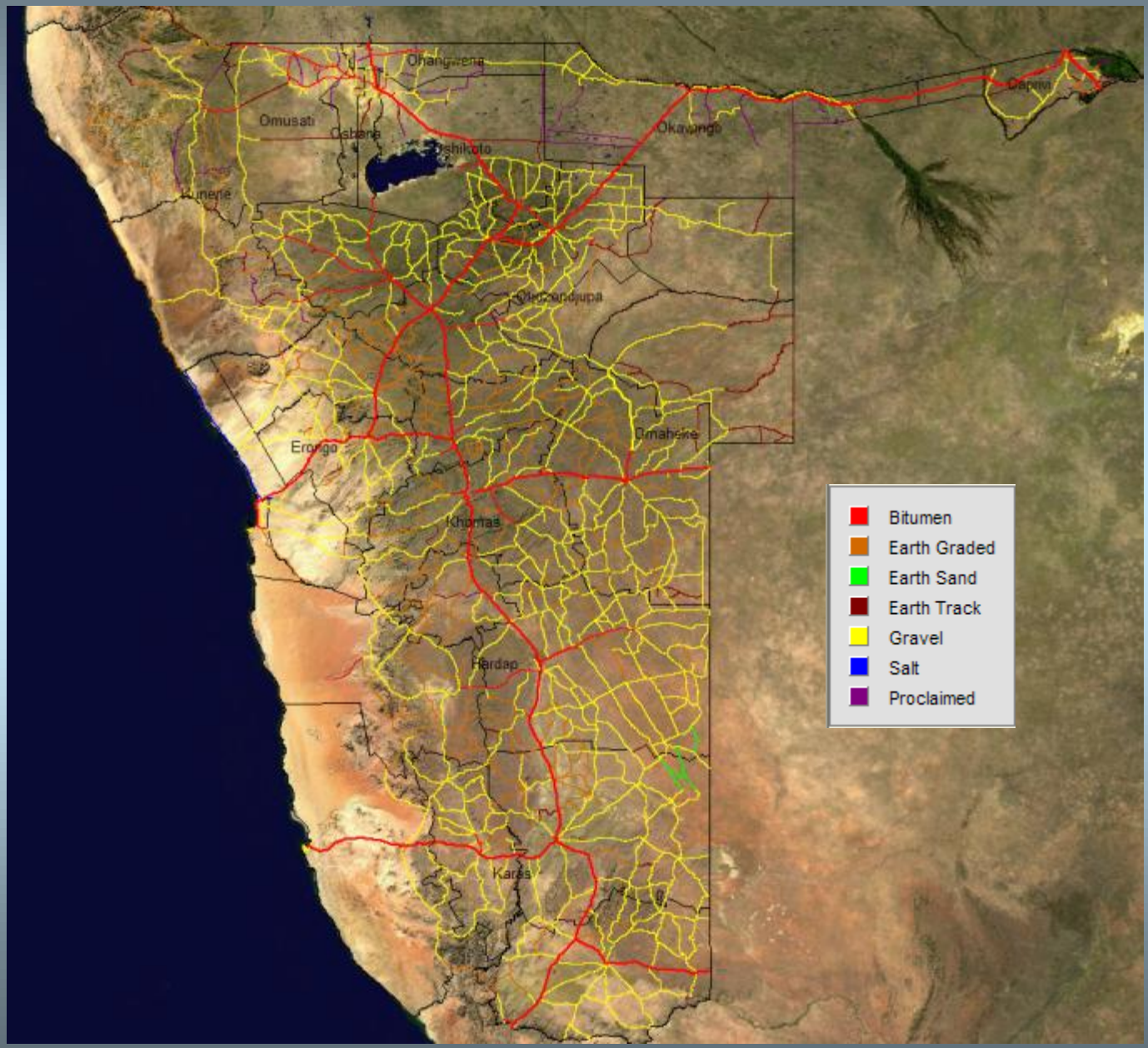
- **RMS OF NAMIBIA DEVELOPED IN THE LAST THIRTY YEARS**
- **PURPOSE OF THE RMS**
  - Record and update road infrastructure asset information
  - Assist the RA in strategic and tactical planning
    - Identification
    - Quantification
    - Prioritisation of projects
    - Budgeting

MOST IMPORTANT SUB-SYSTEMS

- Road Referencing System (RRS)
- Traffic surveillance System (TSS)
- Pavement Management System (PMS)
- Unsealed Road Management System (URMS)
- Network Integration Module (NIM)



2. PAVEMENT MANAGEMENT SYSTEM



Current Network (7)

NETWORK 7		Trunk Roads	Main Roads	District Roads	Proclaimed only	Total
Bitumen		4 135.7	1 945.8	305.8		6 387.3
Gravel		435.9	8 670.8	15 637.0		24 743.7
Salt		0.0	110.5	161.4		271.9
Earth	Earth Graded	0.0	363.5	10 693.0		11 056.5
	Earth tracks	0.0	77.2	1 359.6		1 436.8
	Sand Tracks	0.0	0.0	240.8		240.8
Total		4 571.6	11 167.8	28 397.6		44 137.0
Total including Proclaimed only					1 249.5	45 386.5

Need Identification Systems

- **Pavement Management System (Surfaced Roads)**
- **Unsealed Road Management System (Unsealed Roads)**
- **Bridge Management System (Structures)**
- **Network Integration Module**
  - Combine total needs on existing network

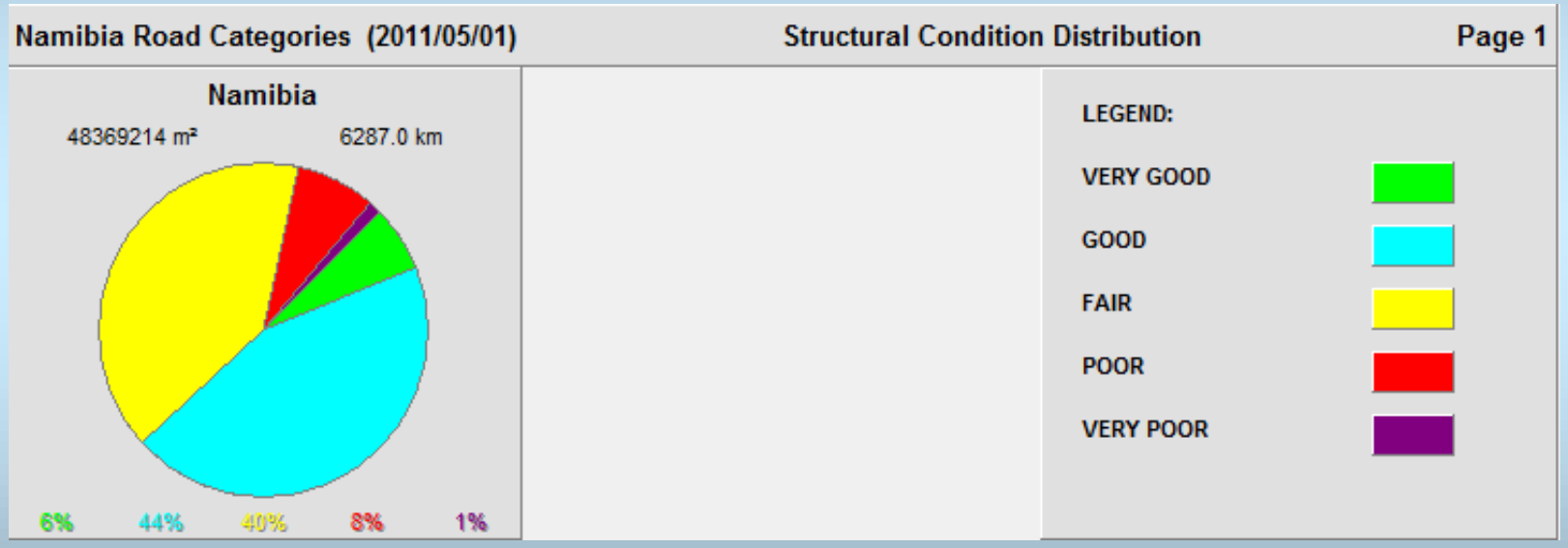
PROCESSES

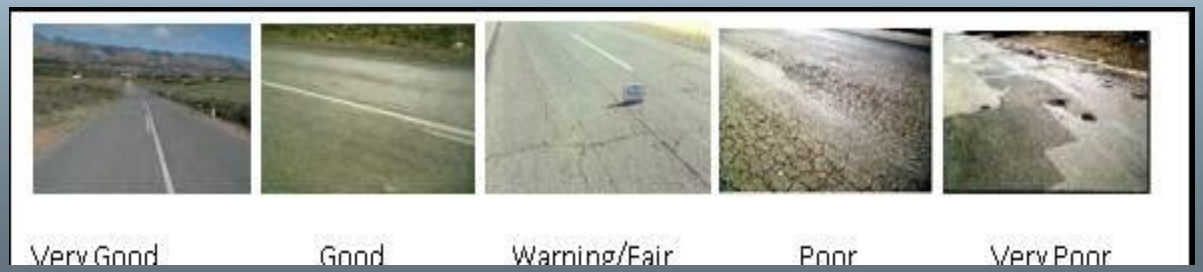
- **Condition assessment**

ROADS AUTHORITY : NAMIBIA										
Visual Assessment : Surfaced Roads										
Road Number	D0212			Date	Date					
Carriageway	0	F	B	Assessor						
Position (km)	0.150			Climate	Dry	Mod	Wet			
CONDITION	**Degree**									
Texture	VF	F	M	C	VC	Var				
Binder	0	1	2	3	4	5				
Bleeding	0	1	2	3	4	5				
Aggregate Loss	0	1	2	3	4	5				
Edge Breaking	0	1	2	3	4	5				
Riding Quality	0	1	2	3	4	5				
Skid Resistance	0	1	2	3	4	5				
CRACKING	**Degree**						**Extent**			
Surfacing / Hardening	0	1	2	3	4	5		m		
Longitudin: Wheelpath	0	1	2	3	4	5		m		
Longitudinal: Edge	0	1	2	3	4	5		m		
Longitudinal: Random	0	1	2	3	4	5		m		
Transverse Cracking	0	1	2	3	4	5		Nr		
Block Cracking	0	1	2	3	4	5		m		
Crocodile Cracking	0	1	2	3	4	5		m		
DISTRESS	**Degree**						**Extent**			
Pumping	0	1	2	3	4	5		m		
Failures: Surfacing	0	1	2	3	4	5		m		
Potholes: Structural	0	1	2	3	4	5		m		
Patching: Surfacing	0	1	2	3	4	5		m		
Patching: Structural	0	1	2	3	4	5		m		
Deformation: Surfacing	0	1	2	3	4	5		m		
Deformation: Rutting	Max depth (mm)							m		
GENERAL	**Condition of the Sample**									
Surfacing	V Good	Good	Fair	Poor	V Poor					
Structure	V Good	Good	Fair	Poor	V Poor					
ACTION	**Assessor's rating of Maintenance requirement**									
Action Required	None	Routine	Resurf	Rehab						
Urgency Rating	None	Low	Medium	High						
COMPARE	**Condition of the section compared to the sample**									
Surfacing	Much B	Better	Similar	Worse	Much W					
Structure	Much B	Better	Similar	Worse	Much W					

PROCESSES

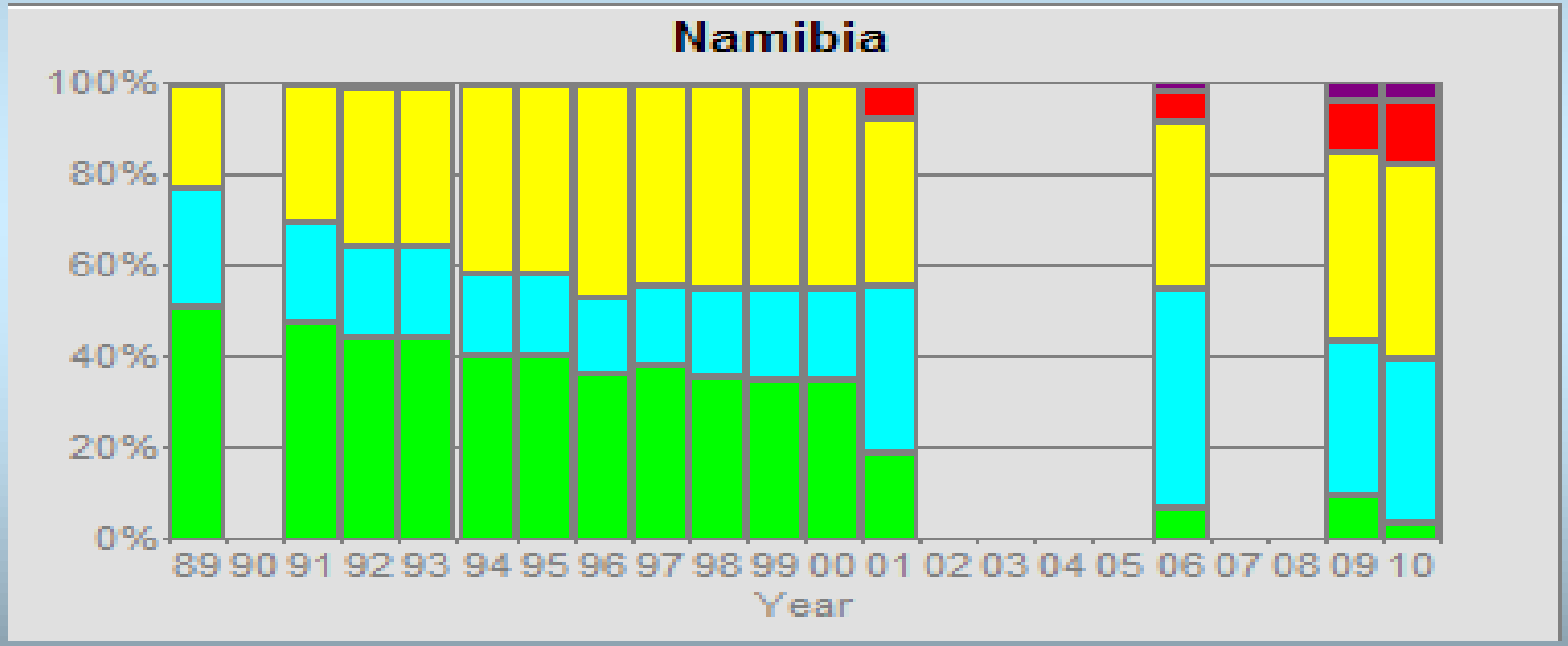
- **Condition description (pavement structures)**





PROCESSES

- **Condition trends (Pavement structures)**



REPORTING

PAVEMENT MANAGEMENT SYSTEM

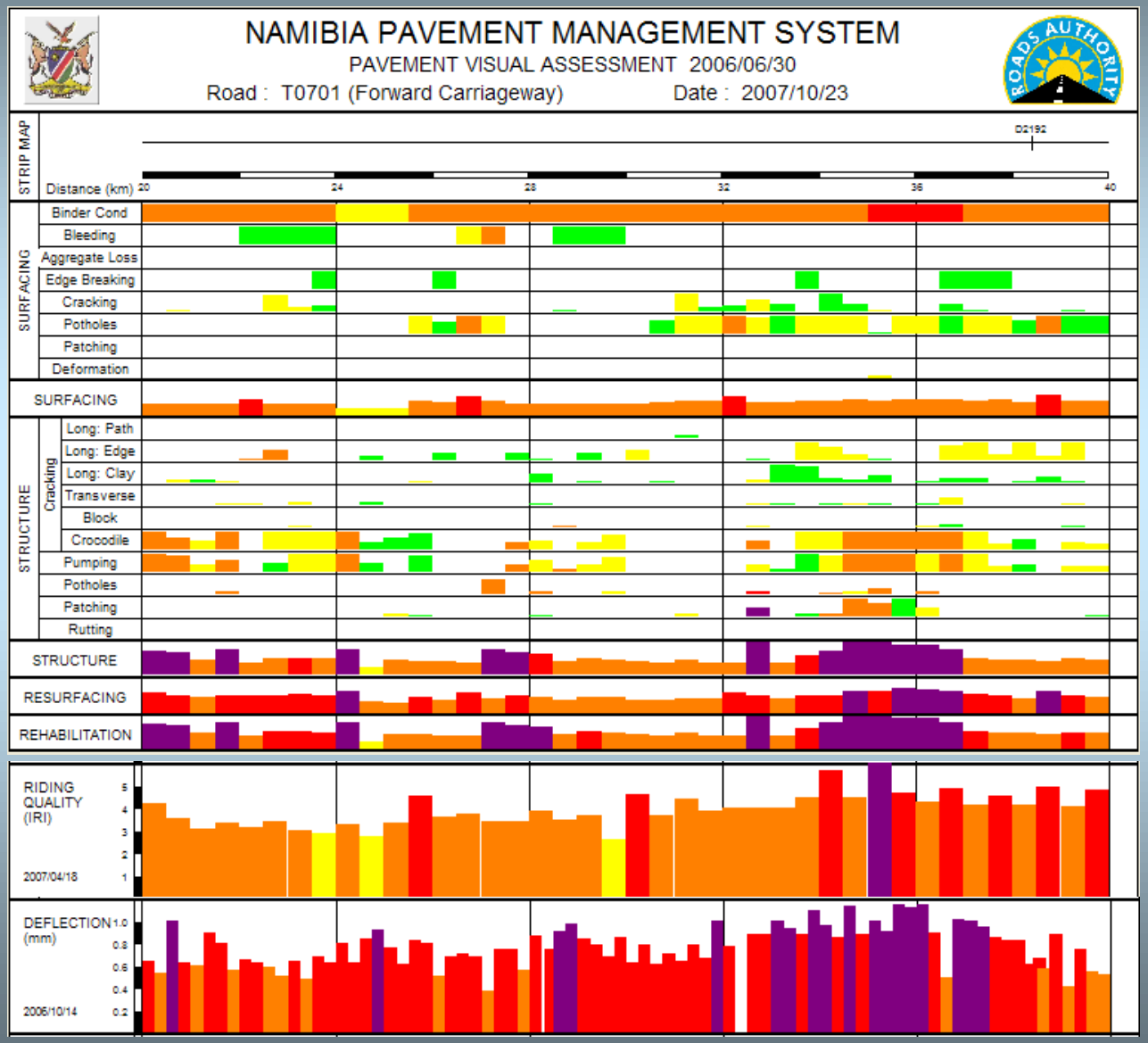
PAVEMENT ASSESSMENT (PHASE 2)

NAMIBIA ROADS AUTHORITY

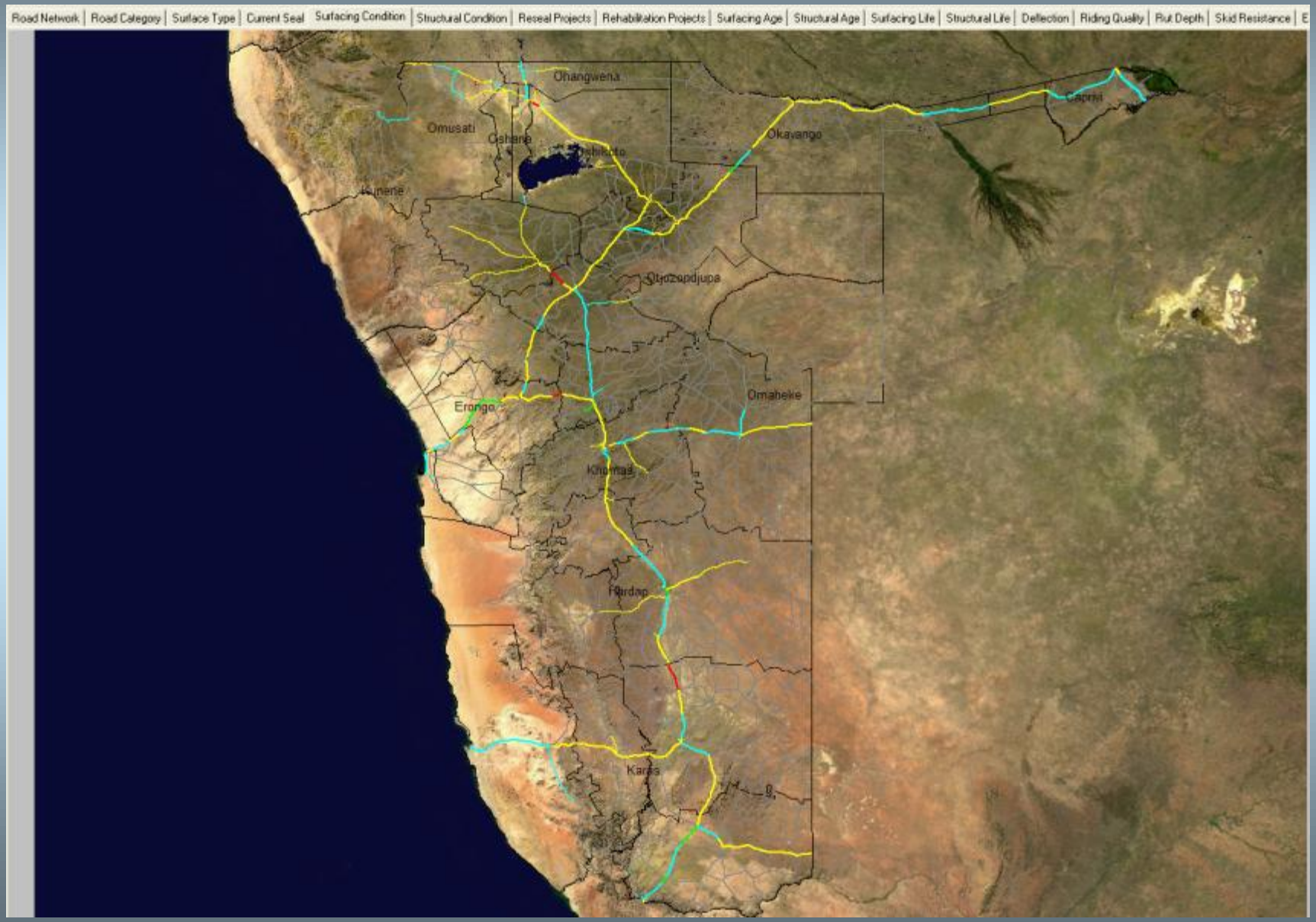
Reseal Project Priorities — **Assessment Date :** 2006/06/30

Road Number	Carriage Way	Section Begin (km)	Section End (km)	Maintenance Region	Road Cat	Length (km)	Width (m)	Traffic Class	Resurfacing Need Index	Resurfacing Need Recommended Action	Resurfacing Cost Year	Resurfacing Cost Cost (N$)	Resurfacing Cost Total (N$)
T0108		0	117.76	Otjiwarongo	T	117.8	6.6	2300/300	0	Seal	1	24,680,531	24,680,531
T0401		0	84	Keetmanshoop	T	84.0	6.8	255/55	0	Seal	1	20,520,107	45,200,638
T0501		1.5	51.62	Windhoek	T	50.1	7.4	230/30	0	Seal	1	13,999,748	59,200,386
T0803		82	103.5	Oshakati	T	21.5	8.0	400/100	0	Seal	1	4,853,206	64,053,592
T0804		61.5	73.5	Oshakati	T	12.0	7.5	285/65	0	Seal	1	3,721,028	67,774,620
M0052		1	22.7	Windhoek	M	21.7	13.6	370/20	0	Seal	1	9,673,862	77,448,482
M0031		0	30.5	Keetmanshoop	M	30.5	6.7	90/10	0	Seal	1	5,951,015	83,399,497
M0048		0	1.5	Windhoek	M	1.5	8.0	85/10	0	Seal	1	355,113	83,754,610
M0066		0	0.29	Windhoek	M	0.3	8.0	55/5	0	Seal	1	68,655	83,823,265
M0067		45.5	154.45	Otjiwarongo	M	108.9	8.0	135/5	0	Seal	1	27,698,119	111,521,384
M0069		157.87	161.04	Otjiwarongo	M	3.2	8.0	40/10	0	Seal	1	750,471	112,271,855
M0070		0	14.88	Windhoek	M	14.9	8.0	140/15	0	Seal	1	5,079,669	117,351,524
M0084		0	35.19	Oshakati	M	35.2	6.2	135/15	0	Seal	1	10,342,297	127,693,821
D1210		0	2.23	Windhoek	D	2.2	8.0	315/15	0	Seal	1	527,934	128,221,755
D3611		0	5.51	Oshakati	D	5.5	7.0	237/22	0	Seal	1	1,138,545	129,360,300
D1010		0	0.54	Windhoek	D	0.5	7.0	68/8	0	Seal	1	111,582	129,471,882
D1103		0	0.2	Windhoek	D	0.2	8.0	22/2	0	Seal	1	47,348	129,519,230
D1228		55.28	56.6	Windhoek	D	1.3	8.0	65/5	0	Seal	1	312,499	129,831,729
D1280		0	0.1	Windhoek	D	0.1	8.0	70/10	0	Seal	1	23,674	129,855,403
D1526		0	1.61	Windhoek	D	1.6	6.4	110/10	0	Seal	1	303,844	130,159,247
D2440		0	1.75	Otjiwarongo	D	1.8	7.1	16/1	0	Seal	1	367,806	130,527,053
D3409		0	1.97	Oshakati	D	2.0	7.0	55/15	0	Seal	1	407,066	130,934,119
D3416		0	3.78	Oshakati	D	3.8	7.1	13/3	0	Seal	1	790,753	131,724,872
D3500		0	0.58	Oshakati	D	0.6	7.1	145/15	0	Seal	1	121,559	131,846,431
D3625		30.43	30.97	Oshakati	D	0.5	7.0	42/2	0	Seal	1	111,582	131,958,013
D3714		0	0.79	Otjiwarongo	D	0.8	7.3	15/5	0	Seal	1	170,702	132,128,715

REPORTING


NAMIBIA PAVEMENT MANAGEMENT SYSTEM
PAVEMENT VISUAL ASSESSMENT 2006/06/30
Road : T0701 (Forward Carriageway)
Date : 2007/10/23
ROADS AUTHORITY
STRIP MAP
D2192
Distance (km) 20 24 28 32 36 40
SURFACING
Binder Cond
Bleeding
Aggregate Loss
Edge Breaking
Cracking
Potholes
Patching
Deformation
SURFACING
STRUCTURE
Cracking
Long: Path
Long: Edge
Long: Clay
Transverse
Block
Crocodile
Pumping
Potholes
Patching
Rutting
STRUCTURE
RESURFACING
REHABILITATION
RIDING QUALITY (IRI)
2007/04/18
5
4
3
2
1
DEFLECTION (mm)
2006/10/14
1.0
0.8
0.6
0.4
0.2

REPORTING


Road Network | Road Category | Surface Type | Current Seal | Surfacing Condition | Structural Condition | Reseal Projects | Rehabilitation Projects | Surfacing Age | Structural Age | Surfacing Life | Structural Life | Deflection | Riding Quality | Rut Depth | Skid Resistance
Ohangwena
Omusati
Okavango
Kunene
Otjozondjupa
Omaheke
Erongo
Karas

UNSEALED ROAD MANAGEMENT SYSTEM

- **Unsealed road network**
- **Monitor condition and trends of deterioration**
- **Identifies and prioritises potential projects**
  - Periodic maintenance measures
  - Potential surfacing/ upgrading
- **Budget requirements**
- **Provides information**
  - Reports
  - Graphs
  - Maps

Visual Assessment (5km)

URMS Road Segment Information

Strip Chart | Find Segment | Print | Close

Road Nr	M0036	Begin (km)	0.000	Segment	Begin (km)	80	Length (m)	5000	Moisture: Wet / Moist / Dry
Carriage	N / F / B	End (km)	437.440	6144	End (km)	85	Width (m)	< 4 / 4 - 5.9 / 6 - 7.9 / 8 - 9.9 / 10 - 12	
District	Swakopmund			Assessor		IG	Road Type	E Grade / E Sand / E Track / Gravel / Salt	

Visual Assessment Form | All URMS Results | Efficiency Frontier | Photographs | Custom Data

Surface, Material Properties, Subgrade

Assessment Date: 2006/10/25

Wearing Coarse / Surface

Gradeability	V G		Good		Fair		Poor		V P
Problem	Deep sand	Hard corrug	Oversize m	Fixed stone	Rock out				

Estimated Gravel Thickness (mm): 0 | < 50 | 50 - 100 | 100 - 150 | > 150

Material Properties

Material Type (main)	Calcrete	Quartzite	Ferricrete	Sandstone
	Granite	Shale	Dolerite	Sand
Maximum Size (mm)	> 100	> 50 - 100	> 25 - 50	> 13 - 25	< 13
Classification	Coarse	Medium	Fine		
Approximate PI	< 6	6 - 10	11 - 15	> 15	

Subgrade

Exposure	None	Isolated	Frequent	General	Continuous
Strength	V G	Good	Fair	Poor	V P
Problem	Clay / Mud	Sand	Wet		

Functional Assessment

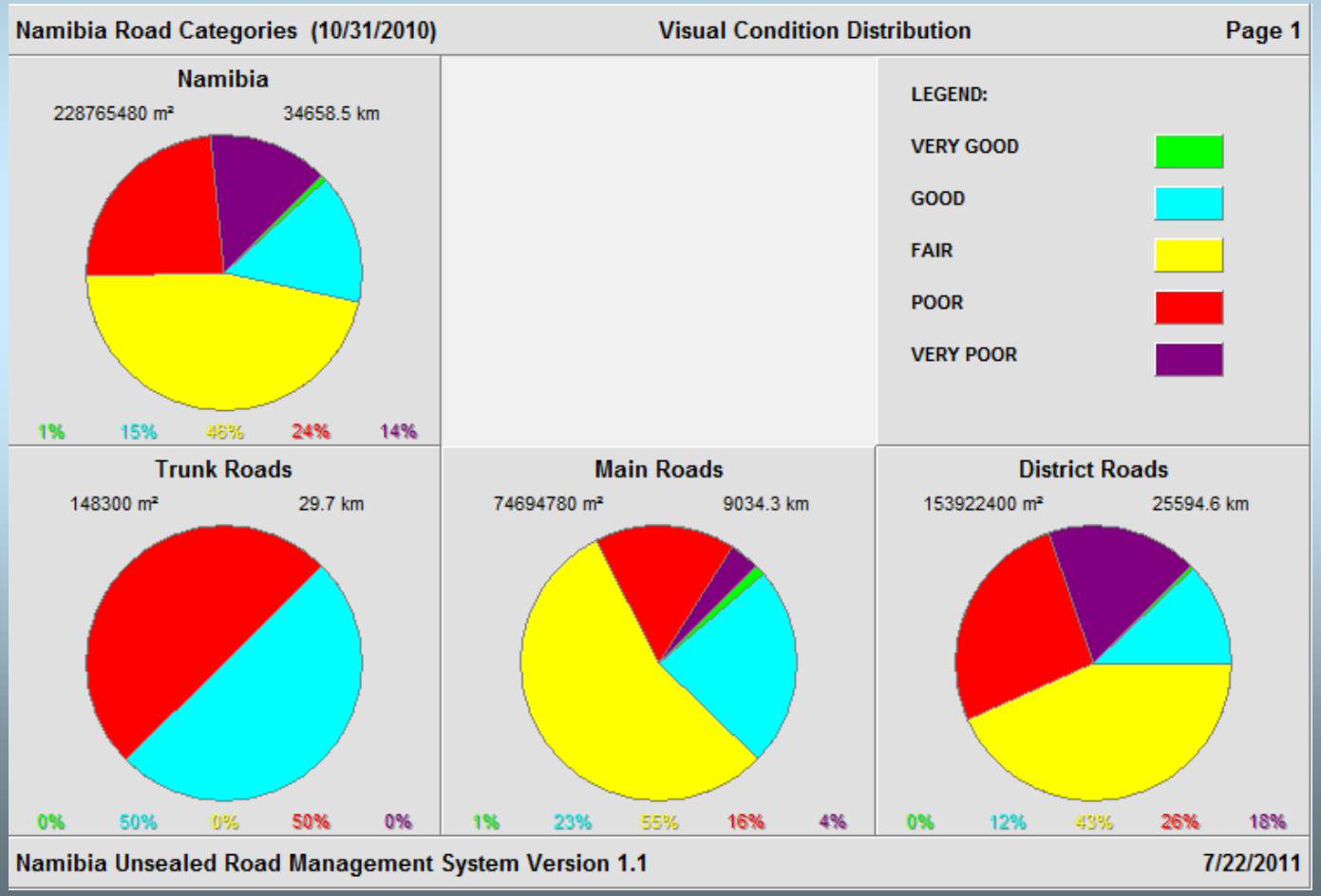
Accessibility	V G		Good		Fair		Poor		V P
Problem	Skid	Sand	Clay	Rocky	Drainage				
Riding Quality	V G		Good		Fair		Poor		V P
Problem	Corrugatn	Stoniness	Potholes	Deep sand	Erosion				
Safety	V G		Good		Fair		Poor		V P
Problem	Geometry	Dust	Slippery	Drainage	Drifts				
Surface Drain	V G		Good		Fair		Poor		V P
Problem	Rd level	Rd shape	Rutting	Wind-row					
Side Drainage	V G		Good		Fair		Poor		V P
Problem	Culverts	Side drain	Mitre drain	Rd level					

Summary

Gen Condition	V G		Good		Fair		Poor		V P
Assessor's Recommendation	Construct	Spot Reg	(Re)gravel						
	Reshape	Rework	Drainage						
Drifts : Large	0	Small	0						

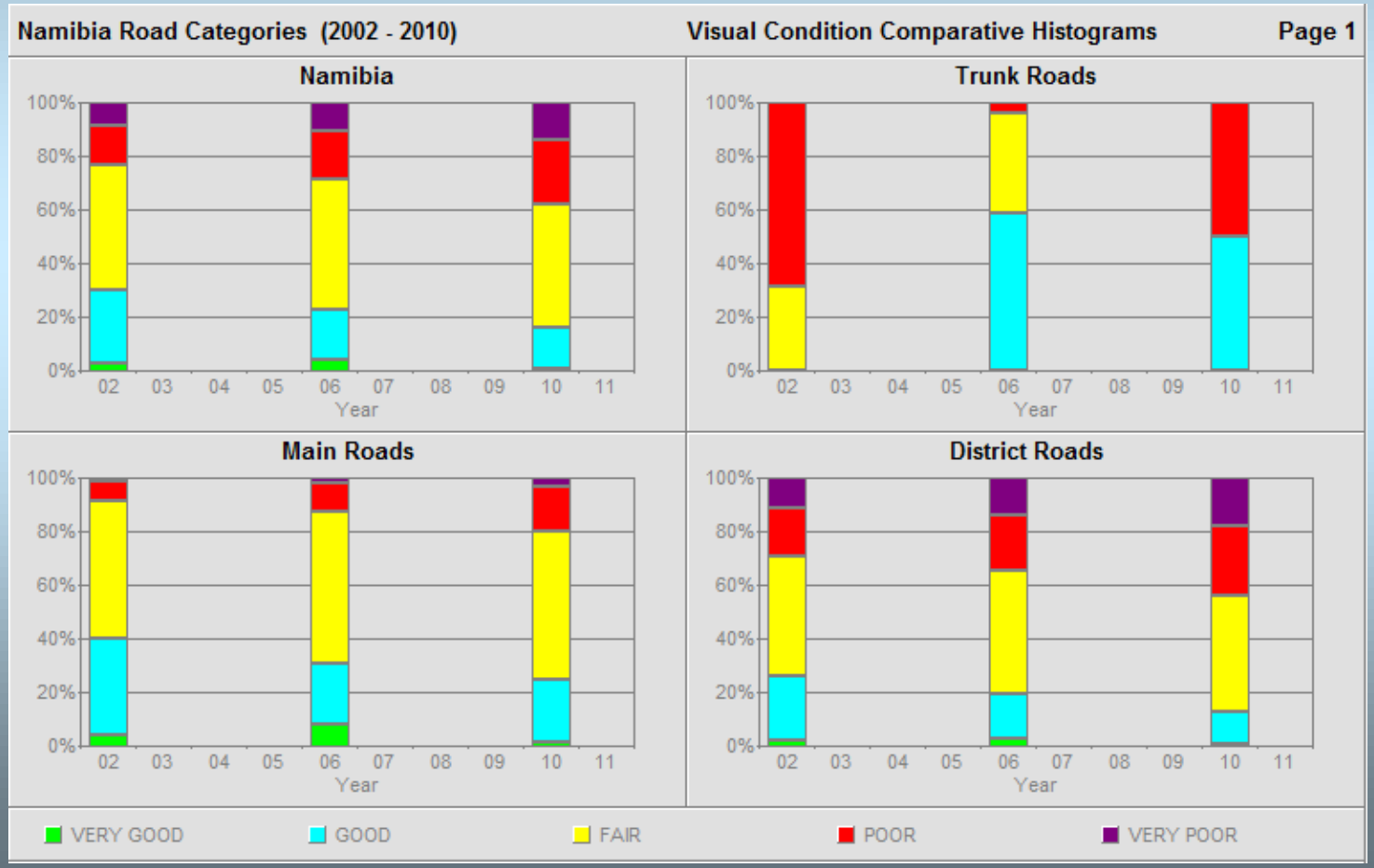
PROCESSES

- **Condition description (Network)**



PROCESSES

- **Condition trends**



URMS SUMMARY

Routine Maintenance Blading (N$)	Routine Maintenance Ancillary(N$)	Scheduled Maintenance (N$)	Sealing of gravel roads (N$)	TOTAL (N$)
181 000 000	125 000 000	525 061 000	180 000 000	1 011 061 000

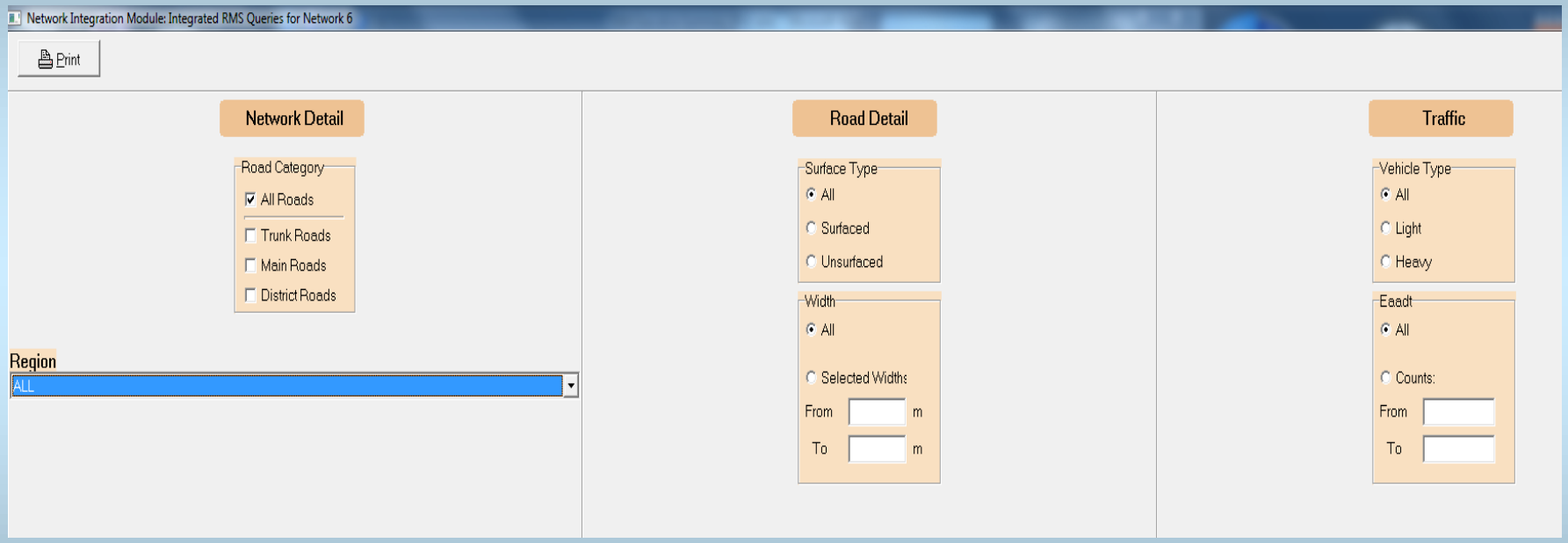
Network Integration Module

- Use HDM for Strategic analysis
- Easily access management outputs from the various RMS sub-systems
- Enter and update annual budget details
- Run integrated queries on the road network
- Enter and manage the five-year work program
- Provide access to annual reports
- Calculate and monitor the road network asset value (not functional yet)

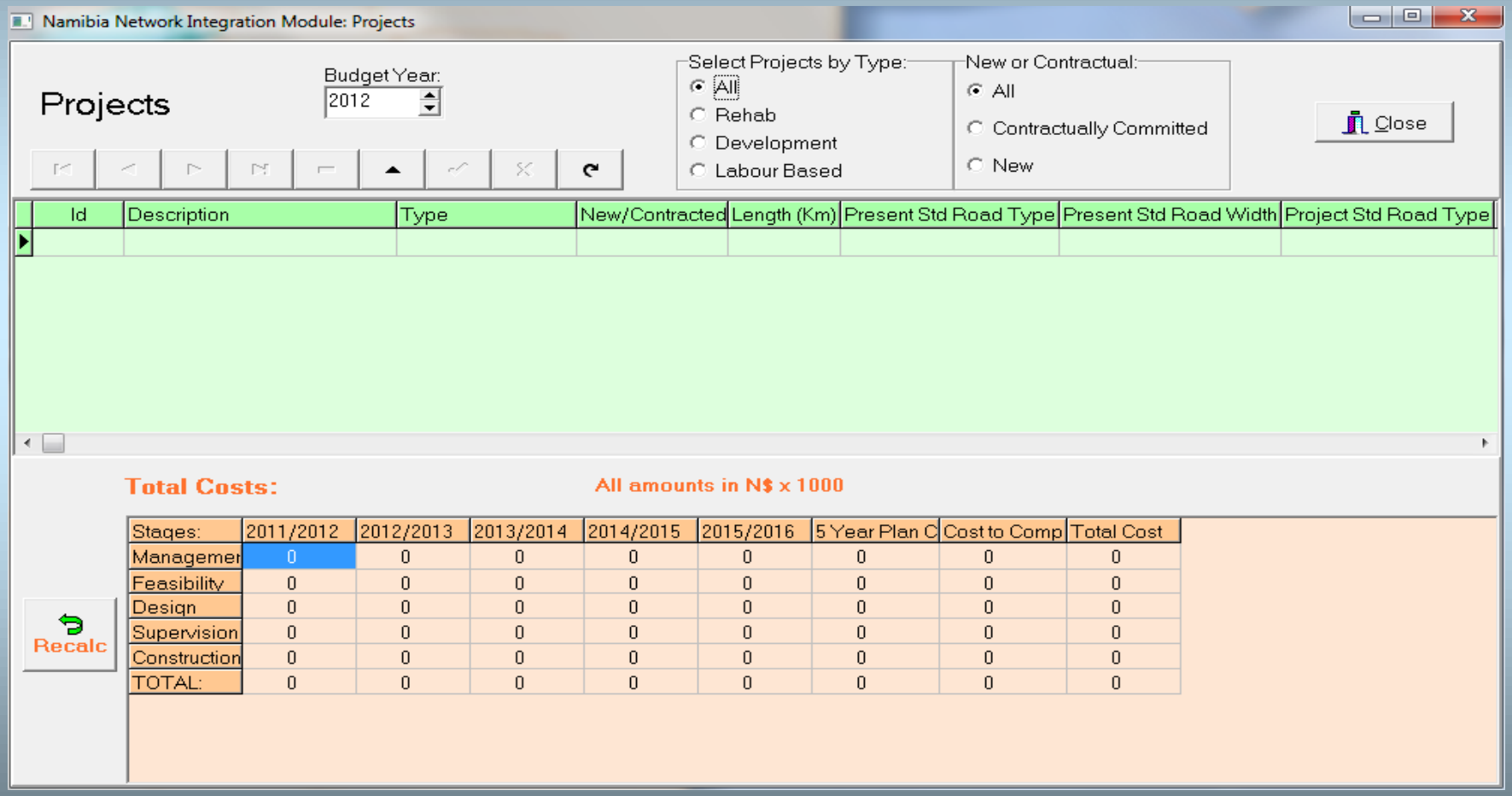
NIM Modules


Inventory module
Quick Access module
Integrated RMS Queries
5y Work Program compilation
Budget Compilation
HDM4 data Preparation
Use HDM4
Annual reports
Asset value
Exit NIM

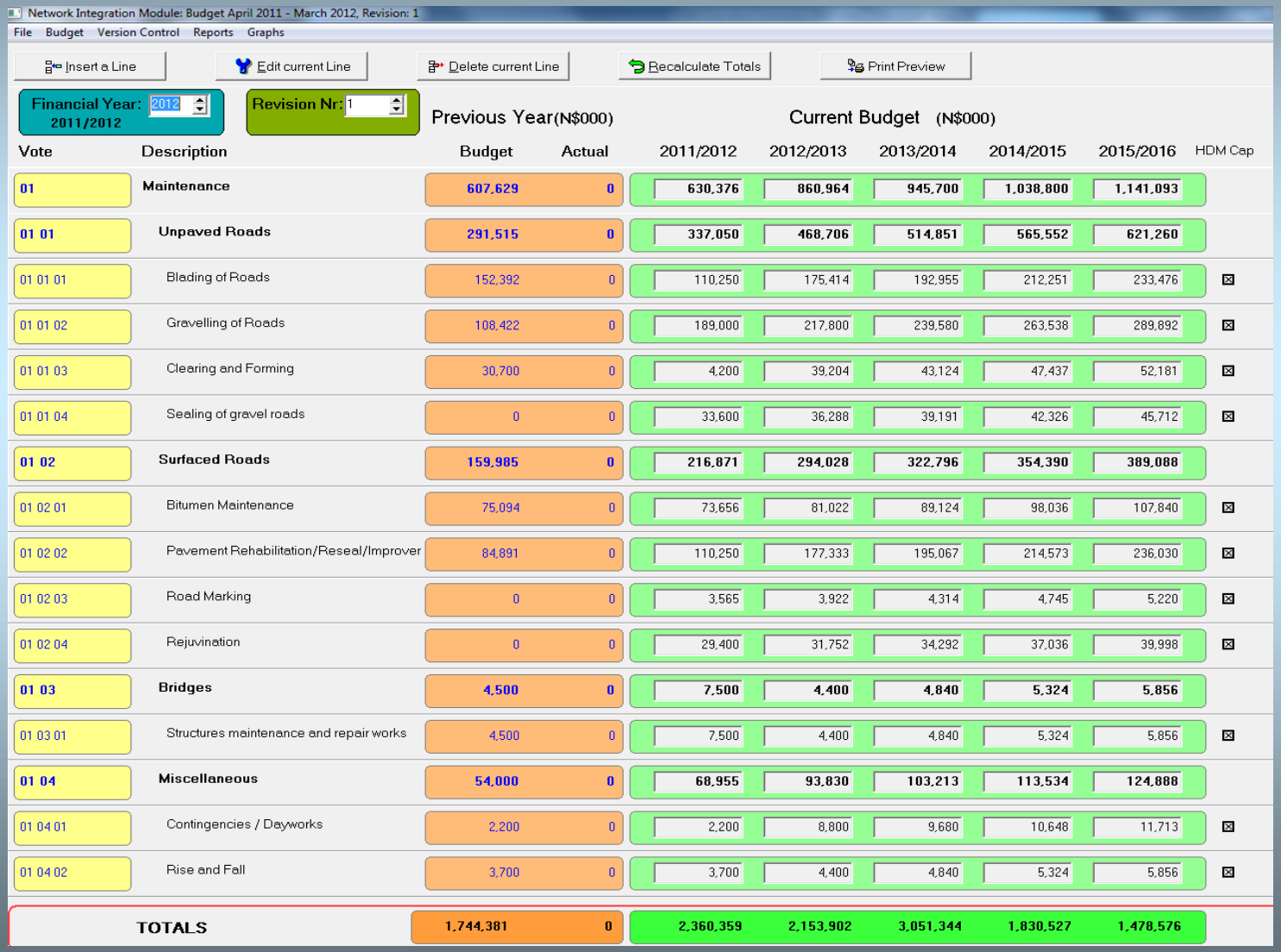
Integrated Queries



Enter/ Display 5-year programs



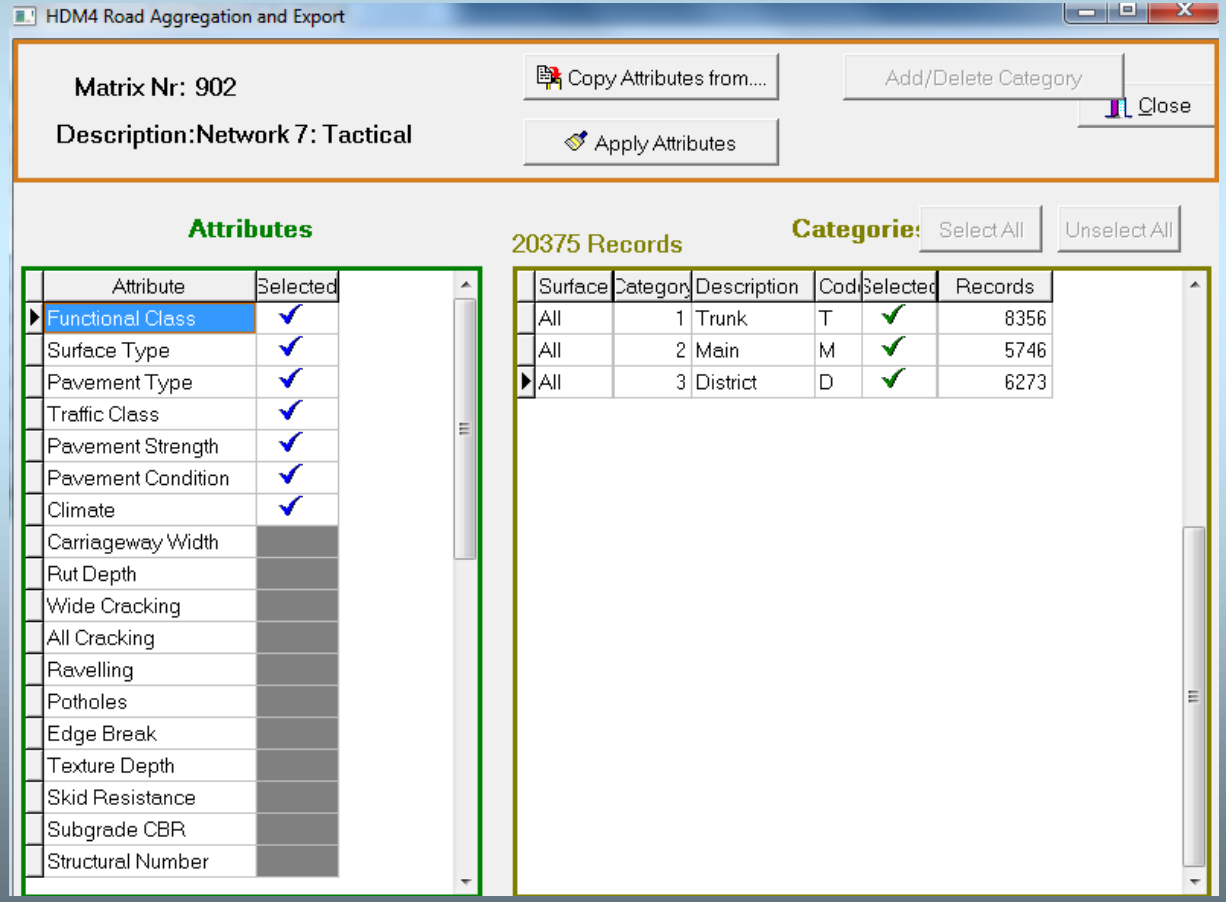
Compile/ Maintain Budgets



Vote	Description	Budget	Actual	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	HDM Cap
01	Maintenance	607,629	0	630,376	860,964	945,700	1,038,800	1,141,093	
01 01	Unpaved Roads	291,515	0	337,050	468,706	514,851	565,552	621,260	
01 01 01	Blading of Roads	152,392	0	110,250	175,414	192,955	212,251	233,476	☒
01 01 02	Gravelling of Roads	108,422	0	189,000	217,800	239,580	263,538	289,892	☒
01 01 03	Clearing and Forming	30,700	0	4,200	39,204	43,124	47,437	52,181	☒
01 01 04	Sealing of gravel roads	0	0	33,600	36,288	39,191	42,326	45,712	☒
01 02	Surfaced Roads	159,985	0	216,871	294,028	322,796	354,390	389,088	
01 02 01	Bitumen Maintenance	75,094	0	73,656	81,022	89,124	98,036	107,840	☒
01 02 02	Pavement Rehabilitation/Reseal/Improver	84,891	0	110,250	177,333	195,067	214,573	236,030	☒
01 02 03	Road Marking	0	0	3,565	3,922	4,314	4,745	5,220	☒
01 02 04	Rejuvination	0	0	29,400	31,752	34,292	37,036	39,998	☒
01 03	Bridges	4,500	0	7,500	4,400	4,840	5,324	5,856	
01 03 01	Structures maintenance and repair works	4,500	0	7,500	4,400	4,840	5,324	5,856	☒
01 04	Miscellaneous	54,000	0	68,955	93,830	103,213	113,534	124,888	
01 04 01	Contingencies / Dayworks	2,200	0	2,200	8,800	9,680	10,648	11,713	☒
01 04 02	Rise and Fall	3,700	0	3,700	4,400	4,840	5,324	5,856	☒
	TOTALS	1,744,381	0	2,360,359	2,153,902	3,051,344	1,830,527	1,478,576	

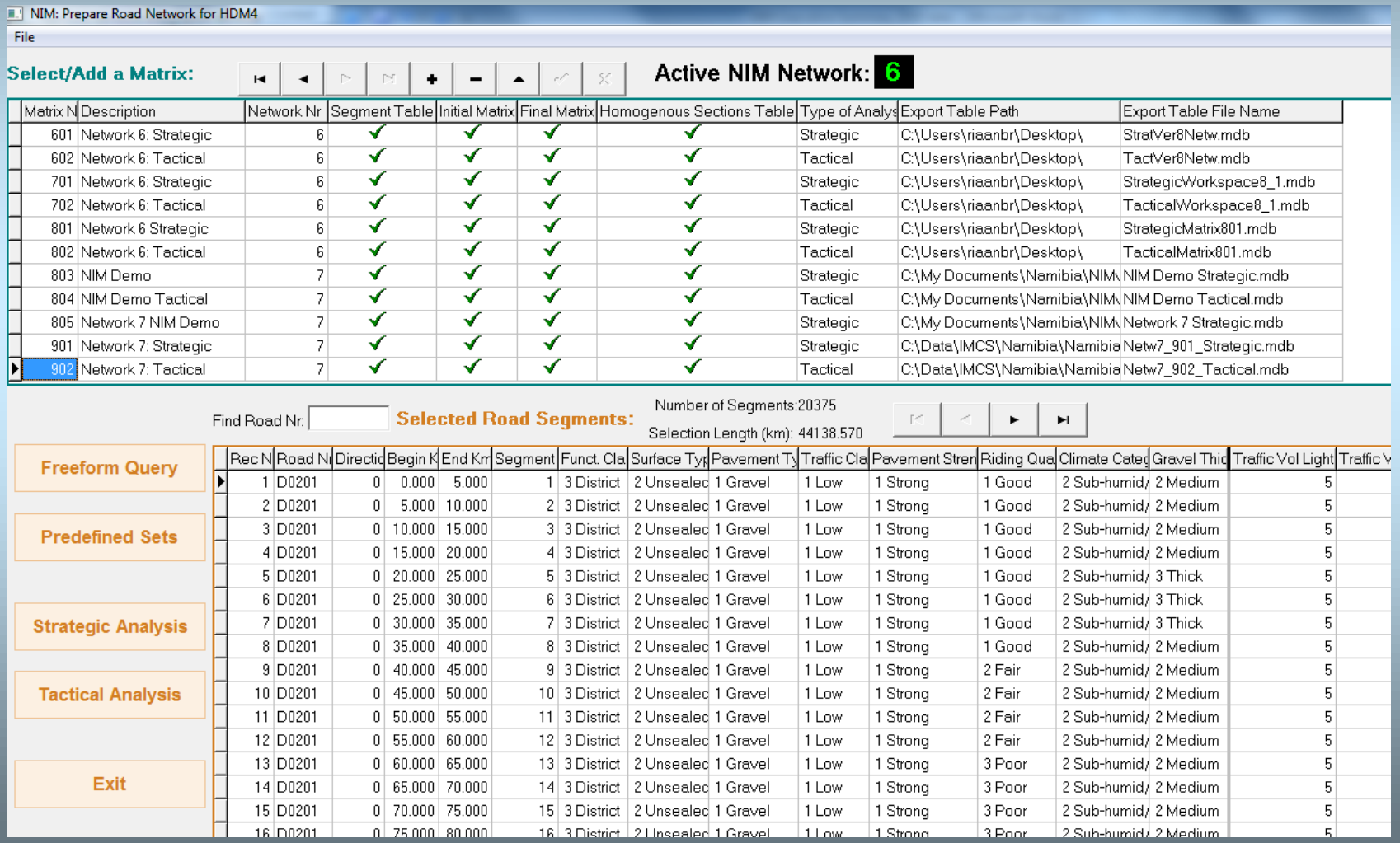
Use HDM

- Data preparation
- Matrix generation



Use HDM

- **Generate real homogeneous sections**

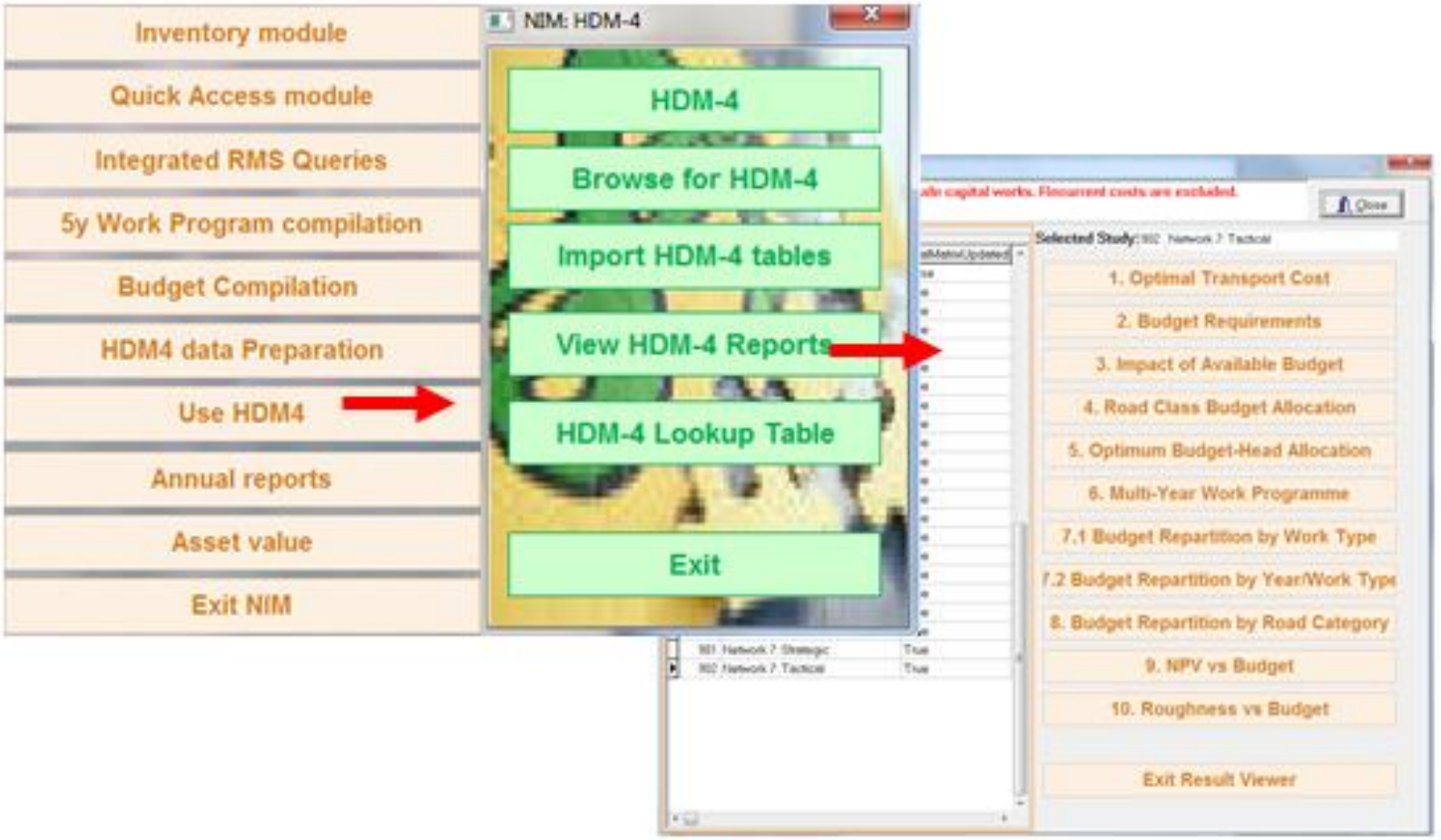


Matrix N	Description	Network Nr	Segment Table	Initial Matrix	Final Matrix	Homogenous Sections Table	Type of Analys	Export Table Path	Export Table File Name
601	Network 6: Strategic	6	✓	✓	✓	✓	Strategic	C:\Users\riaanbr\Desktop\	StratVer8Netw.mdb
602	Network 6: Tactical	6	✓	✓	✓	✓	Tactical	C:\Users\riaanbr\Desktop\	TactVer8Netw.mdb
701	Network 6: Strategic	6	✓	✓	✓	✓	Strategic	C:\Users\riaanbr\Desktop\	StrategicWorkspace8_1.mdb
702	Network 6: Tactical	6	✓	✓	✓	✓	Tactical	C:\Users\riaanbr\Desktop\	TacticalWorkspace8_1.mdb
801	Network 6 Strategic	6	✓	✓	✓	✓	Strategic	C:\Users\riaanbr\Desktop\	StrategicMatrix801.mdb
802	Network 6: Tactical	6	✓	✓	✓	✓	Tactical	C:\Users\riaanbr\Desktop\	TacticalMatrix801.mdb
803	NIM Demo	7	✓	✓	✓	✓	Strategic	C:\My Documents\Namibia\NIM\	NIM Demo Strategic.mdb
804	NIM Demo Tactical	7	✓	✓	✓	✓	Tactical	C:\My Documents\Namibia\NIM\	NIM Demo Tactical.mdb
805	Network 7 NIM Demo	7	✓	✓	✓	✓	Strategic	C:\My Documents\Namibia\NIM\	Network 7 Strategic.mdb
901	Network 7: Strategic	7	✓	✓	✓	✓	Strategic	C:\Data\IMCS\Namibia\Namibia	Netw7_901_Strategic.mdb
902	Network 7: Tactical	7	✓	✓	✓	✓	Tactical	C:\Data\IMCS\Namibia\Namibia	Netw7_902_Tactical.mdb

Rec N	Road N	Directio	Begin K	End Km	Segment	Funct. Cla	Surface Typ	Pavement Ty	Traffic Cla	Pavement Stren	Riding Qua	Climate Categ	Gravel Thic	Traffic Vol Light	Traffic V
1	D0201	0	0.000	5.000	1	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	2 Medium	5	
2	D0201	0	5.000	10.000	2	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	2 Medium	5	
3	D0201	0	10.000	15.000	3	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	2 Medium	5	
4	D0201	0	15.000	20.000	4	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	2 Medium	5	
5	D0201	0	20.000	25.000	5	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	3 Thick	5	
6	D0201	0	25.000	30.000	6	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	3 Thick	5	
7	D0201	0	30.000	35.000	7	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	3 Thick	5	
8	D0201	0	35.000	40.000	8	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	1 Good	2 Sub-humid/	2 Medium	5	
9	D0201	0	40.000	45.000	9	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	2 Fair	2 Sub-humid/	2 Medium	5	
10	D0201	0	45.000	50.000	10	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	2 Fair	2 Sub-humid/	2 Medium	5	
11	D0201	0	50.000	55.000	11	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	2 Fair	2 Sub-humid/	2 Medium	5	
12	D0201	0	55.000	60.000	12	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	2 Fair	2 Sub-humid/	2 Medium	5	
13	D0201	0	60.000	65.000	13	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	3 Poor	2 Sub-humid/	2 Medium	5	
14	D0201	0	65.000	70.000	14	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	3 Poor	2 Sub-humid/	2 Medium	5	
15	D0201	0	70.000	75.000	15	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	3 Poor	2 Sub-humid/	2 Medium	5	
16	D0201	0	75.000	80.000	16	3 District	2 Unsealed	1 Gravel	1 Low	1 Strong	3 Poor	2 Sub-humid/	2 Medium	5	

HDM Results

- **Economic projects**
- **Optimisation based on minimisation TTC**



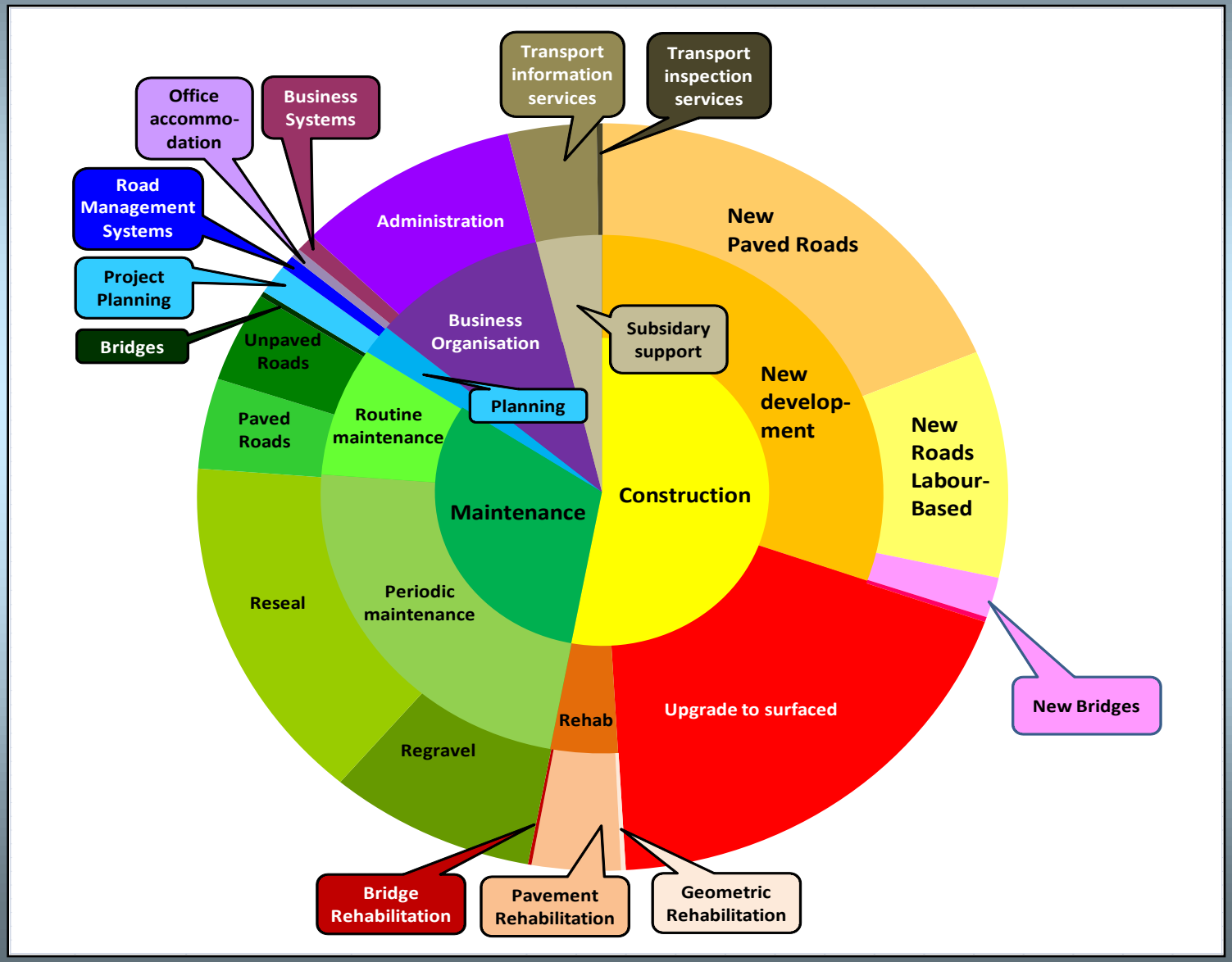
Additional NIM Features

- **Provision to store Annual Reports**
- **Calculation of Asset Value**

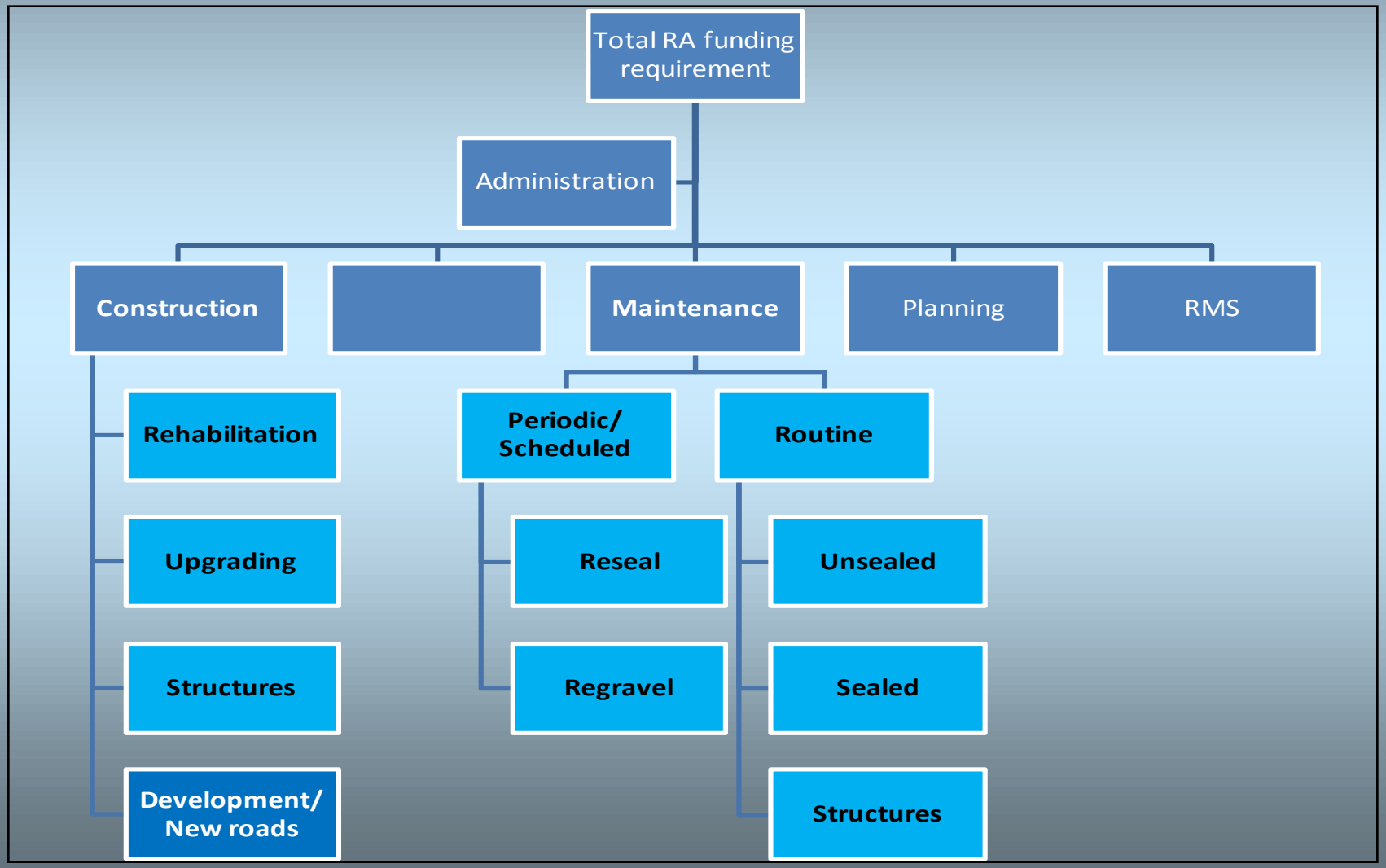
Future NIM Functionality

- **Most important**
  - Combination of Needs
  - Currently done manually

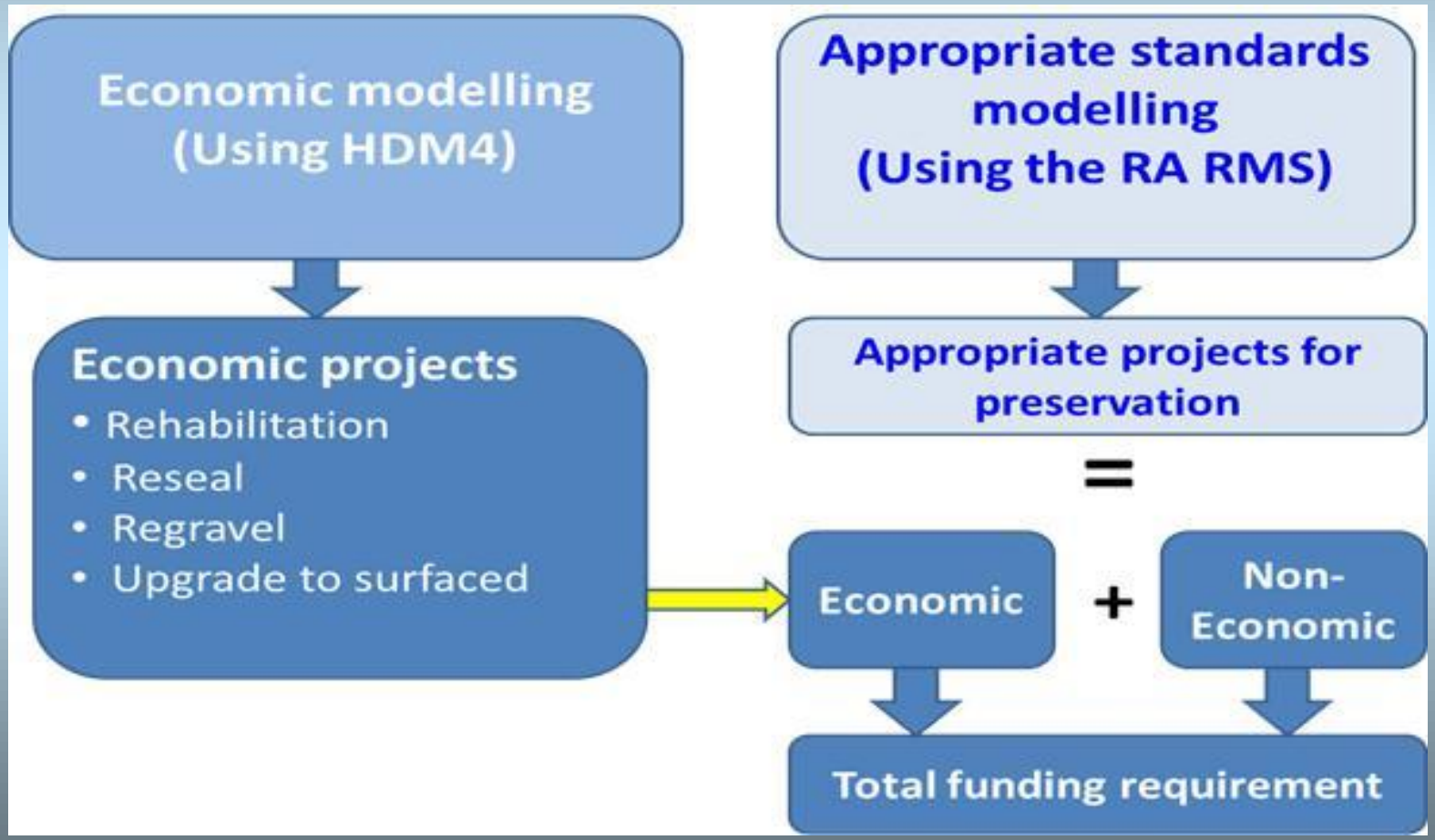
Total Needs on Existing Road Network



Components Modelled



Modelling Strategy



3. RECOMMENDATION AND RESULTS

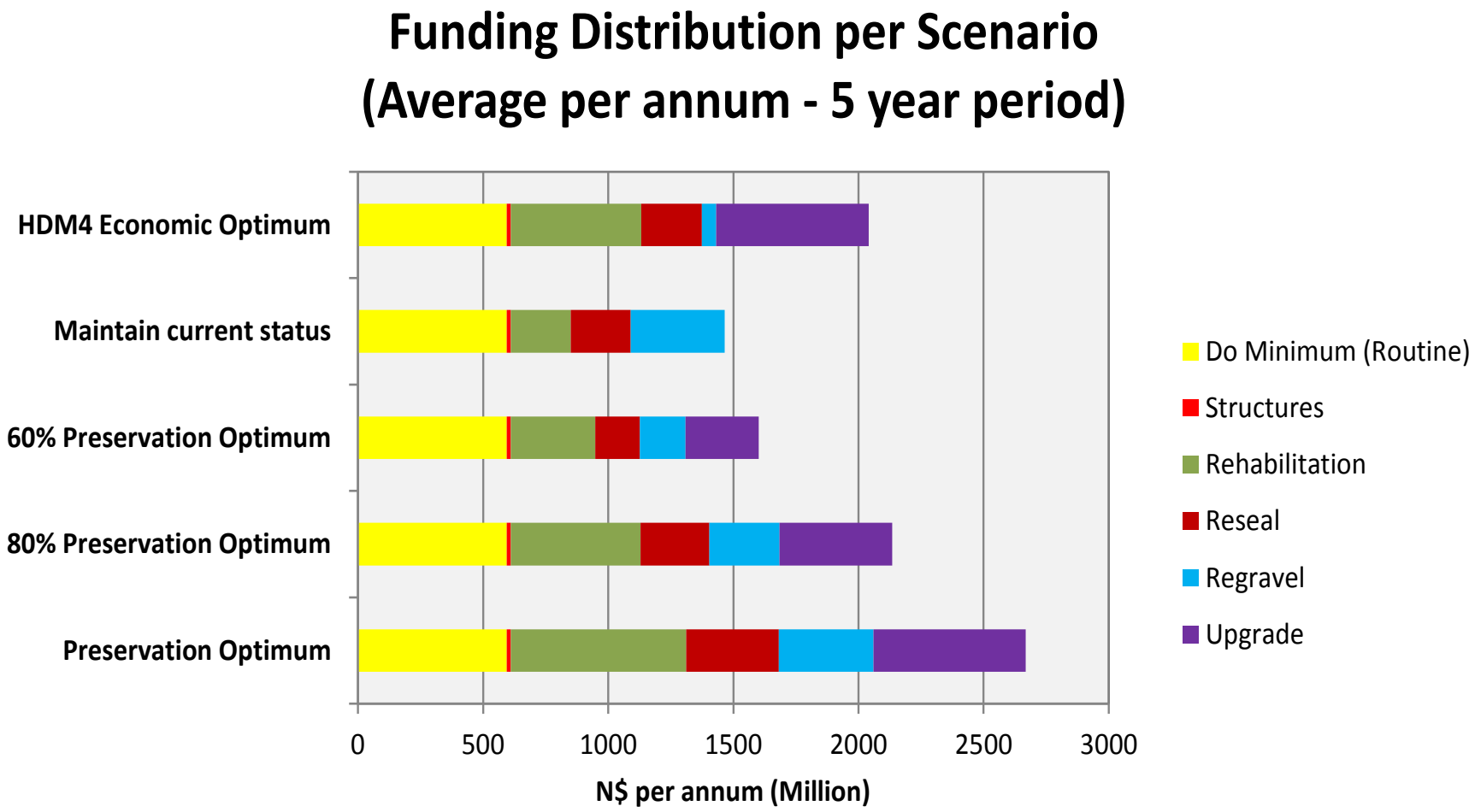
Scenarios

- 1 - Base Option (Do Minimum – Routine)
- 2 – HDM 4 (Economic optimum)
- 3 – Total Preservation optimum
- 4 – 80% of Preservation optimum
- 5 - 60% of Preservation optimum
- 6 – Maintain current status

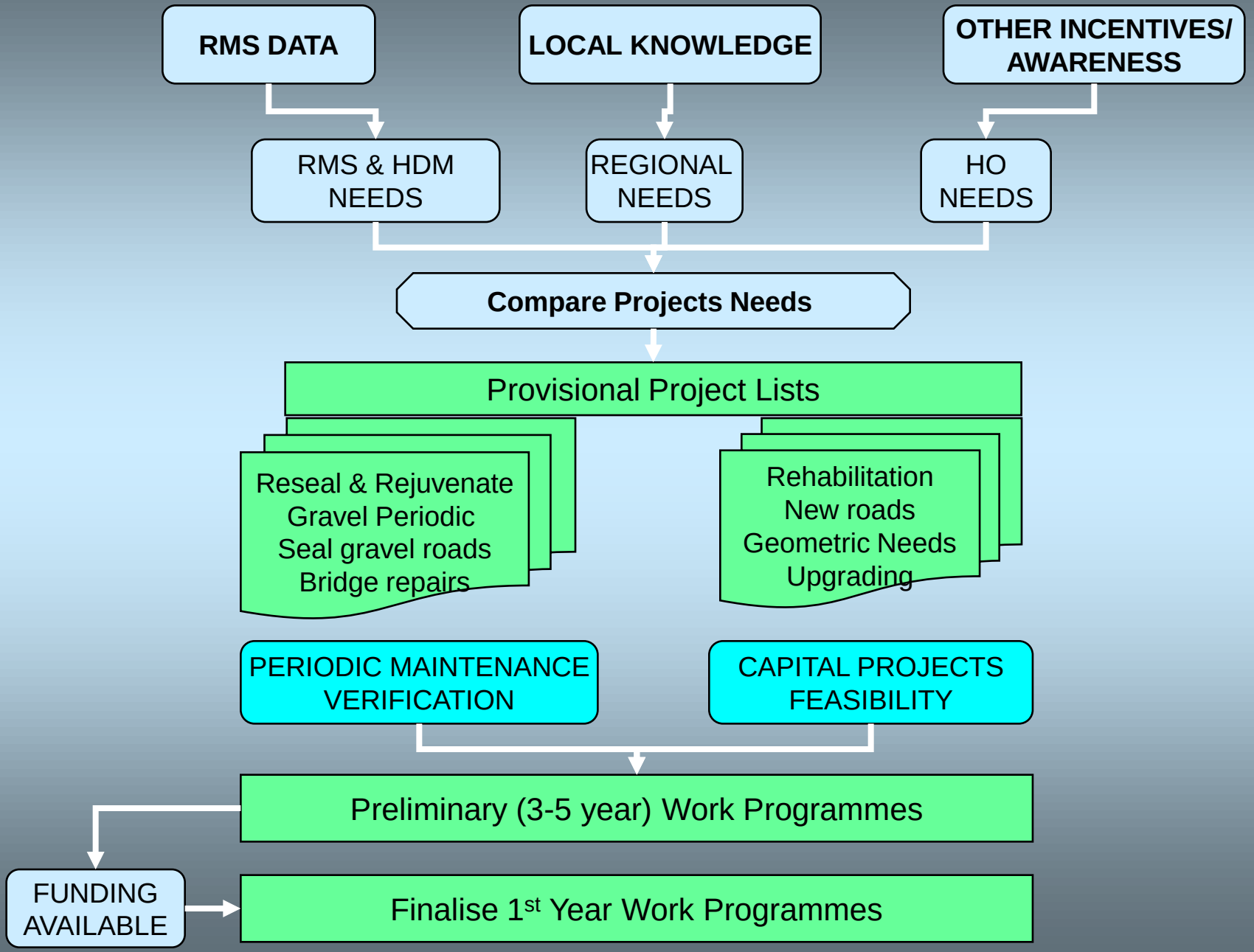
RESULTS

	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 2
Summary	**Optimum Average per annum (Million N$)**	**80% of Optimum Average per annum (Million N$)**	**60% of Optimum Average per annum (Million N$)**	**Maintain current status Average per annum (Million N$)**	**HDM4 Economic Optimum Average per annum (Million N$)**
Capital Works					
Rehabilitation	700	518	337	239	520
Reseal	370	274	178	239	243
Regravel	379	280	182	376	57
Upgrade	609	451	293	0	609
Structures	16	16	16	16	16
Sub-total	**2 073**	**1 540**	**1 006**	**870**	**1 445**
Routine Maintenance					
Sealed	157	157	157	157	157
Unsealed	428	428	428	428	428
Structures	10	10	10	10	10
Sub-total	595	595	595	595	595
Total Need	**2 668**	**2 135**	**1 601**	**1 465**	**2 040**

Results


Funding Distribution per Scenario
(Average per annum - 5 year period)
HDM4 Economic Optimum
Maintain current status
60% Preservation Optimum
80% Preservation Optimum
Preservation Optimum
0
500
1000
1500
2000
2500
3000
N$ per annum (Million)
Do Minimum (Routine)
Structures
Rehabilitation
Reseal
Regravel
Upgrade

TACTICAL PLANNING PROCESS



The End