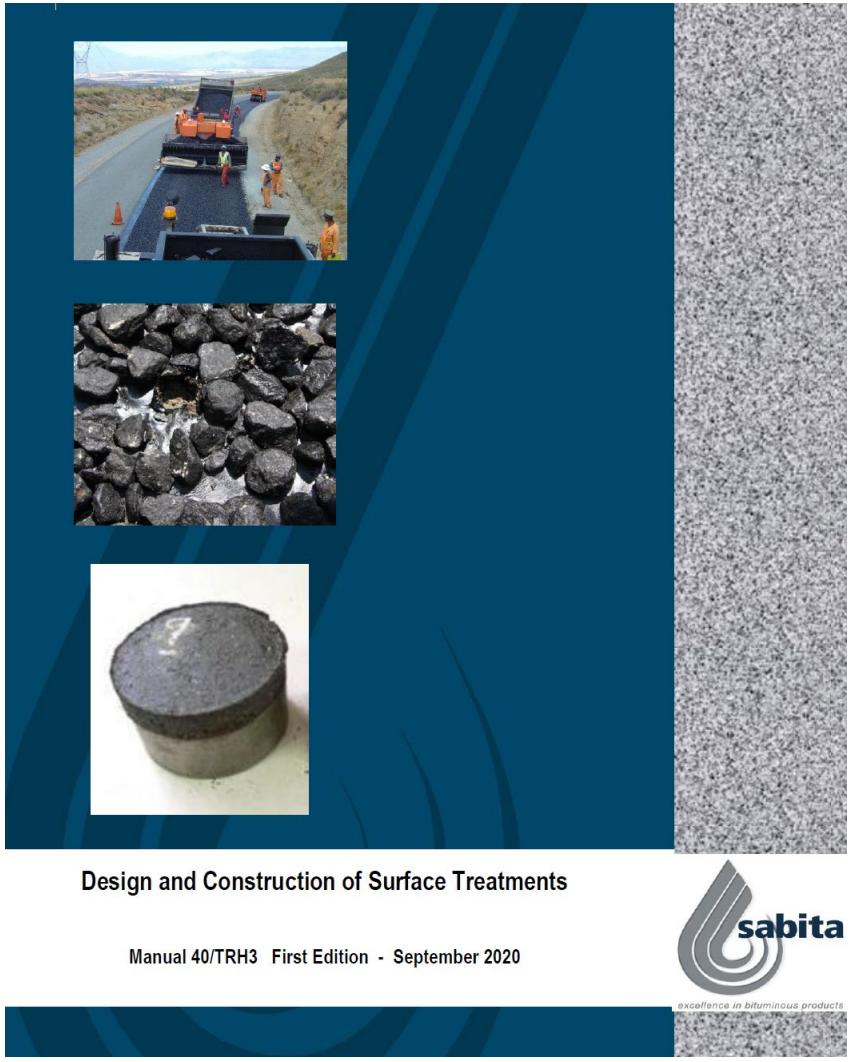
PART D: Seal and binder type selection

Part A	• General
Part B	• Materials
Part C	• Performance
Part D	• Seal type and binder selection
Part E	• Design
Part F	• Construction
Part G	• Quality assurance
Part H	• Repair of premature failures



Part D: Seal and binder type selection

- **Life expectancy & Relative cost of different surface treatments**
- **Selection of initial surface treatments**
- **Selection of reseal types**
- **Specific guidelines for**
  - ❑ Inexperienced contractors
  - ❑ Temporary surfacings
  - ❑ Sealing through winter
  - ❑ Labour enhanced construction
  - ❑ Small airports
  - ❑ Game parks
  - ❑ Forestry roads
  - ❑ Footways, cycle lanes and intersections

Recommended approach

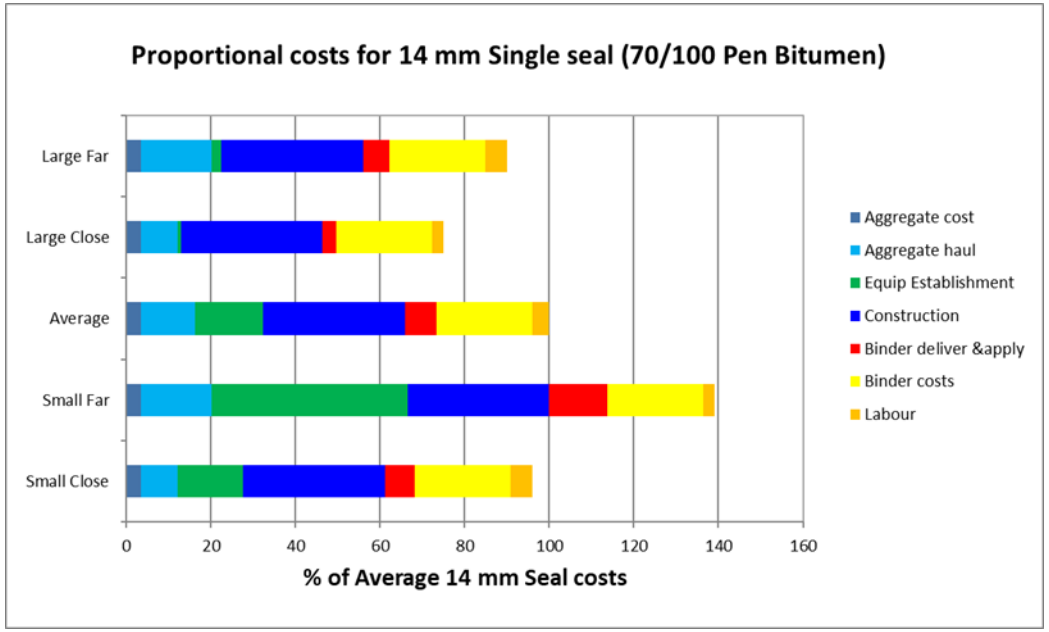
- Obtain all relevant information required for decision making.
- Divide the road into uniform sections of similar existing condition and required characteristics.
- Identify appropriate surfacings for each situation.
- Compare the influence of other factors, e.g. institutional capacity.
- Evaluate life-cycle strategies and compare initial and discounted life-cycle costs.
- Final selection.

Life expectancy

- **Initial seals - Expect 10 year life if:**
  - The pavement structure remains sound
  - A prime coat is applied
  - The seal is well designed and constructed
  - Routine maintenance is carried out where and when required
- **See Appendix F**
  - Understand the background to this data !!!!!
- **Reseal life**
  - Highly dependent on pavement seal and binder, condition, traffic and situation

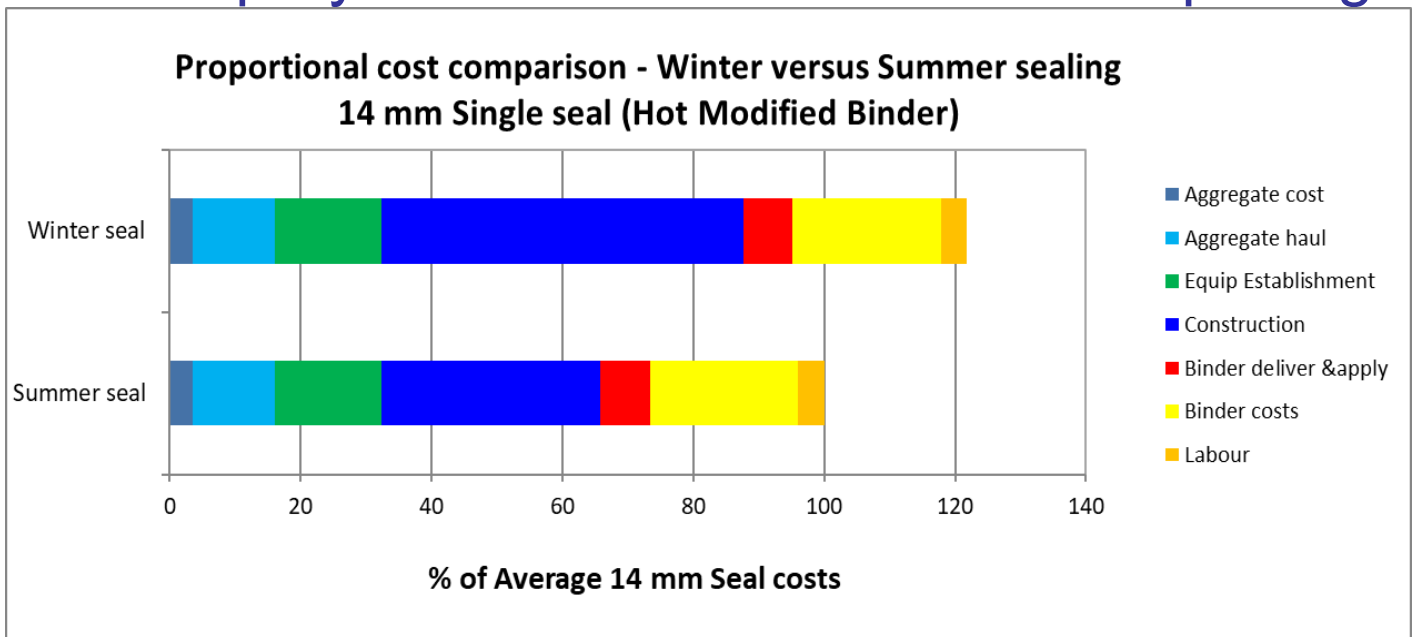
Relative costs

- **Dependent on**
  - Materials;
  - Equipment; and
  - Labour
  - Size and remoteness of project;
  - Haulage of suitable aggregate; and
  - Constraints during construction (e.g. standing time and production rate).
- **Refer Appendix E**
- **Note:**
  - Item tendered for seal could be 50% of the total project cost



Sealing in Winter

- **Waiting for**
  - Road surface temperatures to increase.
  - Emulsion to break before rolling (where emulsion is used as tack coat).
  - Proper adhesion to develop (particularly where S-E1 on precoated stone is used).
  - Cover spray to reduce tackiness before opening to traffic.



Initial seal selection

- **Key aspects**
  - Traffic volume
  - Road geometry
  - Maintenance
  - Surface texture required
  - Experience, equipment and work method
  - Environmental
  - Quality of the base
  - Risk of salt damage
  - Strategy evaluation and final decision

Seal types considered

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Seal Code	Description
S3 (S <10)	Graded aggregate seals - Single application (<10mm)
S3 (S 10+)	Graded aggregate seals - Single application (10mm or more)
S3 (D <10)	Graded aggregate seals - Double application (<10mm per layer)
S3 (D 10+)	Graded aggregate seals - Double application (10+mm per layer or first layer covered with sand seal)
S7 (<10mm)	Thin microsurfacing or Slurry seal
S7 (>10mm)	Thick Microsurfacing or Coarse slurry seal
S1 (7)	Single seal with 7 mm aggregate
S1(10)	Single seal with 10 mm aggregate
S1(14)	Single seal with 14 mm aggregate
S1(20)	Single seal with 20 mm aggregate
S2(10/S)	Double seal with 10 mm aggregate and sand
S2(14/S)	Double seal with 14 mm aggregate and sand
S4(10)	Cape Seal with 10 mm aggregate and one layer of slurry
S4(14)	Cape Seal with 14 mm aggregate and one layer of slurry
S4(20)	Cape Seal with 20 mm aggregate and two layers of slurry
S2(14/7)	Double seal with 14 mm aggregate and a layer of 7 mm aggregate
S2(14/5)	Double seal with 14 mm aggregate and a layer of 5 mm aggregate
S2(20/10)	Double seal with 20 mm aggregate and a layer of 10 mm aggregate
S2(20/7)	Double seal with 20 mm aggregate and a layer of 7 mm aggregate
S2(20/7/7)	Double seal with 20 mm aggregate and two layers of 7 mm aggregate
S8(14)	Slurry-bound Macadam seal with 14 mm aggregate
S8(20)	Slurry-bound Macadam seal with 20 mm aggregate
AC	Asphalt layer with suitable grading and thickness

Seal selection spreadsheet

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- **Enter situation - Selects appropriate seal type**
- **NB: Incorporates Manual 10 recommendations for Low Volume Sealed Roads**
  - ❑ Traffic volume
  - ❑ Gradient
  - ❑ Turning actions
  - ❑ Institutional capacity (Maintenance capability)
  - ❑ Contractor's experience & work method e.g. labour enhanced
  - ❑ Macro texture required

Selected situation		SUITABILITY OF SURFACING TYPES FOR INITIAL SURFACING																						
		S3(S<10)	S3(S10+)	S3(D<10)	S3(D10+)	S7(<10)	S7(>10)	S1(7)	S1(10)	S1(14)	S1(20)	S2(10/S)	S2(14/S)	S2(14/5)	S2(14/7)	S4(10)	S4(14)	S4(20)	S2(20/7)	S2(20/7/7)	S2(20/10)	S8(14)	S8(20)	AC
Traffic Volume (elv)	5000 - 10000	x	x	x	x	x	x	x	x	x	x	x	a	a	Y	x	Y	Y	Y	b	Y	Y	Y	Y
Gradient	6 - 8 %	x	c,d,f,h	c,d,f,h	c,d,f,h	c,f	c,f	d,e,f	d,e,f	d,e,f	d,e,f	e,f	c,e,f	e,f	e,f	f	f	f	e,f	e,f	e,f	Y	Y	Y
Turning actions	Rural with occasional heavy vehicles	x	Y	Y	Y	x	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Maintenance capability	Medium	x	i	Y	Y	x	Y	x	k	k	j,k	j	j	Y	Y	Y	Y	Y	Y	j	j	Y	Y	Y
Experience & work method	Small or emerging contractor	x n	x n	Y	Y	x n	x n	x n	x n	x n	x	Y	Y	Y	o	Y	Y	Y	Y	x	x	q	q	p
Macro texture required	1,0 - 1,5	x	x	x	x	s	Y	Y	Y	Y	Y	Y	Y	Y	Y	t	t	t	Y	Y	Y	t	t	u

Traffic volume

- **Note AADT in both directions**
- **ELV = L + 40H**
  - L = Number of light vehicles/lane/day
  - H = Number of heavy vehicles/lane/day

(ELV/lane/day)
< 750
750 - 2000
2000 - 5000
5000 - 10000
10000 - 20000
20000 - 40000
> 40000

Turning actions

Rural with occasional heavy vehicles turning	Infrequent farm accesses
Residential - developed	Mainly delivery vehicles, garbage trucks etc.
Residential - developing	High proportion of building material delivery trucks and risk of spillage
Urban with occasional heavy vehicles turning	Typical close to small shopping centers
Urban/Rural with many heavy vehicles turning	Industrial areas. Large/heavily loaded turning vehicles e.g. mine haulage vehicles

Gradient

< 6 %
6 - 8 %
8 - 12 %
12 - 16 %
> 16 %

Maintenance capability

High (Can perform any type of maintenance whenever needed)
Medium (Routine maintenance, patching and crack sealing on regular basis, but no formal maintenance management system)
Low (Patching done irregularly, no committed team, no inspection system)
None

Surface texture required

<0,7
0,7 - 1,0
1,0 - 1,5
1,5 - 2,0
>2,0

- **> 100km/h >1.0 mm**
- **60km/h preferably 0.7 mm**

Experience, equipment, work method

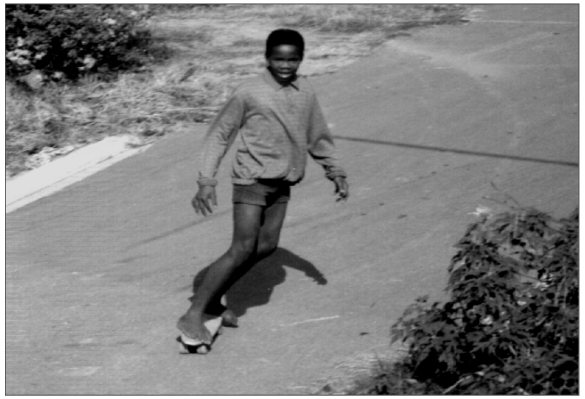
Experienced contractor
Small or emerging contractor
Labour enhanced: Only aggregate by hand/ light equipment
Labour enhanced: Binder and aggregate by hand/light equipment

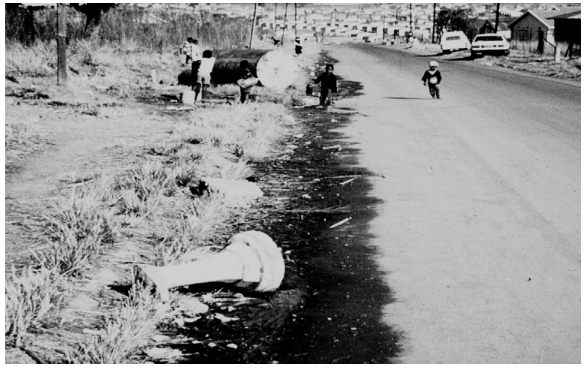
Additional considerations

- **Cold micro climates (Shade, bridges etc)**
  - Stone orientation problem
  - Additional cover spray, small aggregate blinding, cape seal
- **High humidity**
  - Curing of emulsions
  - Microsurfacing allow chemical/ rapid breaking
- **Quality of the base**
- **Risk of salt damage**
  - Minimise risk of salt migration
  - Seal immediately with low permeability seal

Additional considerations

- **Social environment**
  - ❑ Playground
  - ❑ Population stress
    - Detergents
    - Developing areas (Building materials)
    - Poor maintenance
    - Barricades



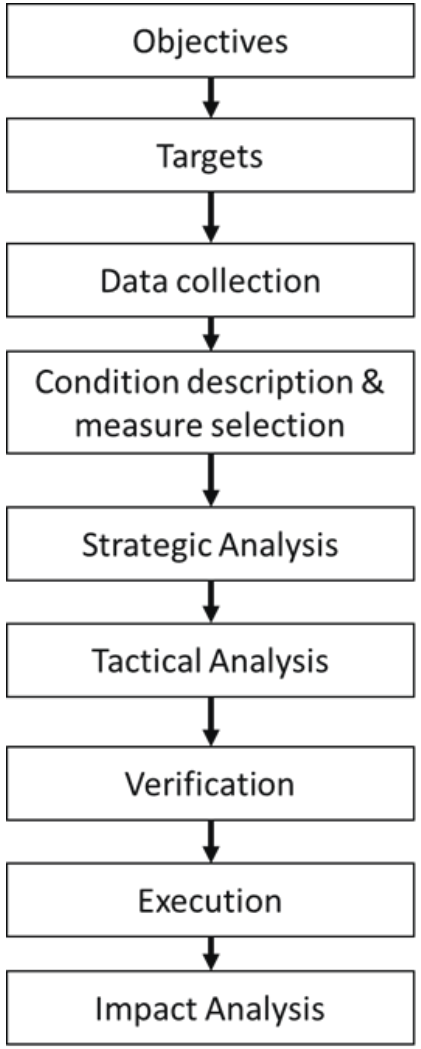


Exersize

- **See spreadsheet**
- **Situation 1**
  - ELV = 500, rural (occasional turning actions), <6% grade, high speed, good contractor
  - High maintenance capability versus low maintenance capability
- **Situation 2**
  - ELV = 1000, urban developing, 7% grade, 60km/h, full labour based
  - Medium maintenance capability versus no maintenance capability
- **Situation 3**
  - ELV = 15000, rural (occasional turning actions), 7% grade, high speed, emerging contractor
  - High maintenance capability versus low maintenance capability

Reseal

- **Asset management principles**

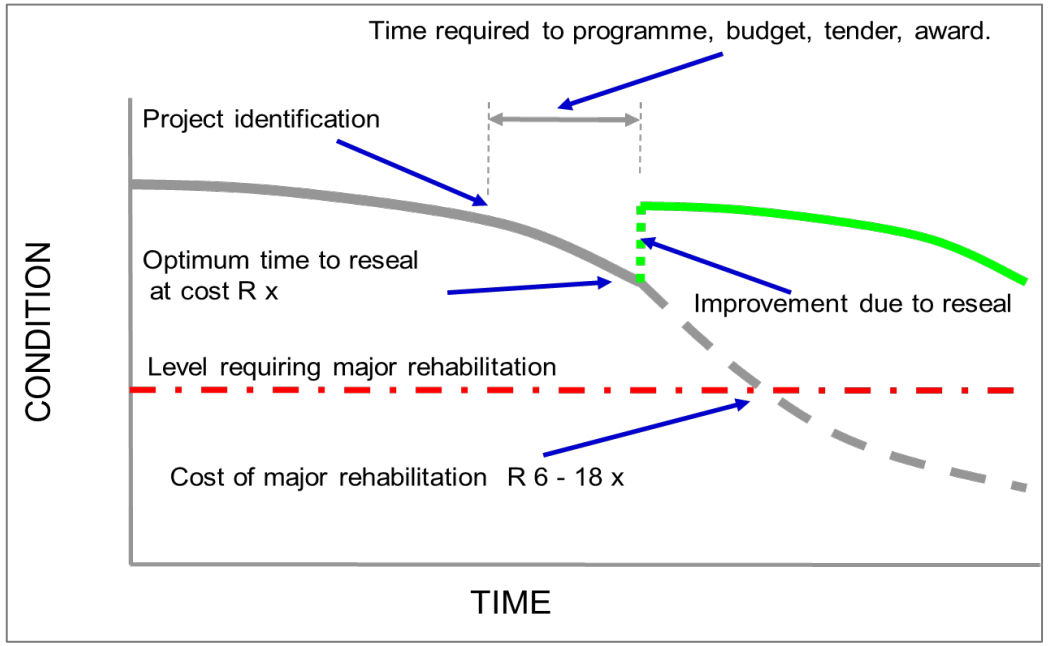


When to reseal

Basic functions of a surfacing	Surfacing distress	Cause of distress	Visually assessable distress
To prevent ingress of water	Porous surfacing	Dry binder Too little binder	Dry binder
			Voids
			Stone loss
			Poor surface drainage
	Surfacing cracks	Dry binder Premature cracking	Surfacing cracks
			Dry binder
	Structural cracks	Various mechanisms	Structural cracks
			Pumping
To protect base from traffic wear	Loss of stone/ravelling	Surfacing cracks	Surfacing failures
			Surfacing cracks
	Potholes	Dry binder Structural cracks	Dry binder
			Structural cracks
To provide skid resistance	Smooth surface texture	Flushing/bleeding Embedment	Flushing/bleeding
			Smooth surfacing texture
	Polishing	Tyre abrasion/poor stone	Polishing
	Rutting	Densification of base or pavement failures due to water ingress	Rutting

Timing

- **Timing of identification, resurfacing and effect of deferment**



Preferred reseal types

- **Small aggregate (5mm or 7mm) or Grit seals**
  - Cut-back binder or emulsions
- **Single seals (Mainly 14mm or 10mm)**
  - 70/100, cationic spray grade, S-E1, SC-E1, SC-E2, S-R1 or S-R2
- **Double seals (Mainly on high trafficked roads)**
  - 20/7, 20/7/7, 20/10
  - S-E1 + cover spray or combination S-R1/S-R2 + S-E1 + cover spray
- **Use of slurry and Microsurfacing**
  - Mainly texture treatment
  - Shape correction (rutting, corrugations)
  - Overlay (seldom)

Surface enrichment/ rejuvenation

- Old seals/ porous/ dry – brittle, too little binder
- Current rejuvenators (invert cutback emulsion) only on very low volume roads
- Higher volume – anionic emulsions or tested proprietary product

Choice of reseal

- **Rutting**
- **Existing macro texture**
- **Aggregate loss**
- **Pavement condition (cracking and pumping)**
- **Functional requirements**
  - Noise levels (Small aggregate in top layer)
  - Low risk of windscreen damage
  - Roughness (only short wave length improvement)

Practical

- Typical distress
- Discussion on appropriate actions

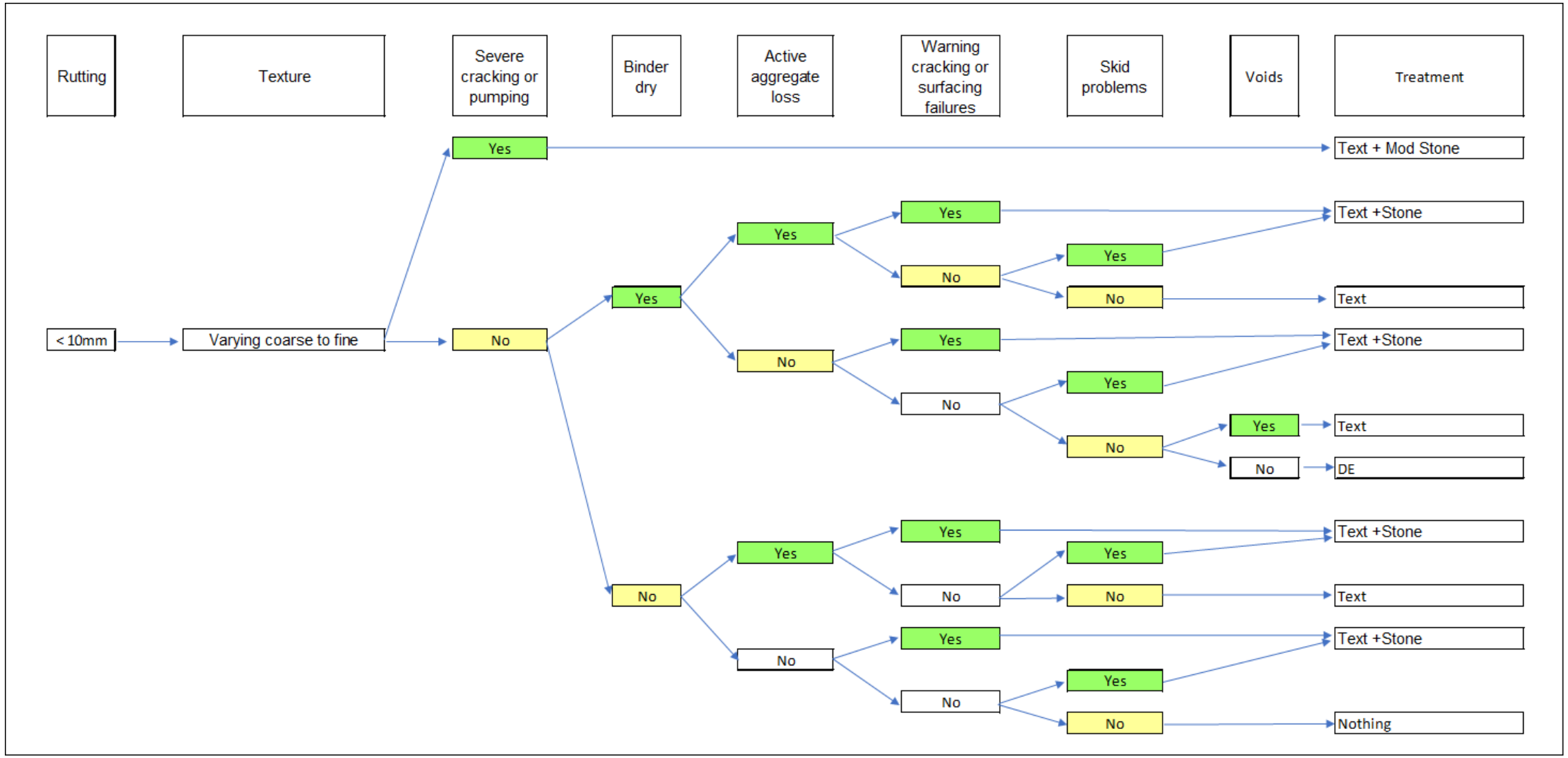
1 st level selection

Category	Description
Nothing	Nothing required
DE	Diluted emulsion or rejuvenator
TEXT	Texture treatment
STONE	Single or double seal with conventional binder
MOD STONE	Single or double seal with modified binder
TEXT + STONE	Texture treatment plus Single or double seal with conventional binder
TEXT + MOD STONE	Texture treatment plus Single or double seal with modified binder
DE + TEXT + STONE	Texture treatment plus Single or double seal with conventional binder
DE + TEXT + MOD STONE	Texture treatment plus Single or double seal with modified binder

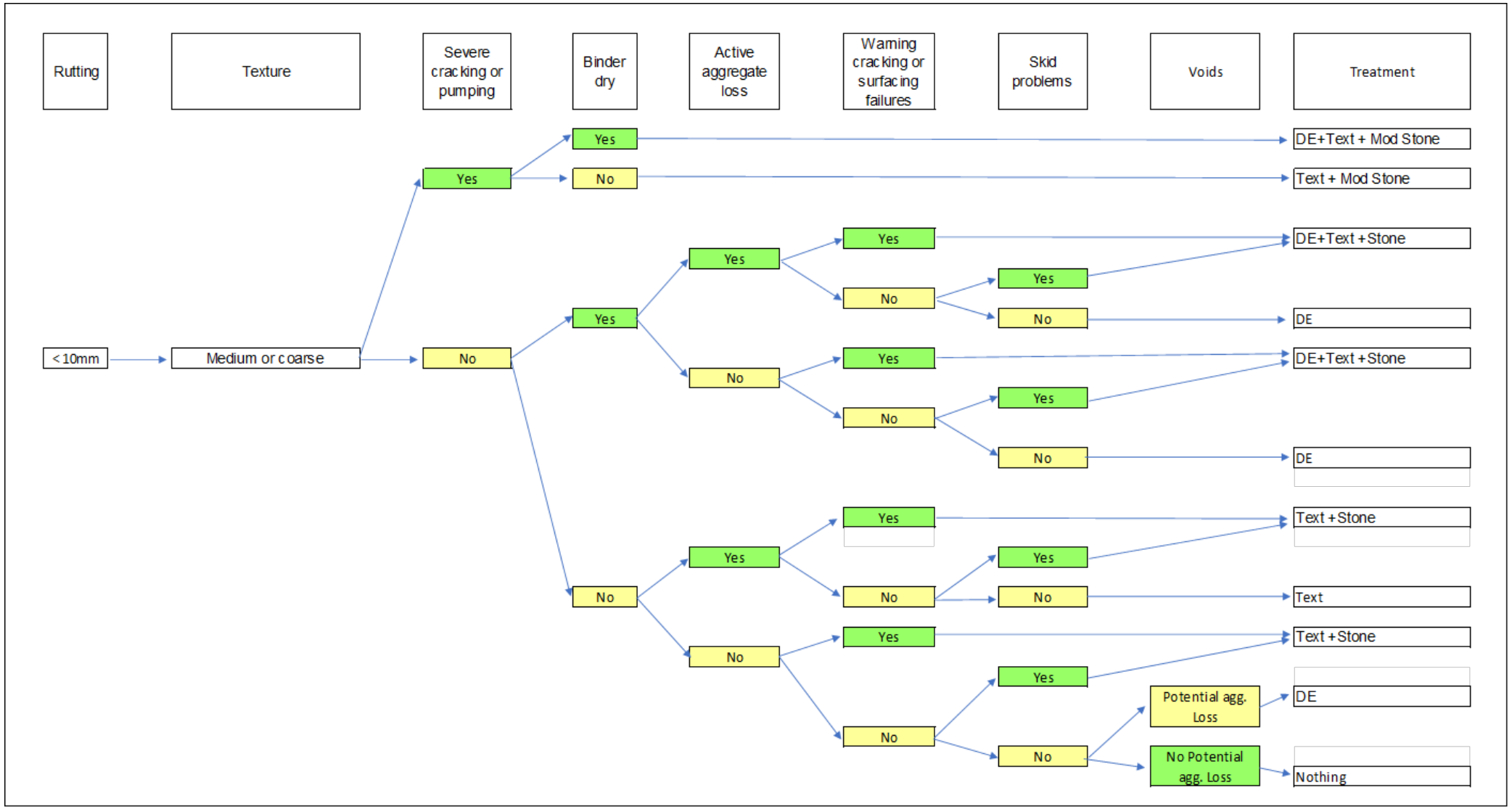
Decision trees

Rutting	Texture	Reference
	Varying coarse to fine	Figure D 29
< 10mm	Medium or coarse	Figure D 30
	Medium-Fine to Fine	Figure D 31
> 10mm		Figure D 32

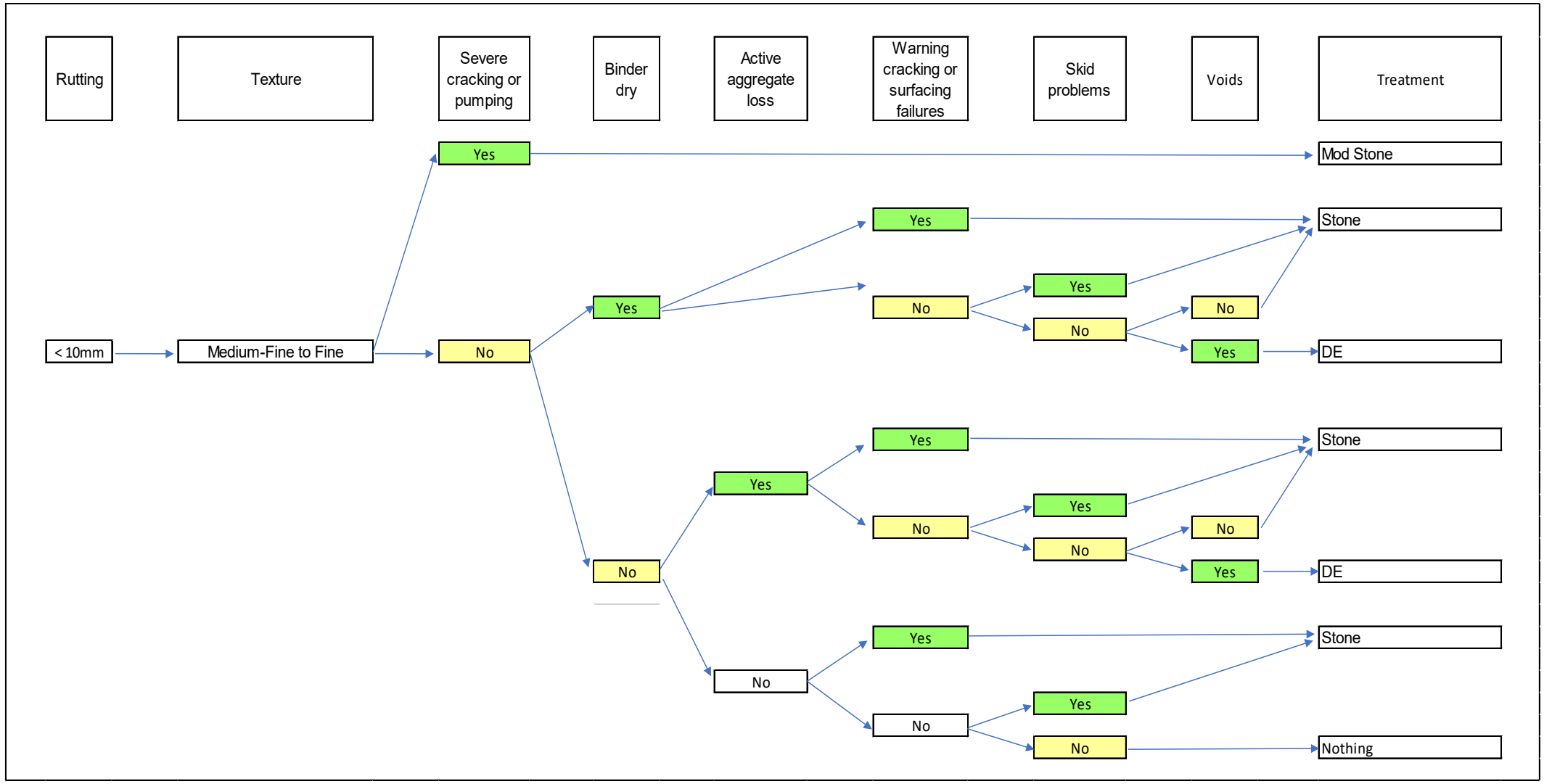
Decision trees



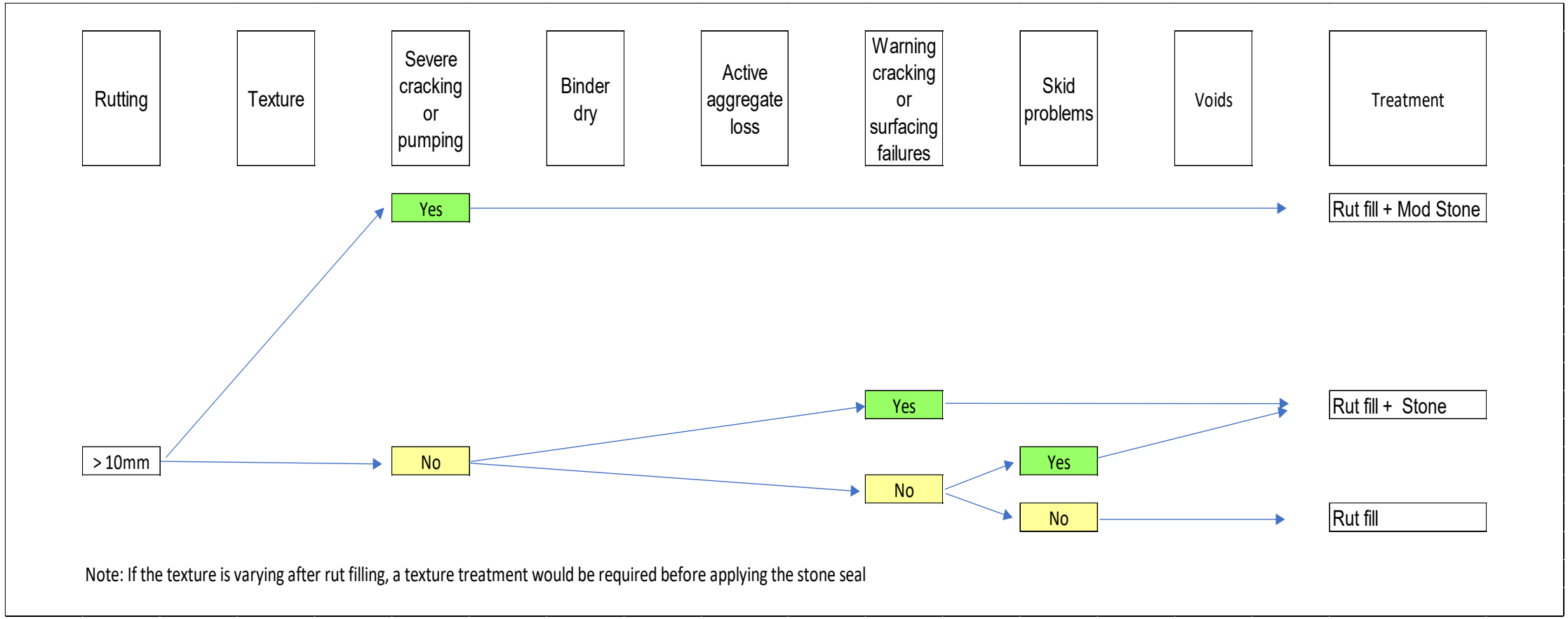
Decision trees



Decision trees



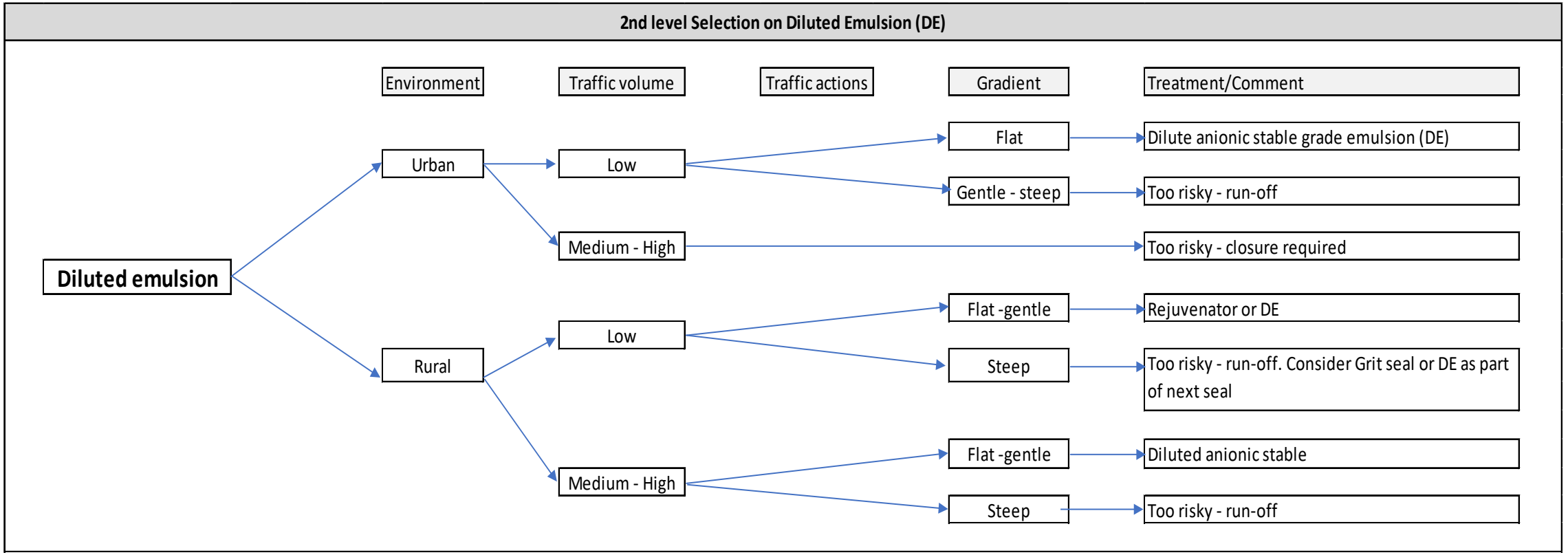
Decision trees



Note: If the texture is varying after rut filling, a texture treatment would be required before applying the stone seal

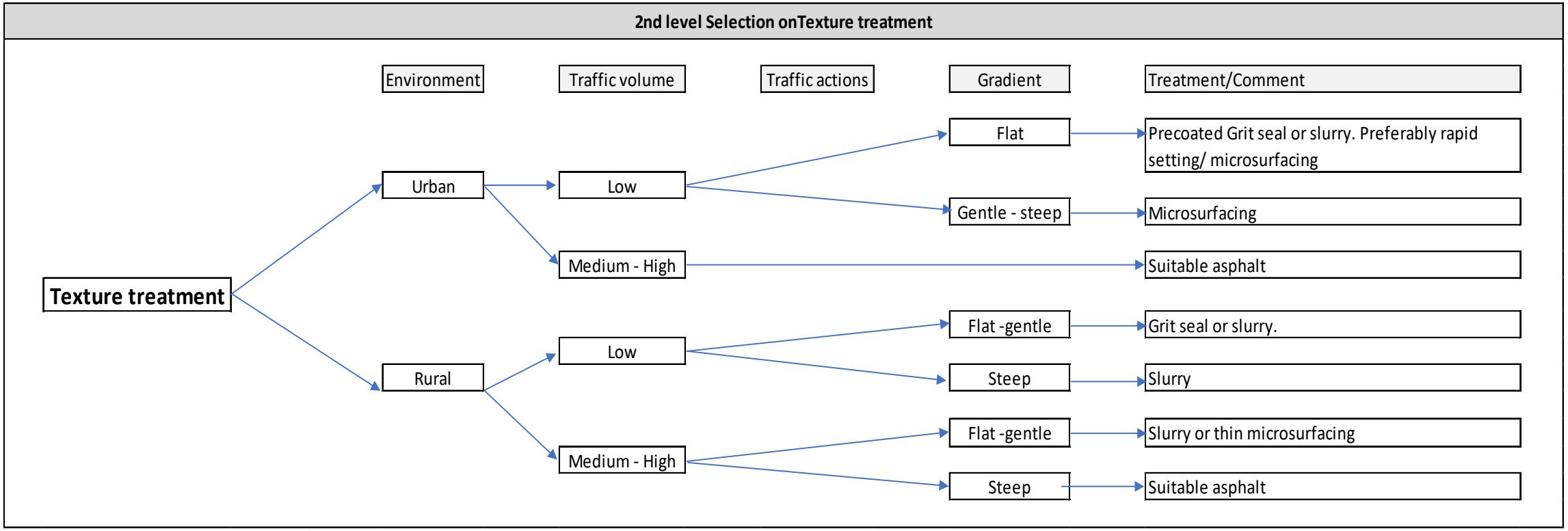
2nd level decision

- **DE**



2nd level decision

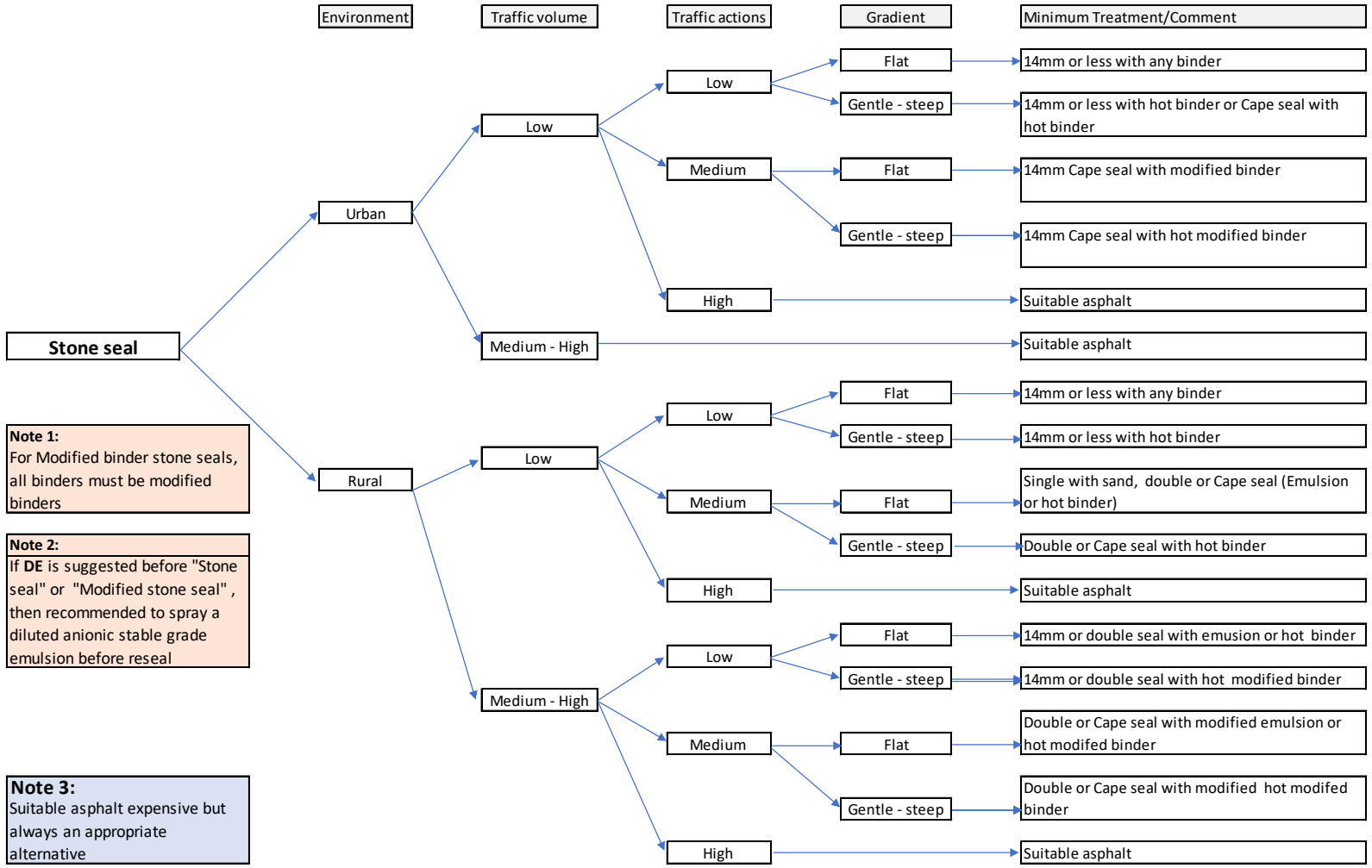
- TEXT



2nd level decision

- **STONE**

2nd level Selection on Stone seal (Including Modified binder stone seals and DE treatment before reseal)



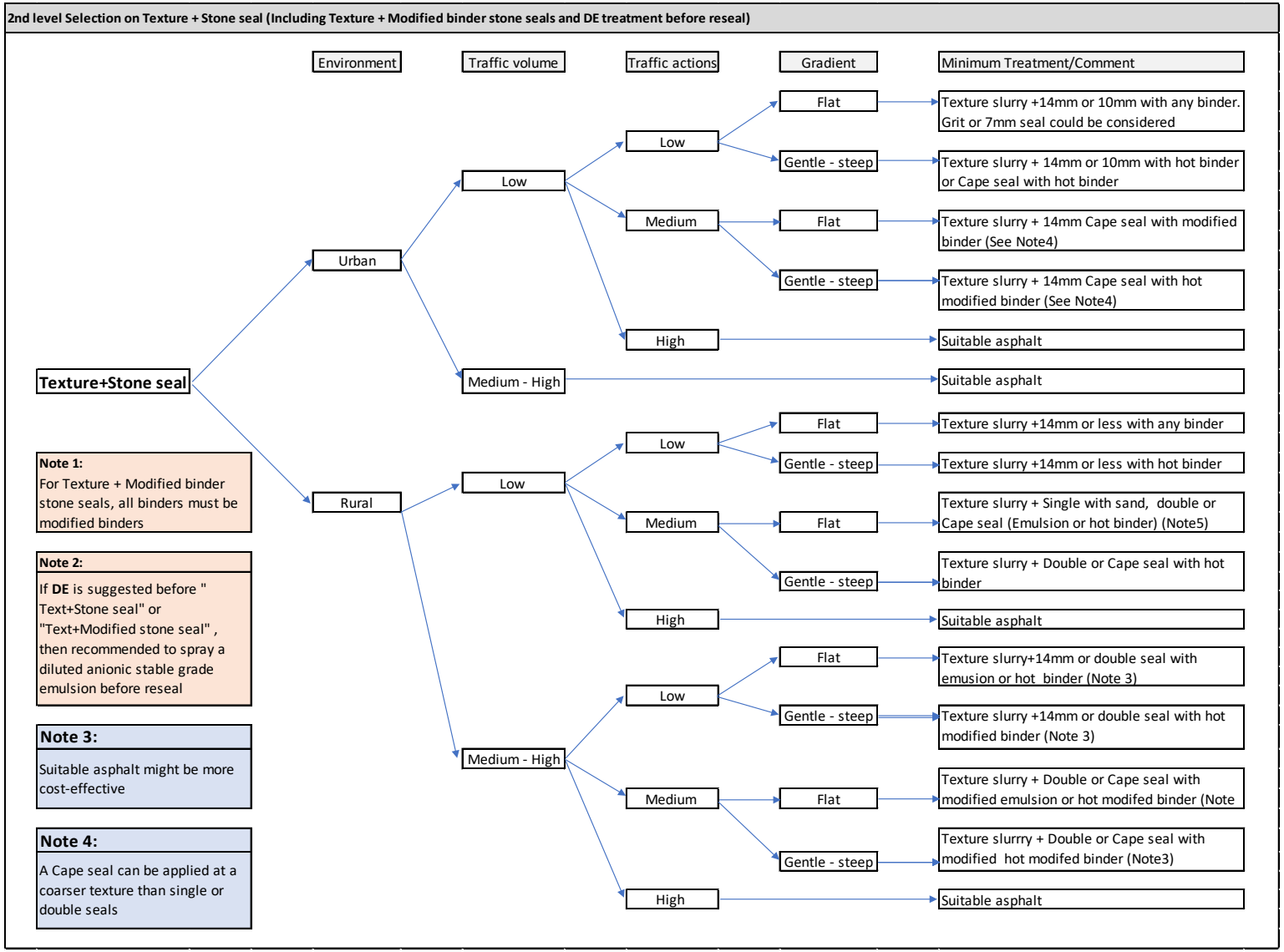
Note 1:
For Modified binder stone seals, all binders must be modified binders

Note 2:
If **DE** is suggested before "Stone seal" or "Modified stone seal", then recommended to spray a diluted anionic stable grade emulsion before reseal

Note 3:
Suitable asphalt expensive but always an appropriate alternative

2nd level decision

- **TEXT+STONE**



Inexperienced contractors

Risk category	Seal/ treatment type	Binders
Low	Rejuvenation	Anionic stable grade emulsions or Invert cutback emulsion
	Slurry Texture by hand	Anionic stable grade emulsions
	Sand, grit or graded aggregate seals	Cationic spray grade emulsion or MC3000[1]
	Single seals with cover sprays and grit blinding	Cationic spray grade emulsion
Medium	Single seals with cover sprays	Conventional binders
	Cape seals	Any binder except MC3000 or bitumen rubber
	Double seals (Stone & 1/3 configuration)	Hot homogeneous polymer modified binder
	Precoated single and double seals with additional cover spray	Conventional binders
High	Precoated single and double seals, even with cover sprays	Hot homogeneous polymer modified binder
Very high	Precoated single and double seal	Bitumen rubber
	S2 20/10 double seal	Any binder combination

Note:

[1] If MC3000 is used, it is recommended that the product is applied by an experienced supplier and not by the inexperienced contractor.

Temporary surfacings

Duration of temporary deviation (months)	Traffic Volume		
	500 vpd	2 500 vpd	10 000 vpd
1	Gravel or S3*	S2(10/S) or S4(10)	S2(14/S) or S4(10)
2	Gravel or S3*	S2(10/S) or S4(10)	S2(14/S) or S4(10)
3 - 6	S2(10/S)	S2(10/S) or S4(10)	S2(14/5) or S4(14)
6 - 12	S2(10/S)	S2(14/S) or S4(10)	S2(20/7) or S4(20)
12 - 24	S4(10)	S2(14/5) or S4(14)	Asphalt
> 24	S4(10)	S2(20/7) or S4(20)	Asphalt

***Note** **

If the seal is only required for a temporary deviation which will be removed after opening of the road, then sand seals and graded aggregate seals constructed with soft binders (e.g. MC3000) are appropriate.

Winter sealing

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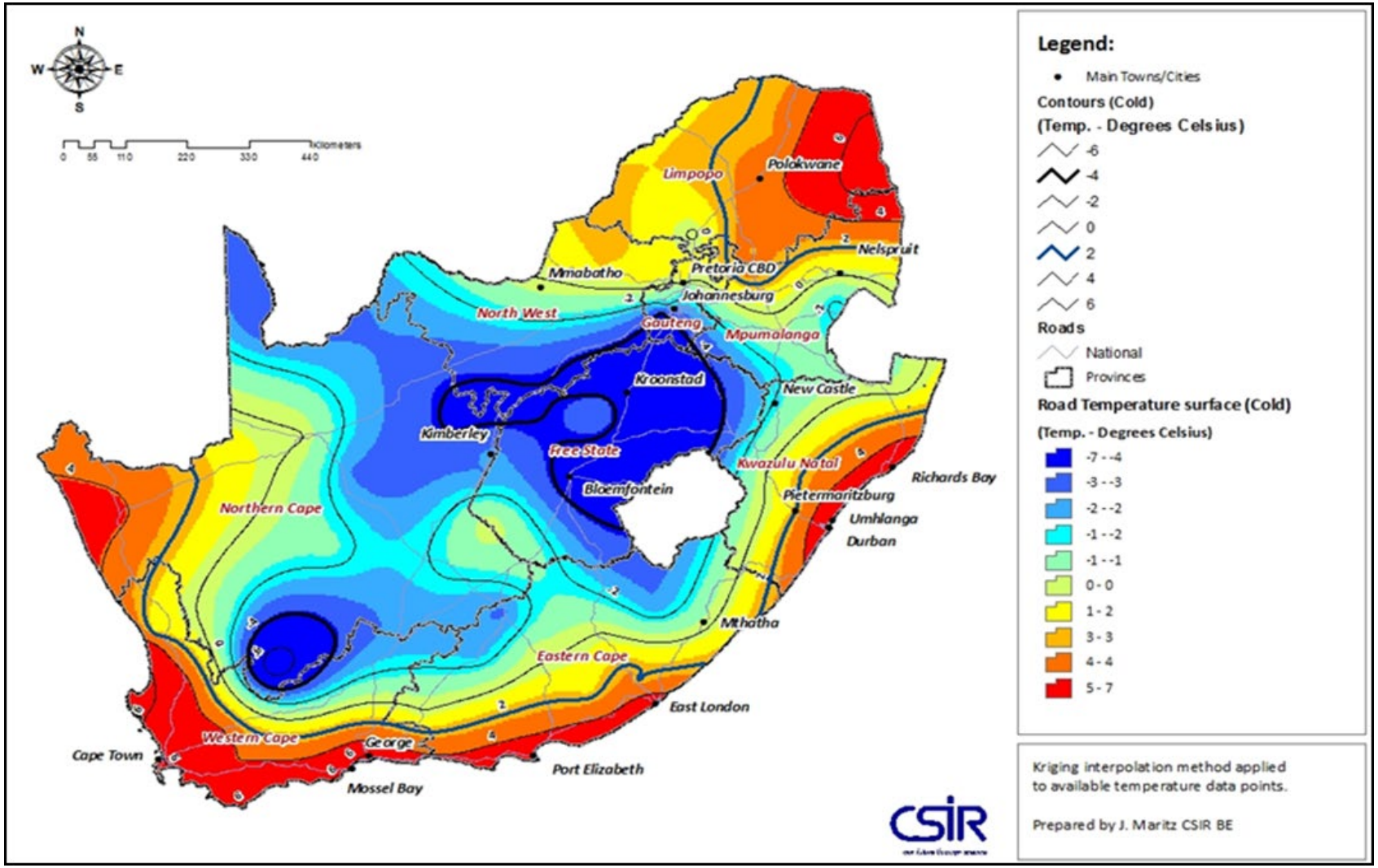


Winter sealing

- **Risk classification**

Traffic	Rainfall Area	Minimum Temperature (°C)	Probability of inexperienced contractor/designer	Risk level (May - Aug)
High (AADT > 3000)	Winter > 150mm	Cold < 0	Yes	High
			No	High
		Mild	Yes	High
			No	High
		Hot > 4	Yes	High
			No	High
	Autumn > 150mm	Cold < 0	Yes	High
			No	High
		Mild	Yes	High
			No	Medium
		Hot > 4	Yes	High
			No	Medium
	Summer	Cold < 0	Yes	High
			No	High
		Mild	Yes	High
			No	Medium
		Hot > 4	Yes	High
			No	Medium

Risk	Recommended strategy
High	Schedule reseal projects for summer period. Enforce winter sealing embargo. De-establish May and re-establish September.
Medium	Schedule reseal projects for summer period, but allow for alternative binders and seal types, should the project run into the winter months
Low	Schedule reseal projects for any period and allow for alternative binders and seal types for sealing during colder periods

Winter sealing

Very Low traffic AADT < 300 (Winter strategy)	
New construction	**Reseal**
S4(20)	S2(14/5)
S4(14)	S2(14/S)
S4(10)	S1(14)
S2(20/7)	S1(10)
S2(14/5)	S1 (7)
S2(14/S)	S3 (S <10)
S2(10/S)	S7 (<10mm)
S3 (D <10)	
S3 (D 10+)	
S8(20)	
S8(14)	

Low traffic AADT 300 - 1000 (Winter strategy)	
New construction	**Reseal**
S4(20)	S4(20)
S2(20/7)	S2(20/7/7)
S2(14/5)	S2(14/5)
	S2(14/S)
	S1(14)
	S1(10)
	S1 (7)
	S3 (S <10)
	S7 (<10mm)

Winter sealing

Medium traffic AADT 1000 - 3000 (Winter strategy)	
New construction	Reseal
S4(10) Temporary	S2(20/7)
S4(20)	S2(20/7/7)
S2(20/7)	S2(14/5)

High traffic AADT > 3000 (Winter strategy)		
New construction	**Reseal**	
Cold	**Cold**	**Mild**
S4(10) Temporary	S2(20/7)	S2(20/7)
S4(14) Temporary		
S4(20)		S2(20/7/7)
S2(20/7)		

Winter sealing : Binders

Seal type	Prefered binder type					
	Cold			Mild		
	Tack coat	Penetration Coat	Fogspray	Tack coat	Penetration Coat	Fogspray
20 Cape Seal	SC-E1 (t)	Cat 65(t) or anionic (50/50)		SC-E1 (t)	Cat 65(t) or anionic (50/50)	
				S-E1 (0% LFS)	Cat 65(t) or anionic (50/50)	
20/7 Double	SC-E1 (2-4% LFS)	S-E1 (4% LFS)	Cat 65 (70/30)	SC-E1 (2-4% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
	S-E1 (2-4% LFS)	S-E1 (4% LFS)	Cat 65 (70/30)	S-E1 (0-2% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
20/7/7 Split Double	SC-E1 (2-4% LFS)	S-E1 (4% LFS)	Cat 65 (70/30)	SC-E1 (2-4% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
	S-E1 (2-4% LFS)	S-E1 (4% LFS)	Cat 65 (70/30)	S-E1 (0-2% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
14/5 Double	Cat 65	Cat 65	Cat 65 (70/30)	Cat 65	Cat 65	Cat 65 (70/30)
	SC-E1 (2-4% LFS)	S-E1 (2-4% LFS)	Cat 65 (70/30)	SC-E1 (2-4% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
	S-E1 (2-4% LFS)	S-E1 (2-4% LFS)	Cat 65 (70/30)	S-E1 (0-2% LFS)	S-E1 (2% LFS)	Cat 65 (70/30)
14/Grit	Cat 65	Cat 65 (70/30)		Cat 65	Cat 65 (70/30)	
	SC-E1 (0-2% LFS)	Cat 65 (70/30)		SC-E1 (2-4% LFS)	Cat 65 (70/30)	
14 Single	S-R1 (8 % HFS)			S-R1 (4 % HFS)		
	S-E1 (4% LFS)			S-E1 (2% LFS)		
	SC-E1 (2-4% LFS)		Cat 65 (70/30)	SC-E1 (2-4% LFS)		Cat 65 (70/30)
10 Single	S-E1 (2-4% LFS)			S-E1 (2-4% LFS)		
	SC-E1 (2-4% LFS)		Cat 65 (70/30)	SC-E1 (2-4% LFS)		Cat 65 (70/30)
	Cat 65		Cat 65 (70/30)	Cat 65		Cat 65 (70/30)
7 Single	Cat 65		Cat 65 (70/30)	Cat 65		Cat 65 (70/30)
	SC-E1 (2-4% LFS)		Cat 65 (70/30)	SC-E1 (2-4% LFS)		Cat 65 (70/30)
Grit	MC 3000*			MC 3000*		
	Cat 65			Cat 65		
Temp 10 Cape Seal	SC-E1(t) (0% LFS)			SC-E1(t) (0% LFS)		
Slurry/ Microsurfacing						

- Grit seals - Cat 65 is preferred above MC 3000 in wet coastal areas.
- Cape seals - If stone is pre-coated, no penetration coat/cover spray is required.
- Where ranges are provided, the lower value applies to autumn when temperatures start to fall. The low flashpoint solvent content (LFS) is increased to maximum (4%) during June and July and reduced to the minimum (2%) at start of spring.

Labour enhanced

- **Preference to:**
  - Slurry-bound Macadam
  - Cape seals
  - Slurry
- **Refer risk classification Table D23**
- **Reference to SABITA Manual 12**

Figure D 18 Slurry bound macadam

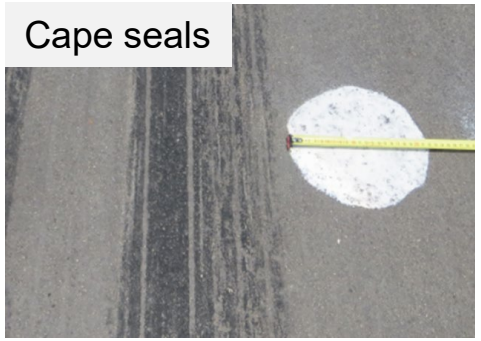
Figure D 19 Cape seal

Small airports

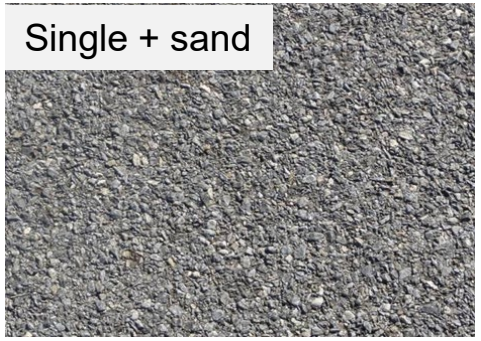
Friction requirements at 1.0 mm water depth						
Device	65 km/h at			95 km/h		
	Minimum	Maintenance planning	New Construction	Minimum	Maintenance planning	New Construction
Mu Meter @ Tyre pressure = 70 kPa	0.42	0.52	0.72	0.26	0.38	0.66
Grip tester @ Tyre pressure = 140 kPa	0.43	0.53	0.74	0.24	0.36	0.64

Macro texture requirements (mm)				
Method	Repair within 2 months	Maintenance planning	New Construction	Minimum after retexturing
Volumetric	0.25	0.76	1.14	0.76

Cape seals



Single + sand



Microsurfacing

Also Stone+1/3

Game parks

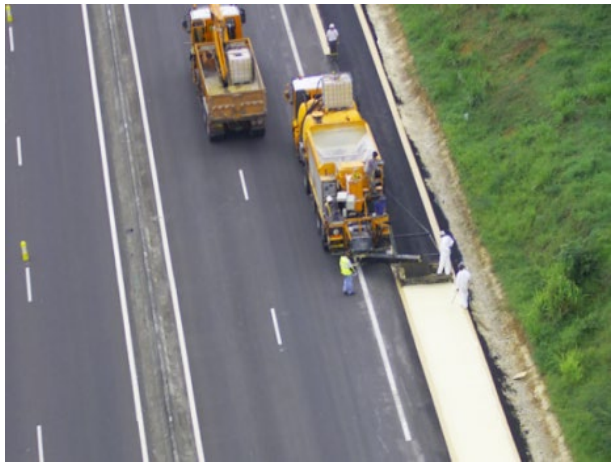
- **Good performance of sand seals and Otta seals**

Forestry roads

- Dependent on frequency of trafficking
- Good performance with slurries on low trafficked roads

Non-Motorized traffic

- Slurry
- Microsurfacing
- Slurry-bound macadam



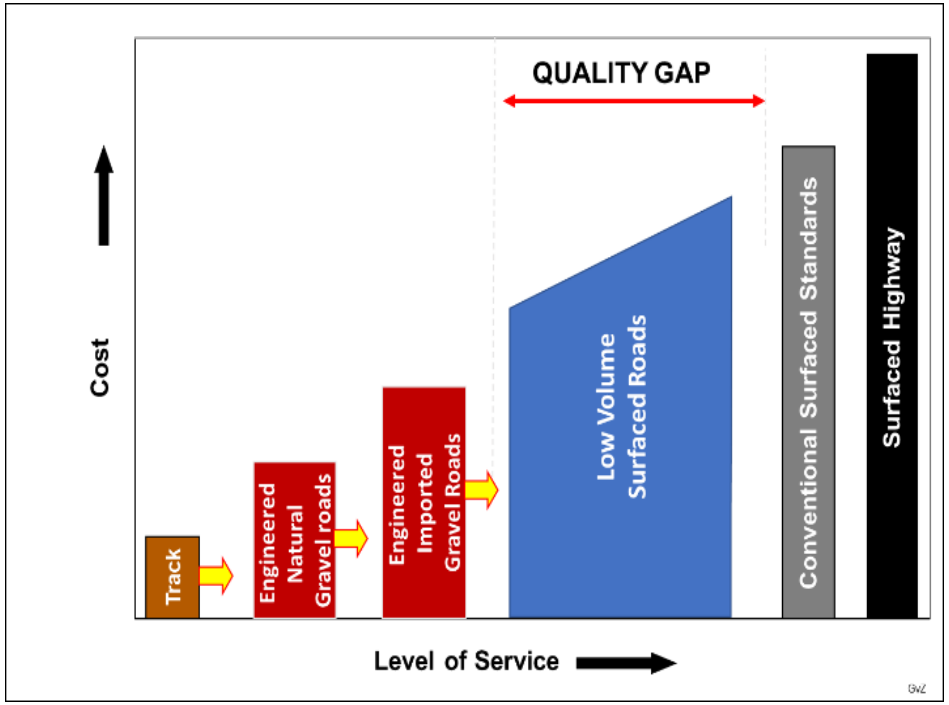
Intersections

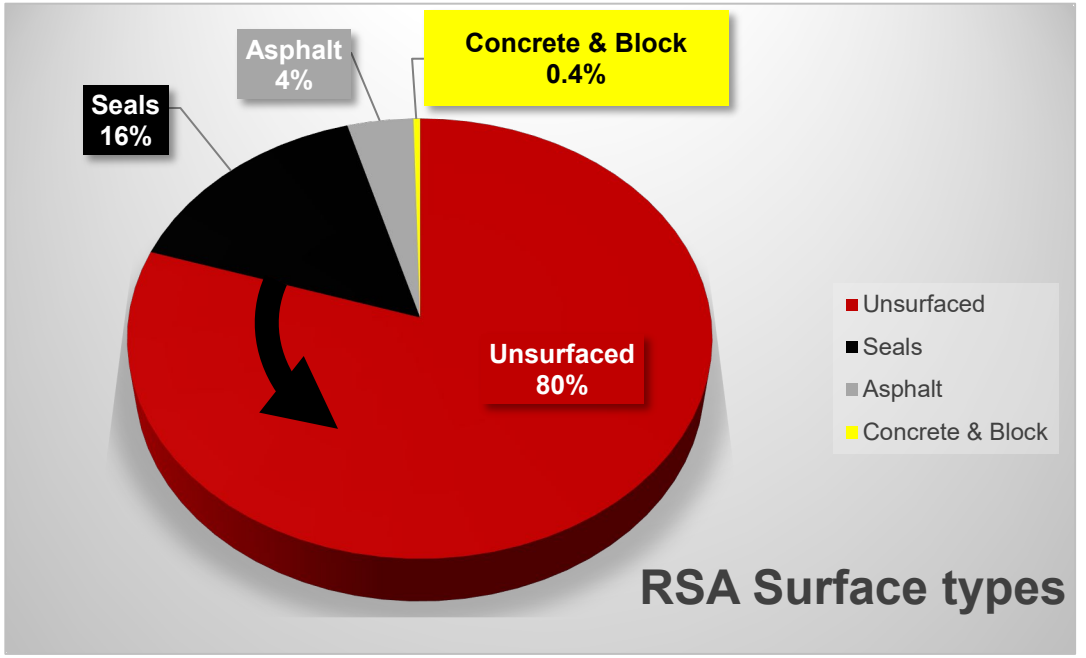
Main surfacing applied	Situation type	Treatment options
Single seal with hot conventional or homogeneous polymer modified binder (no solvents)	Entrances with mainly light vehicles and occasional heavy vehicles (Low volume)	Application of a dry coarse sand layer after the seal construction
		Application of a diluted emulsion cover spray and coarse sand or 5mm aggregate blinding layer
		Application of a fine graded slurry after construction
	Heavy vehicle entrances and rural intersections	Application of a medium graded slurry after construction over the full area where turning actions occur. Note that the binder application rate for the single seal component should be reduced to the minimum (Refer Cape seal design in Part E)
Single seals with bitumen binders containing solvents (including bitumen rubber)	Entrances with mainly light vehicles and occasional heavy vehicles (Low volume)	Application of a dry coarse sand layer after the seal construction
		In case of emulsion seals, a coarse sand or 5mm aggregate blinding layer is applied after the cover spray

- **Turning/ Braking**
  - ❑ Sand
  - ❑ Double
  - ❑ Cape
  - ❑ Asphalt/ Epoxy
  - ❑ Blocks
  - ❑ Concrete

DRAFT

Significant increase in use of surface treatments expected





- NB: Major drive towards LVSRs
- Consider for next RPF
- New guidelines available + New DCP design program (Free !!)
- http://www.research4cap.org/SitePages/Home.aspx."

End

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