NOTES FOR THE PERFORMANCE BASED SPECIFICATION FOR STRUCTURAL DESIGN AND CONSTRUCTION OF FLEXIBLE UNBOUND PAVEMENTS

(These notes are for the guidance of supervising officers and must not be included in contract documents)

1. SCOPE

TNZ B/3 is currently provisional status as this specification has not yet been trialed. Therefore, should you wish to use this specification contact the Engineering Policy Manager of Transit New Zealand John Donbavand to enable appropriate guidance to be given and a system for monitoring is established. In addition, this specification because of its provisional status will likely be modified frequently. Therefore, please regularly visit the Transit New Zealand web site (www.transit.govt.nz/technical_information/specifications.html *) to obtain the latest version.*

Appendix A details the procedures to be undertaken by Contractors for contracts using this specification.

Since the B/3 Specifications a pilot at this stage. The Engineer to the Contract should send details of tenderers which include alternative materials to Greg Arnold at Transit Head Office in order that a data base can be collated.

If assistance is required to evaluate alternative materials or on any other matters relating to B/3 prior or during the tender process John Donbervand is available at your request. Contact details are as follows:

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This performance based specification has primarily been developed to allow the use of any material (lightly stabilised or otherwise) in the pavement including M/4 or M/3. Materials that do not comply with M/4 or M/3 will require testing as per M/22 Notes to prove it has acceptable: strength (assessed in the Repeated Load Triaxial Apparatus or used in other roads); durability (crushing resistance and weathering); and shrinkage (assessed by a shrinkage test to guard against cracking).

There is some risk in allowing the use of alternative materials as other factors can not be assessed in the laboratory such as: constructability; seal adherence; and environmental performance. Therefore, it was considered appropriate that the Contractor is responsible for the pavements performance for the maintenance period of at least 12 months as per this specification. Also, TNZ M/22 *Notes for the Evaluation of Unbound Road Base and Sub-base Aggregates* was given Notes status to ensure Transit is not liable in the maintenance period for failure of a material that has passed the laboratory tests specified in TNZ M/22 Notes.

It is important to realise to protect the Principal's interest to ensure the pavement lasts the required design life the Engineer is required to review the pavement design(s) submitted by the Contractor and advise the Principal whether: the designs meet or exceed the required design traffic volume according to Austroads and the NZ Supp.; the materials are the correct type and are compacted to the required thickness and density. Even though the Contractor has met the requirements of this specification during and immediately after construction it does not exempt the Contractors[1] responsibility for the performance of the pavement for the first 12 months and the ownership of the design of the pavement for the design life. This requirement is similar to NZS 3910: 1998 Section 5.1.3 as quoted below:

Where the Contract Documents expressly provide that part of the Contract Works shall be designed by the Contractor, it shall be fully responsible for that part of such works, not withstanding any approval of the Engineer.

2. SITE INFORMATION FOR DESIGN

This Clause notifies the Contractor where to locate the site information to use for the design. The Engineer should undertake and include in the tender documents site information that would be needed to undertake a pavement design for a range of pavement types. Information on the subgrade soil(s) and/or the materials in the existing pavement should be included to allow Contractors to assess stabilisation options. Other information such as the existing pavement structure, failure mechanism, pavement age and past traffic, expected environment should all be included in the site information.

As soon as the professional services contract has been awarded (i.e. prior to investigation and design) Contractors should be notified of the intention to use this performance based specification as well as be warned that this project is subject to future funding approval. This will allow sufficient time for Contractors to undertake the necessary research and testing that is needed to evaluate local materials. In addition, it will give Contractors time to train their staff in aspects of pavement design. Contractors should also be made aware that they can choose whether or not to design their own pavement or use the Engineers design using M/4 basecourse.

Prior to undertaking a site investigation it is recommended for the Engineer to discuss with local

[1] Referring to those Contractors who use their own pavement design and materials.

Contractors including those specialising in stabilisation the necessary site information to collect.

If pavement deflection is to be used as a measure of compliance then the existing pavement or subgrade will need to be assessed by deflection measurements. This is because the relationship between CBR and modulus is different for various soil types and moisture conditions. Since the finished pavement deflection is very dependent on the underlying materials it is important that the stiffness of these materials are characterised correctly. However, for pavements with no bound layers the pavement thickness design should be based on subgrade CBR or the vertical modulus = 10CBR.

3. SITE ACCEPTANCE

This Clause is to allow the Contractor once awarded the Contract to check that the site information given in the tender that was used for the basis of design is correct. The Contractor will primarily be concerned if the difference between the actual site conditions and the site information given in the tender will be detrimental to the performance of the pavement or surfacing designed in the tender process by the Contractor.

3.1 Pavement Design

Under this Clause the Engineer is to assess in terms of standard engineering measurements (e.g. CBR, deflection tests etc) whether or not there is an area that is weaker or substantially stronger than indicated by the site information given in the Tender documents. When determining the action to take, consideration should be given to the fact that 5% of the area will be allowed to fail the deflection criteria as the design subgrade or pavement strength is usually based on the 95th percentile value.

The Engineer may for certain areas alter the acceptance criteria as an alternative to allowing additional works or a re-design. This can be achieved by exempting the area in question from the acceptance criteria for pavement stiffness (Clause 12.4) and altering the 10 to 12 month assessment criteria of: surface shape (Clause 12.5); rut depth (Clause 12.6); and roughness (Clause 12.7). For these areas the Engineer will still need to ensure that the correct materials are used and are compacted to the required density and layer thicknesses.

This Clause is not intended as an escape for the Contractor from responsibility, but rather as a methodology to deal with un-expected site conditions. It is hoped that there will be minimal disputes as standard Engineering measures will be used rather than opinions. Also, if a conservative soaked subgrade strength was specified in the Tender documents the areas in question weaker than this value should be minimal.

3.2 Surfacing

The Contractor is responsible for the full design of the surfacing to last for 12 months over their proposed pavement. Therefore, strictly speaking this Clause is unnecessary. Provided the surfacing will still meet the performance requirements the Contractor can change the surfacing used. However, payment will still be paid at the tendered rate.

4. DIMENSIONS

This is a Clause to simply instruct the Contractor to build the road in accordance with the Contractors pavement design and the Engineers drawings.

5. CONSTRUCTION TOLERANCES

These construction tolerances are the same as in Transits specification for *Construction of Unbound Granular Pavement Layers* (TNZ B/2: 1997).

6. EDGE DEFINITION

7. PROTECTION OF ROAD FURNITURE

8. NO FOULING OF SEALED SURFACE

9. REMOVAL OF SURPLUS AND WASTE MATERIAL

10. REMOVAL OF SURPLUS CHIPS

Clauses 6,7,8,9 and 10 are the same as those in Transits *Performance Based Specification for Bituminous Reseals* (TNZ P/17: 1998).

11. ACCEPTANCE TESTING

11.1 Accreditation
11.2 Aggregate Sealing Chip Properties
11.3 Bituminous Binder Properties

Clauses 6,7,8,9,10,11.1,11.2,11.3 are the same as those in Transits *Performance Based Specification for Bituminous Reseals* (TNZ P/17: 1998).

11.4 Pavement Materials

This specification has been developed specifically to allow the use of alternative materials to M/4 and M/3. Engineers may follow TNZ M/22 (Notes) *Guidelines for the Evaluation of Unbound Road Base and Sub-base Aggregates* to aid in their decision to accept or reject a Contractors proposed alternative material.

Although, alternative materials used by the Contractor may meet the minimum strength, durability, and other requirements of TNZ M/22 (Notes) *Guidelines for the Evaluation of Unbound Road Base and Sub-base Aggregates* it does not exempt the Contractor from the responsibility for their performance within the maintenance period. As TNZ M/22 (Notes) is given Notes status and it therefore cannot form any part of the contract documents. Local knowledge and other information should also be used by the Contractor for assessing the risk of failure within the maintenance period.

12. COMPLIANCE ASSESSMENT

12.1 Pavement Design

As part of the tender process Contractors may design the pavement layer thicknesses based on the site information given in the tender document.

The Contractor may use any method to design the pavement and is responsible for the pavement's performance for the first 12 months. However, the pavement design will only be accepted if the maximum allowable traffic volume computed using the procedures in the Austroads Pavement Design Guide and the accompanying New Zealand Supplement exceed the design traffic loading. The Contractor shall submit a design certificate for the pavement design(s) from a Registered Engineer at the time of tender. This design certificate will be reviewed when evaluating the Tenders, and will require updating if a re-design is undertaken at the site acceptance stage in Clause 3.1.

Guidelines on using the Austroads mechanistic design procedures for checking pavement compliance are detailed below. When checking the pavement design consideration should be given to Contractors using the design charts for design and not mechanistic principles as this will be acceptable.

The pavement design cross section will comply if using the procedures in the AUSTRAODS Pavement Design Guide and corresponding New Zealand supplement show that the pavement will meet or exceed the design life.

12.2 Pavement Materials

This Clause specifies requirements for sampling and checking the pavement materials comply with those materials chosen by the Contractor to use. The requirements are very similar to TNZ M/4.

12.3 Acceptance Criteria for Pavement Layer Compaction

A key element to ensure sufficient shear strength in pavement materials is compaction. The strength of a material may have been assessed in the Repeated Load Triaxial (RLT) apparatus as detailed in TNZ M/22 (Notes) or from Road trials. A material that meets the minimum strength requirement would have done so at a certain compacted density. This compacted density thus can become the minimum target density to be achieved in the field. Therefore, it is the Contractors best interest to ensure that the material tested in the RLT apparatus or Road trials is compacted at a density that can be achieved in the field.

The requirements for checking compaction is similar to TNZ B/2 (1997) *Specification for Construction of Unbound Granular Pavements.*

When checking compaction it should be realised that the density achievable is very sensitive to the material's grading. If the material used in the field has the exact same grading as the material tested in the laboratory then the target density will be correct. However, if the material in the field is coarser (deficient in fines) than the material tested in the laboratory then an acceptable target density would be lower. The difference between the target densities of the two extremes on the grading envelope of M/4 is 0.1 t/m^3. Therefore, it is considered appropriate to allow a margin of error of +/- 0.05 t/m^3 from the target density to allow for variations in grading.

12.4 Pavement Stiffness

Pavement strength has primarily been already ensured through the use of the correct pavement materials compacted to the right density and depths. A deflection test may be required to check that the pavement layer stiffneses (modulus of elasticity) assumed in the design were achieved in the field.

The modulus of elasticity is a measure of an elastic response to a load a deflection test is the only method for assessment of this parameter. Although, many factors effect the measured deflection and this means of assessment is still early in its development. Data still needs to be collected on deflection testing for developing guidelines. Therefore, it is recommended that the Engineer reviews the Contractors pavement design and material tests and satisfies themselves the stiffenesses assumed are conservative and will not be difficult to achieve in the field. For a standard unbound granular pavement where the stiffenesses assumed were conservative deflection testing is unnecessary.

A conservative acceptable moduli for layers in an unbound granular pavement would be where the requirements of Section 8.2.2 *Procedure for Elastic Characterisation of Granular Materials* in the document *Pavement Design A Guide to the Structural Design of Road Pavements* (Austroads, 1992) are complied with and the minimum layer thickness is 75-100 mm.

FWD deflection testing is recommended for situations where a stabilised aggregate layer is to be constructed. In this situation the stabilised layer could have been assumed in the design to behave as a bound layer with a modulus of 2000 MPa. To achieve a 2000 MPa layer in the constructed pavement it is vital that the cementitious binder has been adequately mixed and the moisture and curing conditions are ideal. Usually, to ensure that at least a 2000 MPa layer is constructed a additional 1% of cementitious binder is added to the amount that was determined to be necessary

from the laboratory tests (UCS). However, the Contractor may skimp on the amount of cementitious binder used and therefore it will probably be necessary to check at least a modulus of 2000 MPa has been achieved in the constructed pavement by means of FWD deflection testing.

If the pavement layers were found to have a lower stiffness than that assumed in design then the pavement should be re-designed to determine the increase in pavement thickness required.

12.5 Surface Shape

The surface shape requirements are similar to TNZ B/2 (1997) *Specification for Construction of Unbound Granular Pavement Layers*.

Road sections that fail the roughness criteria after construction should all be reassessed in more detail for compliance with Clause 12.5 *Surface Shape*.

12.6 Rut Depth

The rutting criteria is considered to be fairly set at 2 mm + AGD - ALD or 10 mm (whichever is the greater) for five reasons: 1. It is difficult to accurately measure rutting less than this amount; 2. A larger proportion of the rutting occurs in the first year; 3. ; the failure criteria for design is a 20 mm rut depth; 4. Only 0.04% of the total current network (covering the whole spectrum of pavement ages) has rutting >30mm; 5. The formula takes into account the effect of rutting of chips lying on their flattest side in the wheel tracks and standing up in the shoulders, centreline and between the wheel tracks.

12.7 Roughness

Roughness is a standard measure in TNZ B/2 for compliance with longitudinal smoothness. As roughness governs end of life conditions for pavements in New Zealand it is a better measure of performance than rutting.

12.8 Surface Texture Requirements

These requirements specified are the same as TNZ P/17 except the seal design life used will be less. For a single layer first coat seal the design life will be governed by when the application of the second coat seal is scheduled (usually the first summer following 1 year after construction). For example the design life for a single layer first coat seal could be 1.5 years (i.e. 18 months).

A multilayer first coat seal is expected to have the same life as a single coat reseal as in TNZ P/17.

The design life of the surfacing is required to be specified in Schedule A for inclusion in the Tender documents.

12.9 Chip Retention

The chip retention requirement is directly from P/17 (1998) *Performance Based Specification for Bituminous Reseals*.

12.10 Surface Waterproofness

This requirement is needed to ensure the surfacing adheres to the underlying pavement materials that were chosen by the Contractor. The requirement for having no bald areas greater than 70 mm in diameter came from the definition of a pothole in TNZ C3 (1993) *Specification for the Repair of Potholes in Bituminous Surfaced Roads*.

12.11 Saturation Prior to Sealing

It is good practice not to seal the pavement if it is fully saturated (i.e. all the available volume of voids is filled with water). Achieving the requirements of TNZ B/2 for saturation is acceptable or drying back to a moisture content of 75% of that used during compaction. The reason for allowing this other requirement to that in TNZ B/2 as there are difficulties in determining the correct solid density for the saturation calculation. Often the solid density used in the saturation calculation is too low and saturation levels of greater than 100% can be determined. However, it is impossible to achieve greater than 100% saturation. Therefore, based on a worst case scenario that the moisture content of the pavement during compaction results in a 100% saturation level then drying back to a moisture content of 75% of this value would reduce the saturation level to an acceptable level.

13. MAINTENANCE

This Clause instructs the Contractor to maintain the road to a specified standard for 12 months.

The Engineer should give consideration to the timing of the second coat seal when agreeing on a repair technique and acceptance criteria.

14. PAYMENT

14.1 Site Investigation

14.2 Pavement Design

14.3 Pavement Layers

14.4 Surfacing

Schedule A

Schedule A includes all the specified design limits and information required for design. This

information is project specific and should be detail and clear.

References

Austroads. 1992. Pavement Design: A Guide to the Structural Design of Road Pavements. Austroads, Sydney, Australia.

New Zealand Supplement to the Austroads Pavement Design Guide (Transit New Zealand, March 2000 draft is available).

Appendix A - Recommended Procedures for Contracts using TNZ B/3