



Contract Specifications Technical Clauses

Rarotonga Road Improvement Project, Apii Nikao Footpath Construction

Contract No. CK171829

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100 CLEARING & DEMOLITION

100.1 General

Refer to the general Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

100.2 Scope

This specification covers the removal from the Contract area of all redundant structures, fences, hedges, trees, weeds, scrub and similar growth (including grubbing up of all roots).

100.3 Extent of Works

Objects and vegetation shall be retained unless specifically required to be removed to complete the contract works.

Objects and vegetation shall not be removed from private property unless expressly authorised by the Engineer.

The clearing works within this contract shall include clearing and removal offsite of, shrubs, weeds, scrub, trees, rubbish, building slabs, foundations, debris, fences and any other material that the Engineer deems not required in the final works.

All vegetation and other materials shall be removed from the site. Materials considered by the Engineer to be of value to the Principal, such as fencing posts and wire, pipes, etc. shall be neatly stacked in the Contract area where directed, and shall remain the property of the Principal.

Tree and other structures shall be brought down in such a manner as to avoid danger to the public or damage to other vegetation or structures which are to remain.

Where vegetation is cleared the ground shall be grubbed clear of all vegetation, refuse and obstructions in the underlying ground. Roots and vegetation that have a diameter of 20mm or more shall be removed and confirmation from the Engineer that any remaining organic matter is acceptable to remain within the contract area.

Boundary fences, structures, or other objects or growths not scheduled for removal, but which are damaged or destroyed by the Contractor's operations, shall be repaired or re-erected by the Contractor at his own expense.

100.4 Bridges, Culvert's and Structures

Unless detailed otherwise or as directed by the Engineer trees and stumps and other vegetation where the drip line extends within 05m of any proposed bridges, culverts and structures shall be completely removed.

100.5 Disposal of Materials

The contractor shall note that the disposal of all clearing material must be to an approved disposal facility and shall provide evidence that this is the case. The Contractor may recover the salvageable value of cleared materials that the Principal has no further use for and which are removed from the site.

On-site burning of selective vegetation and timber shall only be permitted if the Contractor obtains the necessary permits from the appropriate authority and Fire Service, and providing the fire is controlled and does not create a nuisance.

During the clearing operations, the contractor shall ensure that any noxious weeds and plants that may be found onsite are removed from site in a manner that will not spread seeds. Noxious weeds must be sprayed and cleared at the commencement of work, and care taken to see that there is no re-establishment growth either on the original site or on stockpiles etc. prior to completion of the work.



200 EARTHWORKS

200.1 General

Refer to the general Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

200.2 Scope

This specification covers the covers the; stripping of topsoil, excavation and disposal of unsuitable materials, erosion and sediment controls, subsoil drainage (for bulk earthworks dewatering), earthworks including excavation, placement, compaction, trimming of batters, surface drains, formation and the re-spreading of topsoil.

The extent of earthworks for this contact is detailed in the drawings and all earthworks shall comply with the standard specifications and Infrastructure Cook Islands requirements to the complete approval of the engineer. The geotechnical engineer supervising the earthworks will advise any additional standards of compaction and additional earthworks testing.

No works on adjoining properties or sites shall be undertaken without written authorisation from the Engineer.

The contractor shall ensure that sufficient and effective silt/sediment control works are in place at all times.

200.3 Related Documents

This section makes reference to various standards and TNZ Specifications; the main ones referred to are listed below, but it should be noted that these in turn require reference to other standards. In all cases the standards are to include all amendments current at the time of tender.

NZS4404	Land Development and Subdivision Infrastructure
TNZ F/1	SPECIFICATION FOR EARTHWORKS CONSTRUCTION
TNZ F/2	SPECIFICATION FOR PIPE SUBSOIL DRAIN CONSTRUCTION
TNZ T/01	Benkelman Beam Deflection Measurements
NZS 4402	Methods of Soil Testing for Civil Engineering Purposes
BS1377	Methods of Test for Soils for Civil Engineering Purposes
NZS 4404	Land Development & Subdivision Infrastructure
NZS 4407	Methods of Sampling and Testing Road Aggregates
NZS 4431	Code of Practice for Earth Fill for Residential Development.
ARC TP90	Erosion & Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region

200.4 Stripping of Topsoil

All topsoil (as defined by the Engineer) together with turf, on areas of cutting and filling shall be removed and stockpiled in a planned manner on approved sites within the Contract area. In areas of heavy turf vegetation, this material shall be laid on the bottom of the stockpiles if directed by the Engineer for clean topsoil to be stockpiled on top. No extra payment will be made to the Contractor for double handling.

Except where limited by boundaries, existing works or fences and trees to be preserved, stripping shall extend one metre beyond the limits of the areas subject to earthworks or as agreed with the Engineer.

On completion of cut and fill earthmoving operations to the satisfaction of the Engineer, the topsoil (except that quantity directed by the Engineer to be reserved in stockpile on site) shall be spread evenly over the reformed area to the minimum depth shown on drawings (excluding road areas).

The Contractor shall stockpile the scheduled volume only. Any additional topsoil that requires removal from areas under construction shall be removed from site. The best quality topsoil only shall be stockpiled for re-



spreading. If, in the opinion of the Engineer, inferior topsoil has been stockpiled for re-spreading, a deduction shall be made to cover the cost of its replacement.

No topsoil shall be removed from the site without the Engineer's approval, and all surplus topsoil remains the property of the Principal unless agreed otherwise.

200.5 Unsuitable Material

The Engineer shall determine which materials will be classified as "unsuitable" and will in general apply the term to material which, by virtue of its inherent properties of grain size, water content, or organic content, is considered unsuitable for inclusion in earthfills. Unsuitable material that can only be excavated as a special operation involving plant such as dragline, tracked excavator, or other specially adapted plant, shall be paid for at the scheduled rate under the description "unsuitable material". Other unsuitable material shall be paid for at the same schedule rate as topsoil.

Where any material has become wet due to insufficient drainage or other negligent operation of the Contractor, and would not otherwise have had to be excavated, the excavation and backfilling shall be carried out at the Contractor's expense.

All unsuitable material located beneath areas to be filled shall be removed as directed by the Engineer prior to the commencement of filling. This material shall be either carried to dump or stockpiled for further use in locations approved by the Engineer. The extent and measure-up of undercut areas will be confirmed on site by the Engineer.

The Contractor shall ensure that no unsuitable material is buried or deposited on any part of the Contract area other than as directed by the Engineer.

Care shall be taken that unsuitable material and material suitable for filling are not mixed during excavation. Material which is unsuitable purely because of high moisture content due to its location on site, shall be spread and dried for use as fill, as described in this Specification. Material which is unsuitable because of the presence of vegetable matter or its naturally wet colloidal nature shall be placed in regions of general reserve or other areas specified by the Engineer. Such material shall be spread, dried and mixed with suitable material to obtain the best practicable compaction.

200.6 Sediment Retention and Erosion Control

The Contractor shall not commence earthworks until satisfied that all conditions and requirements of the Consents can be met and that suitable sediment and erosion controls, etc., have been constructed. The Contractor shall maintain the control measures as required until no longer required.

200.7 Management of Stormwater

200.7.1 Scope and Priority

Before any earthworks begin, the Contractor shall take all necessary precautions to protect public and private property from possible damage by stormwater runoff from the Contract area and catchment below the Contract area. The Contractor shall continue to provide and maintain adequate stormwater control facilities as the work proceeds and until the end of the maintenance period.

The Engineer may order the Contractor to cease all other operations until he is satisfied that the stormwater control systems are adequate and to the complete approval of the relevant authority.

200.7.2 Surface Profile

During the progress of the work, the surface profile shall be maintained in such shape and condition that there is adequate controlled drainage at all times.

The formation surface within 3 metres of fill batters shall be graded away from the top of the batter and surface water led to suitable discharge positions by means of vee drains to prevent possible batter erosion.

200.7.3 Contour Drains

The Contractor shall allow for the provision and maintenance of effective temporary and permanent open intercepting and contour drains.



All upstream catchments flowing onto the site shall be adequately diverted (clean water diversion drains) away from the site construction zone.

Contour drains discharging on virgin ground shall be put in at intervals to suit the general ground slope after earthworks operations have ceased for the day. Contour drains gradients should not exceed 2% and be spaced at intervals, to suit the site slope.

Intercepting drains shall be dug at the toe of batters and uphill of private boundaries and connected to approved outlets.

Where these drains are required to be dug through soft material, the Engineer may direct that they are lined.

200.7.4 Sediment Retention

The Contractor shall provide silt traps/ponds to the Engineer's approval on all temporary and/or permanent open stormwater channels. The type and size of silt traps/ponds may vary according to location but shall generally consist of a stilling pond and mesh fence, generally in accordance with required standards.

The Contractor shall maintain silt traps/ponds and remove all trapped debris to locations where it will not be washed down into open or piped drains. He shall restore pond areas after all risk of soil contamination has been removed.

Where silt traps/ponds and other drainage work are of a nature that maybe a danger to the public, the Contractor shall take adequate protective measures by fencing off the dangerous areas and erecting clear effective warning signage. If the Contractor fails by virtue of inadequate performance, to prevent damage to private and public properties and utilities, the Contractor shall, at his own expense, clean up and repair all ensuing damage.

200.8 Subsoil Drainage

Where fill is to be constructed over wet areas, springs or areas where in the opinion of the Engineer, water is likely to emerge or seep, then adequate subsoil drains and/or scoria blankets shall be installed. The Engineer shall inspect and confirm the extent of such work before any pipes or metal are placed.

The Contractor shall abide by TNZ Specification F/2.

The perforated pipes shall conform to the requirements for the class, type of joints, diameter, and length, shown on the drawings and specification.

Trenches shall be backfilled to a minimum depth of 200mm above the pipes with filter material spilled over onto the surrounding ground surface.

Filter material shall consist of clean, durable stones and comply with the grading specified in TNZ F/2.

Care shall be taken when placing and compacting earthfilling over the drains to ensure that they are not damaged and open ends shall be protected by a 15mm mesh screen to prevent entry of debris or animals.

The Contractor shall keep a careful as-built record (surveyed position, level) of the location of all subsoil drains or drainage blankets.

200.9 Earthfilling

200.9.1 General

It is intended that all materials other than those classed as unsuitable by the Engineer, which are excavated after stripping, be conditioned as necessary and be compacted to the standards specified below. Furthermore, any area of ground which has been disturbed to such depth (e.g. by grubbing operations) that cannot be compacted to the required standards in conjunction with the first layer of fill, shall be worked and compacted to the required standards before routine fill operations begin.

All earthworks shall be carried out in accordance with TNZ F/1 SPECIFICATION FOR EARTHWORKS CONSTRUCTION.

All earthworks shall be carried out in the dry and before fill is placed in any area, the Engineer shall be notified so that he may inspect the stripping and/or removal of unsuitable materials to see that this prior work meets the specified requirements. No cut and fill shall be undertaken until inspection and approval by the Engineer.



200.9.2 Classification of Materials

The materials to be excavated shall be classified as one of the types listed below. Whenever the Contractor wishes material to be defined as other than "soil" he shall give adequate notice to the Engineer so that an appropriate classification may be determined.

a) Unsuitable Material

This is defined as material that due to grain size; excessive natural water content; and/or organic content is deemed, by the Engineer, to be unsuitable for use as compacted earth fill material.

b) Soils and Soft Rock

Soils suitable for use as compacted earth fill shall be defined as material which can be excavated with reasonable facility by modern excavating plant.

Soft rock shall be defined as material which requires loosening by means of ripping equipment or some means other than continuous drilling or blasting and which can be subsequently removed by excavating plant.

c) Hard Rock

Hard rock shall be defined as solid material which cannot be reasonably loosened and prepared for excavation by means of a heavy-duty ripper and which requires to be broken up by means of explosives or heavy duty rock breakers before it can be handled by mechanical equipment.

Where agreement cannot be reached on classification of soft rock and hard rock material, ripping trials shall be carried out using appropriate plant, to determine the classification as described above.

Where the appropriate plant is not available on site the Contractor will be reimbursed for the cost of transporting, if the classification claimed by the Contractor is proven.

d) Topsoil

Topsoil shall be defined as the layer of material, which may include vegetation, turf, humus and other organic matter immediately below the ground surface and which is unsuitable for use in compacted earthfills.

200.9.3 Materials for Earthworks

The Contractor shall be responsible for selecting material from their nominated source and for the monitoring of the quality of fill material by regular testing. The minimum amount of testing to determine grading and plasticity index shall be one of each test per 500m³ of material and per source.

200.9.3.1 Hardfill

Hardfill is defined as a well graded, durable, granular aggregate which meets specified grading, strength, and durability criteria as defined below.

Hardfill shall be GAP65 or GAP100 supplied from a quarry and shall consist of a well-graded granular aggregate. The aggregate shall be free from organic, calcareous or other deleterious materials.

Hardfill shall have a minimum crushing strength of 130kN (NZS 4407:1991 test 3.10) and weathering quality grade of AA, AB, AC, BA. (NZS 4407:1991 test 3.11). Maximum PI of the fines content is to be 10%.

The grading envelopes for GAP65 and GAP100 are shown on Tables below.

Table - GAP65 Hardfill Grading Envelope Requirements

Sieve Size	% Passing By Weight
63 mm	100
37.5 mm	80 – 90
19 mm	50 – 70
9.5 mm	30 – 55
4.75 mm	20 – 40
2.36mm	15 – 30



1.18 mm	10 – 22
0.6mm	6 – 18

Table GAP100 Hardfill Grading Envelope Requirements

Sieve Size	% Passing By Weight
100.0 mm	100
75.0 mm	80 - 95
37.5 mm	50 - 75
19.0 mm	40 - 60
9.5 mm	27 - 46
4.75 mm	20 - 34
2.36 mm	15- 25
0.6 m	6 - 13
0.075 m	0 - 5

200.9.3.2 Sand

Sand for backfill of undercut areas or elsewhere as directed shall be clean sharp sand, and shall be approved in advance by the Engineer.

200.9.4 Bulk Earthmoving

On-site fill material shall be brought to appropriate moisture content prior to compaction by drying and/or blending as necessary. Oversize material shall be broken up into lumps not greater than 100mm size, be spread uniformly in layers of not more than 200mm loose thickness, and be compacted to the specified minimum strength and density.

Crushing to the approved maximum size may be achieved on the fill or the oversized material may be disposed of within the Contract area as instructed by the Engineer.

Specialised rollers (e.g. "sheep-foot" type), shall be used for fill compaction. Equipment used in transportation and spreading will not be permitted as compaction equipment. Compaction plant shall cover the entire area and subject each layer to a uniform degree of compaction effort. Each layer shall receive at least 4 passes of the roller or as many as necessary to achieve the strength and density requirements. The thickness of each layer shall be limited to ensure that the specified compaction is achieved for the full depth of each layer. Filled areas shall be sealed off with appropriate plant when rain is impending. The Contractor shall carry out, control tests as required on the fill.

200.9.5 Over-Excavation

The Contractor shall direct his operations to avoid excavating beyond the designated profiles. Any over-excavation shall be made good to the direction of the Engineer with compacted fill meeting the requirements of the Specification, all at the Contractor's expense.

200.9.6 Benching

After clearing and stripping of topsoil in the fill area, the ground shall be inspected by the Engineer for any possible unstable areas or exposed unsuitable materials. All such identified materials shall be excavated and the cut areas backfilled and approved prior to the commencement of bulk filling.

Slopes with gradients steeper than 1 vertical to 3 horizontal (1v:3h) shall be benched prior to bulk filling.

Benches shall as far as possible be the width of a machine (but not less than 2.5 m); shall have a slight fall inwards to allow for the control of water, and shall have a longitudinal fall that will ensure adequate drainage and discharge of water.

The rate for bulk earthmoving shall, unless otherwise scheduled, include all such preparatory benching and the Contractor shall allow for such in his bulk earthworks rates.



200.9.7 Depth of Layers

Subgrades

Within 500mm of the finished carriageway subgrade profiles the layers shall be spread to a loose depth not exceeding 150mm.

Bulk Fill

Elsewhere the layers shall be spread to a loose depth not exceeding 200m.

200.9.8 Control of Water Content

At all times the fill material shall be compacted within the specified allowable variation of the optimum water content.

If the Engineer considers the fill material is too wet for efficient compaction, or finds after testing that the moisture content of placed fill is not within the tolerances specified below, he shall order compaction operations to cease and instruct the Contractor to disc the material and allow it to dry, or take other appropriate measures to achieve the required water content for efficient compaction.

If the material has become too dry, the Contractor will be instructed to apply sprinkled water to ensure a uniform distribution throughout to layer.

Whether drying, wetting or a blending operation has to be carried out, the Contractor shall ensure that the material is broken up into lumps not greater than 100mm in size.

When the material has regained its optimum water content after the moisture adjustment process, it shall be recompacted and reshaped as specified.

Before Tendering the Contractor shall familiarise himself with soil and moisture conditions from the geotechnical information provided and the site. No extra payment shall be made for drying wet material or wetting dry material unless agreed to by the Engineer before work is carried out.

200.9.9 Standards of Compaction Required

The standard of compaction and method of determination shall be as set out in NZS4431 and NZS4402. Where this is not applicable the requirements shall be specified by the Geotechnical Engineer.

Fill material shall be placed in layers not exceeding loose depth noted in 200.9.7 and compacted with a sufficient number of passes of approved compaction equipment throughout the whole area and depth of each layer to comply with the following criteria:

The insitu dry density of the fill shall average not less than 95% of the maximum dry density of the fill material; and no single measurement of insitu dry density shall be less than 93% of the maximum dry density so determined.

The Geotechnical Engineer may undertake further tests on the natural soils before and/or during earthworks to establish and/or confirm required compaction standards for the particular natural materials on site.

If standards are to be amended, these will be directed by the Engineer onsite. The Contractor shall ensure that he has made due allowance in his tender for variance of natural materials, moisture contents and associated compaction requirements.

200.9.10 Rolling

The Contractor shall submit to the Engineer the compaction method and compaction equipment proposed to be used. The number of passes of the machinery required to produce the compaction specified shall be determined by the Contractor and confirmed by the Engineer. This number of passes shall be a guide to the Contractor as to the minimum amount of rolling required to be carried out, but shall in no way exempt the Contractor from full compliance with the compaction specification. The movement of all construction vehicles and incidental traffic shall be evenly distributed to prevent the formation of distinct wheel tracks and to ensure that any compaction effected by those vehicles is uniform throughout the filling areas. All fill placement shall in general conform to NZS 4431 and NZS 4404.



200.9.11 Compaction Testing

The Contractor shall arrange for regular control tests to ensure that adequate compaction has been attained over the entire area where fill materials are placed. Frequency of testing shall conform with NZS 4431 and control testing in accordance with NZS 4402.

All costs associated with the retesting of any unsatisfactory fill areas shall be borne by the contractor.

The earthworks will not be passed nor certified, nor final payment made, until the Engineer/Geotechnical Engineer is satisfied with the standard of work.

200.9.12 Subgrade Formation

On completion of subgrade formation, to the satisfaction of the Engineer, a joint inspection shall be carried out to determine compliance for shape, grade, strength and uniformity.

Longitudinal and transverse shape and grade checking shall be determined by the use of:

- i. A 3m straight edge.
- ii. Taut string lines and steel tape offset measurements.
- iii. Electronic survey equipment.

In all cases the tolerance must be within the range of +0 and -30mm to the designed or nominated levels. No gradient or cross-fall shall vary more than 10mm in a 3 metre length when compared with the true gradient or cross-fall

The final subgrade formation shall not locally pond water.

200.9.12.1 Protection of the Subgrade

The Contractor shall be responsible for the protection and care of the subgrade at all times and particularly during wet weather. He shall construct at no extra cost all necessary temporary drains to provide such protection. The whole of the subgrade shall be kept graded at all times to ensure that no areas pond water. The Contractor shall protect the subgrade from damage by laying planks when directed and shall take other precautions as needed. In no case shall vehicles be allowed to travel in a single track. If ruts are formed, the subgrade shall be reshaped and recompacted. Storage or stockpiling of materials on top of the subgrade shall not be permitted.

Any areas found to lack the specified accuracy or to have suffered deterioration shall be scarified, reshaped by adding, removing or replacing material, dried, watered, recompacted or otherwise treated until the specified requirements for the sub-grade and its surface are obtained

200.9.12.2 Subgrade Testing

When the Contractor considers that the preparation of the subgrade is complete in accordance with the above criteria, and that the condition and strength of the subgrade is suitable for the construction thereon of the subbasecourse and basecourse layers, he shall request that an inspection of the subgrade be carried out by the Engineer. The Contractor shall supply the results of all subgrade tests to the Engineer prior to the inspection, and shall carry out such further tests as the Engineer considers to be necessary to confirm the strength and condition of the subgrade. If so directed by the Engineer, the Contractor shall test roll the subgrade in the presence of the Engineer. This test rolling shall be by a 10 to 15 tonne rubber tyred roller, a fully loaded motor scraper, or similar plant item.

For each section of subgrade which has been prepared and completed, testing shall be carried out as follows:

The in-situ CBR shall be determined by testing with a dynamic cone (Scala) penetrometer to a depth of not less than 1 metre. Should any area fail to meet the design CBR the Engineer is to be notified and further works required to achieve the design requirements will be determined including the application of additional compactive effort to the top of the subgrade layer, stabilisation, undercutting etc. Following these works further testing with a dynamic cone Scala penetrometer as above will be undertaken.

Should any area still fail to meet the above deflection criteria, additional Scala penetrometer tests shall be carried out at closer intervals as directed by the Engineer to define areas of failure.



The Contractor shall not commence the construction of the subbasecourse layer until the Engineer’s acceptance of the subgrade is given. If during pavement construction, sealing or maintenance period, failure of any portion of the carriageway occurs which is attributable to the failure of the sub-grade then the Contractor shall make good the carriageway at his own expense.

Should the Engineer consider that the Contractor has not fulfilled his obligations to the extent that softening of, damage to, or failure of the subgrade occurs and that, in the opinion of the Engineer, remedial measures are necessary to restore the subgrade and any subsequent work to their original condition, the Contractor shall carry out such remedial works at no cost to the Principal.

200.9.12.3 Testing

Testing of subgrade, fill etc. shall be carried out in accordance with the following tables. All testing shall be carried out by the Contractor.

Table: Soil Tests Before Compaction		
Soil Type	Test	Frequency
Cohesive	Maximum Dry Density	Once per material type
	Liquid Limit	
	Plastic Limit	
	Plasticity Index	
Cohesionless	Maximum Dry Density	Once per material type
	Liquid Limit	
	Plastic Limit	
	Plasticity Index	
All	Moisture content	As required

Table: Soil Tests After Compaction		
Location	Test	Frequency
Bulk Fill	Surface Levels	20m grid
	Density/Moisture Content	1 per 900m ³ per layer
	Scala Penetrometer	20m grid
Subgrade	Surface levels	20 metre intervals
	Straightedge	Continuous
	Proof Rolling	Continuous
	Density/Moisture Content	20m intervals/lane
	Scala penetrometer	20m intervals/lane
	CBR Test	as directed

200.10 Re-spreading topsoil and grass establishment

On completion of earthworks to the satisfaction of the Engineer, topsoil shall be re-spread from stockpiles to the depths shown on the drawings, or other such depths as the Engineer may direct.

The topsoil shall be prepared so that the top 20mm is free of clods and is open textured and ready for the application of the seed mixture. The remaining topsoil layer should be firmly compacted.

Grass establishment shall be timed to take advantage of the local optimum growth period.

Grass seed shall be of a type approved by the Engineer and shall be supplied by the Contractor.

It is the Contractors responsibility to ensure a satisfactory strike (not less than 75% coverage) and any unsuccessful coverage shall be made good at the Contractor’s cost.

200.11 Protection and maintenance

The Contractor shall be responsible for the reinstatement of any damage within or outside the Contract area attributable to the operations of the Contractor. The Contractor shall at all times ensure that the works are



carried out in a way that prevents the deposition of material on land outside the Contract area by the action of water or causes attributable to the operations of the Contractor.

Any damage or deposition occurring during the Contract and period of maintenance, will be reinstated to the satisfaction of the Engineer at the Contractor's cost.

The Contractor shall be responsible for the stability of all cuttings and embankments until the end of the maintenance period and shall at his own cost, make good any subsidence or failure and replace any portions which have become displaced due to unsatisfactory workmanship, attrition by traffic, inadequate protective/stabilisation measures or any other reasons attributable to the negligent operations of the Contractor.



300 STORMWATER DRAINAGE

300.1 General

Refer to the General Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

300.2 Scope of works

The work comprises the construction complete of all drains, junctions, bends, special fittings, manholes and any ancillary work necessary for the completion of the works in accordance with the Contract Drawings, this Specification and the General and Special Conditions of Contract.

300.3 Related documents

This section makes reference to various standards or documents, which form part of this Specification unless otherwise qualified by this or other contract documents. It should be noted that these documents in turn require reference to other standards. In all cases the standards or other documents are to include the latest version and all amendments current at the time of tender.

Concrete Pipes

AS/NZS 3725 *Design for installation of buried (plus Supplement 1) concrete pipes.*

AS/NZS 4058 *Precast concrete pipes (pressure and non-pressure)*

Plastic Pipes

AS/NZS1254 *PVC pipes and fittings for stormwater and surface water applications.*

AS/NZS4058 *UPVC pipes and fittings for drain, waste, and vent applications)*

AS/NZS2032 *Installation of PVC pipe systems*

AS/NZS7643 *Code of practice for installation of unplasticised PVC pipe systems*

Other

NZS3109 (plus amendments 1 and 2) *Concrete construction*

BS7874 *Method of test for elastomeric seals and joints in pipework and pipelines.*

AS/NZS2566 (plus supplements 1 and 2) *Buried flexible pipelines — structural design and installation.*

NZS4404 *Land Development and Subdivision Infrastructure.*

300.4 MATERIALS

300.4.1 Pipes

Pipes shall be of the material, class and jointing type nominated on the Drawings and shall comply with the relevant specification listed in TNZ F/3, NZS 3725, NZS 2566, NZS 4452 and AS/NZS 5065.

It is noted that all drainage pipes shall include a suitable jointing system that is water tight and that will limit potential displacement between pipes to the satisfaction of the Engineer.

300.4.2 Castings

Castings shall be made from grey iron of a quality not less than that specified as grade ENGJL-150 in BS EN 1561 and shall be free from all defects. Castings shall be hot dipped in bitumen. Covers and grates shall not rock in their frames. Where shown in the Drawings castings shall be “Gatic Non-Roc”.



300.4.3 Step Irons

Step irons for manholes shall be of the type as detailed in NZS 4404 formed from 20mm diameter round Type 316 stainless steel rod.

300.4.4 Concrete

Concrete work shall be in accordance with this Specification. Unless stated otherwise, concrete shall have minimum 28 day strength (f'c) of 20MPa.

300.4.5 Granular Pipe Bedding

Granular pipe bedding shall be AP20 gravel or crushed stone complying with the grading requirements of NZS 4452. The compaction fraction shall be less than 0.1.

300.4.6 Hardfill

Hardfill shall be GAP65 satisfying the requirements of NZS 3725 and NZS 2566, unless specified otherwise on the Drawings. Crushed demolition material shall not be used as hardfill in trenches.

300.4.7 Sand

Sand for pipe bedding and backfilling shall be clean sharp sand.

300.5 CONSTRUCTION

300.5.1 General

Construction of pipe drains and culverts shall be carried out in accordance with TNZ F/3 and/or NZS 4452 as applicable.

Where required, all drainage work shall be carried out by a suitably experienced and competent drain layer using best trade practice. Works shall also meet the requirements of the Cook Islands Building Code as required.

Special consideration is to be given to the proper bedding out at the spigots of reinforced concrete pipes to ensure that the full length of each pipe barrel is completely supported by bedding material, and is not subjected to bending and possible circumferential cracking.

Additions and/or modifications to TNZ F/3 and NZS 4452 are set out below.

300.5.2 Salvage of Existing Pipes

Obsolete pipes shall be excavated and removed or grouted, as shown on the Drawings. All removed pipes shall be removed from site, becoming the property of the Contractor.

300.5.3 Trench Excavation

Concrete, asphalt or chip sealed pavements and footpaths shall be saw cut parallel to and 300 mm outside the edges of the proposed trench. The pavement surfacing shall be carefully removed prior to excavation.

The maximum trench width from the trench invert to a height of at least 150 mm above the top of the pipe shall not be greater than the external diameter of the pipe plus 400 mm for pipes up to 600 mm diameter and plus 600 mm for pipes over 600 mm.

The trench width for corrugated steel pipes shall be the external pipe diameter plus one metre or half the pipe diameter either side of the pipe, whichever is the smaller.

300.5.4 Bedding

Pipes shall be laid upon granular pipe bedding except where expressly detailed otherwise in the Drawings.



Corrugated polyethylene pipes shall be laid on compacted granular material of the following minimum thickness:

100 mm in sands and gravel

200 mm in silts and clays

300 mm in rock

Bedding material for corrugated polyethylene pipes shall be shaped to the curvature of the invert and shall be of sufficient width to permit effective compaction of backfill under the haunches of the pipe. A uniform blanket of sand 50 mm thick shall cover the shaped, compacted bedding material before setting the pipe in place.

300.5.5 Pipe Laying and Jointing

Pipes shall be laid to the lines, grades and invert levels indicated on the Drawings. The installed pipeline shall have a uniform gradient and the pipe invert level at any point shall not vary more than ± 10 mm from the specified design invert level, except that where the design gradient is 1% or flatter, the pipe invert level shall not vary more than ± 3 mm from the design invert level.

Pipes shall be clean and free from dirt or mud on the inside and, in the case of pipes requiring concrete surround, on the outside as well, before laying. Debris shall be prevented from entering the pipes during laying.

The method of lifting and installing of pipes shall prevent damage to the pipes and bedding material.

All pipes shall be laid by a suitably experienced and competent drain layer.

The jointing of pipes to a manhole or other structure shall be carried out in accordance with the requirements of NZS 4452 except that:

Stub connections shall be provided for all pipe connections to a manhole or other structure and shall project not more than 300 mm from the structure for pipes up to 350 mm bore diameter, and not more than 600 mm from the structure for pipes over 350 mm bore diameter. Connections shall be surrounded and haunched with concrete to a minimum distance of 200 mm from the manhole

Where there is likelihood of relative vertical movement in the case of RC pipes less than 350 mm bore diameter, the RC pipe joined to the stub pipe shall be no longer than one metre and shall be flexibly jointed at both ends

For flexible pipes into concrete structures the Contractor shall follow the written requirements of the pipe manufacturer

300.5.6 Backfilling

(a) General

No backfilling shall be done until laying and jointing of the line has been checked and certified, in accordance with Contractors QA system.

Backfilling of trenches and around manholes and other drainage structures, constructed outside of pavement areas, shall be completed with "selected fill" complying with and placed and compacted as specified in TNZ F/3, unless where shown otherwise on the Drawings.

Heavy construction equipment shall not be operated over or near such pipes, or within 1m of the trench, until a minimum cover of 0.6 metre compacted depth has been achieved.

Any pipe moved or damaged during compaction shall be replaced.

(b) Hardfill Backfill



In existing paved areas, or where shown on the Drawings for future paved areas, backfill for trenches and around manholes and other drainage structures shall be hardfill as specified. Hardfill backfill shall be placed in layers not exceeding 150 mm loose thickness. Each layer shall be compacted with approved mechanical compaction equipment before the next layer is placed.

Prior to pavement surfacing newly laid small diameter RC pipes (less than 450mm-dia) are to be inspected by CCTV to ensure pipe has not suffered circumferential cracking because of poor bedding or handling. If cracking is evident the defective pipes shall be replaced.

(c) Reinstatement in Existing Pavement Areas

Backfill material in existing pavement areas above subgrade level shall match that of the existing pavement. It shall be placed and compacted in accordance with TNZ B/2.

The surface of the trench shall be reinstated to a standard equivalent to the existing surface.

Any seal edge previously saw cut and subsequently damaged shall be resawn and made good prior to final surfacing works.

(d) Reinstatement in Existing Grassed Areas:

The final 150 mm of backfilling shall be clean topsoil, free from stones, and sown with grass.

300.5.7 Concrete Structures

(a) General

Concrete work shall be carried out in accordance with C0207 of this Specification, noting the additions and/or modifications set out below.

(b) Sumps (Catchpits)

Sumps shall be constructed as shown on the Drawings. Sumps shall be constructed in the positions and to the invert levels shown on the Drawings.

The quality of materials, formwork and workmanship shall be such that on completion, a smooth even surface is obtained without plastering. The shafts shall be carried up to such height that when cast iron frames are set in position the top of the frame shall be 50 mm below the finished surface of the adjacent channel, roadway or existing ground, as is appropriate, except where otherwise required. Walls shall not be poured directly against the ground.

Precast catchpits meeting the requirements of NZS4404 may be used. Pipe connections shall be haunched and surrounded with concrete to a distance of 150 mm from the catchpit wall.

(c) Cast in Place Manholes

Manholes shall be constructed as detailed in NZS4404 from 20 MPa concrete, unless shown otherwise on the Drawings. Manholes shall be constructed in the positions and to the invert levels shown on the Drawings.

Where practicable, manhole inverts shall be formed with a half pipe centrally bedded in concrete. In all other cases, the channels in the floor of the manholes shall be formed in concrete rendered with cement mortar and finished with a steel tool and neat cement. Leaks shall be carefully stopped and the manholes made watertight. Benching in manholes shall be rendered with cement mortar and finished as above. Pipe ends shall finish 13 mm short of the inside wall and be plastered with cement mortar. Pipes shall be haunched and surrounded with concrete to a minimum distance of 200 mm from the outside of the manhole. In manholes over 900 mm deep, step irons shall be built into the manhole wall in a line vertically above the outlet pipe.

Manhole roof slabs shall be set to levels to ensure the finished cast iron lid levels and slopes will coincide with the surrounding road, path or ground surface as the case may be. Roof slabs and lids shall be heavy duty unless expressly noted to the contrary.



Where shown on the Drawings, junctions shall be constructed into the manhole. Junctions which are not to be connected during the contract shall be sealed.

(d) Precast Manholes

Precast manhole components shall be assembled and jointed strictly in accordance with the manufacturer's written recommendations, and shall consist of centrifugally spun reinforced concrete flush-jointed pipes of the diameters shown on the Drawings. Holes for step irons shall be factory made with step irons bolted into the manhole wall and the outer end of the holes filled flush with mortar. The base benching and mortar shall be constructed in accordance with the detail shown in NZS 4404, unless shown otherwise on the Drawings. Connections shall be haunched as specified above.

Manholes 2.4 m and less to invert shall be constructed from one precast section. Manholes over 2.4 m deep shall have a bottom section of minimum length 1.8 m. Excepting at the base, all joints in the manholes shall be sealed with RB 200 sealant and held together with approved stainless steel replaceable tie bolts on the inside of the manholes.

All manholes shall be watertight.

(e) Inlet and Outlet Structures

Inlet and Outlet structures shall be constructed in accordance with the Drawings complete with concrete apron and flow-dissipation and riprap. (f) Junction and Branch Connections

Where shown on the Drawings, 'Y' Junctions shall be laid in the new drainage lines for future connections. All connections shall be fitted with factory sealed stoppers.

300.5.8 Concrete Encasing and Capping

Where concrete encasing or capping is required, 17.5 MPa concrete shall be used. Unless otherwise detailed, concrete encasing shall be discontinuous at each pipe joint.

300.5.9 Boring and Jacking Installation

Installation shall be carried out with an approved system by an experienced operator and so that no disruption to traffic or damage to the roadway occurs. Pipe shall be installed concurrent with the boring operations unless a jacking sleeve is used. Water shall be prevented from entering the excavation.

300.6 TESTING AND ACCEPTANCE

All pipelines shall be inspected both before backfilling the trench and after all backfilling and surface reinstatement is completed.

The following tests shall be undertaken:

All pipelines and associated sumps, catchpits and other elements shall be surveyed to confirm final position and grade

All pipelines shall be inspected for line and grade. Sighting through each line between manholes and/or outlets after backfilling shall show a full circle at the far end with all pipes concentric

Inspection before final surfacing of 450Ømm diameter or less RC pipe to check for possible cracking resulting from poor bedding or handling. Prior to inspection the pipelines shall be cleaned by flushing

Any elements not meeting the requirements shall be re-laid.



400 CONCRETE FOR MINOR WORKS

400.1 General

Refer to the general Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

400.2 Scope

This specification covers supplying and placing portland cement concrete for minor structures and incidental construction, and includes reinforcing steel and formwork.

400.3 Related Documents

This section makes reference to various standards and TNZ Specifications; the main ones referred to are listed below, but it should be noted that these in turn require reference to other standards. In all cases the standards are to include all amendments current at the time of tender.

NZS 3104:2003	Concrete Production
NZS 3112:1986	Methods of Test for Concrete Part 1: Tests relating to fresh concrete Part 2: Tests relating to the determination of strength of concrete
NZS 3114:1987	Concrete surface finishes
NZS 3121:1986	Water and aggregate for concrete
NZS 3122:2009	Portland and blended cements
NZS 3124:1987	Concrete Construction for Minor Works
AS/NZS 4671:2001	Steel bars for reinforcement of concrete

400.4 MATERIALS

400.4.1 Water and Aggregates

Water and aggregates for concrete shall comply with NZS 3121.

400.4.2 Cement

Cement shall comply with NZS 3122, Type GP.

400.4.3 Concrete

All concrete except site concrete shall be manufactured by an approved readymix plant and shall be High or Special grade to NZS 3104.

Slump shall be in accordance with Table 4 of NZS 3124. The nominal maximum aggregate size shall be 19 mm.

Concrete for structures shall have a minimum crushing strength of 20 MPa at 28 days except where otherwise specified.

Weak concrete where required shall consist of 1 part of Portland cement to 6 parts of AP20 aggregate by volume.

400.4.4 Mortar

Mortar shall consist of two or three parts of fine, sharp, well graded sand to one part of cement measured by dry loose volume, well mixed by hand or in a suitable mechanical mixer with just sufficient water to make it



slightly moist. It shall be mixed in small quantities as required. Any mortar not used within 30 minutes of mixing shall be discarded.

400.4.5 Reinforcing

Reinforcing shall be grade 300 bars unless otherwise shown. Welded wire fabric shall comply with AS/NZS 4671.

400.4.6 Marine Grade Concrete

Where required on the Drawings, marine grade concrete shall be used, having the following properties:

Minimum Compressive Strength at 28 days (f'c)	30 MPa
Cement Content (minimum)	380 kg/m ³
Maximum Water Cement Ratio	0.45
Minimum Water Cement Ratio	0.40

400.5 CONSTRUCTION

400.5.1 Excavation and Foundations

Structures shall be constructed on foundations of equal or better strength than specified for subgrade. Excavation including undercut shall be in accordance with C0203 and as directed by the Engineer. Undercuts shall be backfilled with compacted hardfill.

400.5.2 Formwork

Formwork shall be to the requirements of NZS 3124 as appropriate for this type of construction.

400.5.3 Reinforcing

Reinforcing steel shall be bent and placed in accordance with NZS 3124. Spacers and supports shall be either proprietary or purpose-made using 20 MPa concrete. Bricks, wood or concrete masonry shall not be used as spacers or supports.

400.5.4 Concreting

No concrete shall be placed until the formwork and reinforcing has been inspected and approved.

Concrete shall be placed in accordance with NZS 3124 and as near as possible to its final position. Vibrators shall not be used to move concrete along forms. Vibrators are to be of the immersion type unless otherwise approved.

400.5.5 Finish

Unless specified on the Drawings, surface finishes shall be of the following classes defined in NZS 3114:

- (a) Formed surfaces to be backfilled shall be Class F1.
- (b) Exposed formed surfaces shall be Class F3.
- (c) Unformed surfaces to be backfilled shall be Class U1.
- (d) Unformed surfaces exposed to weathering shall be Class U3.

400.5.6 Tolerances

Unless otherwise specified, tolerances shall be in accordance with Table 2 of NZS 3124.

400.5.7 Defective Concrete Finishes

Concrete that is damaged from any cause, and concrete that is honey-combed, fractured or otherwise defective, and concrete which has surface depressions outside the tolerances specified, shall be cut out and replaced. Minor bulges and abrupt irregularities beyond the specified limits shall be reduced by grinding to approved tolerances. Minor depressions and defects may be repaired by filling. All fillings shall be bonded tightly to the surface of the holes and shall be sound and free from shrinkage cracks and hollow areas after



the fillings have been cured and dried. The Engineer shall determine whether a bulge or depression can be repaired or cut out. Where the repair requires the concrete to be cut out, appropriate size repairs must be made as directed by the Engineer.

Repair of defective concrete finish other than that due to minor porosity of the surface shall be carried out by one or more of the following methods as accepted by the Engineer:

- Concrete removal and replacement
- Hand placed cement mortar
- Pneumatically placed cement mortar
- Epoxy mortar

A method statement for the repair of damaged or defective concrete shall be provided and approved prior to carrying out remedial works.

400.5.8 Backfill to Concrete Structures

All spaces which have been excavated, and the volumes of which are not occupied by the concrete structure, shall be backfilled with suitable material compacted in layers in accordance with the provisions of the specification, or as directed by the Engineer.



500 KERBS, CHANNELS, FOOTPATHS & VEHICLE CROSSINGS

500.1 General

Refer to the general Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

500.2 Scope

This specification covers the construction of concrete kerbs, channels, footpaths, pram crossings and vehicle crossings.

500.3 Related Documents

This section makes reference to various standards and TNZ Specifications; the main ones referred to are listed below, but it should be noted that these in turn require reference to other standards. In all cases the standards are to include all amendments current at the time of tender.

NZS 3104:2003	Concrete production
NZS 3114: 1987	Concrete surface finishes
NZS 3124:1987	Concrete construction for minor works
NZS 4404:2010	Land Development and Subdivision Infrastructure

500.4 MATERIALS

500.4.1 Mortar

Mortar shall comply with the requirements of C0207 of this specification. Any mortar which is not used within 30 minutes of mixing shall be discarded.

500.4.2 Concrete

Unless otherwise specified, all concrete used in roading and street works shall comply with the requirements of NZS3109, and shall have a minimum compressive strength as indicated on the Contract drawings or specified elsewhere.

All materials used in concrete work including formwork, reinforcement, cement, aggregates, etc. shall be subject to the approval of the Engineer who may reject any materials which he considers will lead to an unsatisfactory finished structure.

500.4.3 Precast Kerbs

Precast kerb blocks shall be manufactured to the dimensions shown in and shall be of the type shown in the Drawings. They shall be precast in 20 MPa concrete and shall be sound and free of blemishes when ready for laying.

500.5 CONSTRUCTION

500.5.1 General

The construction of concrete kerbs, channels footpaths and vehicle crossings shall comply with the requirements of NZS 4404 which shall be deemed to form a part of this Specification except as modified herein.



500.5.2 Kerbs

Kerbs shall be laid accurately to the lines, gradients and levels shown in the Drawings. No kinks or flats will be permitted. String lines shall be inspected for line, gradient and level prior to laying kerb.

Precast kerb blocks shall be bedded on and backed with 10 MPa concrete to the minimum thickness detailed on the Drawings, and shall be flush pointed with mortar.

500.5.3 Channels

Channels shall be cast insitu from 20 MPa concrete in accordance with the details shown in NZS 4404 and to the lines and levels shown in the Drawings. Where shown channels shall be reinforced.

Formwork shall be straight and parallel to kerb lines and shall be sufficiently braced to ensure that no deflection occurs during construction. Concrete shall be poured continuously between stop ends.

Contraction joints in unreinforced channels shall be formed at 4 metre centres, at right angles to the kerb line, by insertion of "Malthoid" D.P.C or equivalent strip. The joint material shall be set flush with the surface and shall be a minimum of 25 mm deep. Contraction joints shall be coincident with joints in precast kerb blocks.

The top surface of channels shall be finished smooth and even with a steel trowel. Channels shall not pond water at any point.

500.5.4 Machine Laid Kerb and Channel

Kerb and channel may be cast insitu using 25 MPa concrete placed by an approved machine operated by skilled personnel. The profiles shall be in accordance with NZS 4404 except where specified otherwise.

Contraction joints shall be formed at 5 metre maximum centres, at right angles to the kerb line, by saw cutting or other approved method. Where a footpath adjoins the kerb, contraction joints shall be coincident with joints in the footpath.

500.5.5 Concrete Footpaths

(a) Preparation

The subgrade shall be excavated and trimmed to achieve a firm, uniform surface, and a layer of approved AP20 granular material shall be placed and compacted with a mechanical compactor to a minimum thickness of 25 mm. The granular layer shall be well wetted with water immediately prior to the placing of concrete.

(b) Setting Out

The line of the footpath shall be carefully set out in accordance with the Drawings. The line shall be straight between tangent points and shall sweep around any curves in a true arc without flats, kinks or angles. Levels, gradients and crossfalls shall be as shown on the Drawings, and the finished surface shall be free draining.

(c) Construction

Footpaths shall be constructed from 20 MPa concrete and shall be 100 mm thick or as shown on the Drawings.

The Contractor shall form contraction joints every 4 m by saw cutting or other approved method. The edges of the paths shall be neatly chamfered. Concrete shall be poured in one operation and without interruption between formed construction joints. The whole of the surface shall be screeded and after the initial set it shall be carefully broomed transversely to present a non-skid surface. The surface shall comply with NZS 3114 class U5. The finished work shall be kept continuously wet by approved means and shall be thoroughly protected from frost and from direct rays of the sun and from drying winds for at least seven days after pouring. The boxing supporting the vertical faces shall not be removed for at least 36 hours after the concrete is placed.



(d) Wheelchair Crossings

Wheelchair and pram crossings shall be constructed in accordance with NZS 4121 Code for the Disabled, or as detailed.

500.5.6 Vehicle Crossings

Concrete vehicle crossings shall be constructed from 20 MPa concrete in accordance with the Drawings and NZS 4404.



600 GRANULAR PAVEMENTS

600.1 General

Refer to the general Conditions of Contract, which are equally binding on all trades. The requirements of the various sections of this Specification are inter-related. Therefore, it is necessary that this section of the Specification be read in conjunction with all other sections.

600.2 Scope

This specification covers the construction of flexible road pavements using conventional metal sub-basecourse and basecourse material,

600.3 Related Documents

This section makes reference to various standards and TNZ Specifications; the main ones referred to are listed below, but it should be noted that these in turn require reference to other standards. In all cases the standards are to include all amendments current at the time of tender.

NZS4404	Land Development and Subdivision Infrastructure
NZS 4402	Methods of Testing Soils for Civil Engineering Purposes
NZS 4407	Methods of Sampling and Testing Road Aggregates
TNZ B/02 (+ Notes)	Construction of Unbound Granular Pavement Layer
TNZ M/3 Notes	Sub-base Aggregate
TNZ M/4 (+ Changes)	Basecourse Aggregate
TNZ T/1 (+ Notes)	Benkelman Beam Deflection Measurements
TNZ F/2 (+ Notes)	Pipe Subsoil Drain Construction

600.4 General

600.4.1 Protection of existing kerbs, channels and services

The Contractor shall avoid damage to all existing kerbs, channels, footpaths, sumps, manhole tops, pipes or any other services above, at, or below, ground level. Any damage occurring shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

The contractor should allow all costs to marry new work into existing pavements and shall ensure that Road Managers standards are complied with at all times.

600.4.2 Preparation of road subgrade

The construction of the subgrade for roads is described within the technical Specification.

Scala penetrometer tests of the subgrade will generally be required to determine/confirm the pavement design.

A joint inspection of the subgrade shall be carried to determine the extent of weak areas and the best method for their improvement. The responsibility for the cost of such work shall also be agreed at this time.

The Contractor shall then proceed to improve the soil in the weak areas and carry out the final trimming and rolling of the subgrade. Trimming, shaping and rolling shall be carried out using equipment suited to achieving the required profiles and compaction. Trimming and rolling shall be carried out under dry ground and weather conditions and care shall be taken not to over—compact or disturb sensitive soils. Any point on the final surface of the subgrade shall have a level within 30mm of its designated level.

Benkelman Beam tests of the subgrade if required by the Engineer shall be taken in strict accordance with TNZ Specification T1. Test readings shall be taken at 20m centres along the road at 1 and 3 metres from the



face of each kerb line or edgeline. The Contractor may take tests at any other points that he considers necessary. A copy of the results of the tests shall be supplied to the Engineer, and these shall be analysed to assess the adequacy of the subgrade formation.

On completion of any further subgrade improvement work in the areas showing high deflections, the subgrade shall be considered to be complete and the Contractor shall then assume entire responsibility for its maintenance and the subsequent construction of the pavement layers. Any weaknesses which develop in the pavement or subgrade shall be repaired in accordance with the Engineer's instructions at the Contractor's expense.

600.4.3 Trimming

The Contractor shall be responsible for the final trimming and compaction of the subgrade to a tolerance of no more than 30mm below and not above the required level. Surplus material from the trimming shall be disposed of on site as directed by the Engineer. If in the opinion of the Engineer any portions of the subgrade are unsound, the faulty material shall be removed and replaced with material approved by the Engineer and then compacted.

600.4.4 Subgrade Drains

Drains shall be laid where detailed on each side of the road carriageways or accessway as shown on the Contract Drawings and shall discharge into cesspits or other approved outlet. The drains shall be surrounded with clean scoria or drainage filter metal. Filter socks may also be specified.

600.4.4 Subgrade Protection

When the subgrade has been accepted by the Engineer, and all ancillary work has been completed, the sub-basecourse and basecourse metal shall be placed and compacted.

Under no circumstances shall the prepared and compacted subgrade be left uncovered to suffer damage by weather, construction traffic, or any other cause.

Should the Contractor fail to observe this provision, and damage to the subgrade does occur, the Contractor shall meet the full costs of restoring the subgrade to the specified standards immediately before metalling proceeds.

Despite the fact that the subgrade has been approved by the Engineer, should any subsequent weakness in the subgrade develop during metal placing which is attributable to weakness of the subgrade, then the Contractor shall remove the metal, make good the subgrade, and replace the metal and/or sealing to the satisfaction of the Engineer. If it is found during the course of the carrying out of this remedial work that the cause of the above weakness of the subgrade can be shown to have been due to failure on the part of the Contractor to adhere strictly to the terms of the Specification, then no extra payment for the work done or materials used in making good this failure will be allowed to the Contractor.

600.5 Material

600.5.1 GAP 65, GAP 40, GAP 20

The GAP aggregate shall comprise crushed aggregate and must be free of all non-mineral matter.

600.5.1.1 Crushing Resistance

Crushing Resistance shall be not less than 130 kN when the aggregate is tested according to NZS 4407:1991 Test 3.10 "The Crushing Resistance Test".

600.5.1.2 Weathering Resistance

The aggregate shall have a quality index of AA, AB, AC, BA, BB or CA when tested according to NZS 4407:1991 Test 3.11 "Weathering Quality Index test".

600.5.1.3 Sand Equivalent

The sand equivalent shall not be less than 25 for carriageway pavement metal when the aggregate is tested according to NZS 4407:1991 Test 3.6 "Sand Equivalent Test".



600.5.1.4 Permeability

The permeability shall be greater than 1×10^{-4} m/s when tested in accordance with Section 10.6 of Volume 2 of the “Manual of Soil Laboratory Testing” by K H Head. The test samples shall be compacted to the same density as specified for the completed in-situ sub-base.

600.5.1.5 Grading Limits

When tested according to NZS 4407:1991 Test 3.8.2 "Subsidiary Method by Dry Sieving", or Test 3.8.1 "Standard Method by Wet Sieving" where aggregates contain clay or other fine material causing aggregation of the particles, the grading of the aggregate shall fall within the respective envelope defined below.

Test Sieve Aperture	Percentage by Weight Passing		
	GAP 65	GAP 40	GAP 20
65.0 mm	100		
37.5 mm		100	
19.0 mm	40-65	63-81	100
9.5 mm		40-60	52-76
4.75 mm		25-45	33-57
2.36mm		16-35	20-44
1.18 mm		9-27	12-35
600 micron		5-20	7-25
300 micron	10 max	1-15	4-20
150 micron		10 max	12 max
75 micron		7 max	8 max

600.5.2 NZTA M/4 AP40 & AP20

Where specified on the drawings, all metal used for basecourse or running course construction shall comply with the standards/requirements of NZTA specification M/4 2006 and or subsequent issues.

600.6 Construction

No metalling shall start until the subgrade has been inspected and approved by the Engineer who will determine if testing is required to determine any bearing capacity issues.

Where a subbase is specified, it shall be placed as a separate layer and shall be compacted and trimmed to conform with the lines, grades and cross sections shown on the plans. The sub—base shall be inspected and approved by the Engineer before any basecourse metalling is carried out.

The depths of metal specified on the Contract Drawings for both the subbase and the basecourse may be subject to alteration. Following inspection or testing, the Engineer will advise the Contractor if any variations are required in the specified metal depths.



600.6.1 Preparing Underlying Course

The sub-base shall be constructed, shaped, compacted and finished in conformity with the provisions of this Specification before placing of basecourse is commenced.

Control of levels between the edges of the pavement shall be by stringing between level stakes or steel pins placed in lanes parallel to traffic routes at intervals not exceeding 20 metres or by means of laser levelling equipment.

600.6.2 Supply, Placing, Compaction and Testing

The supply, placing, compaction and testing of the Sub base and basecourse layers shall be carried out in strict accordance with TNZ B/2 specification.

Placing procedure shall be such that no damage to, or rutting of, the subgrade or sub-base occurs. Cartage shall be arranged such that trafficking of the subgrade is avoided, and trafficking of the subbasecourse is minimised. Particular care shall be taken that traffic is not concentrated in any area.

600.6.3 Surface Shape, Surface Finish, Construction Tolerance

Should the finished surface be loose or 'bony' the contractor shall undertake remedial actions as directed by the Engineer at no additional cost. Remedial actions, such as the ones detail below, shall be discussed and agreed with the Engineer on site.

Take up, replace and re-compact all "bony" areas.

Tighten up with the addition of small amount of approved binder fraction following by light watering to ensure optimum compaction is achieved. On no account shall a skin of fines be allowed to form on the basecourse surface.

Refer to TNZ B/2 specification for other surface shape, surface finish and construction tolerance requirements.

600.6.4 Protection and Caring

Where a running course is proposed, construction of the running course shall comply with TNZ B/2 specification, clause 10.

Cartage equipment may be routed over the basecourse provided no damage results, and provided that such equipment is routed over the full width of the basecourse to avoid rutting or uneven compaction. Where any damage is caused by cartage over the basecourse layer, the Constructor shall undertake remedial actions as directed by the Engineer at no additional cost.

600.6.5 Benkelman Beam Deflection Testing

Benkelman Beam testing shall be carried out on top of the basecourse in accordance with TNZ T/1 specification at 20m intervals in each lane in both wheelpaths. The acceptance criteria shall be agreed prior to the commencement of testing on site or as noted on the design drawings. The acceptance criteria may vary for different pavements with different subgrade types.

600.6.6 Presealing

Refer to TNZ B/2 specification, clause 12 for presealing requirements. Joint pre seal inspection shall be carried out by Engineer and Constructor prior to the commencement of surfacing or construction of the upper pavement layer(s).

The finished basecourse surface is expected to be smooth, even, tightly bound and free from sudden changes in profile that will affect the finished surfacing. The surface is to be free from slurry or excessive fines, the surface is to be broomed with a stiff bristled rotary broom and is to be a mosaic surface with larger aggregate bound by smaller aggregate.

Where in the opinion of the Engineer the surface is deemed not to meet these requirements the Contractor will at their cost undertaken remedial works as agreed with the Engineer to rectify the surface profile such as ripping and compacting, drag brooming etc.



600.6.7 Testing

Table 210.3 specifies the minimum acceptable testing frequency for each modified layer.

Table - Minimum Test Frequency

Test Property	Frequency
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Source Property Testing including:

Particle Size Distribution Bearing Strength Crushing Resistance Weathering Resistance Sand Equivalent Clay Index Plasticity Index Broken Face Content Permeability	Prior to agreement of material source and 1 test for each 10,000m ³ of source material used.
Maximum Laboratory Dry Density and Optimum Moisture Content Solid Density (NZS 4407 Test 3.7 or ASTM C127/128)	Prior to agreement of material source and 1 test for each 5,000m ³ of source material used.
For running course material testing only: Crushing Resistance Particle Size Distribution	1 test per material source

Production Property Testing including:

Particle Size Distribution Sand Equivalent Clay Index Plasticity Index	2 tests per 1-400m ³ lots size 3 tests per 400-1500m ³ lots size 4 tests per 1500-4000m ³ lots size. Where the lot size exceeds 4000m ³ , additional testing at the rate of 1 test for every 1000m ³ .
Crushing Resistance Broken Face Content Weathering Resistance	2 tests per source 4 weeks before use on site.

In-situ Testing including:

Particle Size Distribution Sand Equivalent or Clay Index/Plasticity Index (Mat Test)	1 test per 1,000m ³ of material placed.
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Compaction test including Degree of Saturation test immediately prior to surfacing	For each compacted layer. 1 set of test (5 random test points) per lot. If lot size exceeds 1000m ² , additional test at a rate of 1 set for every 1000m ²
Surface level, thickness, surface shape and crossfall	each 20m cross section
Visual Inspection prior to the commencement of the upper pavement layers or surfacing	entire site
Benkelman Beam Deflection	1 test per 20m interval staggered, in both wheelpaths of each lane.

600.6.8 Acceptance Criteria

In addition to compliance with TNZ B/02 Construction of Unbound Granular Pavement Layer the following acceptance criteria is to be utilised.

Table: Compaction testing

	Carriageway	Footpath	Berm
Basecourse	98% MDD or IV 40	IV 30	N/A
Sub-base	95% MDD or IV 30	IV 30	N/A
Deeper Fill	IV 25	IV 15	IV 10

IV = impact value

Compaction testing must be carried out:

- by a suitably qualified person;
- using equipment with a current calibration certificate;
- as specified in the Reasonable Conditions and Quality Plan; and
- as necessary to achieve the standards in the Table above at all depths of any backfill.

A lesser compaction for sand may be approved by the Road Manager if it can be clearly shown that the compaction is at least as much as the undisturbed sand in the adjoining ground.

In the case of low volume roads a minimum impact value of 35 for carriageway base course may be accepted by the Road Manager as an alternative to specifying a maximum dry density (MDD).

The above specifications do not remove the responsibility of the Contractor to ensure that no settlement occurs.

Also note that:

- The Clegg hammer may be used for testing of general fill and base layers of Carriageways;
- Clegg hammer tests only indicate the compaction of the lift last laid of any backfill layer. The impact tester method covers material of 37.5mm and down and may not be suitable for sub-base material with larger stone sizes.

The Contractor must retain the test records and make them available to the Engineer.

Any areas which do not comply with this specification shall be rejected, and reconstructed as agreed with the Engineer.

