



Department of
Building and Housing
Te Tari Kaupapa Whare

Department of Building and Housing Engineering Advisory Group

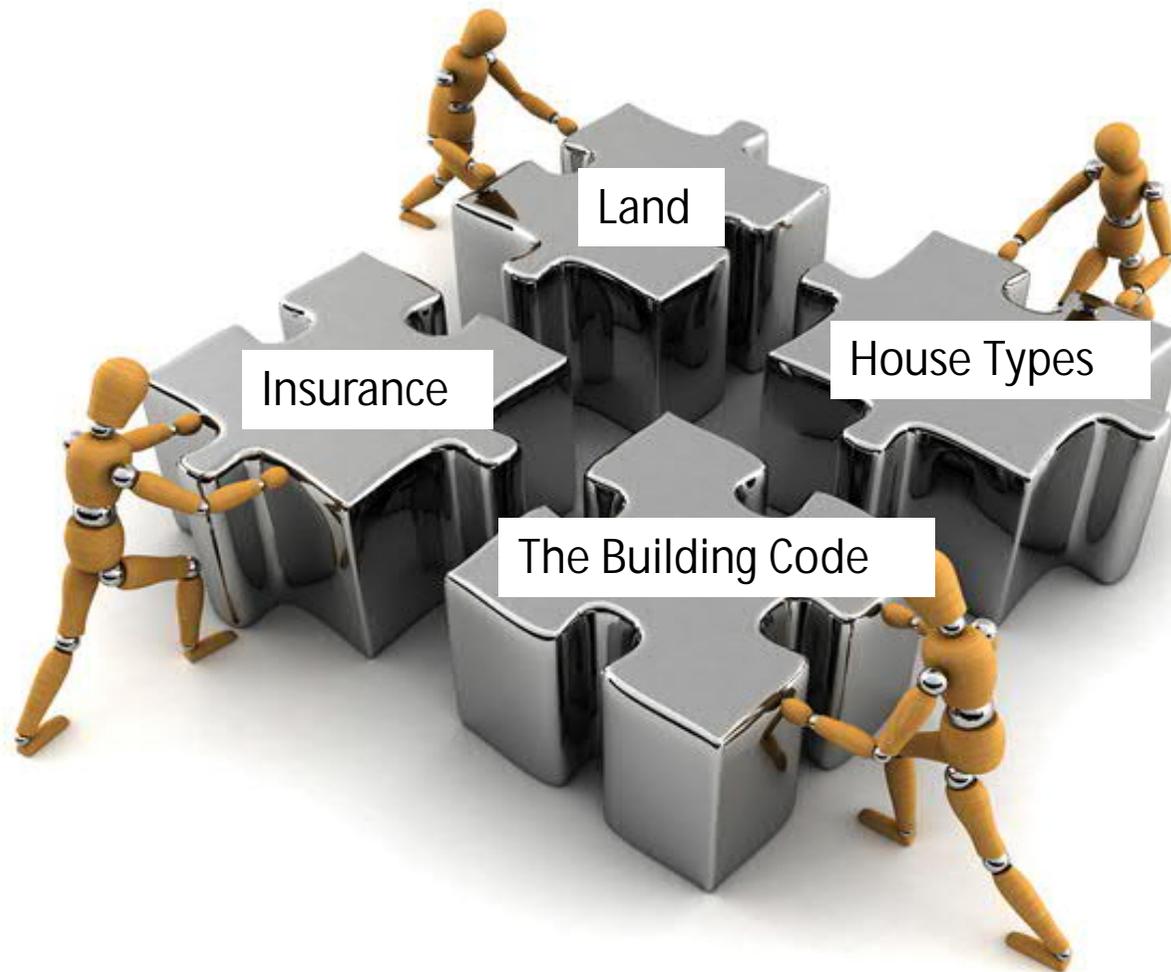
Overview of the Technical Categories and the Guidance Document for Repairing and Rebuilding Houses

Briefing of CCC, WDC and SDC 22 November 2011



Department of
Building and Housing
Te Tari Kaupapa Whare

The Green Zone Puzzle



Understanding future
land performance

Understanding how
standard house types
will perform

Land

Acceptability
to Insurers

Insurance

House Types

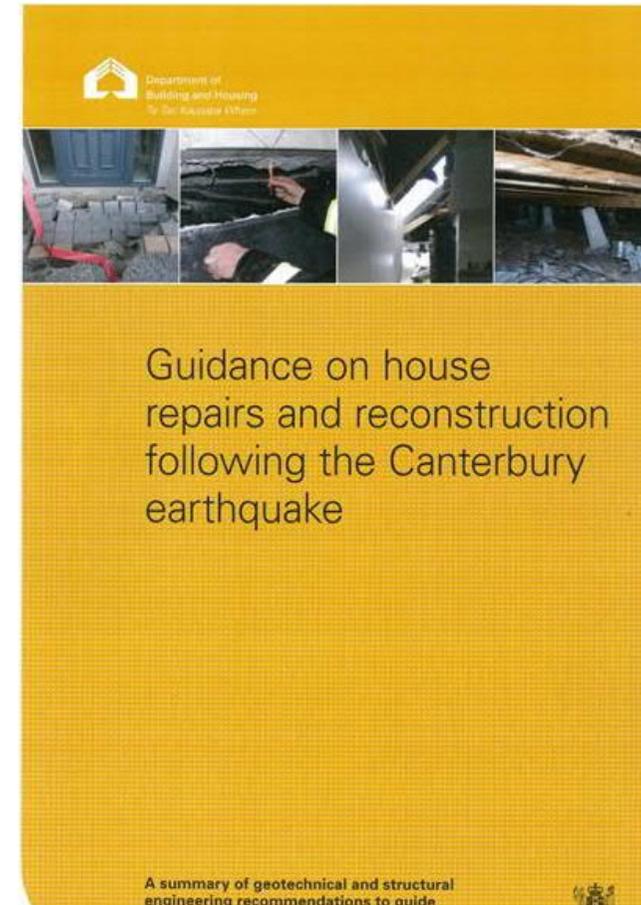
The Building Code

Interpreting building
regulations in a post-
disaster environment

Ensuring the best use of scarce technical resources during the recovery

EAG Representation

- **Representation from:**
 - DBH
 - EQC
 - BRANZ (incl. representing the NZS3604 Committee)
 - GNS Science
 - Structural Engineering Society (SESOC)
 - NZ Society for Earthquake Engineering
 - NZ Geotechnical Society





Objectives of Technical Categories & Guidance Document

To provide repair and reconstruction solutions and options that:

- **are appropriate to the level of land and building damage experienced**
- **take account of the likely future performance of the ground**
- **meet Building Act and Building Code requirements**
- **are acceptable to insurers and homeowners**



Status of Guidance Document Solutions Under the Building Act

- **Update due mid-November 2011**
- **Guidance Document issued under s175 BA**
- **Methods and solutions are not mandatory, but will achieve compliance with BA 2004 and the Building Code**
- **It provides guidance to Building Consent Authorities using the reasonable grounds provisions of s49 BA**



New Features of Updated Document

- **The definition of *Foundation Technical Categories* for the Green Zone on the flat, which guide the selection of repair and rebuilding approaches**
- **New section on Hillside Properties which provides guidance on assessing retaining walls**
- **Expanded guidance on repairing plasterboard walls and chimneys**
- **Annex covering concrete slabs on grade**



Basis for Determining Technical Categories

- **Observations of land and building damage in the Canterbury EQ series**
- **Plus consideration of susceptibility of soil types where liquefaction didn't occur**
- **Establishment of categories of land where similar future performance anticipated, and common approaches and solutions are appropriate**



Foundation Technical Category 1 (TC1)

- **Future land damage from liquefaction is unlikely, and**
- **Ground settlements are expected to be within normally accepted tolerances**
- ***Standard foundations (NZS 3604) are acceptable subject to shallow subsurface investigation***



Foundation Technical Category 2 (TC2)

- **Minor to moderate land damage from liquefaction is possible in future large earthquakes**
- ***Lightweight construction or enhanced concrete raft foundations (e.g. stiffer floor slabs that tie the structure together)***



Foundation Technical Category 3 (TC3)

- **Moderate to significant land damage from liquefaction is possible in future large earthquakes**
- ***Foundation solutions should be based on site-specific geotechnical investigation and specific engineering foundation design***



Foundation Technical Category Not Applicable

- **Normal consenting procedures apply in these areas**
- **This applies to non-residential properties in urban areas**
- **Properties in rural areas or beyond the extent of land damage mapping**
- **Properties in the Port Hills and Banks Peninsula**

Legend

DBH Residential Technical Category

- Technical Category 1
- Technical Category 2
- Technical Category 3
- N/A - Urban Nonresidential
- N/A - Rural & Unmapped
- N/A - Port Hills & Banks Peninsula

CERA Residential Recovery Zones

- Orange Zone
- Red Zone

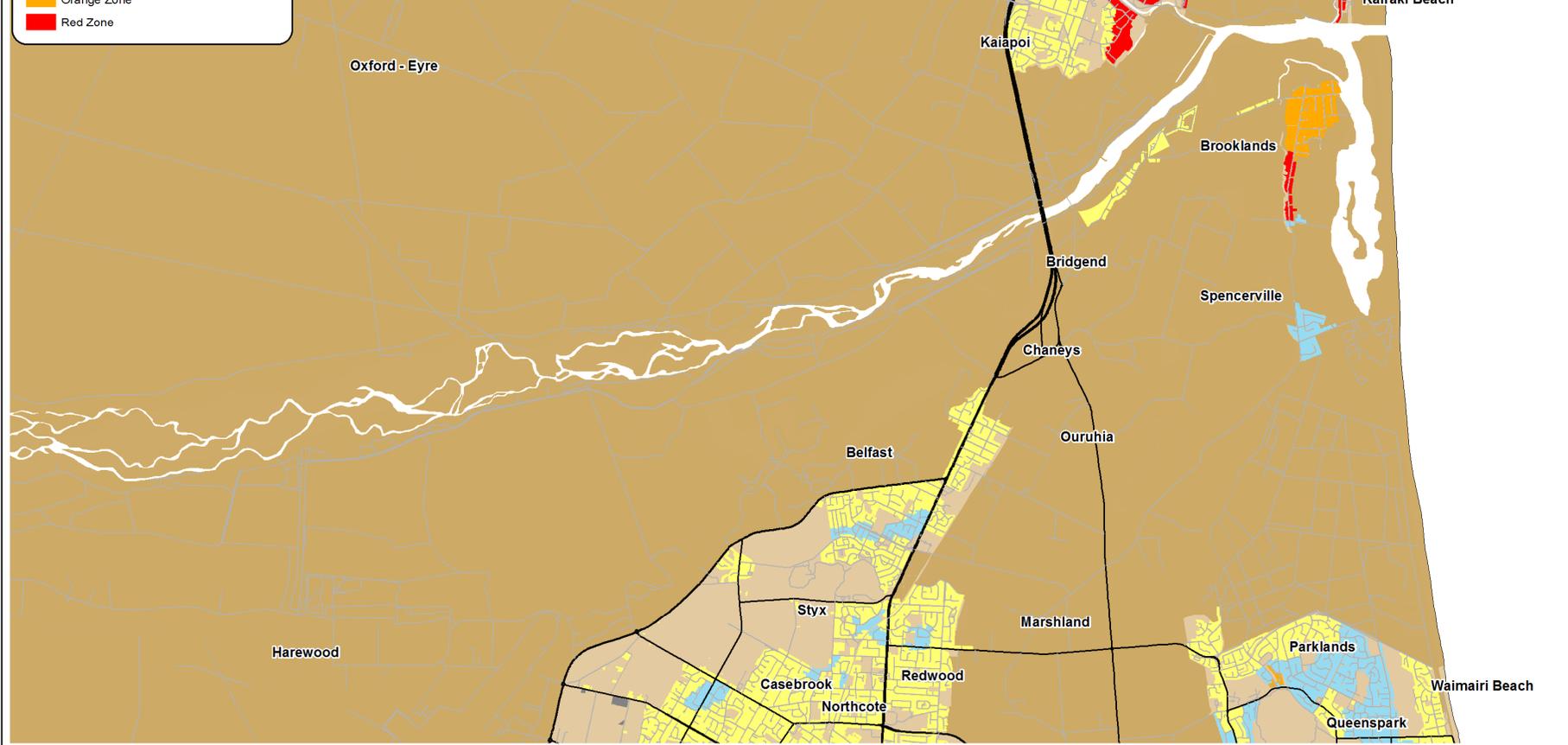
FOR RESIDENTIAL PURPOSES ONLY

Foundation Technical Category 1 (TC1):
 Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances. Standard foundations (NZS 3604) are acceptable subject to shallow geotechnical investigation.

Foundation Technical Category 2 (TC2):
 Minor to moderate land damage from liquefaction is possible in future large earthquakes. Lightweight construction or enhanced foundations are likely to be required such as enhanced concrete raft foundations (ie, stiffer floor slabs that tie the structure together).

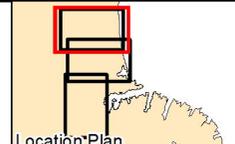
Foundation Technical Category 3 (TC3):
 Moderate to significant land damage from liquefaction is possible in future large earthquakes. Foundation solutions should be based on site-specific geotechnical investigation and specific engineering foundation design.

Foundation Technical Category map not applicable (N/A):
 Normal consenting procedures apply in these areas. This applies to non-residential properties in urban areas, properties in rural areas or beyond the extent of land damage mapping, and properties in the Port Hills and Banks Peninsula.



Notes:
 (1) Not to be relied upon for assessment of new subdivisions.
 (2) This map should be read in conjunction with the DBH Guidance Document.
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0 1 2 3 4 (km)
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Legend

DBH Residential Technical Category

- Technical Category 1
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CERA Residential Recovery Zones

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Foundation Technical Category 1 (TC1):

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Foundation Technical Category 2 (TC2):

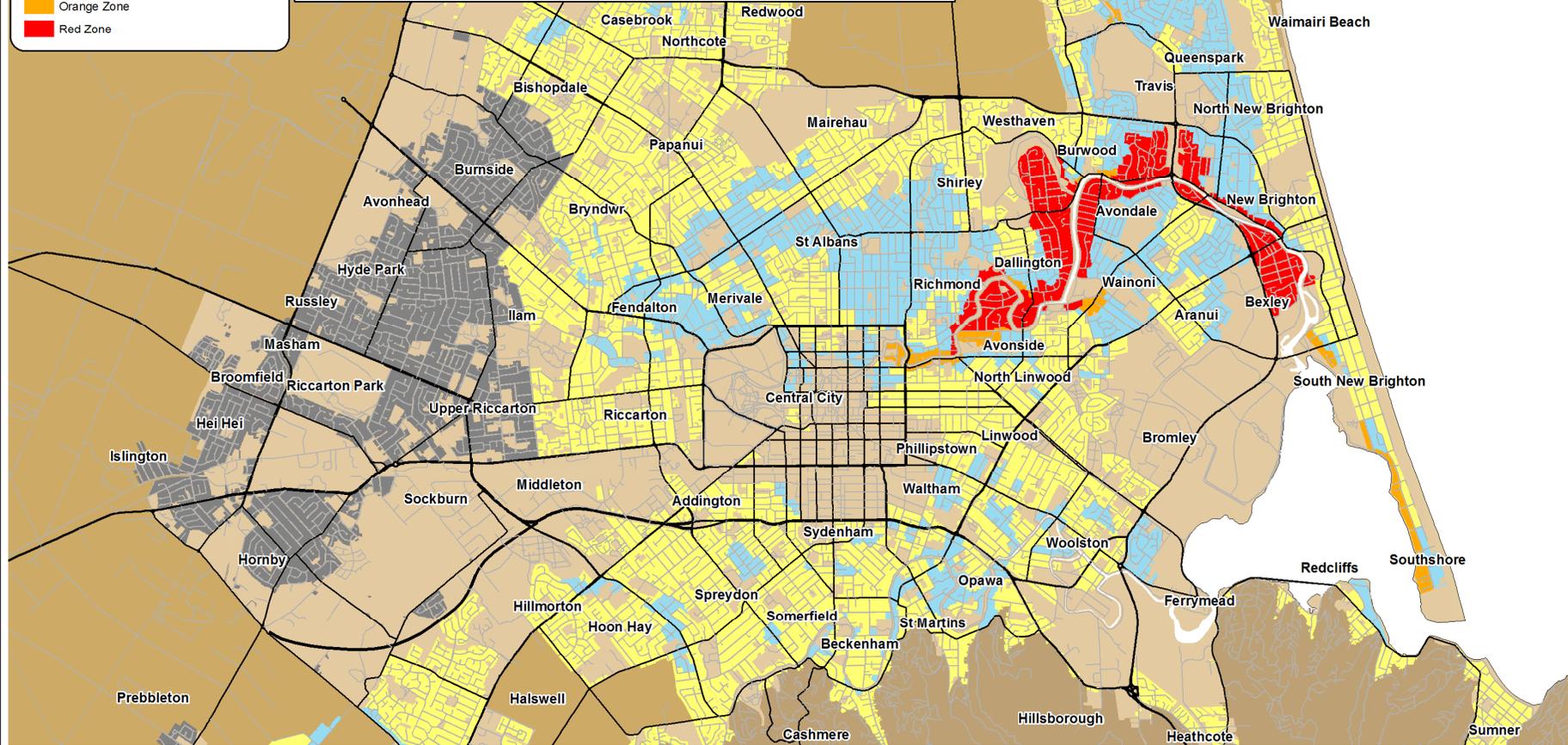
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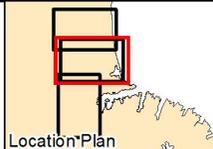
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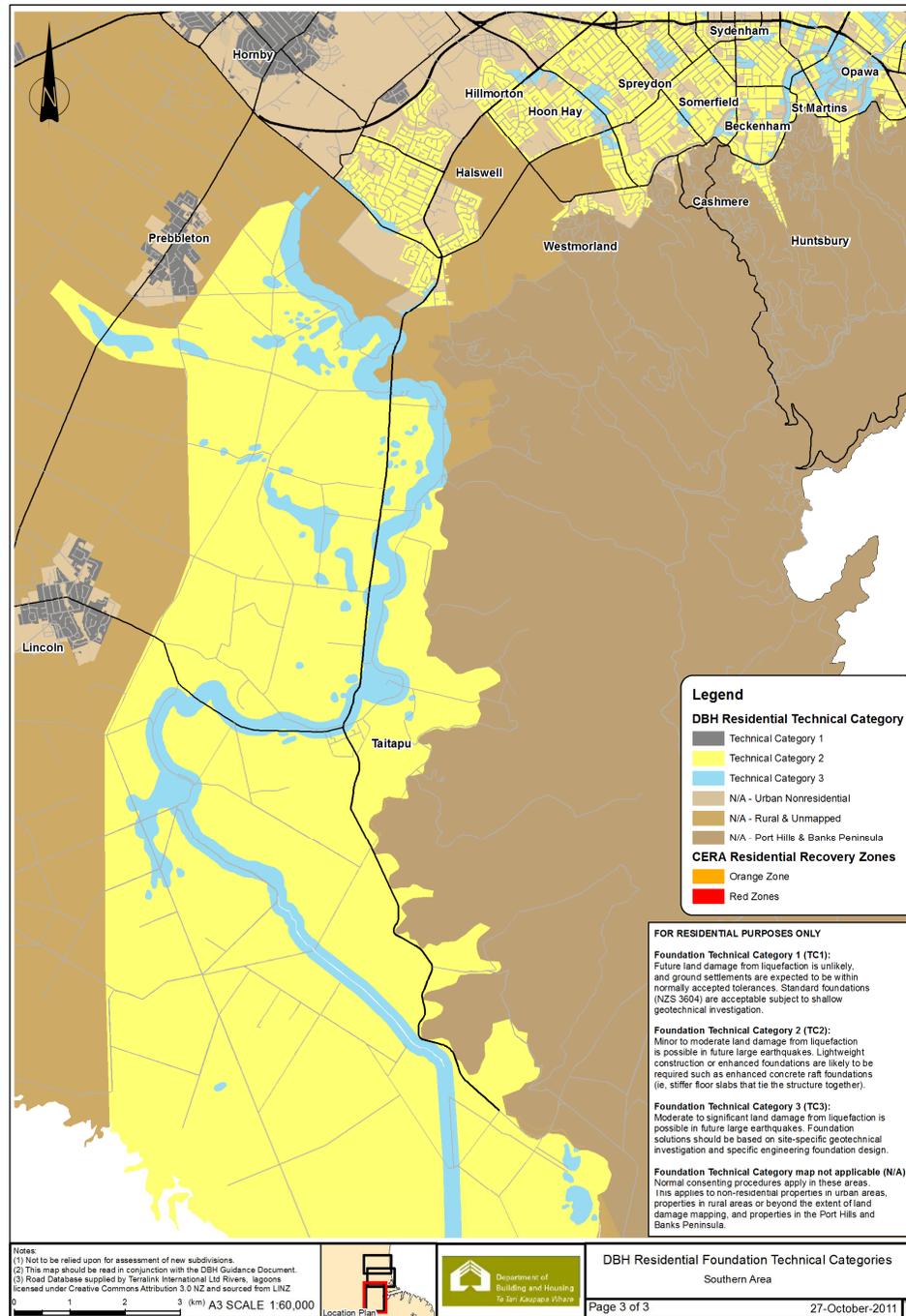


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DBH Residential Foundation Technical Categories

Central Area



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0 1 2 3 (km) A3 SCALE 1:60,000





Foundation Technical Categories

for the CERA Green Zone on the Flat

	TC 1	TC 2	TC 3
Repair Options	Guidance provided	Guidance provided	Repairs to superstructure can proceed where no foundation damage present. Foundation repairs require geotech investigation
New Foundation Options	NZS3604: 2011 timber piles and floor, or tied concrete slabs	Light & mediumweight cladding and roofing with timber floor and foundations in accordance with NZS 3604 Or Enhanced slabs from Options 1-4 from Dec 2010 DBH Guidance Document	Deep piles (Option 5 from Dec 2010 DBH Guidance Document) where bearing layer <10m Or Other Specific Engineering Design solutions (including ground improvement)



Guidance Document Solutions Focus on TC1 and TC2

- **Assessment guidance covers all TCs, as does superstructure repair guidance**
- **But foundation repair and re-building solutions are only provided for TC1 and TC2 at this stage**
- **TC3 requires specific engineering investigation and design (including for the deep pile solution indicated)**



Ground Improvement Options for TC3

- **Investigating options to avoid surface liquefaction through site-based ground remediation**
 - Options include soil mixing (creating shallow raft, or deep columns); dynamic compaction; perimeter curtain wall
- **Trial at QE2 Park to investigate construction feasibility, cost and future liquefaction performance**



Foundation Solutions for TC3

- **Reporting with trial outcomes and feasible solutions and costs in December**
- **General solutions being developed during December and January with input from international peer reviewers, insurer PMOs**
- **Guidance on TC3 solutions anticipated in February**





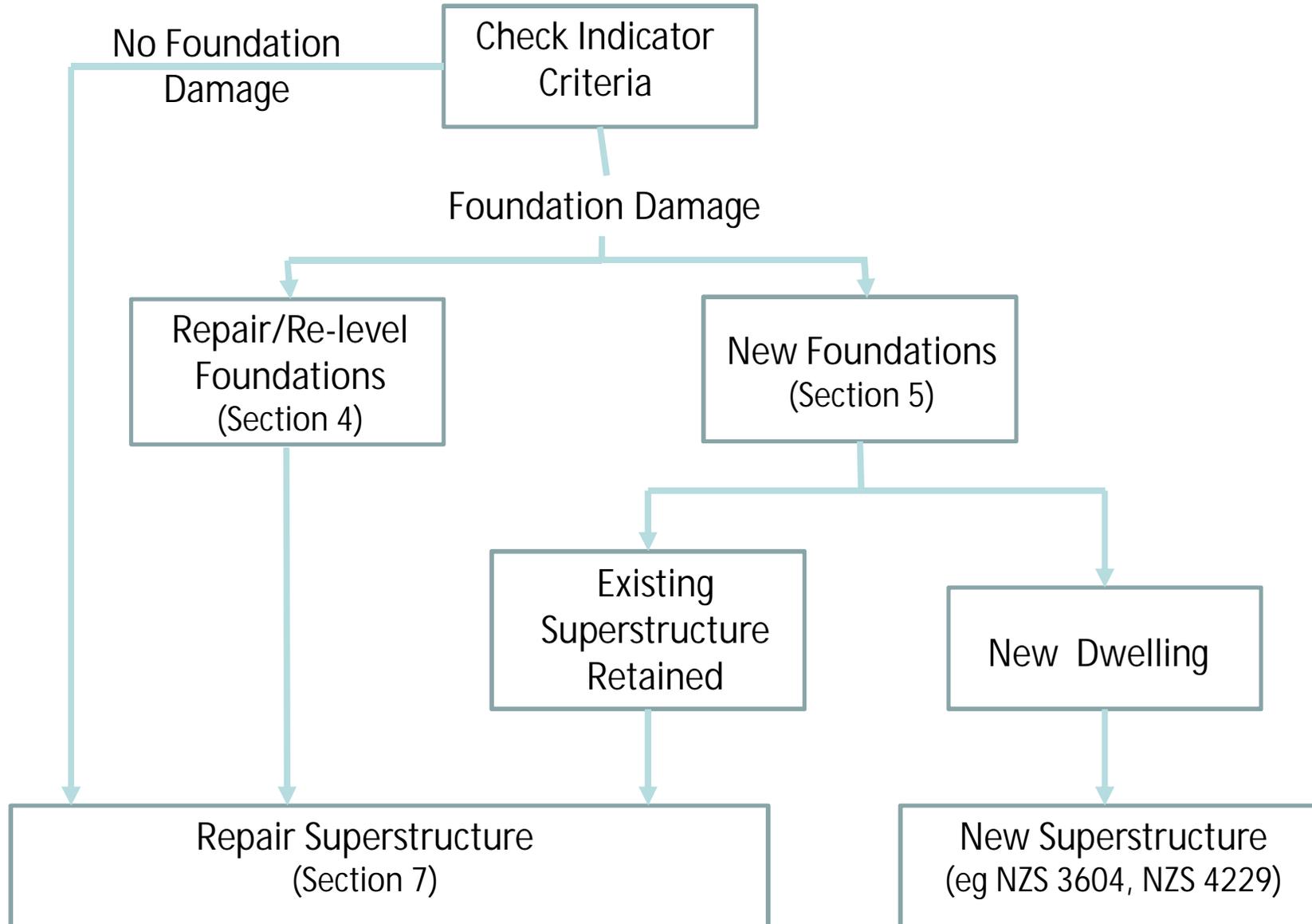
Table 3.1

Expected Future Land Performance

	Future Land Performance Expectation	Expected SLS land settlement	Expected ULS land settlement
TC1	Future land damage from liquefaction is unlikely	0 – 15mm	0 – 25mm
TC2	Minor to moderate land damage from liquefaction is possible in future large earthquakes	0 – 50mm	0 – 100mm
TC3	Moderate to significant land damage from liquefaction is possible in future large earthquakes	>50mm	>100mm



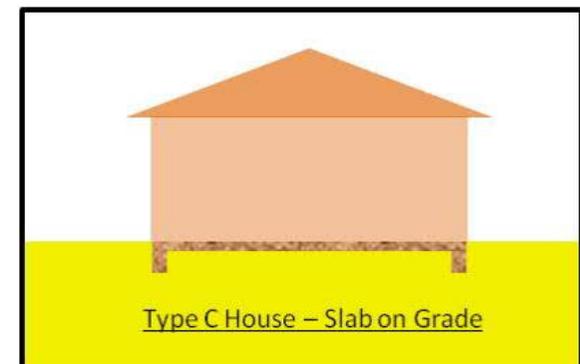
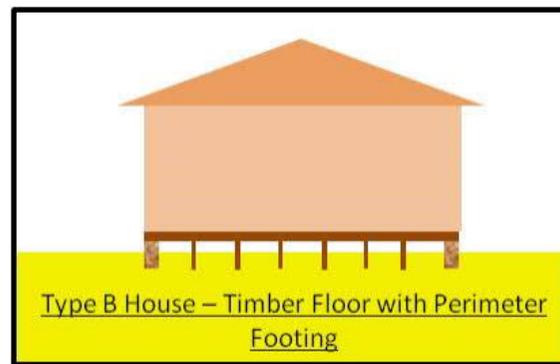
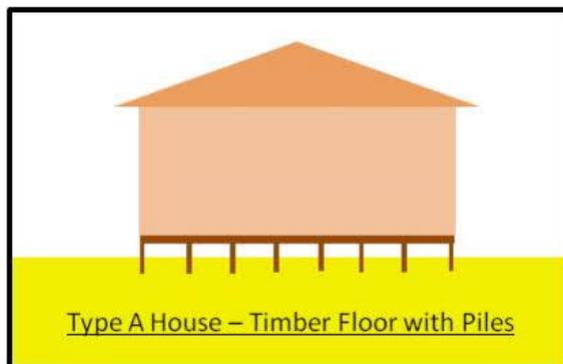
Process Map





Three Timber Frame Building Types

- **Type A – Timber floor on piles**
- **Type B – Timber floor and perimeter concrete foundation beam**
- **Type C – Slab on grade**





Foundation Damage – 3 Aspects to Consider

- 1. Differential and overall settlement**
- 2. Overall lateral ‘stretch’ of floor**
- 3. Damage to specific foundation elements**



Table 2.2

Criteria for 'No Foundation Damage'

Type A Timber/ conc piles	Vertical Differential Settlement <50mm	AND	Lateral Stretch <20mm	AND	Pile tilt <15mm per 1m height; no floor framing damage
Type B Perimeter Conc Foundn Wall	AND				<5mm cracks in perimeter foundation
Type C Conc slab	Floor slope <1 in 200 over 2m				<5mm cracks in floor slab

Note: Cracks widths are those principally related to earthquake actions

Table 2.3

Indicator Criteria for Foundation Re-level/Rebuild

	No Foundn Re-level Necessary	Re-level	Foundation Re-build	House Re-build
Type A Timber/ conc piles	Slope < 0.5% (1 in 200) over 2m or more <u>and</u> variation in floor level < 50mm	Variation in floor level >50mm and <100mm	Variation in floor level >100mm <u>or</u> stretch >50mm	House has fully or partially collapsed off piles
Type B Perimeter Conc Foundn Wall	As for Type A	As for Type A	Variation in floor level >100mm <u>or</u> cracks in perimeter beam >5mm or stretch >20mm	House has fully or partially collapsed off piles
Type C Conc slab	As for Type A <u>and</u> no floor covering distress evident	Variation in floor level >50mm and <150mm	> Re-level limit <u>or</u> variation in floor level >150mm	Relates to degree of superstructure damage



Table 2.3 Operation

- Provides indicative thresholds (1 in 200) for re-levels or more
- Objectives for completed re-level are:
 - Slopes comparable with new and not generally noticed
 - Maximum overall variation 50mm

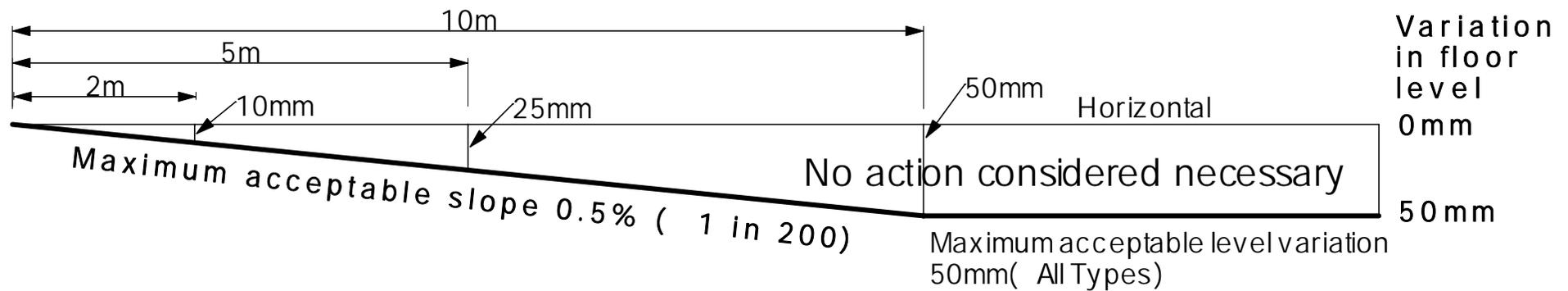


Note Changes from Table 4.1 in the December 2010 Document

- **Relaxation of some criteria for changes in floor level and settlement**
 - No re-level action necessary if **< 1 in 200** (was 1 in 400)
 - Re-levelling of conc slab houses considered viable if variation in floor level **<150mm** (was <100mm)



Foundations Re-level/Rebuild Indicator Criteria



Variation in floor level
0mm

Vertical scale is exaggerated for clarity

0mm	All Types - No action considered necessary UNLESS slope is greater than 1 in 200 (0.5%)	
50mm	Type A and B floor re-level	Type C floor re-level
100mm		
150mm	Type A and B foundation rebuild	Type C foundation rebuild



Repairing Foundations (TC1 & TC2)

- **Check against Table 2.3**
 - Repair of foundation and superstructure may be possible without re-level (compare with Column 2)
- **Local repairs**
 - Shallow subsurface investigation required
 - > 300 kPa → simple solutions
 - < 300 kPa → Specific engineering design

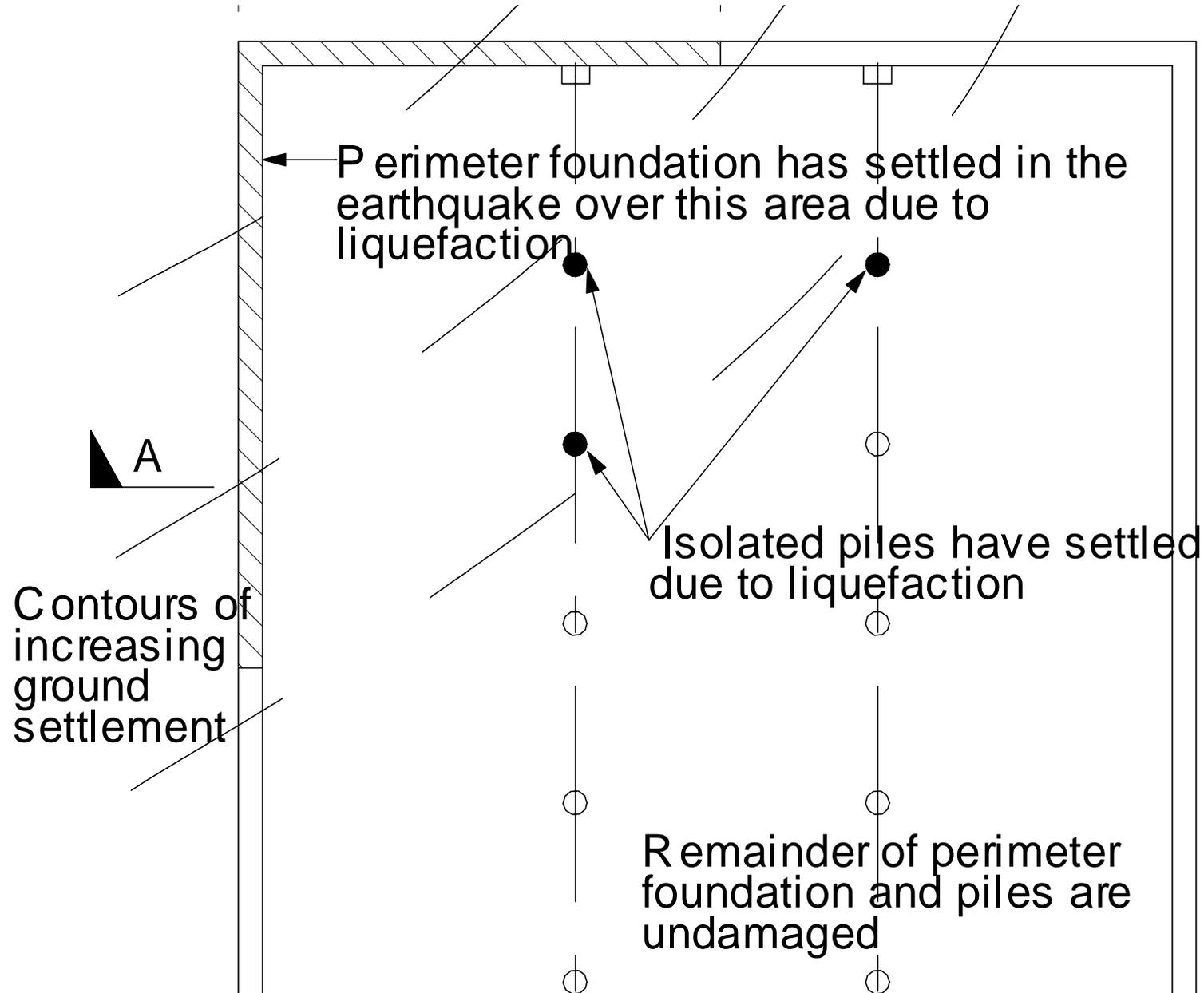


Repairing Foundations (TC1 & TC2)

- **Shallow subsurface investigation required**
- **> 300 kPa - Simple solutions**
 - **Type A** – replace/repair piles (NZS 3604), re-level (if required)
 - **Type B** – enhanced foundation wall and repair/replace piles, re-level (if required)
 - **Type C** – repair cracks and re-level
- **< 300 kPa – Specific design**
- **Re-levelling processes as in December 2010 Guide, with low mobility grout (LMG) option added**

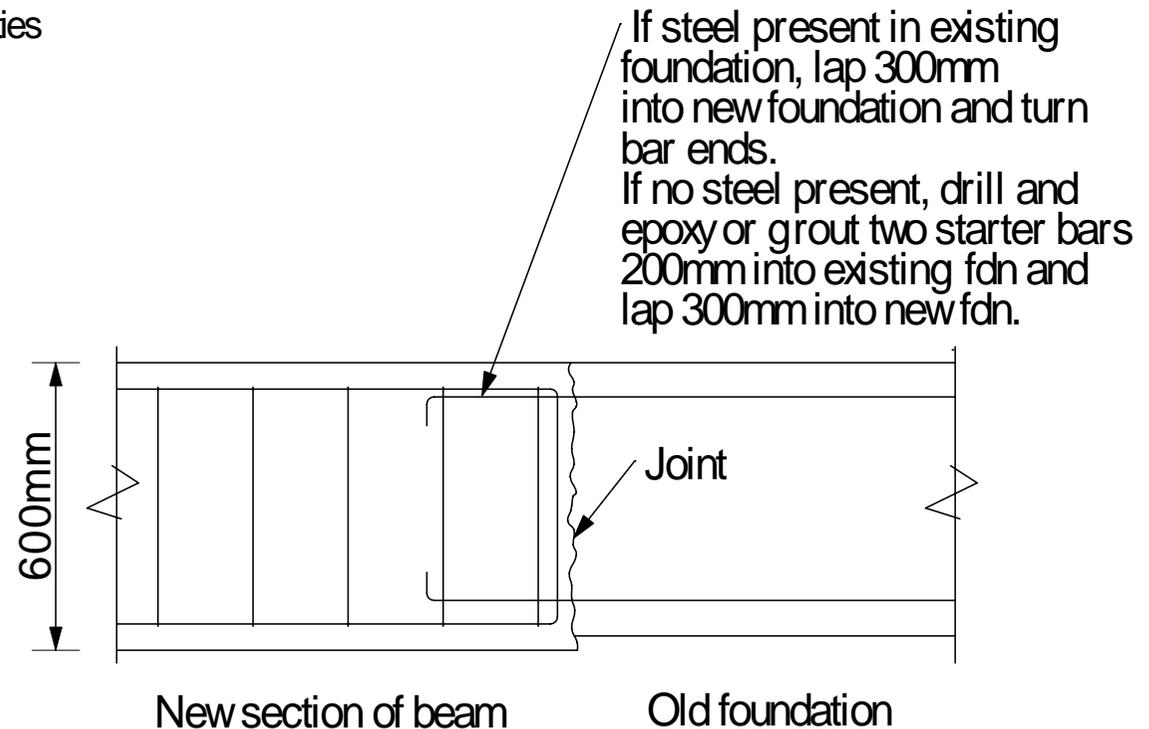
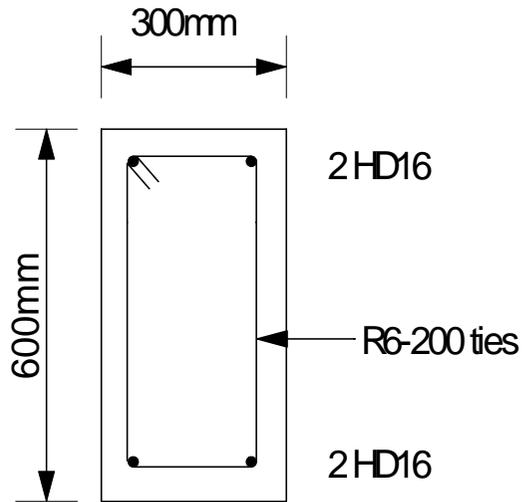


Local Repairs – Type B (Fig 4.2)





Local Repairs/ Partial Re-build – Type B





Type C Re-levelling Options

- **Perimeter foundation jacking with portable jacks**
 - In conjunction with grouting beneath slab
- **Perimeter foundation jacking with screw piles**
 - In conjunction with grouting beneath slab
- **Perimeter foundation and slab jacking with engineered resin**
- **Perimeter foundation and slab jacking with low mobility grout**



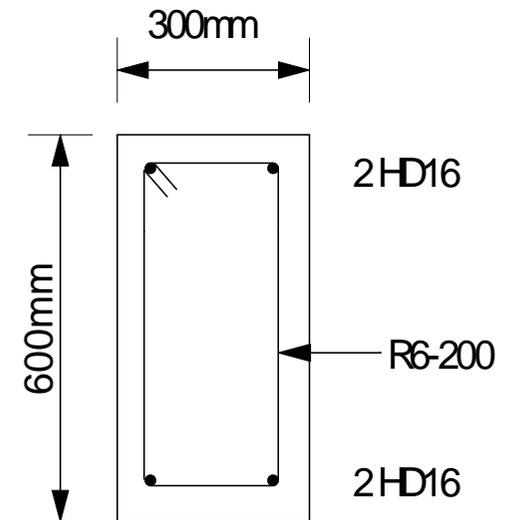
Replacing Foundations (TC1)

- **Shallow subsurface investigation required**
- **Type A and B dwellings**
 - > **300 kPa** → Shallow pile and foundation wall systems in accordance with NZS 3604
 - < **300 kPa** → Specific engineering design
- **Type C dwellings**
 - > **300 kPa** → Tied slabs in accordance with NZS 3604
 - < **300 kPa** → Specific engineering design, except if
> 200 kPa, stiffened raft may be used



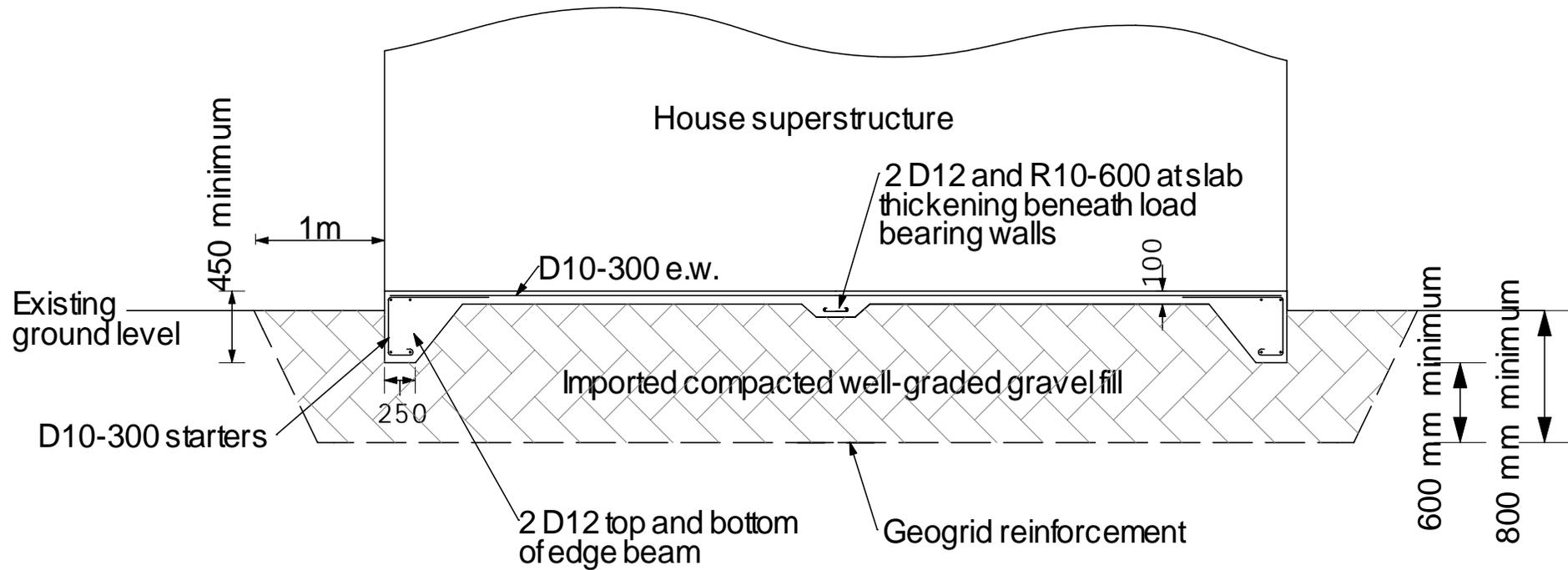
Replacing Foundations (TC2)

- **Shallow subsurface investigation required**
- **Type A and B dwellings**
 - > **300 kPa** → Shallow pile and enhanced perimeter wall systems
 - < **300 kPa** → Specific engineering design
- **Type C dwellings**
 - > **200 kPa** → Stiffened raft foundations
 - < **200 kPa** → Specific engineering design



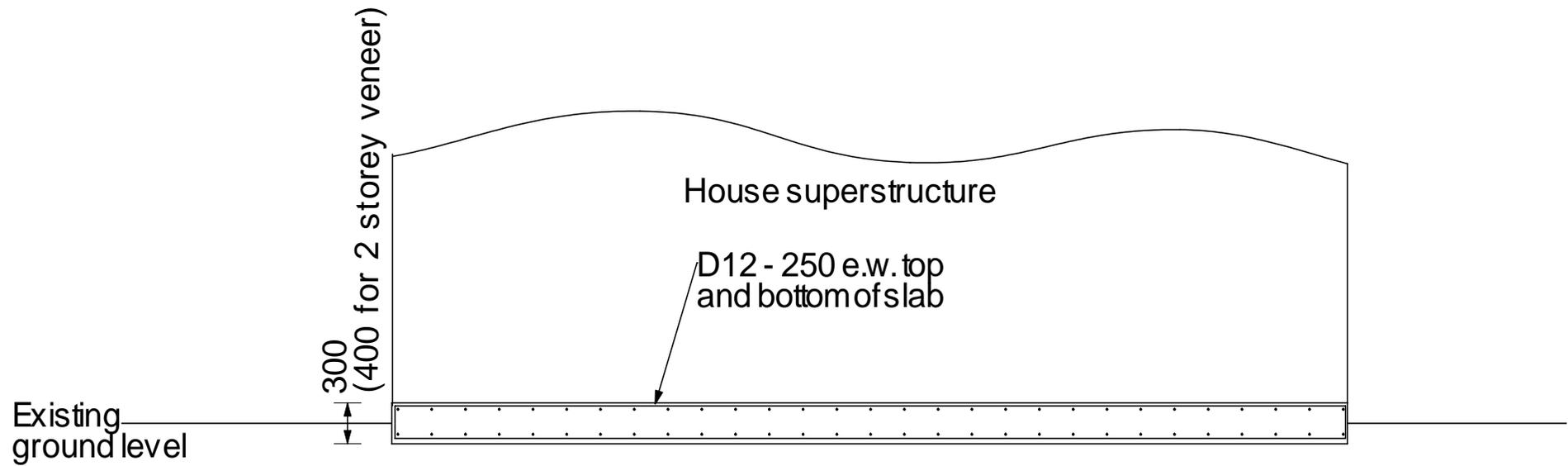


Enhanced foundation – Option 1



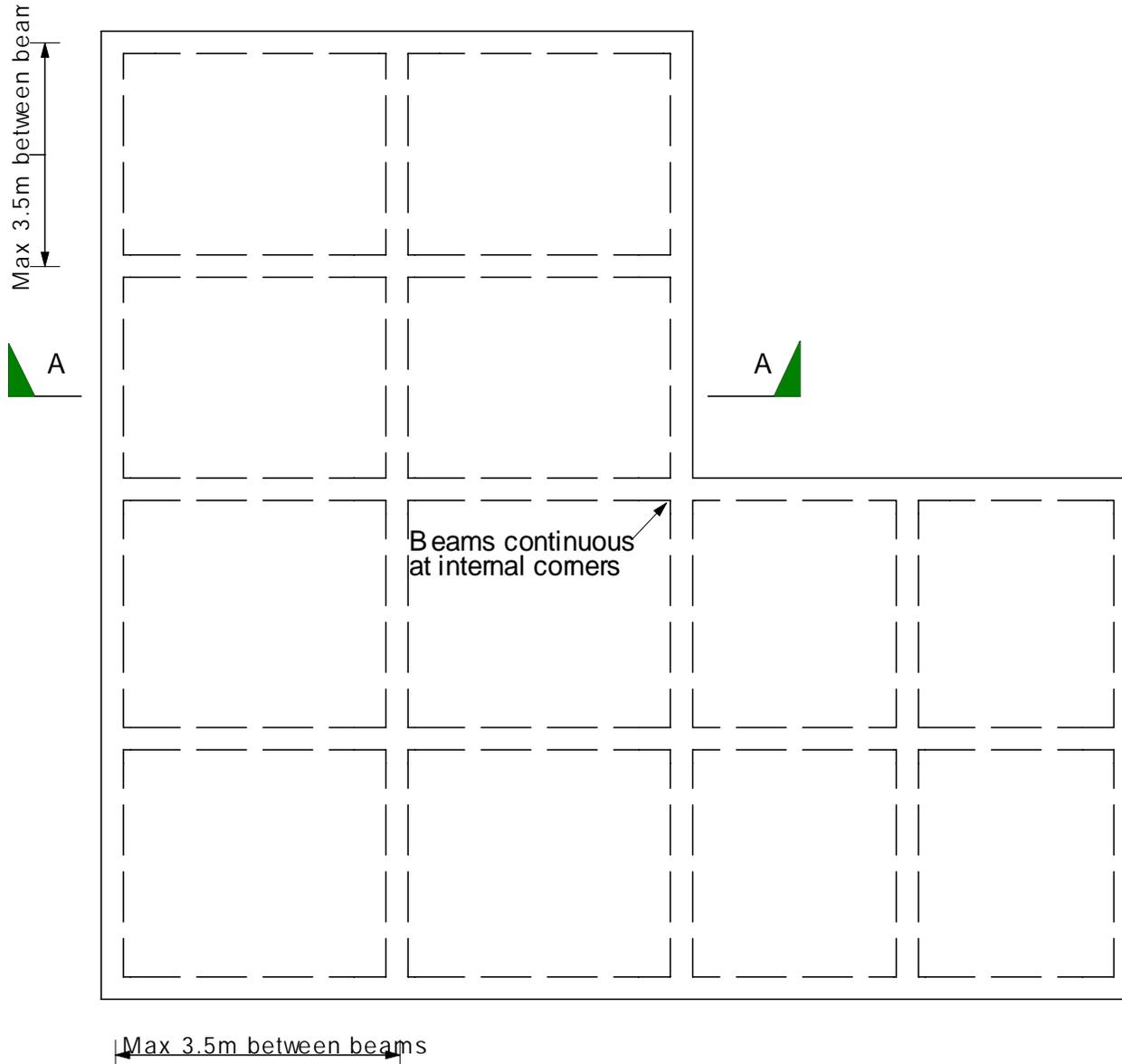


Enhanced foundation – Option 2



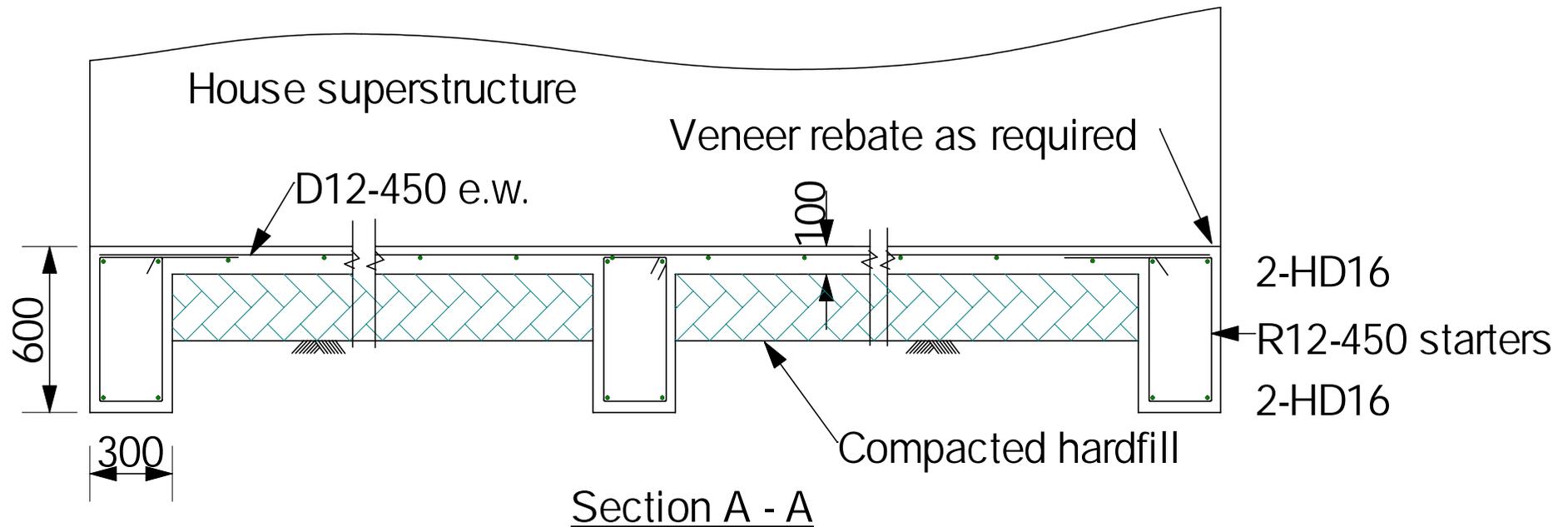


Enhanced foundation – Option 3



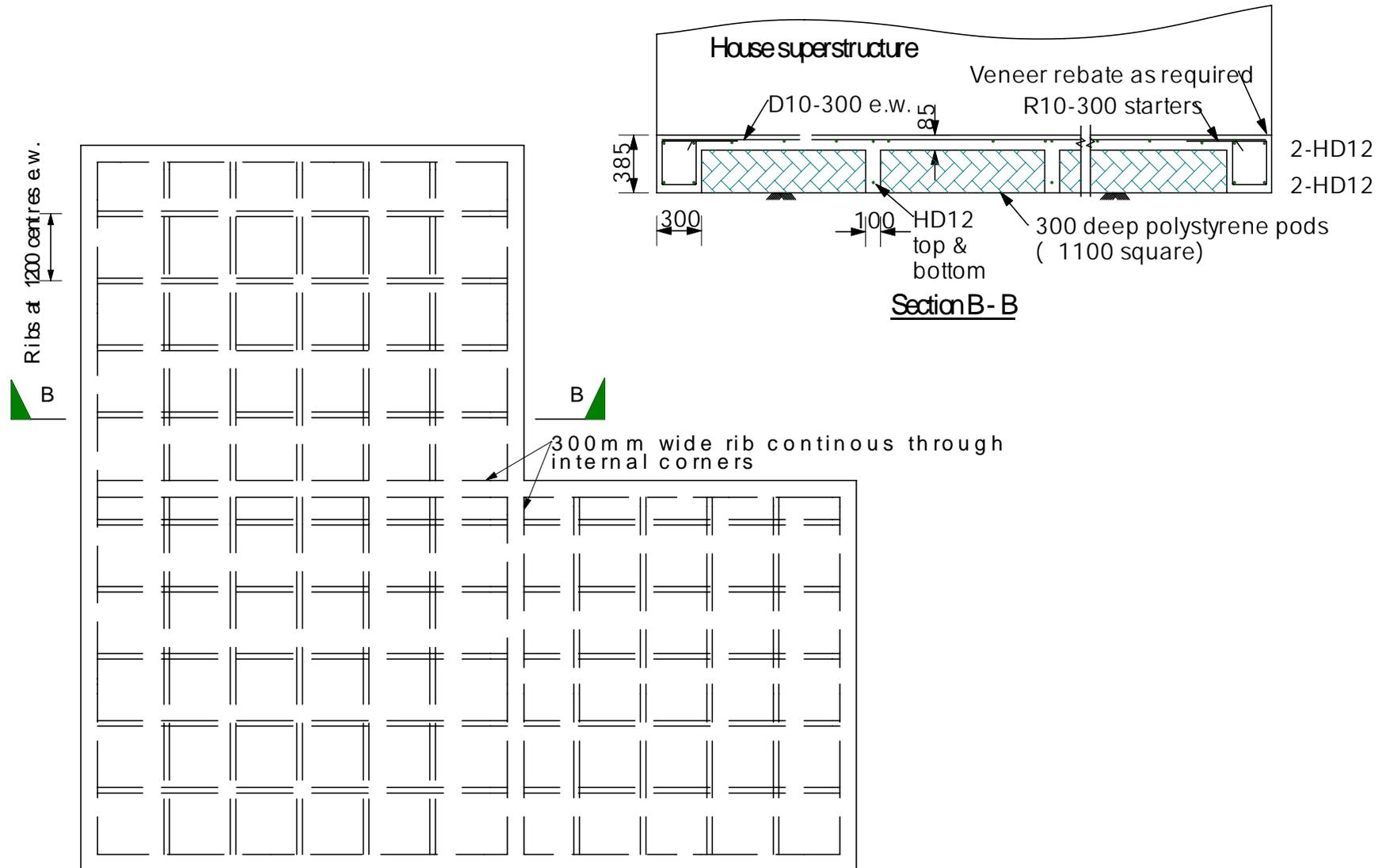


Enhanced foundation – Option 3 (contd)



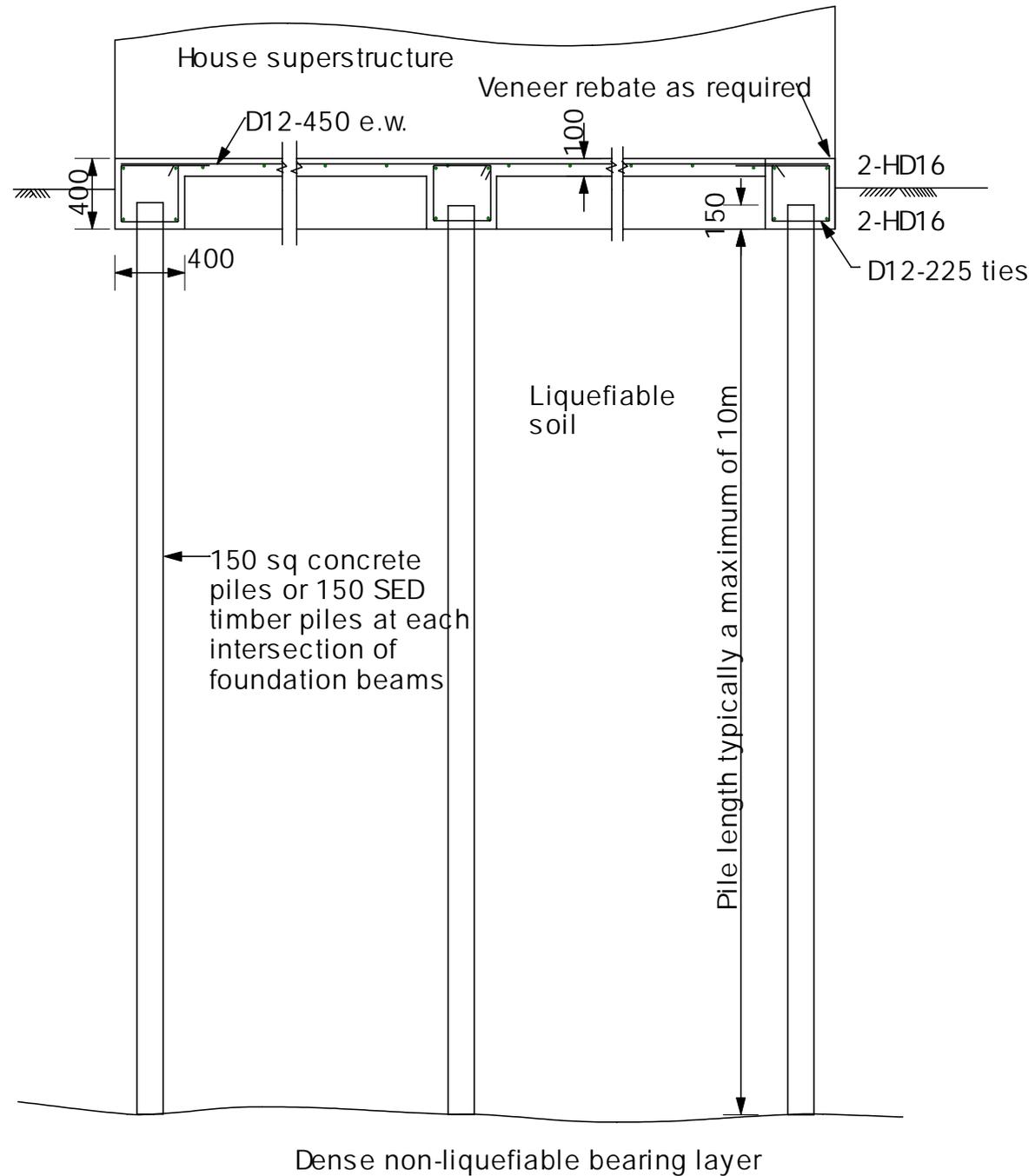


Enhanced foundation – Option 4



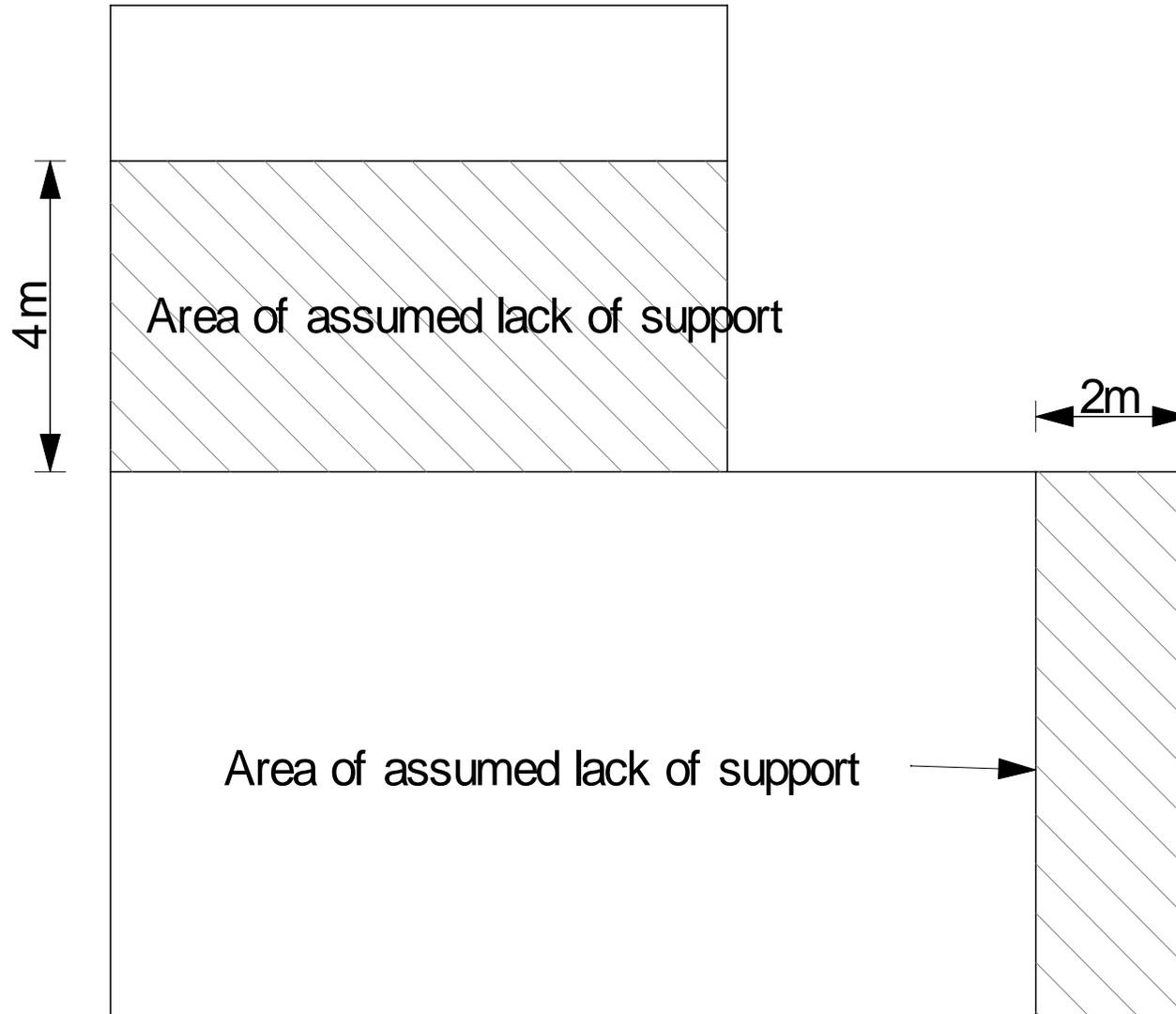


Enhanced foundation – Option 5





Design Assumptions for Rafts



Areas of lack of support for design



Replacing Type A and Type B Timber Floors

- **Type A applicable for light roof and light and medium weight wall cladding**
- **Perimeter foundation for Type B as for partial repair**
- **Venting of subfloor required**
- **NZS 3604 subfloor framing connections important for tying together**



Services

- **Some guidance on services, particularly waste pipes**
- **Flexibility is the key for better performance**



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Superstructure Repairs



Plasterboard Lining

- **Minor cracking (<0.5mm)**
 - cosmetic repair
 - Schedule 1(a) and 1(ah) exemption
- **Moderate cracking (superficial and localised)**
 - Replace cracked panels with comparable component fixed as a bracing element
 - Schedule 1(a) and 1(ah) repairs in accordance with the Guide
- **Significant damage to panels**
 - Re-line of whole walls or rooms with comparable component
 - New bracing element at least matches the replaced element
 - Complete or substantial repairs – comply with BC



Superstructure Repairs

- **Light gauge steel framing**
- **Pole frame structures**
- **Reinforced and unreinforced masonry**



Assessing Slab Cracks

- **Uncontrolled shrinkage of concrete prime cause of cracking**
- **Shrinkage crack indicators**
 - Age
 - Fretted edges
 - Build up of detritus in crack
 - Non-uniformity of crack width
 - Narrower towards edge of slab (constraint from reinforced edge thickening)
- **Appendix A4 – crack identification guidance and treatment methods**



Slab Crack Widths & Repair Approaches

Table A4.1

	No Action	Epoxy Injection	Grout Injection	Break out & Recast
Slab crack widths	<1mm	1mm to 10mm	10mm to 20mm	>20mm



Indicative New Foundation Costs

Foundation Type	Incremental Foundation Cost
Standard tied concrete slab (NZS 3604) <i>(Base cost \$15,000 for 150m² house)</i>	Base
Shallow piles and light construction (NZS 3604)	Base
Raft slabs (DBH Options 1 to 4)	\$0 to +\$10,000
Deep Piles (DBH Option 5) - light superstructure (Pile length 6m to 10m; includes design)	+\$25,000 to \$35,000
Deep Piles (DBH Option 5) - heavy superstructure (Pile length 6m to 10m; includes design)	+\$30,000 to \$50,000
Ground improvements Soil mixed raft, Dynamic compaction, Deep soil mix columns, Deep soil mix curtain	To be determined



Site Investigations TC1 & TC2

- Almost 'business as usual' - Shallow investigation (NZS 3604:2011) by soils technician or other suitably trained person (under guidance of CPEng in TC2)
- Where practical extend augerhole to 3-4m to check for peat
- **300 kPa** geotechnical ultimate - 3604 foundations OK in TC1 (as modified by DBH), 3604 timber piles or enhanced perimeter wall foundation in TC2.
- **200 kPa** - DBH enhanced foundations options 1-4, or specific design.
- **<200 kPa** or other non-compliance (eg peat, fill etc) - specifically engineered design required



Site Investigations TC3

- **Deep investigation required, scope to be determined by CPEng geotechnical engineer**
- **Broadly follow investigation procedures for subdivisions (Appendix B2.2)**
- **Generally minimum of 2 deep investigation points (CPTs, boreholes & SPTs etc) and supplementary shallow investigation points**
- **Groundwater information**
- **Liquefaction analysis as per Appendix B2.4 and appropriate foundation design or ground improvement design by CPEng geotechnical engineer**
- **More work being done to potentially streamline this process**



TC Information Management Arrangements

- **System being currently (rapidly) developed, hope to be online within weeks**
- **Online query by authorised user (engineer, PMO etc) will generate a summary report of Tech Category, land damage, settlement, flood risk from property in question**
- **Once appropriate investigation carried out, soils report lodged electronically with Council alongside Consent application**
- **Online form filled in with brief details of investigation – method, number, depth, liquefiable materials, <300 kPa etc (online questionnaire is tailored to suit TC)**
- **Online form also requires confirmation (or not) of TC. (If recommending a change, require some details in geotechnical report)**



TC Information Management Arrangements (2)

- **Council officer checks information and ‘livens’ report in system. Geotechnical information becomes public, searchable and available for download by other users**
- **TC confirmations and change recommendations – where clusters of ‘change requests’ are showing up, map boundaries reviewed and altered if appropriate by a technical panel**



Hillside Properties

- **More complex than the flatlands**
 - *Get a suitably qualified and experienced engineering geologist or geotechnical engineer*
- **Things to Consider (depending on scope of work):**
 - Effects of new fault – i.e. enhanced seismicity, and topographical effects
 - Overall site stability
 - Proximity to cliffs, steep slopes
 - Vulnerability to uphill hazards
 - Areas of past instability
 - Local stability issues
 - Vulnerability to stormwater inflows etc
 - Presence of non-engineered fill etc
 - Presence of surface and subsurface erosion features
 - Disposal of stormwater and effluent



Retaining Walls

- **Difficult to assess damage as most elements are hidden**
- **Knowledge of pre – earthquake condition a considerable advantage**
- **EQC assessment if already done, may have been to a different criteria**
- **Table provided of general ‘damage indicators’ and possible outcomes for a variety of wall types**
- **Some very general design principles are discussed**
- **Discussion of problem of walls ‘not requiring a building consent’**



Subdivision Investigations (1)

- **Stand-alone geotechnical report required at both Plan Change and Subdivision Consent stage**
- **General geotechnical requirements in NZS 4404, and the TA's COPs or IDS**
- **Liquefaction not well covered in those documents, some guidance in NZGS guidelines**
- **Need deep investigations in most cases, scala penetrometer is not a liquefaction tool**



Subdivision Investigations (2)

- **Investigation methods (CPT etc), depth and density discussed**
- **Liquefaction assessments methods, input parameters (eg pga, site observations) discussed**
- **Site is to be classified into one of the DBH Technical Categories, based on deformation limits (vertical, horizontal)**
- **Recommendations for Subdividers about further investigations, and carrying out ground remediation to provide 'better' land**



Other Land Considerations that Need to be Taken into Account

- **Flood risk – establishment of building platform heights and finished floor levels**
- **Land remediation**

Understanding future
land performance

Understanding how
standard house types
will perform

Land

Acceptability
to Insurers

Insurance

House Types

The Building Code

Interpreting building
regulations in a post-
disaster environment

Ensuring the best use of scarce technical resources during the recovery