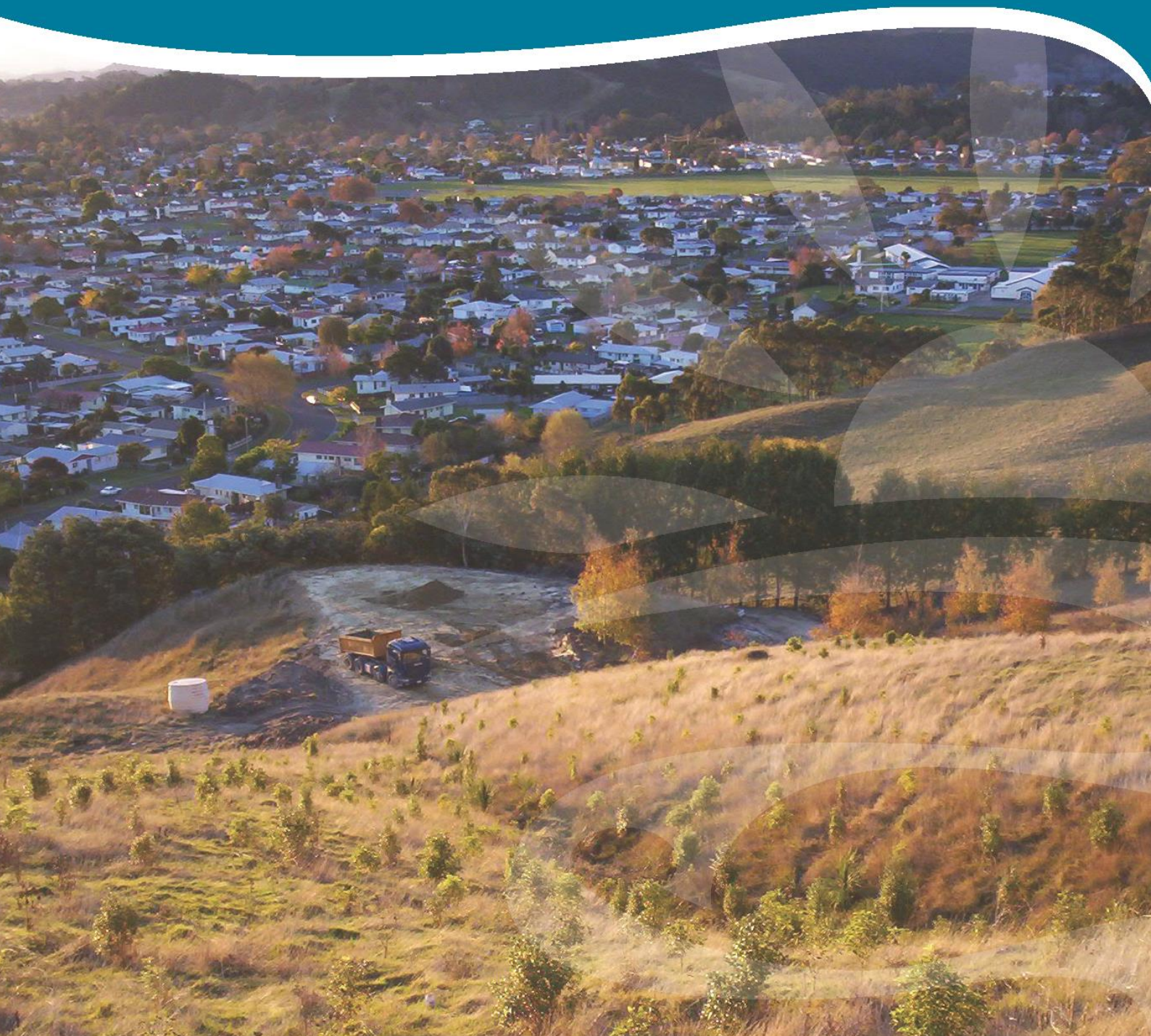
Bearing Capacity and Geotechnical Investigation Requirements for Buildings

New Zealand Building Code Requirements

GISBORNE DISTRICT COUNCIL

Revised
September 2023



Contents

Requirements outlined in this pamphlet are intended to apply generally to buildings (up to 3 storeys high) such as domestic dwellings, and most residential and most commercial/industrial buildings. Council also has a Minimum Requirements for Geotechnical reports document that should be read in conjunction with this brochure.

Please Note: Gisborne District Council reserves the right to request further information for any building irrespective of the following requirements, depending on the nature of the site and building.

Contact:

Gisborne District Council
Building Services

PHONE: (06) 867-2049 FREEPHONE: 0800 653 800
EMAIL: buildinginfo@gdc.govt.nz • www.gdc.govt.nz

INTRODUCTION

New Zealand Standard 3604: 2011 – Light Timber Framed Buildings requires an allowable ground 'strength' of 100kPa (or 300kPa ultimate) for foundation support, termed 'good ground' in the standard. Potentially compressible ground, expansive soils/shrink-swell soils and ground that can experience more than 25mm of movement is excluded from the definition of 'good ground'. Liquefiable ground has also been excluded from the definition of 'good ground' since November 2021. Ground 'strength', usually termed 'bearing capacity', is required so that buildings are supported adequately and don't suffer differential settlement or lateral displacement through their lifespan. Differential settlement is when one end or part of a building sinks more than the other, leading to uneven or cracked floors.

Differential settlement is likely to occur in areas with high liquefaction potential in a sufficiently large seismic event. Lateral spread may also occur in areas of high or moderate liquefaction risk where there is a free face e.g. a river, stream, or drain bank, or steep drop off; relatively close (within 120m) to the building platform. Lateral spread is the moving of land towards this free face when subject to severe shaking.

Commercial buildings, whether large or small, require the same consideration. Most engineers will qualify this on their producer statements (a document which guarantees their work) with the assumption of 100kPa, or 'good ground'. If the ground does not meet the 100kPa requirement or may be subject to any of the ground conditions outlined above, the building will require specific foundation design, usually deeper and/or bigger foundations. There is little 'good ground' in the Gisborne region and consequently testing is required on all sites. Any PS1 documents should be provided by

suitably qualified professional and specifically reference the soil report with the geotechnical consultant's project reference number.

Suitably Qualified Professional

The Gisborne District Council has adopted the MBIE guidance on the authoring of geotechnical reports and consequently all reports authored after 1 August 2023 must be signed by either a CPEng (geotechnical) or a PEngGeol. All reports, regardless of the date must be signed off by a CPEng or PEngGeol after 1 November 2023. This may require the updating of older reports at the applicants cost.

SUBDIVISION LEVEL & BUILDING CONSENT LEVEL INVESTIGATIONS

When a subdivision is applied for, the council has a duty under the Resource Management Act to avoid inappropriate subdivision, or in lay terms, a residential lot that can't be built on. To satisfy this duty council may require a subdivision level geotechnical report that shows that a stable building platform is available on each lot. When it comes to building on the subdivided lots, house design varies considerably from owner to owner and each individual house will have a different foundation and stability impact on the land. As a result, any existing subdivision level geotechnical report will need to be 'fine-tuned' at building consent stage to reflect the specific house design for the site. This fine tuning will be in accordance with the "Ground Bearing Capacity – Building Consent Level" section later in this document. There may also be a consent notice on the Certificate of Title for the land to alert the buyer that more geotechnical investigations will be required.

RECENT SUBDIVISIONS

If you are intending to build on land which has recently been part of a subdivision, check to see if a ***'Consent Notice'*** is on the ***Record of Title***. A

'Consent Notice' may dictate the level of subsurface investigations and instability remedial measures required at the building consent stage. Alternatively, 'advice notes' on the subdivision consent may give an indication of the level of testing required. The Council's Development Control Planners can help you with identifying consent notices.

The subdivision level consent may have been assessed under a previous level of peak ground accelerations (PGA). The PGAs for the east coast of the North Island were increased significantly by MBIE in November 2021. This increase could result in building platforms having markedly increased setbacks from the edge of a building platform or much more robust, and therefore expensive, foundation requirements.

All geotechnical reports must address the 2021 PGAs.

GEOTECHNICAL INVESTIGATION – SUBDIVISION LEVEL

The requirement for a subdivision level geotechnical investigation is site specific and based around the type of subdivision and presence of natural hazard.

Subdivisions that do not require subdivision level geotechnical reports include single lot infill developments on low and moderate liquefaction potential flat land not subject to natural hazards and subdivision of rural land with no change of use proposed (i.e. land that will remain as productive).

For all other subdivisions, a Subdivision level Geotechnical Report prepared by a suitably qualified professional (see above) needs to certify that a stable building platform exists within each proposed lot and which:

i. Certifies to the satisfaction of the Consent Authority that the foundations can be designed for any proposed

building that are suitable with respect to the bearing strength and shrink-swell potential of the supporting ground (In accordance with New Zealand Standard)

ii. Includes site specific geological, geomorphological, liquefaction and lateral spreading analysis that confirms that the proposed development will not be subject to natural hazards; and;

iii. Includes a site specific analysis which confirms that the proposed development will not be subject to instability or erosion or lateral movement under fully saturated ground conditions and earthquake seismic loading;

iv. Specifies as appropriate, any remedial works to be undertaken to protect the development from natural hazards.

v. Shows that these remedial and/or mitigation measures will not affect any neighboring properties.

Geotechnical Reports may be subject to independent peer review at the applicant's cost.

GROUND BEARING CAPACITY – BUILDING CONSENT LEVEL

Most houses in New Zealand are built to New Zealand Standard 3604 'Light Timber Framed Buildings' (NZS3604:2011). As discussed above this standard requires that houses are founded on 'good ground'. There is very little ground in Gisborne that meets these requirements.

The minimum investigation required by Council involves testing the bearing capacity of the supporting ground beneath a proposed building. This must be undertaken by a **suitably qualified professional** (see definitions at the beginning and end of this document), approved by the Council, prior to designing the foundations. The method of

testing varies depending on the subsurface conditions. For example, if it is a sandy soil, as in the Te Hapara area, a 'penetrometer' is to be used, or if a clay soil, like those found around the Kaiti area, a 'shear vane' should be used. Additionally, the plasticity of this material should be recorded. The type of ground and its bearing capacity determines the foundation requirements.

Generally, if the ground beneath a proposed light-weight timber framed building meets the NZS3604:2011 criteria of 'good ground', as required by the Building Code, then foundations can be constructed in accordance with this standard. This means they can be constructed without the need for specific engineering design.

However, where the 'allowable ground-bearing capacity' is less than 100kPa OR the ground consists of expansive soils (shrink – swell), soft soils (clays) or loose gravels, or any other ground that may experience ground deformation during the defined life span of a building (minimum of 50 years) the foundations *(not necessarily the remainder of the building)* must be specifically engineer designed.

For areas and/or buildings where liquefaction or lateral spreading testing is required, electronic cone penetrometer tests (CPT's) are necessary, and foundations will be required to be designed to allow for any settlement or lateral spreading.

BUILDINGS NEEDING SITE INVESTIGATIONS

Residential buildings

The following buildings will require subsurface investigations:

- All new habitable buildings (including sleep outs)
- All relocated houses
- Substantial additions > 50% of original area

- Large (generally over 110m^2) ancillary buildings (sheds, garages etc.). See exemptions for pole sheds and the definition of a pole shed at the end of this document.
- All buildings in **areas of natural hazards**, including sheds, garages, retaining walls with surcharges and swimming pools. Areas of natural hazard include (but are not limited to):
  - On or at the base of sloping land or on ridge tops.
  - Mangatuna Formation geology (commonly found in hills around the district). See the Mangatuna formation extent at https://data.gns.cri.nz/geology/ . on the 1:250k layer. The Mangatuna Formation is the yellow unit. Council should be contacted if any project is envisioned in this problematic geology.
  - Fill material.
  - Coastal environment.
  - Wheatstone Road/Sponge Bay area including the mud volcano hazard area – check mud volcano zones on Tairawhiti Maps.
  - Te Puia landslide.
  - Adjacent to watercourses, drains or rivers.
  - Areas with high or moderate liquefaction potential.

Liquefaction testing for residential buildings

Single storey buildings on sand soils or in mapped high liquefaction zones as per 2015 Tonkin & Taylor sub-regional scale liquefaction hazard map will require liquefaction analysis. Liquefaction analysis will also be required for buildings of more than one storey, heavy buildings, or buildings with an asymmetrical design in moderate liquefaction risk zones. Heavy buildings include those constructed in brick veneer or other heavy cladding and heavy (concrete tile) roofs. Asymmetrical buildings are structures that have different weight

characteristics in just part of the building. An example would be a light timber framed building with one concrete tilt panel wall.

Single storey lightweight, timber framed buildings in moderate liquefactions risk zones do not require liquefaction assessments, if they are constructed on timber pile or raft foundations unless they are within 120m of a free face.

Light timber framed buildings in high liquefaction zones can be designed with a gravel raft overlain by a reinforced slab foundation (e.g., rib raft, waffle slab), or -where applicable- a so-called TC3 Option 1 foundation. The latter is a modified NZS3604:2011 shallow timber pile design, stabilized by plywood bracing. Both designs are much more resilient in earthquake events than either concrete pad or standard NZS3604:2011 pile foundations.

Contact Gisborne District Council for further information with regard to the 2015 Tonkin & Taylor sub-regional scale liquefaction hazard mapping.

Requirements:

a) Flat Sites

On a generally flat site, a '**Geotechnical Bearing Capacity Report' MUST** be submitted as part of the building consent application. This report must be prepared by a suitably qualified professional and be within the limitations in the associated 'Minimum Requirements for Geotechnical Reports' document published by the Gisborne District Council and contain:

1. A site plan (to scale) showing the position of the proposed building 'on the lot' and accurate locations of the investigation sites. As the report is building footprint specific re-siting of the building may require a whole new series of investigations.
2. Auger profiles and ground bearing capacity test results (see specifications below).

3. A description of the landscape and an interpretation of the results, including recommendation for bearing capacity plus depth of good-ground (if available) and reasoning how this was derived. Confirmation that the potential for differential (uneven) settlement and liquefaction is either a low, moderate, or high risk. Mitigation measures must also be included.
4. Recommendations for any foundation design (engineered) requirements i.e., for expansive soils, loose gravels or due to low bearing capacity.

b) Areas of natural hazards

A detailed **'Geotechnical Report' MUST** be included with a building consent application where a proposed building site is to be located:

- On or at the base of sloping land (including ridge tops). Machine borehole testing may be required for mid-slope sites - please ask council before commencing the testing process.
- Within 120m of a watercourse, drain, river, or other free face.
- On fill material.
- In an area of natural hazard (see above).

The investigations and report must be undertaken by a suitably qualified professional with appropriate geotechnical experience, such as an engineering geologist or geotechnical engineer and signed off by a CPEng or PEngGeol. The report shall include the requirements outlined for "flat sites" and include stability analysis and recommendations for appropriate foundation design and development options (stability measures). Council can supply the minimum requirements of a detailed geotechnical investigation and report.

Exemptions

Note:- These exemptions may not apply to areas of natural hazards. You are advised to discuss buildings in these zones with council before commencing the design work.

Ancillary buildings less than 110m^2 and pole sheds with dirt floors that have engineer designed foundations will be assessed by Council on a case-by-case basis depending on location and proposed use.

Note: - proprietary pole sheds that have a PS1 that states NZS3604:2011 'good ground' in the assumptions will not be accepted without a soil bearing report to prove that 'good ground' exists.

For ***Small to Medium Additions*** to an existing building, which shows no sign of previous movement and depending on location, it may be possible to construct the foundations to the same dimensions as the existing foundations or to that required by the NZS3604:2011 whichever is the greater, without the need for subsurface investigations.

TESTING SPECIFICATIONS

1. If your building is 200m^2 or less and generally rectangular in shape:
    - Five auger holes and five ground-bearing capacity tests.
    - One in each corner of the building platform and one in the center.
2. If the building platform is greater than 200m^2 or an irregular shape additional test(s) will be required - 1 extra test site per additional 50m^2 is required. For very large and simple rectangular buildings this testing frequency may be reduced in agreement with Building Services. This agreement should be confirmed via email.

3. Testing must be to a minimum depth of:

a) 2m below the underside of the proposed strip or bored pile footings; or

b) 600mm beneath short driven timber piles or 2.5m in depth, whichever is the deeper; or

c) until refusal (justification for refusal must be given). Refusal must be in accordance with the NZ Standard and is generally at 20 blows per 100mm penetration.

Note: Where foundation depth may need to be deeper than the required testing depth, testing will need to be extended to allow for this.

4. A penetrometer must be used in sandy soils and a shear vane in cohesive, expansive or clay soils. Shear vane readings are to be taken every 200mm in depth in each bore. Ideally, peak and re-molded values should be recorded.

COMMERCIAL/INDUSTRIAL BUILDINGS NEEDING SITE INVESTIGATIONS

In addition to the requirements for residential buildings (bearing strength and stability analysis), all building consents for commercial/industrial buildings greater than 110m^2 and all tilt slab buildings regardless of size, shall include liquefaction testing in the form of electronic cone penetrometer tests (CPT's) and, if required, engineer designed foundations or mitigation measures to account for settlement or movements (lateral spreading). Commercial/industrial buildings (not including tilt slab) less than 110m^2 shall be in accordance with the same requirements as residential buildings.

Note: Allowance for consolidation settlement of soils from building loading and floor loadings shall be considered in the

foundation/floor slab design for all industrial/commercial buildings.

Exemptions

- Pole sheds without concrete floor.
- Pole sheds with concrete floor but not attached to the pole foundations.
- Portal frame tin sheds <401m^2 (this does not apply to any tilt panel buildings). **Note:** - If the PS1 design certificate assumes 'good ground' then a bearing capacity test will be required.

ENGINEER DESIGN SOLUTIONS

Where the ground-bearing capacity does not meet the 'good ground' requirements for NZS3604:2011, or if the ground consists of clays, expansive soils or loose gravels, liquefiable soils, or if slope stability remedial measures are required then the foundations and any remedial measures (e.g. a retaining wall) must be designed by a suitably qualified CPEng registered structural engineer.

The consulting engineer is also required to give a professional guarantee through a 'Producer Statement' (PS1) which must also be supplied with the building consent application.

ASSOCIATED EARTHWORKS

Depending on the location of your proposed building site, you may require earthworks (cut and fill) to form the building platform and associated areas. This may trigger a requirement for a building consent for 'site works' or resource consent for land disturbance, particularly if you are on a hill slope. Please contact the Resource Consent Section of Council if earthworks are required as part of the development. Resource Consents for land disturbance are issued by the regional arm of the Resource Consent team of Council. In some

cases when a land disturbance consent is not required you may still require a building consent before undertaking any earthworks. **Asking first** costs nothing and can save significant delays or costs during the building consent application and approval process.

DEFINITIONS

Bearing Capacity

Determination of whether 'good ground' exists for the founding of a building. This determination requires testing by hand augers and penetrometer tests. PLEASE NOTE: - expansive clays are ruled out of the definition good ground in NZS3604 – 2011. Testing of these soils requires use of a shear vane.

Cone Penetrometer Test (CPT):

CPT is an in-situ testing method used to determine the geotechnical engineering properties of soils, delineating soil stratigraphy and gather pore water pressure data. CPT data is used for determining liquefaction and lateral spreading potential. Please note, this test is not suitable to identify any non-engineered fill, deleterious material, or the NZS3604:2011 required 100kPa allowable bearing capacity.

Differential Settlement:

Uneven, downward movement of the foundation of a structure, usually caused by varying soil or loading conditions and resulting in cracks and distortions in the foundation.

Infill Subdivision:

The subdivision of an existing residential allotment that is located in a built-up residential area.

LIMIT STATES

SLS - Serviceability Limit State

The SLS represents a level of stress or strain within the building below which there is a high expectation the building can continue to be used as originally intended without repair. As a consequence, the limiting level of stress or strain defined for this limit state is low.

ILS – Intermediate Limit State

The ILS represents a level of stress or strain within the building which could occur within the life of the building. The ILS level test should be set at a one in one hundred year expected seismic shaking level. This test allows the consent authority to more accurately assess where liquefaction levels may become unacceptable as compared to the SLS (25 year) and the ULS (500 year) analysis.

Ultimate Limit State

Design for the ULS represents a defined process that is aimed at ensuring the probability of collapse of a building (and therefore the risk to human life) is at an acceptable level. The ULS process is therefore primarily associated with consideration of large (severe), relatively rare events.

Liquefaction:

This is the process where a saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid. This process is most often observed in saturated, loose (low density or un-compacted) sandy soils.

Areas susceptible are often found along riverbeds, beaches, dunes, and areas where windblown silt and sand have accumulated.

Liquefaction-induced Lateral Spreading:

Lateral displacement of gently sloping ground as a result of liquefaction during an earthquake. Affects areas in close proximity to rivers and streams. The displacement appears as parallel cracks and the surface and the land can drop.

Mud Volcano

A mud volcano or mud dome is a landform created by the eruption of mud or slurries, water and gases and can form after seismic shaking.

PGA – Peak ground Acceleration

Peak ground acceleration is the maximum force (in proportion of gravitational force) from an earthquake. PGA will be expressed as 0.65g which equates to 65% of one gravity during an ULS seismic event (probability of exceedance of 500 years) for a habitable dwelling. As part of the Building Code, all buildings have to be designed to tolerate this kind of event. However, the PGA may vary with the so-called Importance Level of the structure. The PGAs are generally used to assess the performance of a building in an SLS, ILS (or SLS-2), or ULS event.

Pole Shed

For the purpose of this document a pole shed is a shed where the primary structure is round vertical tanalised pole with rafters, purlins and girts to support the cladding. Pole shed foundations are poles set in concrete only. If there is a concrete floor that is part of the foundation, then the shed is outside this definition. Pole sheds that are to be used as habitable dwellings require the same testing and design as any other dwelling. Conversion of a pole shed to a dwelling will require additional testing and probably additional foundation and bracing.

Slope Stability:

Defined as the resistance of an inclined surface to failure by sliding or collapsing. The main objectives of slope stability analysis are finding endangered areas, investigation of potential failure mechanisms, determination of the slope sensitivity to different triggering mechanisms, and designing possible remedial measures, e.g., barriers, stabilisation and building setbacks restriction.

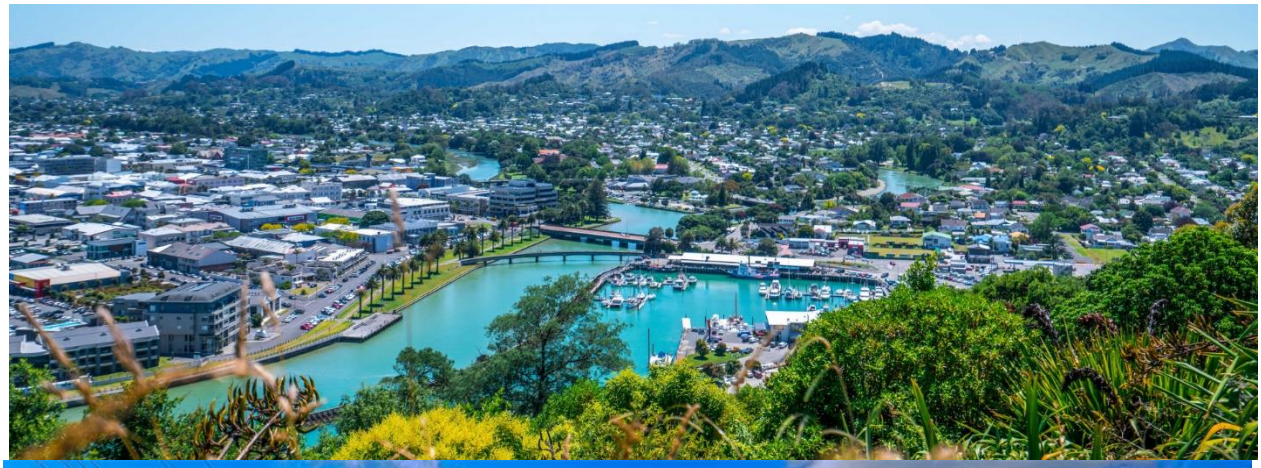
Suitably Qualified Professional: -

- For all geotechnical reports including, but not limited to, high liquefaction sites, medium liquefaction sites with any free face within 120 meters and all sloped sites, regardless of location - a suitably qualified and experienced geotechnical engineer and/or engineering geologist who is a registered Chartered Professional Engineer with Engineering New Zealand and awarded a geotechnical practice endorsement, and /or a Professional Engineering Geologist (PEngGeol) registered with Engineering New Zealand with a minimum of 10 years demonstrable experience in the investigation, assessment and mitigation of earthquake geotechnical hazards
- For flat low and medium liquefaction sites – bearing capacity testing only - a suitably qualified and experienced geotechnical engineer as per the definitions in this document.

PLEASE NOTE: Gisborne District Council reserves the right to seek independent peer review of any Building Consent application at the owner/client expense.

If you require further information, we recommend you contact Building Services or Resource Consent staff before committing to any major project.

NOTES:



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