

# ***Determination***

## ***under the***

### ***Building Act 1991***

#### **No. 95/005: Construction of a house on a steep site**

##### **1. The matter to be determined**

- 1.1 The matter before the Authority was whether, in the proposed construction of the first of a proposed group of five houses on a steep site, the proposed provisions for soil stability and for disposing of surface water would comply with the building code (the First Schedule to the Building Regulations 1992).

##### **2. The parties**

- 2.1 The applicant is the owner of adjacent property.
- 2.2 The applicant is entitled to be a party to the determination under section 16(d) of the Building Act 1991. As such, the applicant may apply for a determination only “if the matter for determination relates to a provision of the building code that has the purpose of protecting [the applicant’s] property”.
- 2.3 The other parties to the determination are the owner of the land on which the houses (referred to as “units”) are proposed to be constructed (“the developer”) and the territorial authority concerned.

##### **3. The matter to be determined**

- 3.1 The applicant has the right to apply for a determination only because the matter for determination relates to provisions of the building code that have the purpose of protecting the applicant’s property. However, the Authority takes the view that the scope of the determination need not be confined to such provisions. Once an application has been made by a party entitled to do so, the Authority considers that it may consider any of the provisions of the building code that arise naturally out of the application.
- 3.2 The Authority takes the view that it is being asked in effect to determine whether, if properly completed in accordance with the plans and specifications submitted for building consent, the building work concerned would comply with clauses B1 Structure (in respect of soil stabilisation) and E1 Surface Water of the building code.

3.3 In making its determination, the Authority has not considered the other provisions of the building code.

#### **4. The proposed building work**

4.1 The units are proposed to be constructed on the face of a steep escarpment. The applicant's property lies at the base of the escarpment. A drive serving the units is to run along the crest of the escarpment, and each of the units is to be constructed on various levels down the face of the escarpment above the applicant's property.

4.2 The units are to be supported on timber poles. A "building platform" is to be prepared for each unit by excavating the soil beneath the unit to create a series of sloping steps supported by timber retaining walls. The original ground is not proposed to be altered except to the extent necessary for the construction of the units and the drive.

4.3 Surface water from the roofs of the units and from sitework such as the drive is to be directed through 150 mm private stormwater pipes:

(a) Units 1 to 4: To a 225 mm public stormwater pipe which runs through the applicant's property to a 675 mm public stormwater pipe which also carries the discharge from a detention dam installed by the territorial authority further up the valley. That 675 mm pipe discharges into a catchpit on the applicant's property, which in turn discharges into a 900 mm pipe.

(b) Unit 5: To a public catchpit which discharges through a 225 mm pipe to the same 675 mm pipe.

4.4 The territorial authority issued a building consent for one of the units ("unit 1"), and the Authority is being asked to confirm, reverse, or modify the territorial authority's decision to issue that consent. In fact, unit 1 has already been completed, and the outcome of the determination will affect not only unit 1 but also the proposed units 2, 3, 4, and 5.

4.5 The proposed development has already been the subject of proceedings in the High Court in relation to the Resource Management Act 1991, and most of the submissions to the Authority in respect of soil stability matters were originally prepared for those proceedings. Those High Court proceedings related to land use consents for the removal of trees, for subdivision, and for excavation of earth, and a certificate of compliance in respect of proposed buildings. The Court issued a restraining order in respect of tree felling and bush clearance against the developer<sup>1</sup>.

4.6 The Authority reads the judgment in that case as indicating that the actual removal of some trees and bush was of the nature of subdivisional work undertaken under the Resource Management Act and was not "sitework" as defined in the Building Act. Accordingly, in considering the provisions for disposal of surface water the Authority did not need to

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<sup>1</sup> *Burton v Auckland City Council*, 5/7/94, Blanchard J, H C Auckland M. 1973/93.

consider the effect that the clearance of vegetation might have had on the surface water flowing on to the applicant's property from the cleared areas.

## **5. The parties' contentions**

5.1 The applicant in effect contends that:

- (a) Section 36 of the Building Act required the territorial authority to refuse to issue the building consent;
- (b) Inadequate site investigations and stability analysis have been undertaken to verify the structural stability of the houses and of the timber retaining walls; and
- (c) The provisions for disposal of surface water are inadequate both as to the private system and as to the public system into which it discharges.

5.2 The developer and the territorial authority contend that the investigations and analysis actually undertaken were adequate and also that the provisions for disposal of surface water are adequate.

5.3 The applicant's contentions as to soil stability matters are supported by a consulting engineer ("the applicant's geotechnical engineer"), the developer's by another consulting engineer ("the developer's engineer") who was responsible for the geotechnical investigations and analysis of the site and the structural design of the units, and the territorial authority's by an engineer on its staff ("the territorial authority's engineer") who reviewed and advised on the structural aspects of the application for building consent.

5.4 The applicant's contentions as to the disposal of surface water are supported by another consulting engineer ("the applicant's hydrological engineer").

5.5 The territorial authority and the developer made no specific submissions as to the disposal of stormwater. The applicant and the applicant's hydrological engineer said that they had requested information about the territorial authority's public system but failed to obtain sufficient information to satisfy their concerns as to whether or not it had the capacity to receive and dispose of the discharge from the development.

5.6 The Authority understands that the requested information is of a type which the territorial authority should make available, and is disappointed that the applicant and the applicant's hydrological engineer could not obtain it.

## **6. Section 36 of the Building Act**

6.1 The Authority has not considered the applicant's contention that the territorial authority should have refused building consent on the grounds set out in section 36 of the Building Act. That raises questions of law and appears to be outside the limitations placed by section 18 on matters which may be submitted to the Authority for determination. However, the Authority observes that in its opinion:

- (a) The proposed building work will protect the building platforms and the drive, although whether it does so to the required extent is a question to be addressed in this determination; and
- (b) The proposed building work will not accelerate, worsen, or result in, but if anything will reduce the likelihood of, slippage on the remainder of the development property.

## **7. Site investigations and stability analysis**

### *7.1 Geotechnical reports*

- 7.1.1 Three geotechnical reports were prepared by the developer's engineer. The first (which was not submitted to the Authority) was apparently written specifically in support of the building consent application for unit 1 only, but was replaced by a second report (which was submitted to the Authority) in response to the territorial authority's request for the "stability of the whole site be examined in order to assess the engineering viability of the proposed development". That second report was considered by the territorial authority when it processed the application for building consent for unit 1, and the developer's engineer addressed the stability of the other units in the third report (which was also submitted to the Authority). The third report followed the logic of the second, and has not been considered in detail by the Authority. However, the Authority's comments on the second report may be taken as applying to the third report also.
- 7.1.2 The site is very steep, with gradients of up to 35° and even steeper in localised areas, about which the developer's engineer said: "The steepness of this area would indicate that there has at some stage been slumping of the surface layers." Parts of the site were covered with fill material. The developer's engineer found evidence of "shallow surface slumping" but considered that "there was no obvious evidence of any deep seated instability on the site".
- 7.1.3 The applicant's engineer also inspected the site, and said that it was "amphitheatrical in shape and is extremely hummocky". In his opinion it showed signs of advanced creep and had obviously slumped from time to time.
- 7.1.4 The New Zealand Geological Series map for the area identifies the underlying bedrock material as hard siltstones and sandstones of the Waitemata formation.
- 7.1.5 In October and November 1993, sixteen boreholes were drilled with a hand auger at various points on and adjacent to the proposed locations of the units. In situ soil shear strengths were measured at selected depths using a hand shear vane, and penetrometer readings were taken to assist in identifying soil strengths. A sample for triaxial testing was taken from a test pit adjacent to one of the boreholes, and a sample for a shear box test was taken from that borehole. A further two boreholes were drilled adjacent to the existing sanitary sewer lines to determine the type of backfill material and groundwater conditions at those locations.
- 7.1.6 The borelogs revealed that overlying the sandstone were firm to stiff silts and clayey silts 5 to 6 m thick along the ridge but seldom more than 2 m thick on the steeper slopes. Fill up to 1.6 m thick was identified along the ridge, with fill up to 1 m deep at the locations of two of

the units. No groundwater was encountered in any of the borelogs during the investigations, and no soft or wet layers were found.

- 7.1.7 From the borelogs, the developer's engineer plotted profiles of the underlying sandstone. Slip circle calculations were then made for each unit. The developer's engineer adopted minimum safety factors of 1.5 across building platforms and 1.25 outside building platforms, which he said were "generally considered to be adequate".
- 7.1.8 The developer's engineer considered that the results of the shear box test "do not truly represent the material observed on site which has a degree of cementation and will stand unsupported at quite steep angles". He accordingly "revised" the shear box test results for the purposes of the slip circle stability analysis.
- 7.1.9 No water table was assumed for the slip circle analysis, apparently because none had been observed, the development did not receive run-off from properties above it, and it was assumed that the stormwater disposal provisions for the units and associated drive would reduce the infiltration area to 45% of the total area of the developed property.

## 7.2 *Discussion*

- 7.2.1 The applicant's engineer made detailed criticisms of the developer's engineer's reports. The territorial authority's engineer accepted that some of those criticisms were valid in general terms but not "in the context of the circumstances pertaining to the site".
- 7.2.2 The High Court Judge who heard the evidence of those engineers in proceedings relating to the Resource Management Act said in his judgment:

"Far be it from me to suggest in any way that this development is inconsequential or unimportant. . . . But having said that one cannot lose sight of the fact that within the [Resource Management] Act . . . it is nevertheless yet another development of some residential units on something less than a level section. One merely needs to observe what is going on [elsewhere] to understand the strength of the evidence of the Council officers who describe this as a case of a not extraordinary nature. . . . There was a vigorous challenge in the evidence of [the applicant's engineer] to the [developer's engineer's] report but when that is analysed it is really a challenge to methodology and approach rather than to conclusion. . . . The [territorial authority's engineer] recognises that perhaps in a perfect world all sorts of tests could be conducted but he accepts that there is a degree of unreality about it."

- 7.2.3 That judgment was delivered in relation to the Resource Management Act and is not directly relevant to this determination under the Building Act. Furthermore, as mentioned in 3.1 above, determinations are not of the nature of adversarial proceedings in Court, they are more of the nature of reviews of the technical aspects of disputed decisions by territorial authorities. The Authority takes account of the submissions of all of the parties, but its task is not to decide which party has made the better case but whether building work complies with the building code.

- 7.2.4 The first point challenged by the applicant's engineer was the use of hand auger boreholes. In his opinion, hand augers do not define sandstone bedrock profiles with sufficient accuracy and machine auger boreholes are necessary on sites as steep as the one concerned.
- 7.2.5 The territorial authority's engineer responded:
- “the soil profile in the vicinity of this site is generally uniform and does not warrant such an approach except in relation to very heavy or very important jobs. . . . While it would be prudent to do one or two machine bores . . . to further confirm the hand auger results . . . there is nothing on the site or indicated in the information obtained that would indicate that anything further needs to be done.”
- 7.2.6 As mentioned in 7.1.2 above, visual assessment of the site noted slumping and creep of surface soils, which should necessitate a careful geological assessment of stability. Furthermore, the arcuate or amphitheatre-like features of the slopes could be scarps of old slips. The Authority considers that those features necessitated a closer evaluation.
- 7.2.7 In those circumstances, the Authority considers that it was particularly necessary to establish the surface of the underlying sandstone or siltstone. The nature and position of that surface was important in the geological model analysed for stability. The Authority accepts that it is often difficult to establish such a surface with hand auger holes.
- 7.2.8 On the question of groundwater, the Authority notes that the boreholes were drilled at the end of an abnormally dry winter. The Authority considers that making the slip circle analysis without including a water table involved an optimistic assumption. The Authority is not convinced by the developer's engineer's justification of that assumption, as outlined in 7.1.9 above, because it understands that groundwater is commonly observed perched within the weaker more weathered Waitemata Group soils near the ground surface, even on ridge tops and near slip faces.
- 7.2.9 As for soil properties, the Authority has not seen a report on the triaxial test sample mentioned in the developer's engineer's report, see 7.1.5 above, but it has seen the test laboratory report on the box shear test. There are discrepancies between that report and the borelog of the borehole from which the sample was taken. In any event, the developer's engineer “revised” the results from the box shear test for the purposes of the stability analysis, see 7.1.8 above. The shear vane and Scala penetrometer test results were not queried by the applicant's engineer and the Authority accepts them.

7.2.10 The applicant's engineer said:

“To accurately represent all of the overburden materials I would consider that at least three of four effective stress tests (or shear box as appropriate to the material type) would be necessary.”

7.2.11 The territorial authority's engineer responded:

“[The applicant's engineer] is factually correct but I should point out that there is a reasonable body of information which has been gathered from other developments in the same area. When this lab test is taken together and compared with other results from the same area, it is apparent that a similar geology is present in the vicinity and therefore previous calculations can be correlated to this case.”

7.2.12 The Authority recognises the force of those comments, but considers that an actual test result must take precedence over any assumption that the site is similar to other sites in the same area. If the results of that test are anomalous, then the Authority considers that further tests should be made to resolve the discrepancy. It may well be that the single box shear test gave an incorrect result, but the Authority considers that making the slip circle analysis on the basis of the “revised” results involved another optimistic assumption. The Authority does not accept the developer's engineer's justification for “revising” the result.

7.2.13 Six slip circles, all circular, were analysed by the developer's engineer using hand calculations. The applicant's engineer said that in his opinion a “more sophisticated analysis should be carried out on all slope cross sections containing building platforms”. The Authority agrees, and understands that the general practice of geotechnical engineers is to use computer rather than hand methods so that a larger number of potential slips, including non-circular slips, can be analysed and the one with the lowest factor of safety searched for.

7.2.14 The Authority considers that the factor of safety of 1.5 across building platforms (see 7.1.7 above) is appropriate. It observes that the factor of safety of 1.25 for the rest of the land is below what is normally regarded as acceptable. However, the stability of that land does not affect and will not be affected by the proposed building work, so that is not a matter that comes within the scope of this determination.

7.2.15 The Authority was not supplied with any structural calculations for the retaining walls or the pole foundations. Given that the site could not be described as “good ground”, and that the developer's engineer recommended that the pole foundations be designed for lateral soil loads due to creep, the Authority would have expected the territorial authority to require structural calculations to be included with the application for building consent.

## 8. Surface water

### 8.1 General

8.1.1 The applicant's property is at the bottom of a valley which collects water from the wider valley area downstream of a retention dam constructed by the territorial authority some time ago. In other words, the applicant's property is on an overland flow path. The flooding experienced on the applicant's property is contributed to by water flowing off the developer's property. The plans for the proposed development show that surface water will be collected from buildings and paved areas and piped to the public stormwater system. The main question is whether the proposed provisions for disposing of surface water comply with clause E1.3.1 of the building code, which reads as follows:

**E1.3.1** Except as otherwise provided under the Resource Management Act 1991, surface water, resulting from a storm having a 10% probability of occurring annually and which is collected or concentrated by buildings or sitework, shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property.

8.1.2 That leads to further questions:

- (a) Is the private system adequate to convey the surface water resulting from a storm having a 10% probability of occurring annually which is collected from buildings and paved areas to discharge into the public system?
- (b) Is the public system adequate to accept and dispose of that discharge?

### 8.2 The parties' contentions

8.2.1 The applicant's main concern about surface water arises from flooding on his property. He complains that he has been unable to discover how the surface water from the development is to be disposed of. The applicant's property and neighbouring properties have been flooded in the past, and the applicant says: "Any inadequacies in pipe capacity or blockages, would exacerbate any tendency to flooding." In particular, the applicant contends that the private system itself did not comply with the building code and its outfall into the public system was not appropriate because that system was overloaded.

8.2.2 The applicant's submissions and evidence fell short of establishing those contentions. That evidence included photographs and a video showing flooding on the applicant's property, but there was no evidence as to whether that flooding occurred in a storm with a probability of less than 10% nor as to the extent, if any, to which the level of flooding was affected by building work, as distinct from subdivisional work, on the developer's property. In any case, the territorial authority submitted that the video was taken while the system was under construction (although the Authority notes that building work is required to comply with the building code at all stages of construction and not merely when completed).

8.2.3 The Authority considers that the applicant knew, or ought to have known, at the time of purchase, that the applicant's property was in a valley prone to flooding.



8.2.4 Nevertheless, the territorial authority's replies to or submissions in respect of various questions about the drainage system raised by the applicant have left the Authority uncertain as to the reasonable grounds, if any, on which the territorial authority, in issuing the building consent, had been satisfied as to the system's compliance with the building code. That uncertainty has been compounded by the fact that the parties have not supplied necessary technical information in a clear manner. For example, at the hearing the territorial authority's representative was understood to say that part of the private system shown on the "sheet 6" plan was temporary for one unit only, and that "sheet 6" would be replaced by "sheet 6A" when (or if) the other units were constructed. That was not apparent from the plans, and subsequently caused some queries to be raised by the applicant's hydrological engineer. In fact, the Authority is satisfied that nothing turns on the point, which merely involves the future possible relocation of a 150 mm pipe, but it exemplifies the difficulties the Authority has experienced with the parties' submissions on technical matters.

8.2.5 The Authority accordingly appointed its own consulting engineer ("the Authority's hydrological engineer") to report on the design of both the private system and the public system into which it discharges. The territorial authority provided the Authority's hydrological engineer with sufficient information for that purpose.

8.2.6 The applicant's hydrological engineer commented on that report.

### 8.3 *The private system*

8.3.1 The applicant's hydrological engineer could not obtain any calculations in respect of the private system. The Authority recognises that it is not unusual for the surface water system for a single unit development to be designed without specific calculations. However, the Authority considers that calculations should be made for a multi-unit development.

8.3.2 The applicant's hydrological engineer also commented adversely about some of the installation details of the private system. The Authority acknowledges those comments but considers that some of them arise from a misunderstanding as to the intended future relocation of a pipe and others are of a minor nature which need not be discussed in this determination. The Authority relies on the territorial authority to ensure that installation defects, if any, are remedied before a code compliance certificate is issued.

8.3.3 The Authority's hydrological engineer obtained and verified check calculations from the territorial authority to confirm the adequacy of the pipe sizes.

### 8.4 *The public system*

8.4.1 The Authority's hydrological engineer obtained from the territorial authority details of the public system, including design assumptions and calculations. The retention dam was designed to accept runoff associated with a storm with a return period of 100 years (annual probability of exceedance of 1%). The engineer's verification calculations indicated that the piped system downstream of the detention dam was adequate to accept the discharge from the private system.

8.4.2 The applicant's hydrological engineer commented on the Authority's hydrological engineer's report. The Authority carefully considered those comments but did not consider that they affected the reliability of the report. Particular criticisms related to:

- (a) The fact that the clearing of vegetation had not been taken into account.

As mentioned in 4.6 above, the Authority does not consider the clearing of vegetation in this case to be "sitework" for the purposes of the building code. However, the Authority notes and accepts its hydrological engineer's conclusion that the development should improve the applicant's property in respect of flooding in that some of the rainfall which previously flowed overland on to the applicant's property is now diverted to an adequate piped water system.

- (b) The applicant's engineer's opinion that a runoff coefficient of 0.65 would have been more appropriate than the coefficient of 0.55 which the territorial authority had used for the design of the dam and the pipework carrying the discharge from the dam and from downstream developments including this one.

That point had in fact been addressed in the report as follows:

. . . even if complete townhouse development of the catchment upstream of [the applicant's] property was to be permitted (giving a runoff coefficient of 0.65 [instead of the 0.55 used for the design of the dam and downstream pipework]), 10 year return period inflows to the detention dam would still be some 35% less than the 100 year return period inflows calculated by the Council's design engineer.

The Authority accepts that view.

## **9. Conclusion**

- 9.1 The Authority concludes that the developer's engineer's geotechnical report does not confidently establish the geological profile to sufficient depth, previous instability is not adequately assessed, and assumptions as to groundwater levels and soil properties are optimistic. The assessment of soil stability might in fact be correct, but it is not adequately justified.
- 9.2 Specific design calculations for the retaining walls and pole foundations, if not already held by the territorial authority, should be supplied to it.
- 9.3 There is no reason to believe that the disposal of surface water will not comply with the provisions of the building code.

## **10. The Authority's decision**

10.1 In accordance with section 20(a) of the Building Act the Authority hereby modifies the building consent by adding the following conditions:

- (a) Further geotechnical investigations shall be undertaken, including:
  - (i) Machine auger boreholes to establish with confidence the surface of the underlying sandstone or siltstone;
  - (ii) Laboratory tests of samples from several locations to establish with confidence the soil properties to be used in stability analyses; and
  - (iii) Investigations of groundwater levels shall be undertaken, if practicable, to establish with confidence the highest groundwater table likely to be experienced throughout the life of the building concerned.
- (b) Computer slip-circle analyses shall be made across each building platform for a large number of potential slips, including non-circular slips. Those analyses shall use the information established by the geotechnical investigations required by condition (a) except that if it is impracticable to establish an appropriate groundwater table by investigation then the analyses shall assume a fully saturated slope condition.
- (c) The plans and specifications included in the application for the building consent are to be amended if and as necessary in the light of those investigations and analyses to the satisfaction of the territorial authority.

10.2 The Authority confirms the building consent in respect of the provisions for the disposal of surface water.

Signed for and on behalf of the Building Industry Authority on this 15<sup>th</sup> day of December 1995

J H Hunt  
Chief Executive