12 March 2018 Our Ref: 439282/Rev. A

Robert Logan
C/- Kim Logan
18 Lombard Place
Avonhead
Christchurch 8042

Attention: Robert Logan

Dear Robert

PC54 – Possible Fault

1 Introduction

Further to your instruction, we have reviewed the fault information that was publicly available to us at the time of this report and have visited the site to inspect the topography across the site and the surrounding areas to identify any topographical features that may be associated with previous fault movement. We are writing to comment on the potential for an active fault to be located across the area of proposed Plan Change application PC54.

This report shall be considered as an addendum to our previous "*Geotechnical Report for Plan Change*", ref. 369527, dated 23 August 2013.

2 Available Reports

As part of this report, we have read the following guidelines and technical reports;

- Kerr, J.; Nathan, S.; Van Dissen, R.; Webb, P.; Brunsdon D.; King, A. 2003. *Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand*. Ministry for the Environment (MfE), published July 2003.
- Dorn, C., A. G. Green, R. Jongens, S. Carpentier, A. E. Kaiser, F. Campbell, H. Horstmeyer, J. Campbell, M. Finnemore, and J. Pettinga (2010), *High -resolution seismic images of potentially seismogenic structures beneath the northwest Canterbury Plains, New Zealand*, J. Geophys. Res., 115, B11303, doi:10.1029/2010JB007459.
- Barrell, D. J. A. 2013. *General distribution and characteristics of active faults and folds in the Selwyn District, North Canterbury*, GNS Science Consultancy Report 2012/325. 53 p.
- Langridge, R. M.; Barrell, D. J. A. 2015. *Assessment of active fault hazard at proposed Yaxley and Pauling irrigation pond sites, Springfield, Canterbury*, GNS Science Consultancy Report 2015/33. 14 p.

3 Selwyn District Plan

Information shown on the Canterbury Maps Viewer identifies the Springfield Fault crosses the site. It is recorded as a '*possible fault*' with surface form '*not expressed*'. This is shown on the Selwyn District Council's Planning Map (ePlan website[1]). Refer to Figure 1.

[1] http://eplan.selwyn.govt.nz/#!Property/VAL2421031701

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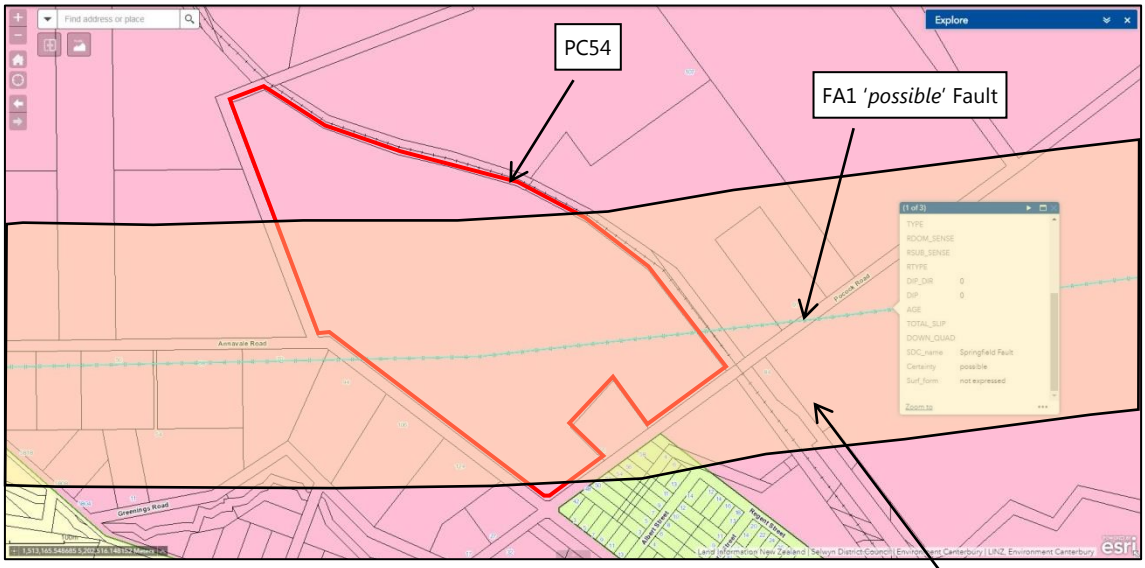

Figure 1: Selwyn District Council Operative District Plan

4 FA1 '*Possible*' Fault

The study of Dorn et al, 2010, provides summary maps that identify the location of definite and inferred faults from seismic reflection data.

The report advises the Springfield Fault is a '*definite*' fault that that is located west of Springfield and terminates somewhere southwest of the site, however, a possible extension to this fault, or to the Kowai Fault is shown as '*FA1*'. This is inferred from seismic reflection data and may be located in an east-west line across the site. The inferred FA1 Fault may connect the Springfield and Chalk Hill Faults. The location and alignment of FA1 is shown with the fault shown on the Selwyn District Plan. The recurrence interval of fault FA1 is not specifically known.

GNS report CR 2015/33 was prepared to assess the presence of any active fault hazards at a proposed irrigation pond site located approximately 2.5km southeast of the site (southeast of Pocock Road). This report concluded that "*there is no surface fault traces as yet mapped in the vicinity of the sites, on a land surface that is estimated at between 16,000 and 18,0000 years in age.*"

GNS report CR 2012/325 defines "*possible*" fault as "*where there is some reason to suspect the presence of an active fault or fold, but cannot say for sure that it is because, for example, the landforms are unsuitable (e.g. too young) to have preserved any direct evidence of young movement*". The report also notes "*Features identified as "possible" should not be treated as delineated active faults or folds unless investigated further. They are identified to highlight areas that are worth a closer look with regard to the possible existence of active faults or folds.*" The fault is labelled as Surf_form '*not expressed*' which means "*not expected to have any physical expression on the ground, because they lie in areas of landforms that are probably younger than the most recent deformation.*"

We understand from our communications with GNS the location of any "*possible*" fault alignment across the site is not confirmed and may be up to 250m to the north or south of the location shown in the GNS reports and Selwyn District Council's Planning Map. This has been annotated on Figure 1 so the potential extent of the fault zone can be understood in the context of the wider area.

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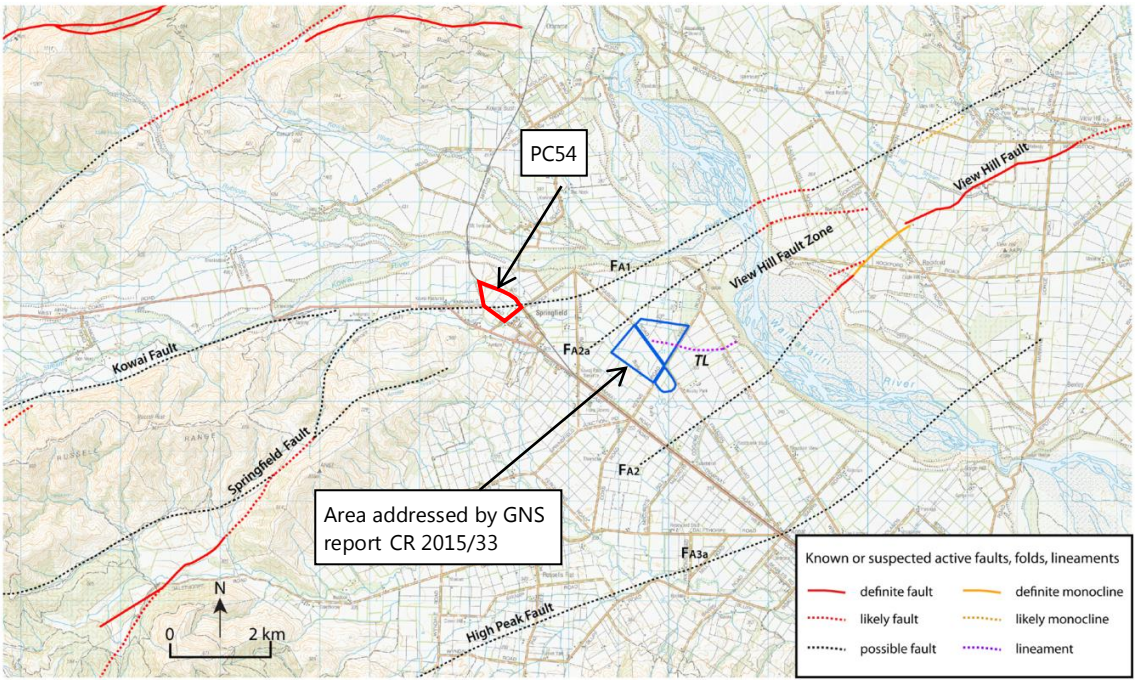

Figure 2: Known and suspected fault and fold traces in the general area of the site (source: GNS CR 2015/33)

5 Site visit

We initially inspected the site on 1 July 2013 and re-inspected the site again on 20 February 2018 to assess the general ground surface across the site for any evidence of ground deformation that may be associated with obvious fault displacement.

During our site visits we did not observe any topographical features across the site that were obviously associated with previous fault rupture. This site is flat, and our observations are consistent with the definition of "*possible*" fault and surface form '*not expressed*'.

6 Risk-Based Approach Assessment

GNS report CR 2012/325, Table 1, p. 18, indicates that where there is a "*possible*" fault with surface-form that is '*not expressed*' it still should be considered as an active fault.

Importantly, MfE's Active Fault Guidelines states "*where the level of certainty is low regarding the fault location, its complexity and recurrence interval, it may be difficult to justify rules that limit any building in these areas.*"

If it is correct that the FA1 Fault is a continuation of Springfield Fault, then it is estimated to have an average Recurrence Interval (RI) of **7,200 years**[2]

Taking this into account, MfE's Active Fault Guidelines set out a simplified risk-based approach that can be followed to assess whether or not the site can be considered for residential development. (Refer to Appendix A)

- RI Class = **Class IV**
- Fault complexity = **Type C - Uncertain** (refer also to GNS CR 2012/325, Table 1, p. 18)
- Building Importance Category (BIC) = **2a** - residential timber-framed construction

[2] GNS CR 2012/325, Table 2, p. 20

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Based on this, MfE's criteria concludes that **building within the FA1 fault hazard avoidance area should be a permitted activity**.

Please note the above assessment is based on Category 2a, as this seems to be the more logic and sensible option for residential construction within the proposed plan change PC54. However, the future development of the site should not be limited to this category, as other options for residential constructions are also available in Table 9.1 of the MfE's Active Fault Guidelines such as:

- **Category 1** for "*structures presenting a low degree of hazard to life and other property*" (i.e. structures <30m^2, farm buildings, isolated structures, in-ground swimming pools, etc.)
- **Category 2a** for simple residential construction (i.e. timber-framed single-storey dwellings)
- **Category 2b** for more complicated residential construction (i.e. timber framed houses of plan area of more than 300m^2, houses outside the scope of NZ 3604 "Timber Framed Building", etc.)

Whether the future construction on the proposed plan change PC54 falls within Category 1, Category 2a or Category 2b, the Risk-Based Approach Assessment will reach to the same conclusion (i.e. **building within the FA1 fault hazard avoidance area should be a permitted activity**). Refer to Appendix A.

In summary, by conservatively adopting the average RI for Springfield Fault when assessing the risk posed by "possible" fault, we conclude the site is suitable for future residential construction, and given the significant uncertainty about whether or not reactivation of the fault will occur, the location where surface rupture could occur, we conclude there should be no restrictions in relation to Active Faults that need to apply to the proposed plan change PC54.

Yours sincerely
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Enc. Appendix A

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Appendix A : Risk-Based Approach Assessment

Reference: *Kerr, J.; Nathan, S.; Van Dissen, R.; Webb, P.; Brunsdon D.; King, A. 2003. Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand. Ministry for the Environment (MfE), published July 2003.*

Table 7.1: Fault recurrence interval classes

Recurrence interval class	Average fault recurrence interval of surface rupture
I	≤2000 years
II	>2000 years to ≤3500 years
III	>3500 years to ≤5000 years
IV	>5000 years to ≤10,000 years
V	>10,000 years to ≤20,000 years
VI	>20,000 years to ≤125,000 years

Table 8.1: Defining fault complexity types

A **Well defined**	**A well defined** fault trace of limited geographic width Typically metres to tens of metres wide
B **Distributed**	Deformation is **distributed** over a relatively broad geographic width Typically tens to hundreds of metres wide Usually comprises multiple fault traces and/or folds
C **Uncertain**	The location of fault trace(s) is **uncertain** as it either has not been mapped in detail or it cannot be identified. This is typically a result of gaps in the trace(s), or erosion or coverage of the trace(s)

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Table 9.1: Building Importance Categories: a modified version of New Zealand Loading Standard classifications

Building Importance Category (BIC)	Description	Examples
1	Structures presenting a low degree of hazard to life and other property	Structures with a total floor area of les than 30m^2 Farm buildings, isolated structures, towers in rural situations Fences, masts, walls, in-ground swimming pools
2a	Residential timber-framed construction	Timber framed single-story dwellings
2b	Normal structures and structures not in other categories	Timber framed houses of plan area of more than 300 m^2 Houses outside the scope of NZS 3604 "Timber Framed Buildings" Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate less than 5000 people and also those less than 10,000 m^2 gross area. Public assembly buildings, theatres and cinemas of less than 1000 m^2 Car parking buildings
3	Structures that, **as a whole, may** contain people in crowds or contents of high value to the community or pose **risks to people in crowds**	Emergency medical and other emergency facilities not designated as post disaster facilities Buildings where more than 300 people can congregate in one area Buildings and facilities with primary school, secondary school or day care facilities with capacity greater than 250 Buildings and facilities with capacity greater than 500 for colleges or adult education facilities Health care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities Airport terminals, principal railway stations, with a capacity of more than 250 people Any occupancy with an occupancy load greater than 5000 Power generating facilities, water treatment and waste water treatment facilities and other public utilities not included in Importance Category 4 Buildings and facilities not included in Importance Category 4 containing hazardous materials capable of causing hazardous conditions that do not extend beyond the property boundaries
4	**Structures with special post disaster functions**	Buildings and facilities designated as essential facilities Buildings and facilities with special post-disaster function Medical emergency or surgical facilities Emergency service facilities such as fire, police stations and emergency vehicle garages Utilities required as backup for buildings and facilities of importance level 4 Designated emergency shelters Designated emergency centres and ancillary facilities Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries.

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Tables 11.1 and **11.2** show an example of resource consent activity status for proposed buildings within a fault hazard avoidance area. The activity status will depend on the Building Importance Category, the fault recurrence interval, and the fault complexity.

Table 11.1: Resource consent activity status for greenfield sites

Building importance category	1	2a	2b	3	4
Fault complexity	**Activity status**				
Fault recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	*Non-complying*	*Non-complying*	*Non-complying*	Prohibited
B – Distributed	Permitted	*Discretionary*	*Non-complying*	*Non-complying*	Non-complying
C – Uncertain†	Permitted	*Discretionary*	*Non-complying*	*Non-complying*	Non-complying
Fault recurrence interval class II greater than 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	*Non-complying*	*Non-complying*	*Non-complying*	Prohibited
B – Distributed	Permitted	*Discretionary*	*Non-complying*	*Non-complying*	Non-complying
C – Uncertain†	Permitted	*Discretionary*	*Non-complying*	*Non-complying*	Non-complying
Fault recurrence interval class III greater than 3500 to but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	*Non-complying*	*Non-complying*	Non-complying
B – Distributed	Permitted	Permitted	*Discretionary*	*Discretionary*	Non-complying
C – Uncertain†	Permitted	Permitted	*Discretionary*	*Discretionary*	Non-complying
Fault recurrence interval class IV greater than 5000 but less than or equal to 10,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	*Non-complying*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	*Discretionary*	Non-complying
C – Uncertain†	Permitted	Permitted	Permitted	*Discretionary*	Non-complying
Fault recurrence interval class V greater than 10,000 but less than or equal to 20,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain†	Permitted	Permitted	Permitted	Permitted	Non-complying
Fault recurrence interval class VI greater than 20,000 but less than or equal to 125,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Permitted*
B – Distributed	Permitted	Permitted	Permitted	Permitted	Permitted**
C – Uncertain†	Permitted	Permitted	Permitted	Permitted	Permitted**

Note: Faults with a recurrence interval of greater than125,000 years are not considered active.

* The activity status is permitted, but could be controlled or discretionary because the fault location is well defined.

** Although the activity status is permitted, care should be taken in locating BIC 4 structures on or near known active faults. Controlled or discretionary activity status may be more suitable.

† Where the fault trace is uncertain, specific fault studies may provide more certainty on the location of the fault. Moving the fault into the distributed or well defined category would allow a reclassification of the activity status and fewer assessment criteria.

Italics show that the activity status is more flexible. For example, where *discretionary* is indicated, controlled activity status may be considered more suitable.

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