Tonkin+Taylor

Job No: 29115.3000
2 October 2015

Whakatane District Council
14 Commerce Street
Whakatane 3120

Attention: Jeff Farrell

Dear Jeff

Awatarariki Debris Flow Peer Review Workshop

Further to the Awatarariki debris flow workshop held at Tonkin + Taylor's Auckland office on 17 September 2015, we are pleased to be able to provide the following information as requested.

Risk Overlay Map

Annualised Loss of Life Risk contours for shorter return period events (Figure 15 in T+T, 2015[1]) have been overlain on the debris distribution plan (Figure 4 in T+T, 2015). This is attached.

Note that areas of "significant timber accumulation" were expanded. The original Figure 4 essentially showed where large timber accumulations were located beyond the large debris field which consists of both boulders and timber. The reason for this minor edit was to better match the distribution see in aerial photographs.

Parameter Sensitivity

The annualised Loss of Life Risk contours presented in T+T (2015) were in the form of shorter return periods and longer return periods assigned to each event magnitude. These effectively bracket the range of Loss of Life Risk for the fanhead, with a "best estimate" of risk represented by some intermediate value. The other potential variables in the risk calculation were fixed on what were considered to be best estimates.

In order to determine the effect that choosing alternative input parameters could have on the outcome of the risk analyses, a Monte Carlo simulation was undertaken in which the shorter and longer return period risk calculation spreadsheets were replaced by a single spreadsheet in which the input parameters were chosen at random from distributions of potential values. A normal distribution was chosen in each case.

The mean and standard deviations of the distributions are presented in Table 1, together with the approximate minimum, mean and maximum values. A small number of lookup errors were found in the original spreadsheets affecting the distal low risk areas on the fringe of the debris flows. These errors, which have now been fixed, were 2 or more orders of magnitude less that the contribution to

[1] Tonkin + Taylor (2015). Supplementary Risk Assessment, Debris Flow Hazard, Matata, Bay of Plenty. Report prepared for Whakatane District Council dated July 2015.

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total risk from the high risk zones and therefore did not affect the distribution of the Loss of Life Risk contours.

The Monte Carlo simulation was run by generating input parameters and output for a single risk calculation. The outputs of this analysis was saved and the process repeated. A total of 100 analyses were undertaken.

The spreadsheet and the outputs can be seen on the spreadsheet attached to this letter.

Table 1: Distribution of Risk Input Parameters

Return Period (yrs)	Mean	Std Dev	Random Value	Min	Mean	Max
50,000m^3	75	10	77	45	75	105
150,000m^3	175	30	203	85	175	265
300,000m^3	350	60	280	170	350	530
450,000m^3	750	100	657	450	750	1050
	%	%	%	%	%	%
$P_{(T:S)}$	75	2	77	69	75	81
P(S:H) Zone 1	100			100	100	100
V(D:T) Zone 1	75	5	86	60	75	90
P(S:H) Zone 2	100			100	100	100
V(D:T) Zone 2	20	2	22.5	14	20	26
P(S:H) Zone 3	20	2	18.1	14	20	26
V(D:T) Zone 3	5	1	4.4	2	5	8
P(S:H) Zone 3	5	1	4.0	2	5	8
V(D:T) Zone 3	5	1	4.9	2	5	8
P(S:H) Zone 4	10	2	13.9	4	10	16
V(D:T) Zone 4	5	1	4.8	2	5	8
P(S:H) Zone 4	1	0.1	1.0	1	1	1
V(D:T) Zone 4	1	0.01	1.0	1	1	1

The results of the analyses are as expected, with the most common risk estimate essentially being the median or intermediate value between the risk values calculated for the shorter and longer return periods. This reflects the overriding importance of return period on the outcome of the result compared to other parameters such as vulnerability which have a much more restricted range of possible values.

To assess the effects that the Monte Carlo simulation may have had on the outcome of the risk analysis, the following assessment was made:

- The most seaward properties on the fanhead (No. 8 to 18 Clem Elliot Drive) all fall within the Risk Zone G1 based on where the properties are located within the debris field of each of the four different volume events;
- The calculated $R_{(LOL)}$ for area G1 is 1.13 x 10^{-3} and 4.8 x 10^{-4} for the shorter and longer return periods respectively. The 1 x 10^{-3} annualised $R_{(LOL)}$ contour passes through these properties for the shorter return periods. The properties lie between the 10^{-3} and 10^{-4} contours for the longer return period (approximately 3 x 10^{-3});

- The range of R(LOL) calculated for the G1 location using the Monte Carlo simulation was $5x10^{-4}$ to 1×10^{-3}, with a mean value of 7×10^{-4}. These closely match those risk values developed from the stand alone shorter and longer return periods.
- The range of risk values does not include a single value in the range of 10^{-5} i.e. regardless of the input values adopted, all properties within the Clem Elliot Drive area have a R(LOL) in excess of 10^{-4}. The 10^{-5} risk value does not lie on the histogram of results.

See attachments:

1) Figure 29115.3000-F1
2) Risk calcs rev4.xls

Yours sincerely

Kevin J. Hind
Project Director, PEngGeol

2-Oct-15
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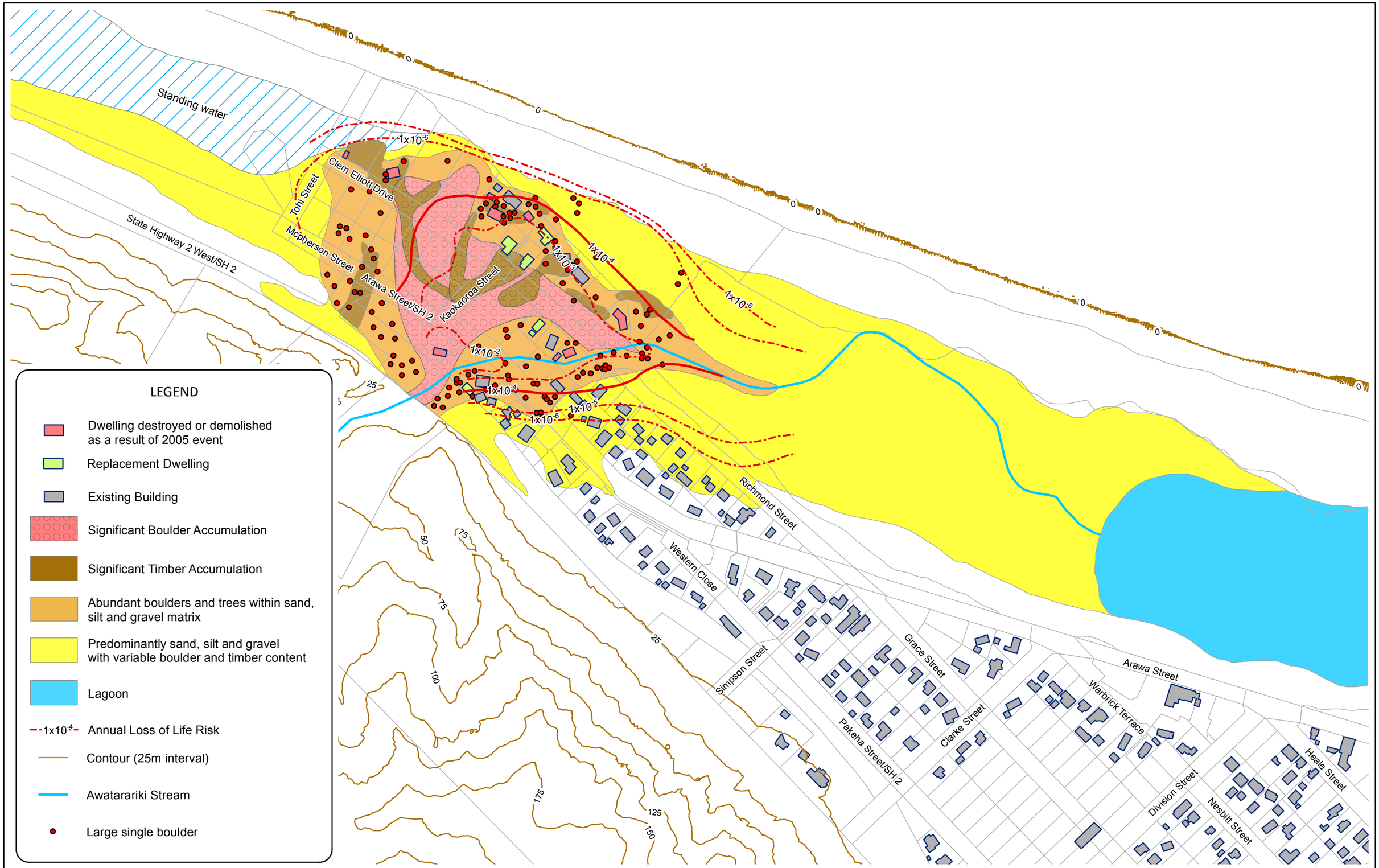

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WHAKATANE DISTRICT COUNCIL

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Debris from 2005 event

Sheet:

FIGURE No. Figure 1.

Rev. 0