4.9. Arrival Times

Arrival times of the first wave and the maximum water level at significant locations are provided in Table 1 for the three source scenarios (the minimum time for each scenario has been used). Times are given in minutes following the tsunami generating earthquake. The first wave arrival was deemed to occur when the water level first increases by 5 cm above the undisturbed level of the sea (in this case MHWS). Unlike 'ordinary' waves, tsunami waves sometimes occur more like an unusually fast rising tide. It can take several minutes (even up to hours) for the water level to rise to the maximum level. The maximum water level arrival time occurs when the modelled tsunami water level attains its maximum. The times given for the South American tsunami are indicative and/or relative only, as the actual time taken depends on exactly where the source occurs.

Table 1: Arrival time (minutes after the source event) of the first wave and maximum water level at French Island, Marsden Point, Takahiwai, Whangarei (Port), Otaika and Oakleigh.

	South American		TKSZ	
Location	T_1 (mins)	T_{max} (mins)	T_1 (mins)	T_{max} (mins)
Frenchman Island	931	1239	87	159
Marsden Point	939	1239	97	223
Takahiwai	947	1237	105	124
Whangarei (Port)	979	1293	145	162
Otaika	979	1297	144	159
Oakleigh	989	1307	156	174

For the South American event, the first wave arrives after about 15 hours (900 minutes), the maximum water level typically occurs a further 5 - 5.5 hours later (after 1230 minutes). For tsunamis originating from the TKSZ, the first waves arrive after about 85 minutes. The maximum water level occurs about 70 minutes after the initial wave at Frenchman Island, approximately 20 minutes later for Takahiwai, Whangarei, Otaika and Oakleigh and 126 minutes after the first wave at Marsden Point. The Point (location supplied by NRC) at Hatea – Town Basin is only inundated when sea level rise is incorporated in the M_w 9.0 TKSZ and South American scenarios. Times for wave arrival at Whangarei are arrival times at the port.

4.10. Maximum Water Level

The maximum water level for points at Frenchman Island, Marsden Point, Takahiwai, Whangarei, Otaika and Oakleigh are given in tables 2 and 3. Maximum water level is the highest recorded water level during the tsunami simulation time series. The times

given are indicative and/or relative only. The actual water level and time depends on the location of the point (Point locations given in Figure 4).

Table 2: Maximum Water Level and predicted time (minutes after the source event) of the maximum water level at French Island, Marsden Point, Takahiwai, Whangarei (Port), Otaika and Oakleigh for South American sources. Underlined values are the earliest wave times; these are used in Table 1.

	South American MHWS		South American MHWS + 0.5 m	
Location	Height (m)	T_{max} (min)	Height (m)	T_{max} (min)
Frenchman Island	3.06	1241	3.54	1239
Marsden Point	2.16	1241	2.63	1239
Takahiwai	1.70	1237	2.36	1251
Whangarei (Port)	1.89	1296	2.40	1293
Otaika	1.78	1299	2.31	1297
Oakleigh	1.92	1313	2.50	1307

For the South American event, the maximum water level arrives after about 20 hours, for Frenchman Island, to 21.75 hours in Oakleigh.

For tsunamis originating from the Tonga-Kermadec subduction zone, generally the maximum water level is reached after 124 - 180 minutes after the source event. For the TKSZ M_w 8.5 scenario the maximum water level is reached between 165 and 181 minutes after source rupture for Otaika, Whangarei and Oakleigh. At Takahiwai the maximum water level is reached at around 520 minutes (8.7 hours) and for Frenchman Island and Marsden Point at around 215-223 minutes (3.5 hours).

The TKSZ M_w 9.0 maximum water level generally occurs from 124 to 177 minutes. At Marsden Point the maximum water level is reached at 351 minutes (nearly 6 hours) after the source rupture.

The results presented here are for the maximum water level. There may be several waves of similar magnitude to the maximum recorded level after and including the initial wave.

4.11. Bercich Drain

The current modelling study incorporated a virtual link between grid elements situated at either end of the culvert. For the purposes of modelling, the height of the culvert outflow is taken (by the modelling software) as approximately 1.1 m above MSL, and the height of the culvert intake within the refinery is approximately 4.75 m. Water elevations due to the tsunami reached a maximum of about 3 m above MSL at the

seaward end of the culvert. Because the water level was less than 4.75 m water did not emerge from the culvert into the refinery with the current model mesh configuration.

Table 3: Maximum Water Level and predicted time (minutes after the source event) of the maximum water level at French Island, Marsden Point, Takahiwai, Whangarei (Port), Otaika and Oakleigh for Tonga-Kermadec Subduction zone sources. Underlined values are the earliest wave times; these are used in Table 1.

	TKSZ 8.5		TKSZ 8.5 + 0.5 m		TKSZ 9.0		TKSZ 9.0 + 0.5 m	
Location	Height (m)	*Time (min)*	Height (m)	*Time (min)*	Height (m)	*Time (min)*	Height (m)	*Time (min)*
Frenchman Island	1.81	*215*	2.27	*215*	3.349	*160*	3.75	*159*
Marsden Point	1.37	*223*	1.87	*223*	1.92	*353*	2.45	*351*
Takahiwai	1.28	*521*	1.78	*518*	1.61	*124*	2.10	*124*
Whangarei (Port)	1.26	*169*	1.76	*167*	1.59	*164*	2.11	*162*
Otaika	1.20	*168*	1.71	*165*	1.43	*163*	1.96	*159*
Oakleigh	1.24	*181*	1.75	*178*	1.51	*177*	2.07	*174*