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11 March 2013

Mr Glenn Stevens
Tasman District Council
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RICHMOND 7050

Dear Glenn

GROUNDWATER MONITORING AT FORMER FCC SITE, MAPUA – MARCH 2013 SAMPLING UPDATE

This letter provides our summary of groundwater quality results at the former Fruitgrowers Chemical Company (FCC) site at Mapua. This letter discusses the trends in the bores that are routinely monitored and then comments on the patterns across the site. The groundwater sampling that is the subject of this letter review was carried out by Tasman District Council (TDC) during May and November 2012.

Monitoring Programme

The groundwater monitoring that was undertaken at the Mapua FCC site in the last twelve months was:

(i) six-monthly monitoring in:

BH1A
BH5A
BH9A
BH101
BH102
BH108
BH109
BH110

These six-monthly samples were analysed for:

turbidity
electrical conductivity
nitrate-N
ammoniacal-N
DDX
ADL

(ii) annual monitoring in:

BH1A

BH2A

BH3A

BH4A

BH5A

BH9A

Old BH1

BHG

BHH

BHL

BHD

BH101

BH102

BH103

BH104

BH105

BH106

BH107

BH108

BH109

BH110

BH111

BH112

BH113

13 Tahi Street

17a (was 15) Tahi Street

21 Tahi Street

23 Tahi Street

26 Tahi Street

27 Tahi Street

29 Tahi Street

36 Tahi Street

East estuary coastal seepage

West estuary coastal seepage

These annual samples were analysed for:

turbidity

pH

electrical conductivity

dissolved copper

dissolved iron

nitrate-N

ammoniacal-N

dissolved reactive phosphorus

DDX

ADL

The six-monthly monitoring was carried out in May and November 2012 and the annual monitoring was undertaken in November 2012.

Long-Term Regularly Sampled Wells

The results in the wells that have been sampled most regularly in the past have been compared with the previous sampling that has been carried out at the site, which prior to December 2007 had been arranged by MfE. A series of plots have been attached to this letter to highlight the major trends in those bores that were included in the latest sampling round. Figure 1 shows the location of the most regularly sampled boreholes that are referred to in this letter. BH1A and BH2A are upgradient of the eastern groundwater discharge to the Mapua channel. BH5A and BH9A are upgradient of the south-western groundwater discharge into the Waimea Inlet. The bore at 13 Tahi Street is the nearest private bore downgradient of the site.

Earlier sampling that was carried out in January and April 2008 has included three nearby pairs of boreholes: BH1/BH1A, BH5/BH5A and BH9/BH9A. On the plots that follow, the points from these adjacent boreholes have been joined by a vertical line to indicate how similar or different they are. However, the more recent data in the plots is only from boreholes BH1A, BH2A, BH5A, BH9A and 13 Tahi Street. Three bores (BH1A, BH5A and BH9A) were sampled in May and November; the remaining two bores (BH2A and 13 Tahi Street) were only sampled in November. The following comments relate to the trends that are apparent from the most recent round of groundwater monitoring.

Figure 2 shows nitrate-nitrogen concentrations. Three boreholes have historically shown elevated concentrations: BH2, BH5 and BH9. Since late 2007, concentrations have decreased substantially, which coincides with the cessation of the MCD reactor in mid-2007. Despite this general decline, BH5 continues to show significantly elevated concentrations. During the last year, only BH5 and BH9 have had measured nitrate-N concentrations above the Maximum Acceptable Value in the Drinking Water Standards for New Zealand 2005 (Revised 2008), which is 11.3 mg/L. BH9 had one exceedence of the MAV in November 2012 (19.9 mg/L), while the concentration in May 2012 was approximately half the MAV (6.4 mg/L). BH5 recorded concentrations of 74 mg/L in May 2012 and 47 mg/L in November 2012. Figure 2a shows the boreholes that have typically displayed lower nitrate-N concentrations. Both BH1 and 13 Tahi Street remain at stable, low concentrations significantly below the MAV.

Figure 3 shows ammonia-nitrogen concentrations. The bores with elevated concentrations (BH1A and BH2A) have maintained stable levels and are very similar to the previous year. Those bores with lower ammonia-N concentrations (BH5, BH9 and 13 Tahi Street, see Figure 3a) maintain stable concentrations. The slight rise observed in BH9 in November 2012 to 0.25 mg/L is still significantly below the ANZECC Aquatic Ecosystem Guideline of 0.71 mg/L.

Figure 4 shows dissolved reactive phosphorus concentrations, which have remained stable over the last year.

Figure 5 shows DDX concentrations. The bores with elevated concentrations (BH1 and BH5) remain above the MAV in the Drinking Water Standards (0.001 mg/L). However, the large fluctuations observed in the DDX concentrations in bores BH1 and BH5 during 2011 were not observed during 2012, possibly because the wells were measured less frequently (six-monthly monitoring in 2012 compared to quarterly monitoring in 2011). Of the bores showing lower concentrations, BH2 has shown a slow but steady rise in concentrations, whilst BH9 and 13 Tahi St showed low stable concentrations over the last year.

Figure 6 shows aldrin + dieldrin concentrations. All of the regularly sampled wells with the exception of 13 Tahi St are above the MAV in the Drinking Water Standards (0.00004 mg/L). The highest concentrations occur in BH5 and BH2 and remain at similar concentrations to those measured during the remedial works.

Figure 7 shows lindane concentrations, which have decreased significantly since the remedial works and have been stable over the last year. All of the regularly sampled wells have concentrations below the MAV in the Drinking Water Standards (0.002 mg/L).

Figure 8 shows electrical conductivity values, which are a general indicator of all the chemicals dissolved in the water. These show a gradual decline in values, indicating a general improvement in groundwater quality beneath the site.

Figure 9 shows dissolved copper concentrations. Copper was one of the reagents used in the MCD process. The results show stable concentrations with a gradual decline in levels in bores BH2 and BH5.

Iron was utilised in the MCD process, but has only been sampled since January 2008. The results are shown in Figure 10. During the November 2012 sampling round, dissolved iron was measured in BH1 (0.21 mg/L) and 13 Tahi St (0.32 mg/L). Dissolved iron was below the detection limit (0.02 mg/L) in the other three bores (BH2, BH5 and BH9).

Figure 11 shows a plot of depth to water in bores BH1 and BH5. During the last year water levels have been at the lower end of their typical range in BH5, but have tended to be higher than average in BH1. Most chemical concentrations have been generally stable or shown a slight improving trend over the last year, with the exception of nitrate-N in BH9, DDX in BH1 and aldrin + dieldrin in BH2 and BH5. It is expected that the more significant fluctuations in these bores are related to groundwater level fluctuations causing two contrasting mechanisms to operate. At times of low groundwater level, there is less groundwater throughflow to dilute the on-site concentrations. At times of high groundwater levels there will be some areas of the site where groundwater inundates the treated fines, or where there has been a time of increased infiltration, resulting in increased leaching of chemicals.

Figure 12 shows the groundwater level and nitrate-N concentration in the bore showing the most significant fluctuations (BH5). Whilst water level fluctuations in this bore may be partly affected by the artificially placed bund and backfill material it does give an indication of the times of high and low groundwater levels. The resulting pattern in Figure 12 indicates a general pattern of increased nitrate at higher groundwater levels. Figures 13 and 14 show a more variable pattern for DDX and aldrin + dieldrin, with the peak concentrations sometimes coinciding with groundwater level peaks and the opposite pattern at other times, such as the more recent DDX data for BH5 in Figure 13.

Piezometric Survey

The elevation of the groundwater table within the on-site monitoring bores for the most recent monitoring round (19 November 2012) is plotted in Figure 15. The groundwater levels on 19 November 2012 are approximately 0.3 – 0.4 m lower than those recorded on 7 November 2011. Most of the groundwater discharges either to the Mapua channel to the east, or the Waimea Inlet to the south-west. The piezometric contours have not been extended into the bunded area, as the presence of the bund and the backfill material within it appear to have created some distorted groundwater level elevations within nearby bores.

Patterns of Concentration

Figures 16 - 25 have been prepared to show the spatially varying trends that exist across the site. Comments are made below about some specific bores, although these comments ignore the very elevated concentrations that occur in BH101 and BH102. These two bores are on either side of the small clay bund separating FCC West from the old landfill area containing commercial grade soil. BH101 is on the inside of the bunded area and BH102 is on the outside. The clay bund does not extend to the surface and it is possible there is some interchange of groundwater through the top 500 mm of soil (the highest groundwater level measured in BH101 is 0.45 m below ground level).

Nitrate-Nitrogen

Figure 16 shows the nitrate-nitrogen concentrations, which have been colour coded as follows:

- green – less than half the Maximum Acceptable Value (MAV) in the Drinking Water Standards (<5.7 mg/L);
- orange – between half the MAV and the full MAV of 11.3 mg/L;
- red – greater than the MAV.

Comparing the individual borehole concentrations from the latest sampling round to the previous November 2011 results, most concentrations have reduced. In 2011, eight bores exceeded the MAV, down to seven in 2012. Five bores were within the half MAV bracket this year, down from six in 2011. The highest concentration (other than for bores BH101 and BH102) was recorded in bore BH108 (118 mg/L).

In our previous monitoring letter (dated March 2012), it was noted that of the domestic bores sampled, 26, 27 and 29 Tahi St had elevated concentrations (between 5.6 and 13.5 mg/L). In the latest November 2012 sampling round, the concentrations in all three of these bores had dropped by about half (to between 3.3 – 7.6 mg/L).

Ammonia-Nitrogen

Figure 17 shows the ammonia-nitrogen concentrations, which have been colour coded as follows:

- green – less than the aesthetic guideline value in the Drinking Water Standards (<0.3 mg/L);
- orange – between the aesthetic guideline value in the Drinking Water Standards and a significantly elevated value of 10 mg/L of aquatic ecosystems;
- red – above a significantly elevated value of 10 mg/L.

Comparing to the November 2011 results, there has been no consistent change with some bores showing higher and others showing lower concentrations. The current results show elevated concentrations occur in both the east, around bore BH111 (1,860 mg/L in November 2012, up from 1,010 mg/L in November 2011), and west of the site, around bore BHG (88 mg/L in November 2012, up from 14.6 mg/L in November 2011). The ammonia-N concentrations indicate some areas of the site have significantly higher concentrations than the values measured in the regularly monitored bores.

Total Nitrogen

Figure 18 shows the total Nitrogen concentrations, which have been colour coded as follows:

- green – less than 1 mg/L, which is above the ANZECC guideline value for marine water of 0.12 mg/L;
- orange – between 1 and 20 mg/L;
- red – greater than 20 mg/L.

All of the wells tested showed total nitrogen levels above the ANZECC guideline values. The spatial distribution trends for total nitrogen are the same as those for ammoniacal nitrogen with elevated concentrations occurring in both the east, around bore BH111 (1,850 mg/L in November 2012, up from 980 mg/L in November 2011), and west of the site, around bore BHG (88 mg/L in November 2012, up from 13 mg/L in November 2011).

Samples taken at the East and West Seepage locations (0.97 and 0.37 mg/L respectively) are close to but above the ANZECC guideline value for marine waters (0.12 mg/L).

Dissolved Reactive Phosphorus

Phosphorus is the other nutrient (in addition to nitrogen) that contributes to algal growth problems in surface waterways. Diammonium phosphate was one of the re-agents used in the remediation process (along with urea).

Figure 19 shows the DRP concentrations, which have been colour coded as follows:

- green – less than the ANZECC guideline value for marine water (<0.01 mg/L);
- orange – between the ANZECC guideline value and one hundred times the ANZECC guideline value;
- red – more than 100 times above the ANZECC guideline value (>1.0 mg/L).

Concentrations are generally lower than the concentrations in November 2011. The number of wells classified red has reduced from six to five, the number of wells classified orange has reduced from eighteen to fifteen and the number of wells classified green has increased from eight to twelve compared to November 2011. However, there continue to be some bores showing localised high concentrations (e.g. 18 mg/L in BH108, up from 13.7 mg/L in November 2011).

DDX

Figure 20 shows the DDX concentrations, which have been colour coded as follows:

- green – close to or less than the laboratory detection limit (<0.00006 mg/L);
- orange – greater than the laboratory detection limit and below the MAV in the Drinking Water Standards;
- red – greater than the MAV in the Drinking Water Standards (>0.001 mg/L).

Most of the wells are classified the same (green, orange or red) compared to the November 2011 results. There continues to be no detectable DDX in any of the private wells in the residential areas to the south and north of the site. DDX was detected in the west seepage sample, but the concentration (0.000065 mg/L) was well below the MAV in the Drinking Water Standards and very close to the detection limit (0.00006 mg/L). The variation in concentrations within the site is most likely due to the localised effects of soils with elevated DDX concentrations.

Aldrin + Dieldrin

Figure 21 shows the aldrin + dieldrin concentrations, which have been colour coded as follows:

- green – less than the MAV in the Drinking Water Standards (<0.00004 mg/L);
- orange – between the MAV and ten times the MAV;
- red – more than 10 times above the MAV (>0.0004 mg/L).

There has been no consistent change since November 2011, with some bores showing increased concentrations and others showing lower concentrations. All the wells within the site have elevated concentrations above the MAV (0.00004 mg/L), with most wells recording concentrations more than ten times the MAV (0.0004 mg/L). Concentrations were measured in both the eastern and western seepages. The western seepage level (0.0000365 mg/L) is just below the MAV in the Drinking Water Standards while the eastern seepage level (0.0000435 mg/L) is just above the MAV. These results may indicate a transmission of aldrin and dieldrin out of the site by the groundwater and into the marine environment.

All of the domestic wells sampled in November 2012 had concentrations below the MAV. In 2011, two wells, 13 Tahi St and 26 Tahi St registered very low levels of dieldrin. In 2012, the levels of dieldrin in 26 Tahi St have decreased to below the detection limit but there has been a further increase in levels in 13 Tahi St (0.000025 mg/L in 2012, up from 0.000012 mg/L in 2011). The presence of dieldrin in this bore may be due to the migration of dieldrin from the site.

Lindane

Figure 22 shows the lindane concentrations, which have been colour coded as follows:

- green – close to or less than the laboratory detection limit (<0.00001 mg/L);
- orange – greater than the laboratory detection limit and below the MAV in the Drinking Water Standards;
- red – greater than the MAV in the Drinking Water Standards (>0.002 mg/L).

There has been no consistent change since November 2011, with some bores showing increased concentrations and others showing lower concentrations. The results show elevated concentrations occurring to the east of the site. With the exception of bores BH101 and BH102 in the clay bund, only BH108 (0.0031 mg/L up from 0.00199 mg/L in November 2011) registered lindane levels in exceedence of the MAV in the Drinking Water Standards.

In previous sampling rounds, low levels of lindane were detected in some off-site boreholes, although subsequent checking by TDC indicated that this was due to residual lindane within the tubing used to collect the samples rather than in the boreholes themselves. The sampling procedures have been altered to rectify this problem, although a lindane concentration of 0.000033 mg/L was reported in the rinsate blank collected during the November 2012 sampling, indicating some cross-contamination is still occurring. The low concentration detected should not influence the interpretation of the patterns shown in Figure 22.

Lindane was not detected in any of the domestic bores in the November 2012 samples.

Conductivity

Figure 23 shows the pattern of electrical conductivity values in the groundwater. This is a general indication of all the chemicals dissolved in the groundwater. The following colour coding has been used:

- green – typical background values (<30 mS/m);
- orange – moderately elevated values (30-100 mS/m);
- red – highly elevated values (>100 mS/m).

This plot shows the pattern of values beneath the site, with the highest groundwater conductivity value recorded at bore BH111 (1,691 mS/m in November 2012 up from 1,060 mS/m in November 2011). The values show a similar pattern to those measured in November 2011.

Copper

Figure 24 shows the pattern of dissolved copper concentrations, which have been colour coded as follows:

- green – less than the ANZECC guideline value for protection of 95% of species in marine water (<0.0013 mg/L);
- orange – between the ANZECC guideline value and ten times the ANZECC guideline value;
- red – greater than 10 times above the ANZECC guideline value.

Concentrations are quite similar to the November 2011 results. The highest concentration was measured in bore BH108 (0.077 mg/L in November 2012, up from 0.075 mg/L in November 2011).

Four of the samples (BHD, BH111 and both the east and west seepages) had high laboratory detection limits (0.003 mg/L for the two bores and 0.05 mg/L for the seepages), which do not allow for a comparison to the ANZECC guideline value. The laboratory confirmed these four samples had high salinity, which required them to be diluted and therefore raised the laboratory detection limit. A fourth category was used in Figure 24 to classify these four samples.

Iron

Figure 25 shows the pattern of iron concentrations in the groundwater, which have been colour coded as follows:

- green – below the laboratory detection limit (<0.02 mg/L);
- orange – above the laboratory detection limit, but below the aesthetic guideline value in the Drinking Water Standards;
- red – greater than the aesthetic guideline value in the Drinking Water Standards (>0.2 mg/L).

There has been no consistent change since November 2011, with some bores showing increased concentrations and others showing decreased concentrations. The results show the majority of the elevated concentrations occurring at the east of the site. The concentration in bore BHG dropped dramatically (<0.04 mg/L in November 2012, down from 26 mg/L in November 2011) meaning the highest concentration was in bore BH111 (5.1 mg/L in November 2012, up from 1.71 mg/L in November 2011).

Overview

The patterns shown in Figures 16-25 indicate a continuing impact from the site soils on the underlying groundwater. Figures 26 and 27 show exceedences of Drinking Water Standards and ANZECC guidelines respectively and Tables 1 and 2 below indicate the chemicals and magnitude of the exceedence.

Table 1: Exceedences of Drinking Water Standards - November 2012

Borehole	MAV (chemical; rate of exceedence)				GV (chemical; rate of exceedence)	
BH 1A		DDX; 2.1x	Aldrin + Dieldrin; 4.6x		Ammonia-N; 26x	Dissolved Iron; 1.1x
BH 2A			Aldrin + Dieldrin; 39x		Ammonia-N; 5.8x	
BH 3A			Aldrin + Dieldrin; 15x			
BH 4A			Aldrin + Dieldrin; 2.5x			
BH 5A	Nitrate-N; 4x	DDX; 1.3x	Aldrin + Dieldrin; 47x			
BH 9A	Nitrate-N; 2x		Aldrin + Dieldrin; 9.4x			
BH D			Aldrin + Dieldrin; 63x			
BH G			Aldrin + Dieldrin; 5.7x		Ammonia-N; 73x	
BH H		DDX; 4.0x	Aldrin + Dieldrin; 45x		Ammonia-N; 6.0x	
BH L						Dissolved Iron; 1.1x
BH 101	Nitrate-N; 14x	DDX; 11x	Aldrin + Dieldrin; 152x	Lindane; 12.5x	Ammonia-N; 592x	
BH 102	Nitrate-N; 8x		Aldrin + Dieldrin; 18x	Lindane; 7.6x	Ammonia-N; 192x	Dissolved Iron; 1.7x
BH 103			Aldrin + Dieldrin; 377x			
BH 104	Nitrate-N; 6x		Aldrin + Dieldrin; 5.3x		Ammonia-N; 12x	
BH 105			Aldrin + Dieldrin; 1.3x			
BH 106			Aldrin + Dieldrin; 13x			
BH 107			Aldrin + Dieldrin; 17x			
BH 108	Nitrate-N; 10x	DDX; 8.7x	Aldrin + Dieldrin; 122x	Lindane; 1.6x	Ammonia-N; 175x	
BH 109		DDX; 2.2x	Aldrin + Dieldrin; 37x		Ammonia-N; 161x	
BH 110		DDX; 3.0x	Aldrin + Dieldrin; 50x		Ammonia-N; 267x	Dissolved Iron; 2.8x
BH 111		DDX; 2.8x	Aldrin + Dieldrin; 55x		Ammonia-N; 1550x	Dissolved Iron; 26x
BH 112	Nitrate-N; 1x		Aldrin + Dieldrin; 20x		Ammonia-N; 136x	Dissolved Iron; 1.8x
BH 113						
Old BH 1			Aldrin + Dieldrin; 288x			
13 Tahi						Dissolved Iron; 1.6x
21 Tahi						
23 Tahi						
26 Tahi						
27 Tahi						
29 Tahi						
36 Tahi						
17a Tahi						Dissolved Iron; 6.0x
West Seepage						Dissolved Iron; 5.0x
East Seepage			Aldrin + Dieldrin; 1.1x			Dissolved Iron; 5.0x

Table 2: Exceedences of ANZECC Levels - November 2012		
Borehole	**ANZECC** (chemical; rate of exceedence)	
BH 1A		
BH 2A	Dissolved Copper; 4.2x	Dissolved Reactive Phosphorous; 380x
BH 3A	Dissolved Copper; 3.2x	Dissolved Reactive Phosphorous; 4.4x
BH 4A		Dissolved Reactive Phosphorous; 6.6x
BH 5A	Dissolved Copper; 6.2x	Dissolved Reactive Phosphorous; 126x
BH 9A	Dissolved Copper; 1.9x	Dissolved Reactive Phosphorous; 6.1x
BH D	Dissolved Copper; 1.2x	Dissolved Reactive Phosphorous; 1.6x
BH G		
BH H	Dissolved Copper; 3.8x	Dissolved Reactive Phosphorous; 82x
BH L	Dissolved Copper; 1.5x	
BH 101	Dissolved Copper; 269x	Dissolved Reactive Phosphorous; 12500x
BH 102	Dissolved Copper; 2.2x	
BH 103	Dissolved Copper; 2.3x	
BH 104	Dissolved Copper; 3.0x	
BH 105		
BH 106		
BH 107	Dissolved Copper; 1.4x	Dissolved Reactive Phosphorous; 2.3x
BH 108	Dissolved Copper; 59x	Dissolved Reactive Phosphorous; 1800x
BH 109	Dissolved Copper; 8.2x	
BH 110	Dissolved Copper; 18x	Dissolved Reactive Phosphorous; 1040x
BH 111	Dissolved Copper; 1.2x	
BH 112	Dissolved Copper; 4.6x	Dissolved Reactive Phosphorous; 4.8x
BH 113		Dissolved Reactive Phosphorous; 1.9x
13 Tahi	Dissolved Copper; 2.5x	Dissolved Reactive Phosphorous; 3.1x
21 Tahi	Dissolved Copper; 4.4x	Dissolved Reactive Phosphorous; 2.0x
23 Tahi	Dissolved Copper; 1.9x	Dissolved Reactive Phosphorous; 1.4x
26 Tahi	Dissolved Copper; 15x	Dissolved Reactive Phosphorous; 7.0x
27 Tahi	Dissolved Copper; 4.3x	Dissolved Reactive Phosphorous; 2.4x
29 Tahi	Dissolved Copper; 3.4x	
36 Tahi	Dissolved Copper; 4.6x	Dissolved Reactive Phosphorous; 11x
17a Tahi		
Old BH 1	Dissolved Copper; 1.2x	
West Seepage	Dissolved Copper; 19x	
East Seepage	Dissolved Copper; 19x	

Figure 26 and Table 1 show that all of the bores within the site had exceedences of the Drinking Water Standards in November 2012, with most wells having an exceedence of more than ten times the standards. The most common exceedence was for aldrin+dieldrin. Of the domestic wells, BHL, 17 Tahi St and 27 Tahi St had exceedences of the Drinking Water Standards aesthetic guideline value for dissolved iron.

Figure 27 and Table 2 show that five bores, namely BH1A, BHG, BH105, BH106 and 17a Tahi St, had no exceedences of the ANZECC guidelines in November 2012. Many of the other bores exceeded the ANZECC guidelines for both dissolved copper and dissolved reactive phosphorus. The largest exceedence (not including BH101 and BH102) was for dissolved reactive phosphorous in bore BH108 (1,800 times ANZECC guideline value).

In summary, while there are still fluctuations in some contaminants at the site, the contaminant levels are fluctuating less than they were a few years ago. The biggest fluctuations still occurring are in:

- nitrate-N in BH5;
- DDX in BH1 and BH5;

aldrin + dieldrin in BH2 and BH5.

In terms of the sampling results from all bores, the main contaminants of concern are:

nitrogen (mostly nitrate in the west and ammonia in the east);

DDX;

aldrin + dieldrin.

Isolated occurrences of elevated concentrations of phosphorus, copper and iron also occur within the site.

Future Monitoring

The occurrence of elevated concentrations of several chemicals beneath the site means that regular groundwater sampling should continue. However, due to the more stable patterns that are now being exhibited it would be reasonable for the sampling frequency to be reduced to once per year, if this was also considered acceptable from the perspective of TDC and MfE.

Future Development

The proposed residential development of part of the land on the western side of Tahi St may see the loss of monitoring bores BHG, BH9A, BH102, BH103, BH104, BH105 and BH106. It is important that any monitoring bores that can no longer be used are properly decommissioned and grouted up in accordance with the NZ Drilling Standards. These bores contribute to understanding the pattern of dissolved chemical residues beneath the site and given that some elevated concentrations are still present, it would be helpful if some of these boreholes could be retained, or replacement boreholes installed in public spaces within the new subdivision. As a minimum it would be helpful to leave:

- At least two monitoring bores within the subdivision area, one near BH105/BH106 and one near BH104.
- At least two monitoring bores on the southern margin, similar to the location of BHG, BH9A and BH103 to monitor contaminants migrating off-site

We trust you find these comments helpful. Please contact us if you wish to discuss any of the information contained in this letter.

Yours sincerely

PATTLE DELAMORE PARTNERS LIMITED

CHewlett JSanson P.F. Callander

Chris Hewlett, Jeremy Sanson and Peter Callander

Encl.

Source: Cadastral information derived from LINZ data.

Figure 1 : LOCATION OF REGULARLY MONITORED WELLS

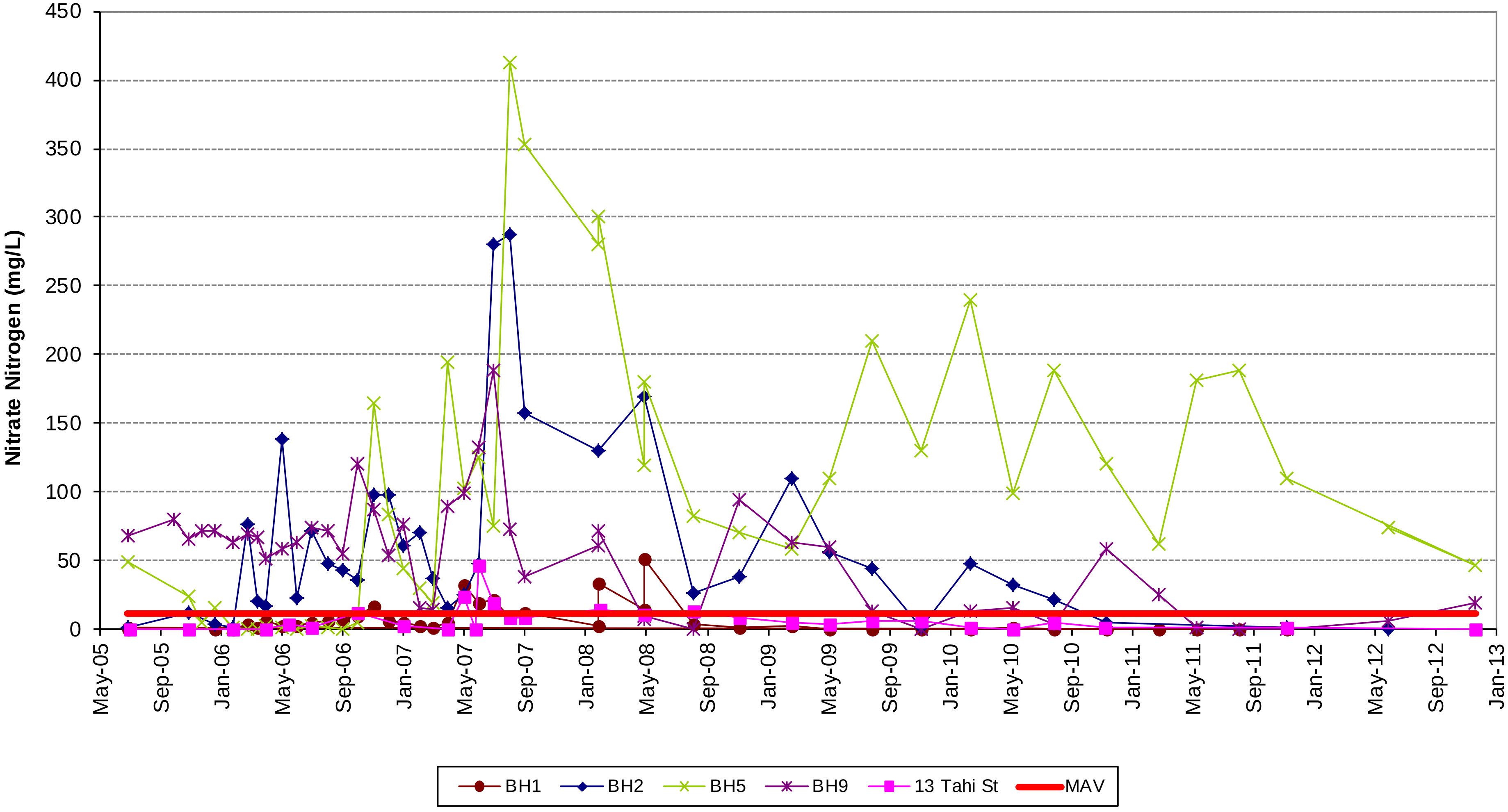


Figure 2. Nitrate-N
MAV DWSNZ 11.3 mg/L

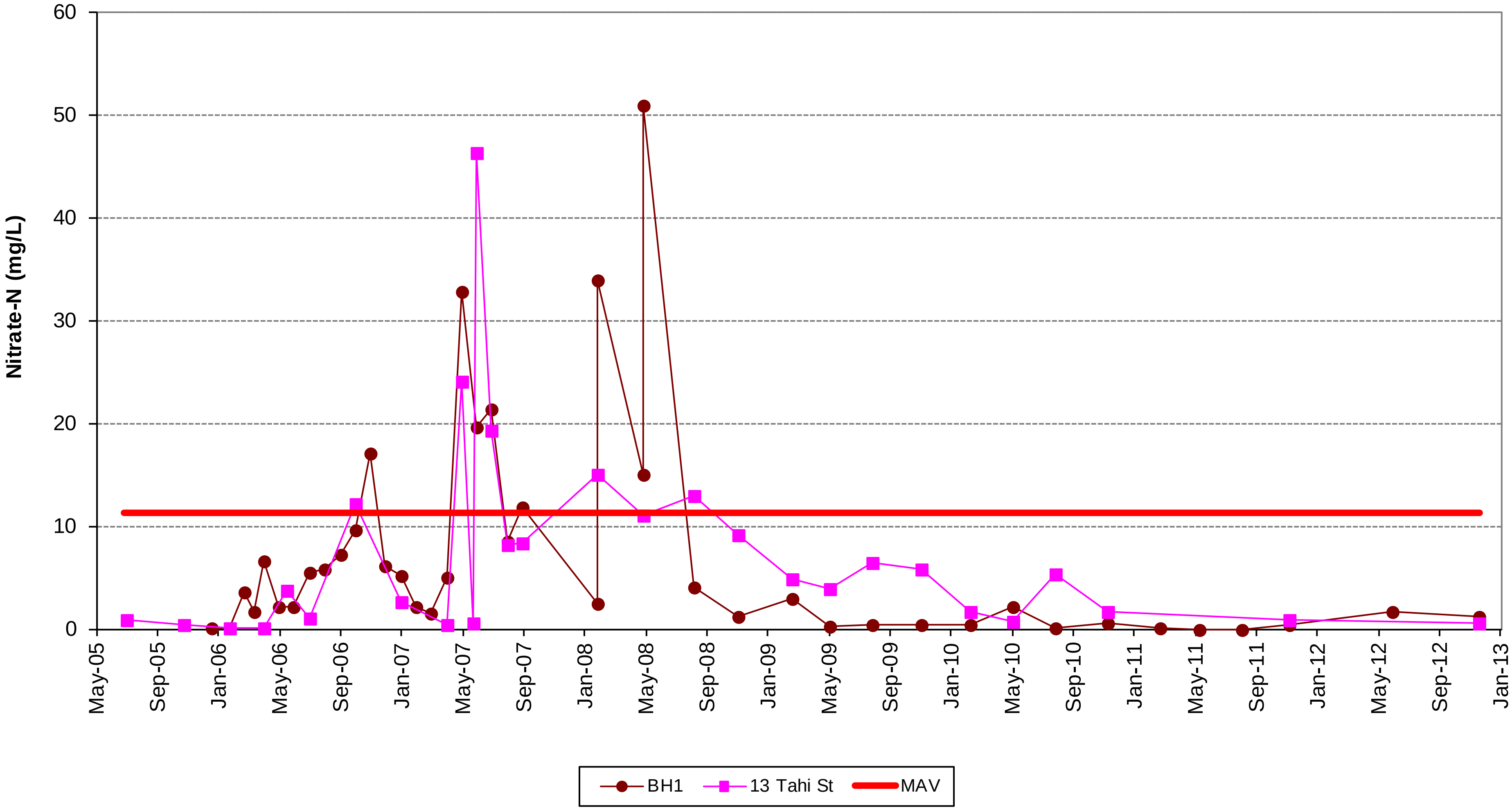


Figure 2a. Nitrate-N
MAV DWSNZ 11.3 mg/L

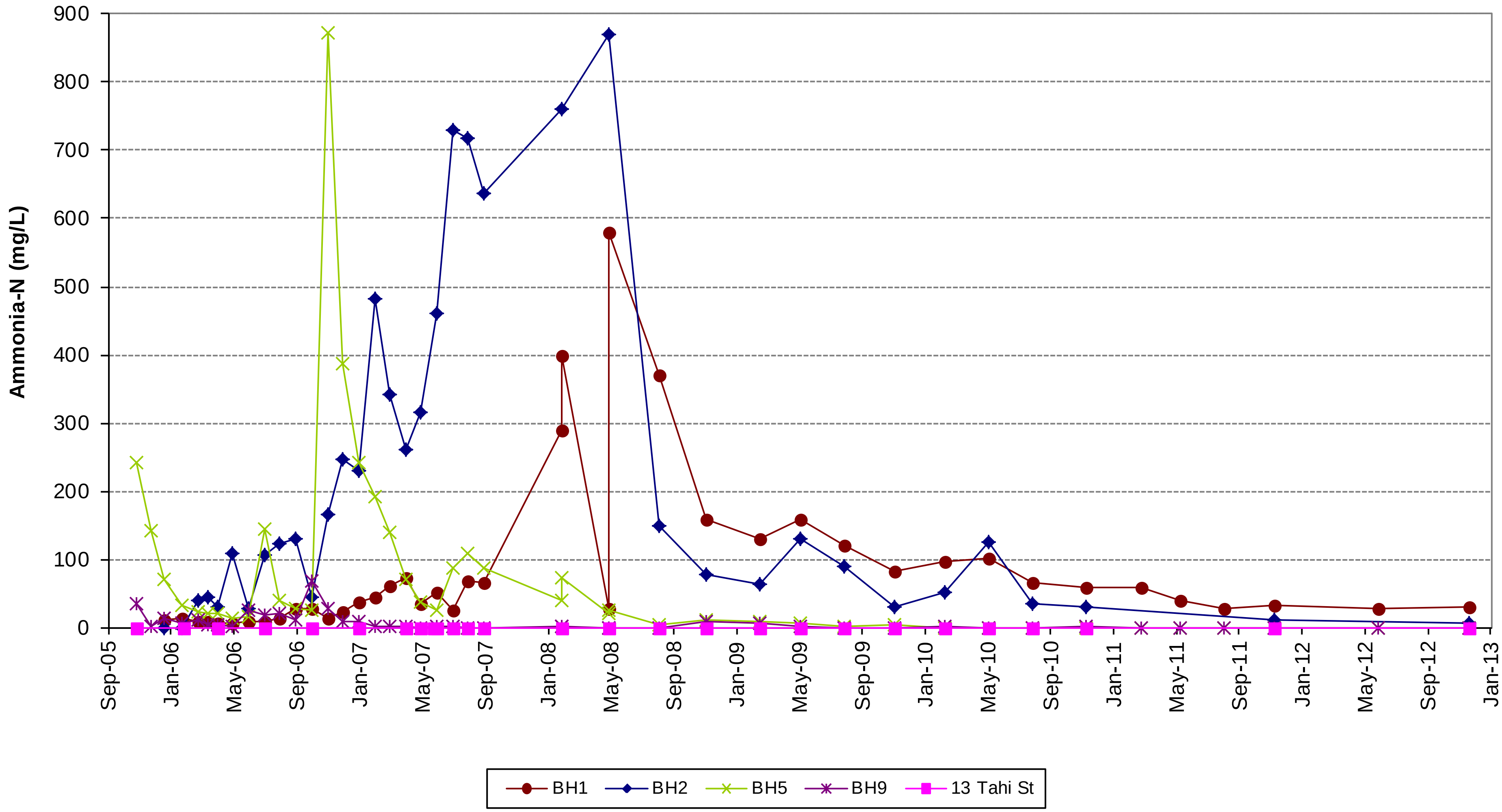


Figure 3. Ammonia-N
GV Aesthetic DWSNZ 1.2 mg/L; Aquatic Ecosystem Guideline 0.71mg/L

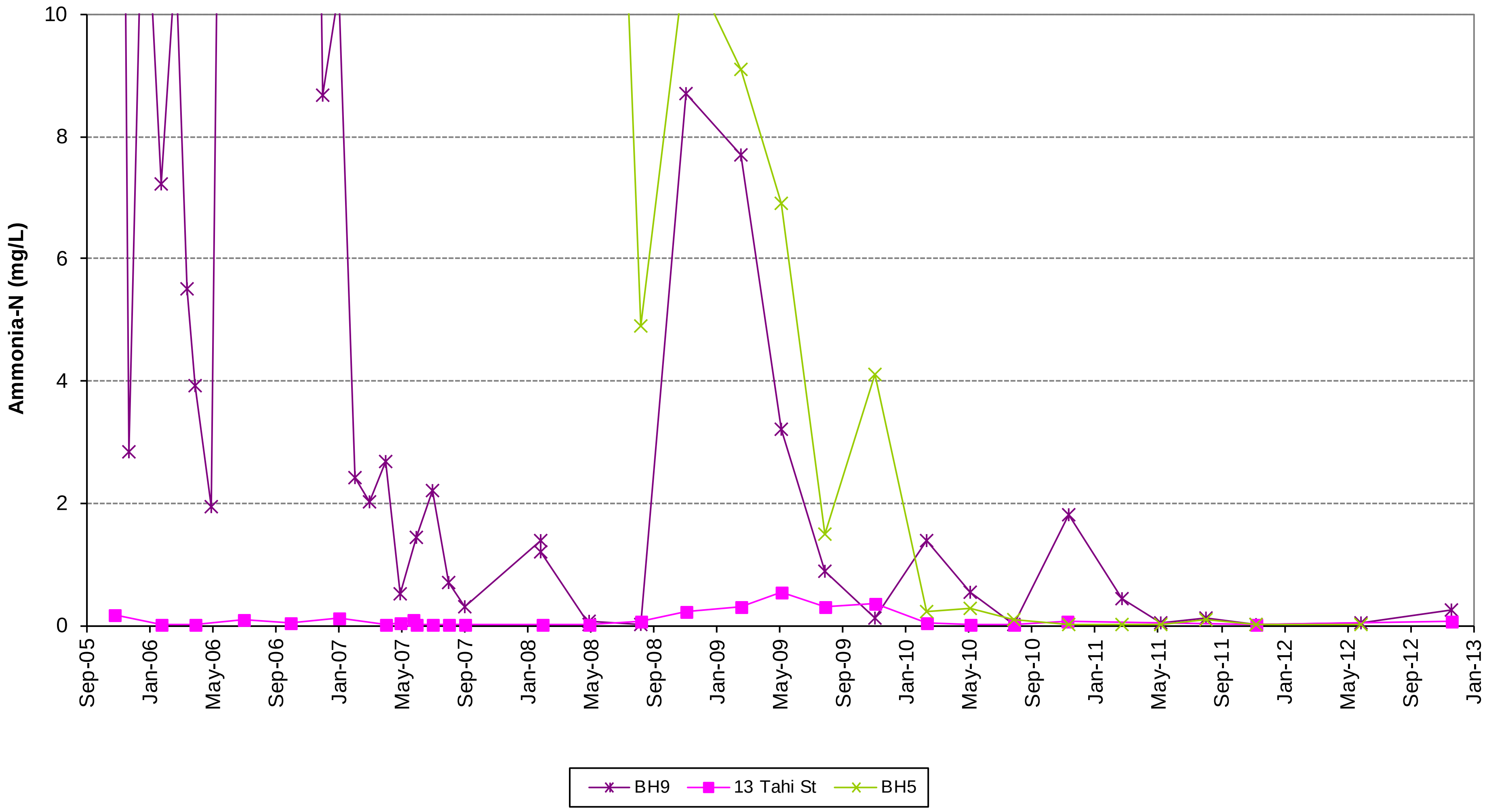


Figure 3a. Ammonia-N
GV Aesthetic DWSNZ 1.2 mg/L

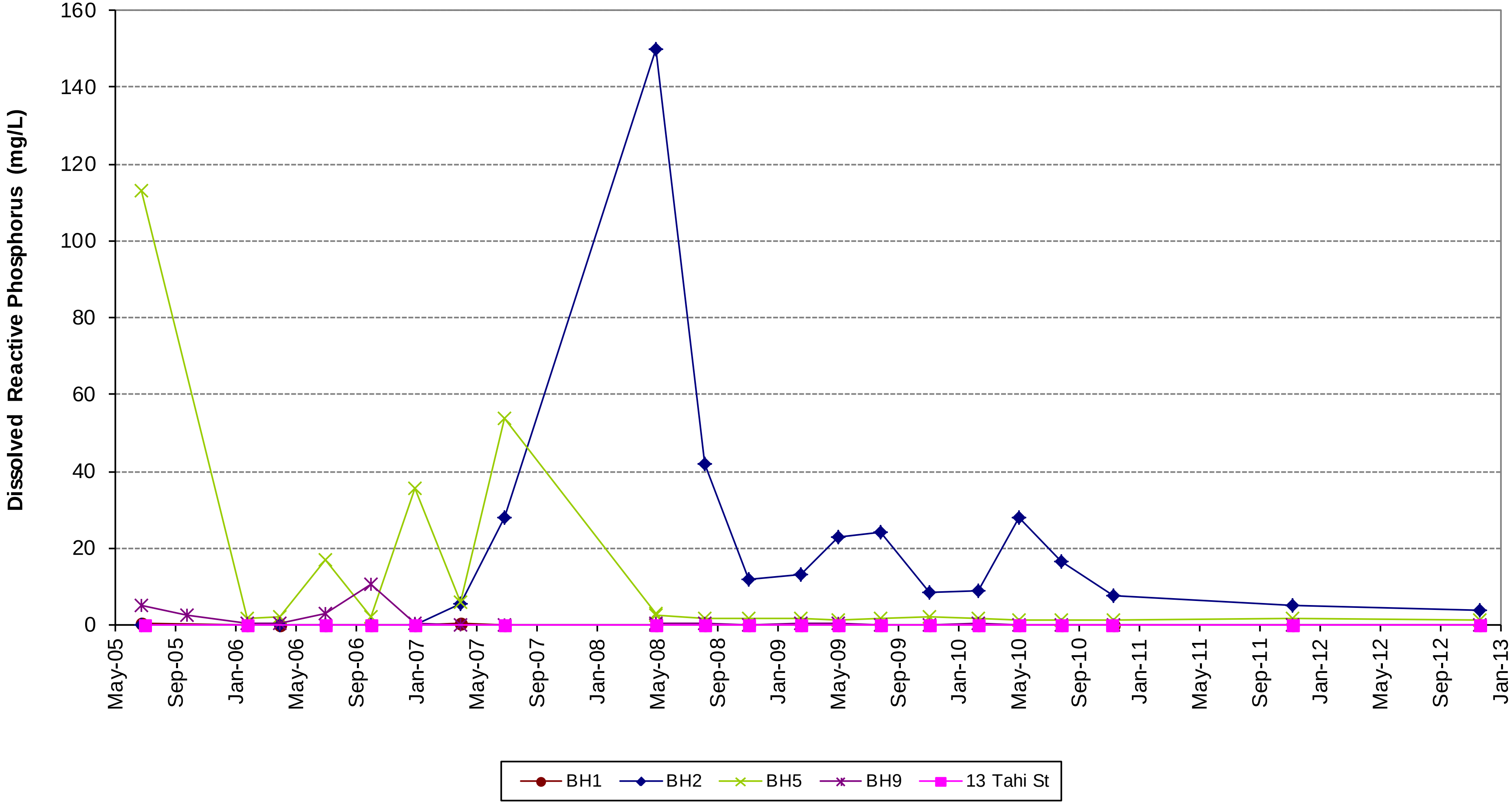


Figure 4. Dissolved Reactive Phosphorus
Aquatic Ecosystem Guideline 0.01 mg/L

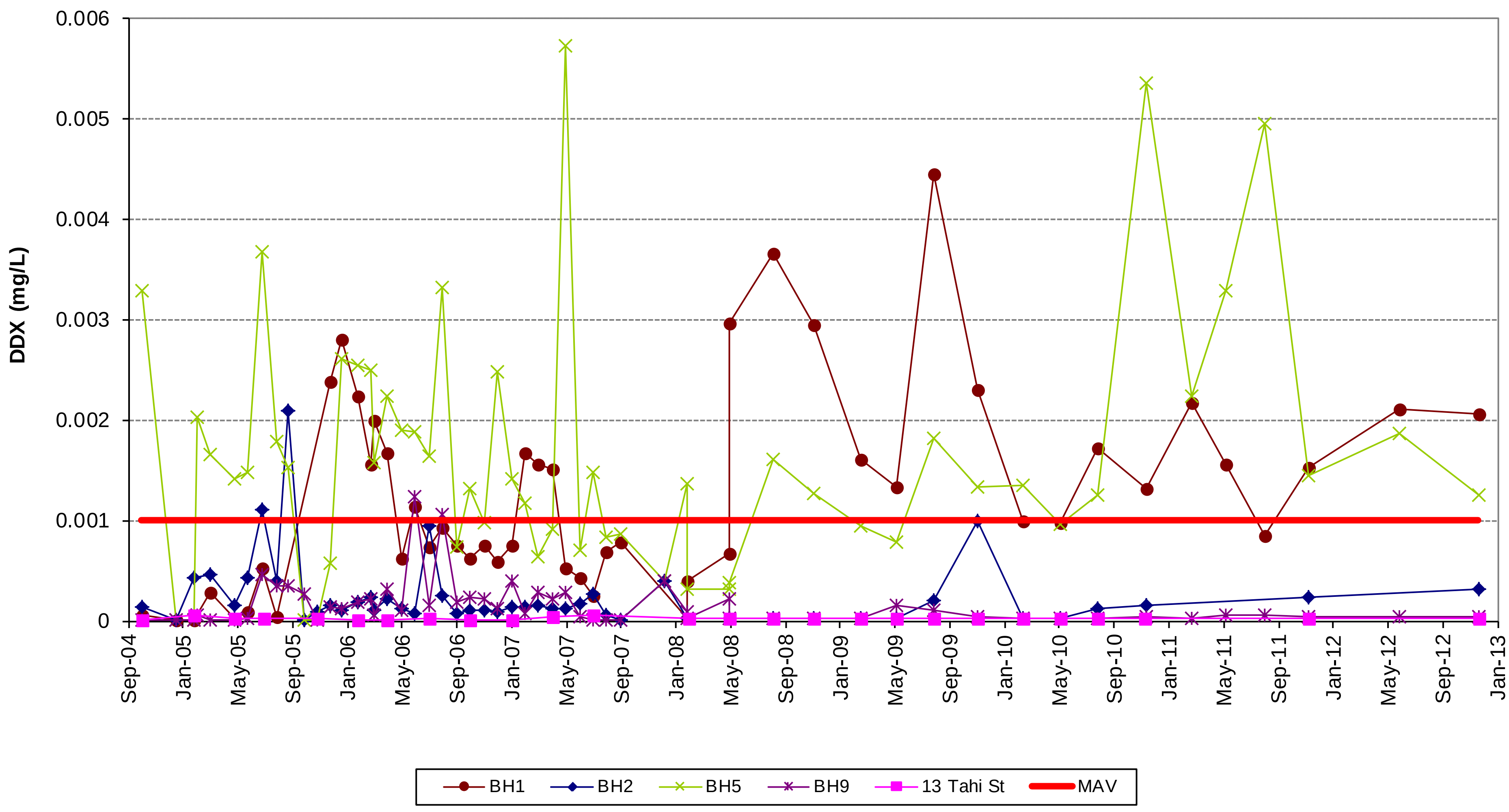


Figure 5. DDX
MAV DWSNZ 0.001 mg/L

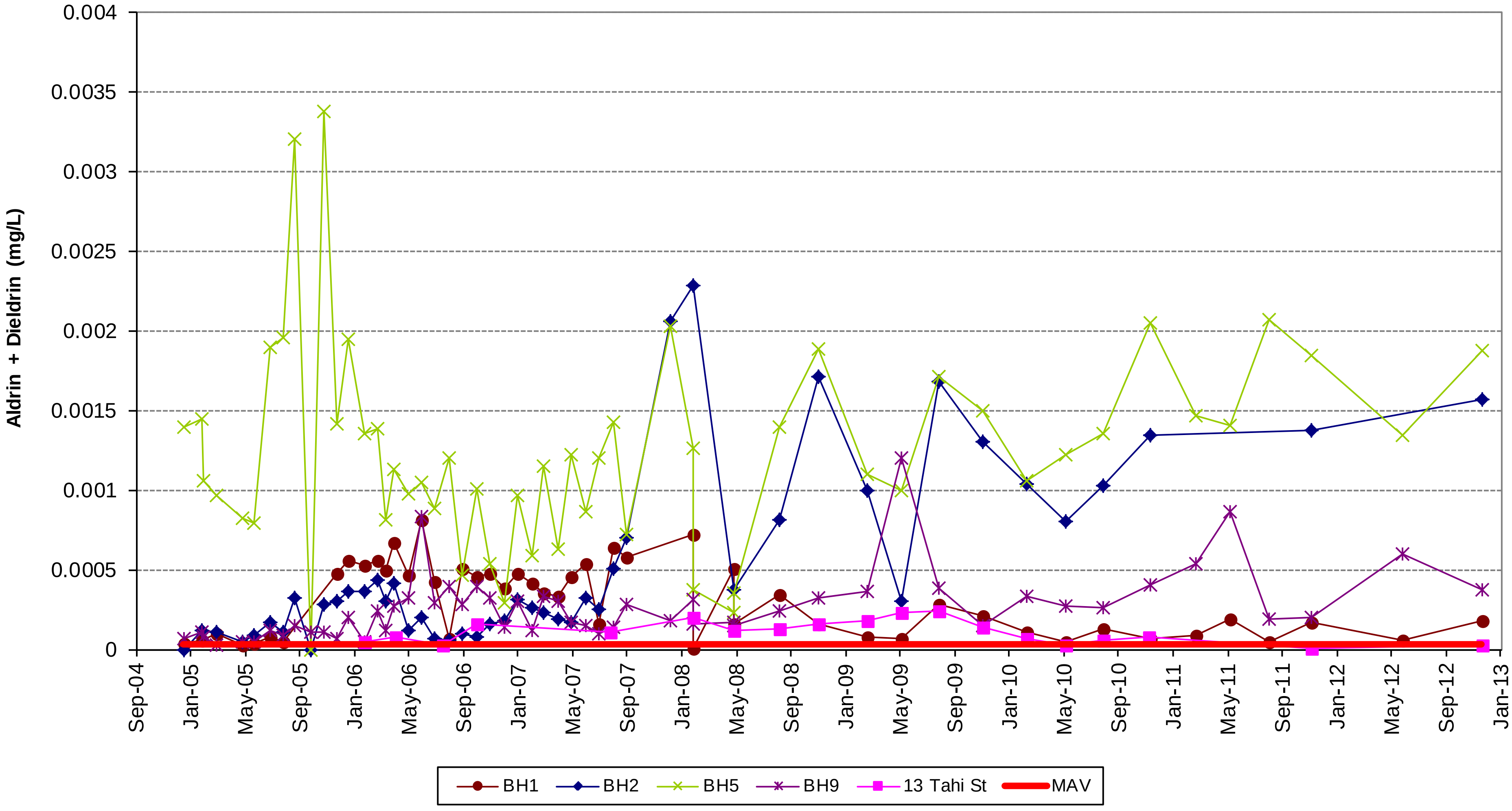


Figure 6. Aldrin + Dieldrin
MAV DWSNZ 0.00004 mg/L

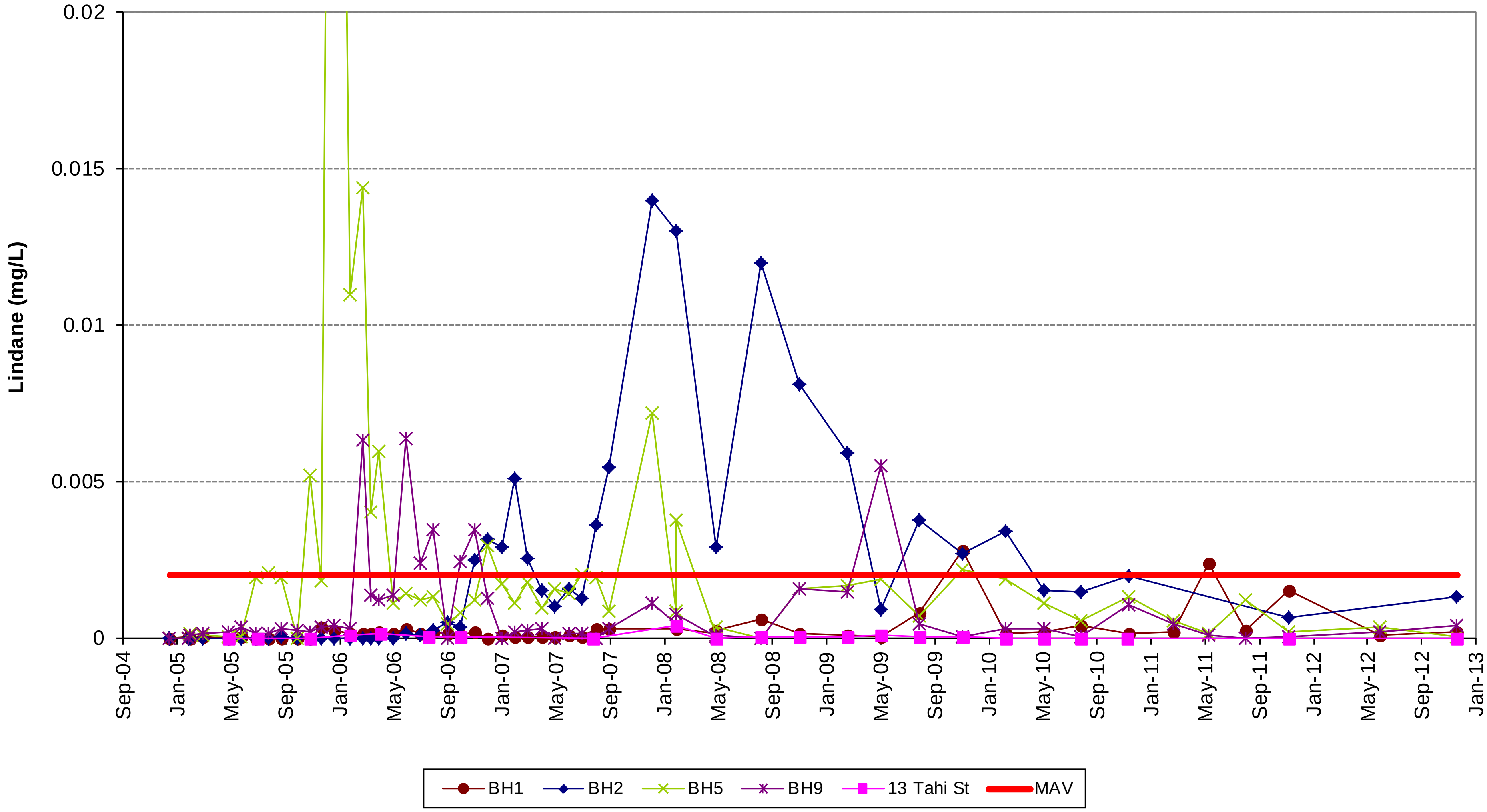


Figure 7. Lindane
MAV DWSNZ 0.002 mg/L

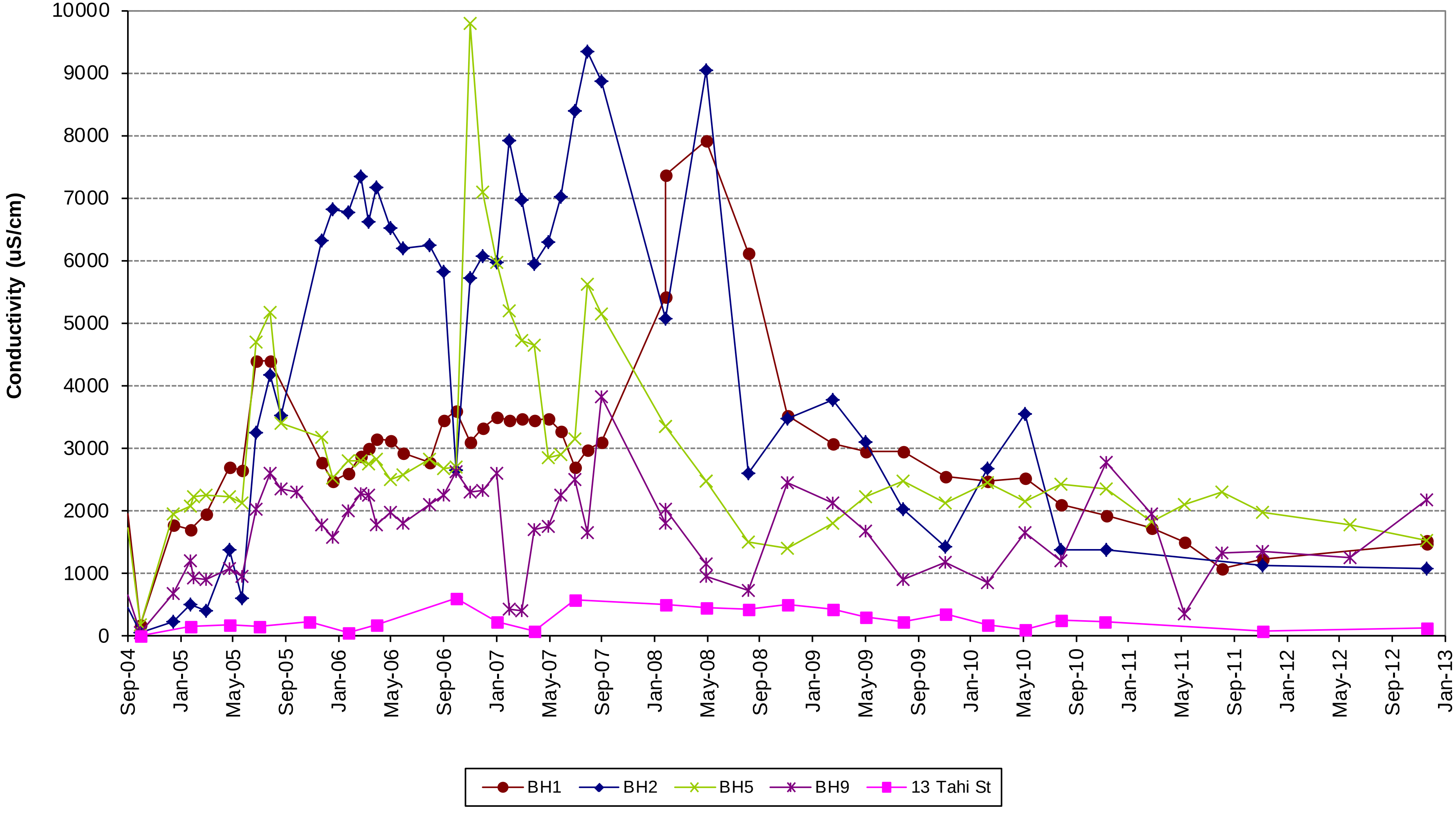


Figure 8. Conductivity

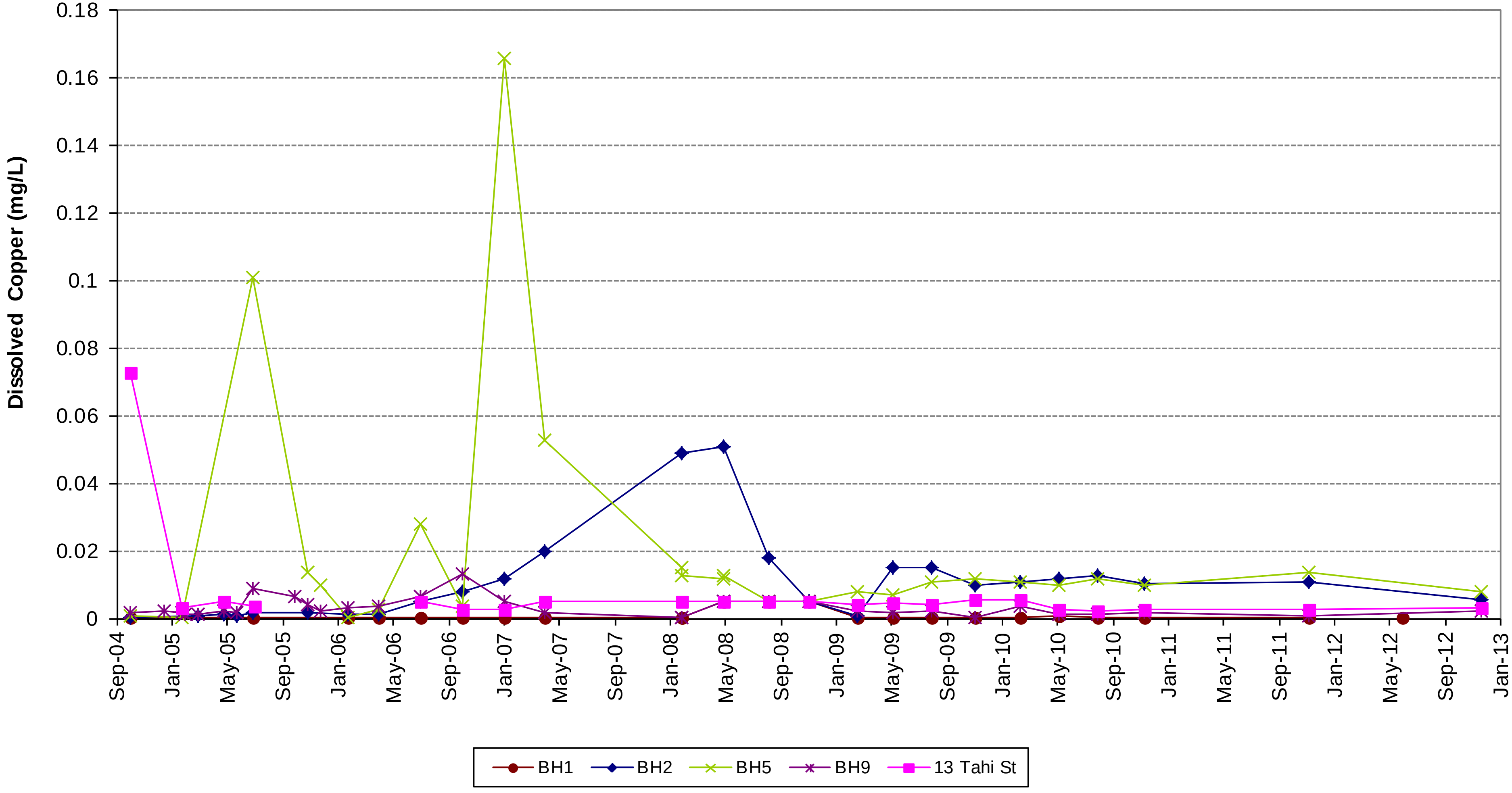


Figure 9. Dissolved Copper
MAV DWSNZ 2 mg/L, ANZECC Marine Guideline = 0.0013 mg/L

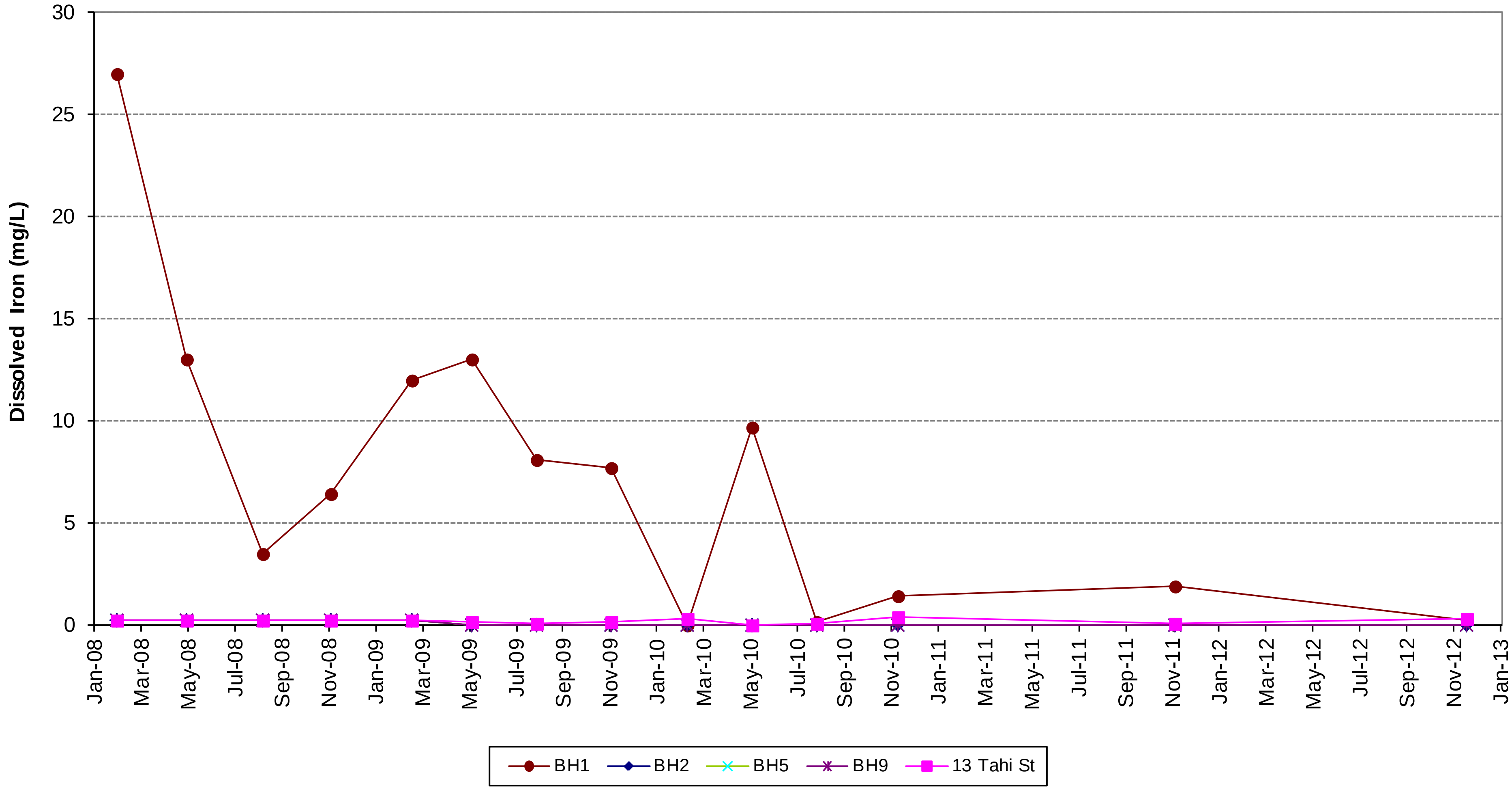


Figure 10. Dissolved Iron
Aesthetic Guideline Value DWSNZ 0.2 mg/L

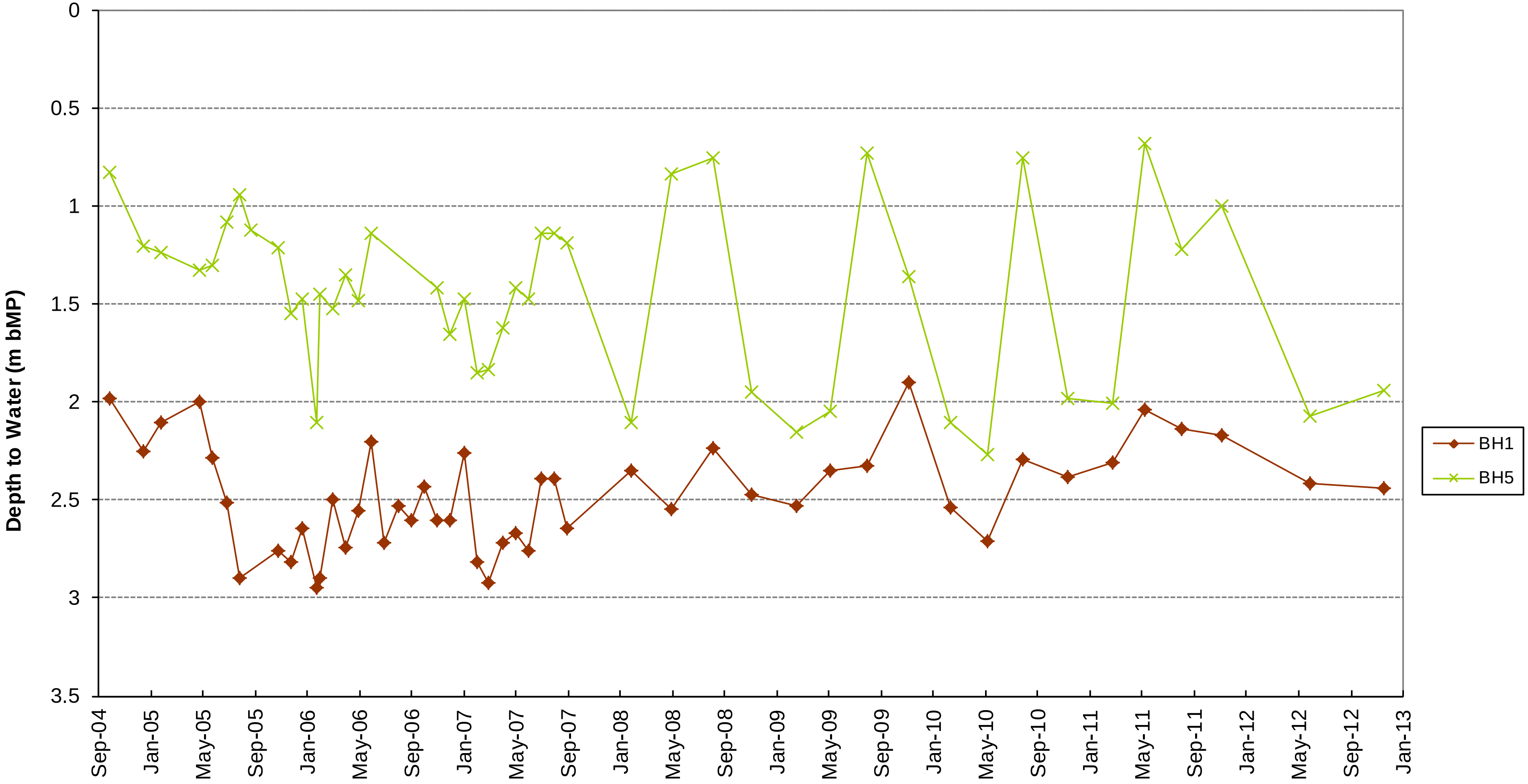


Figure 11. Water Level Plot

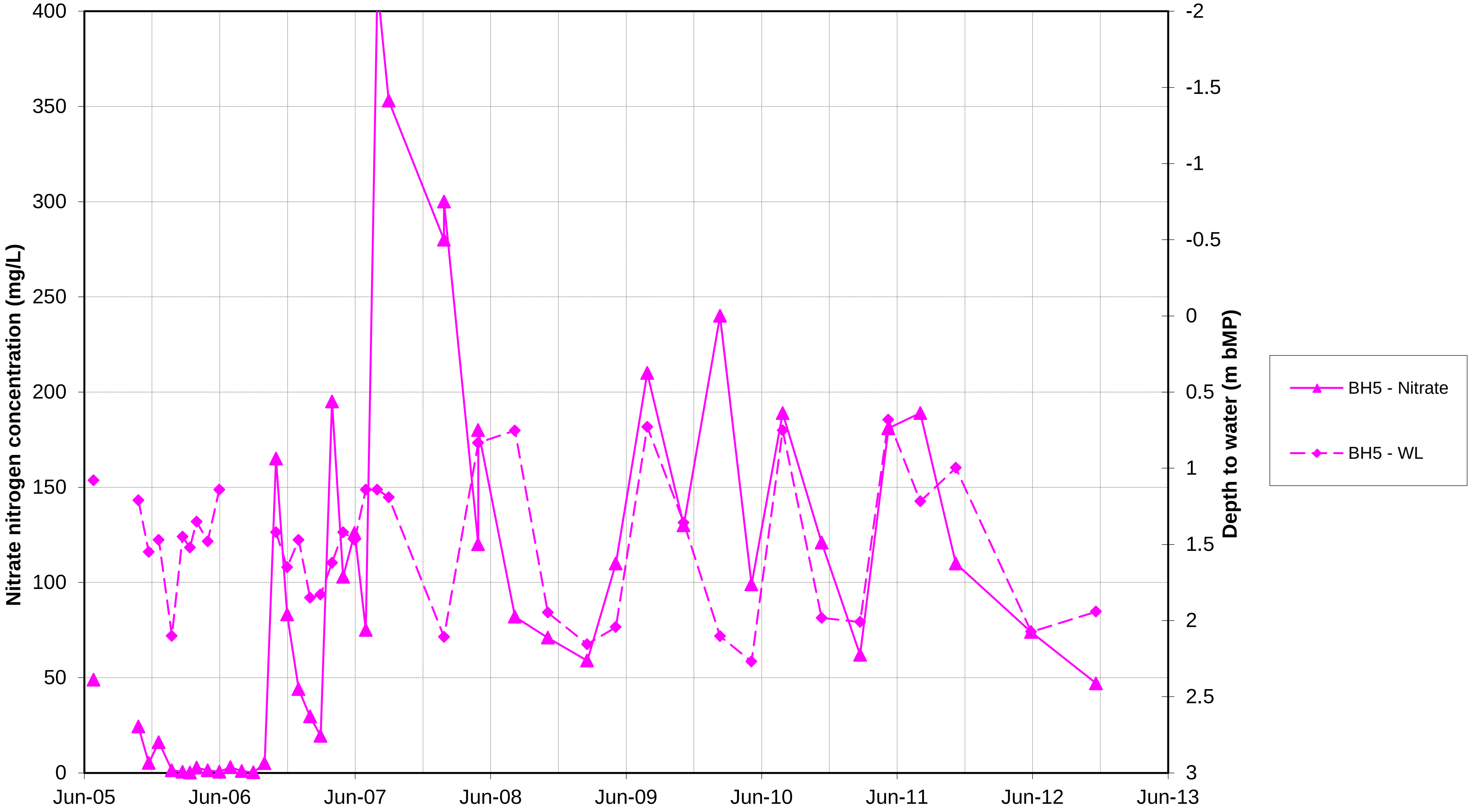


Figure 12. Nitrate vs Water Levels in BH5

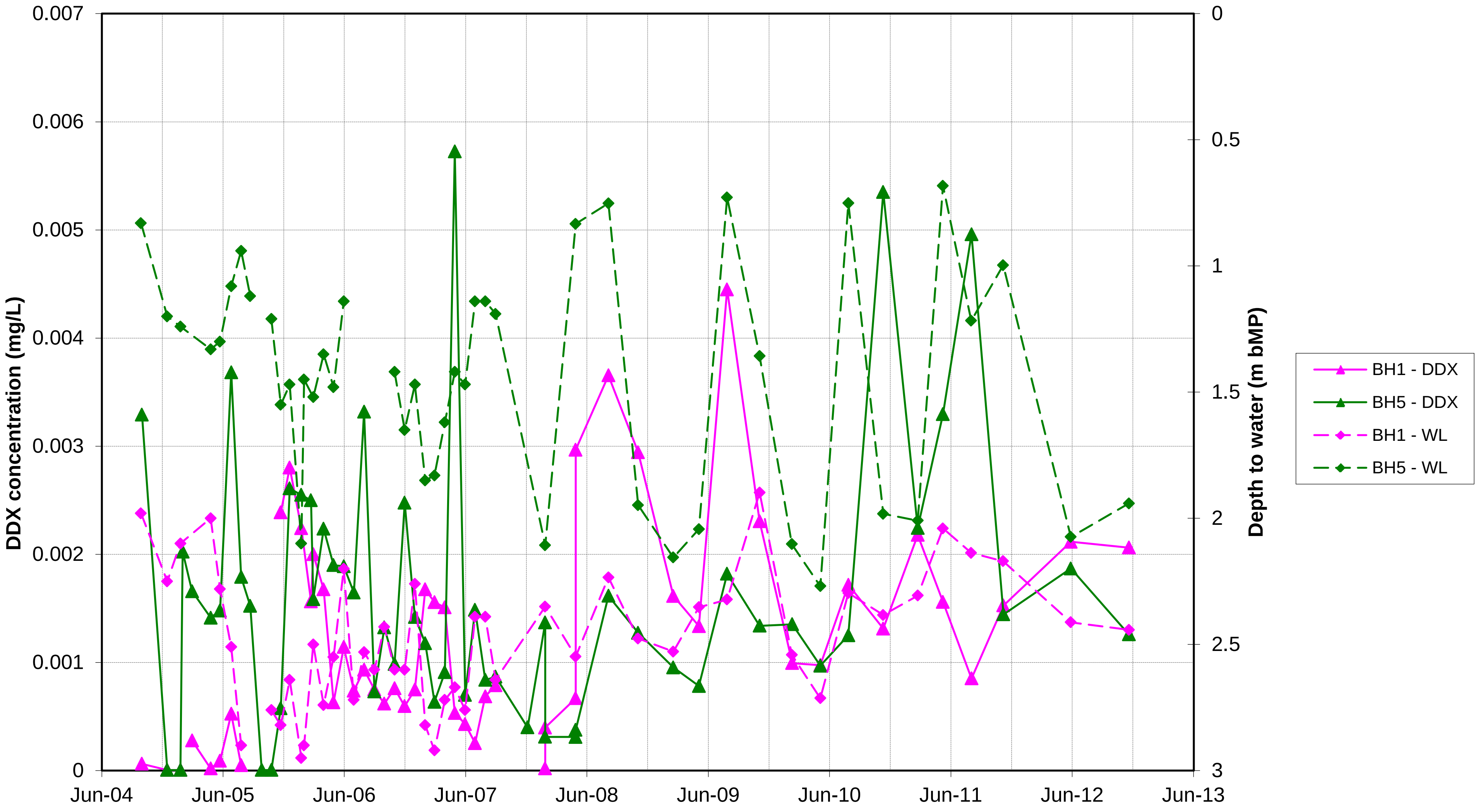


Figure 13. DDX vs Water Levels in BH1 and BH5

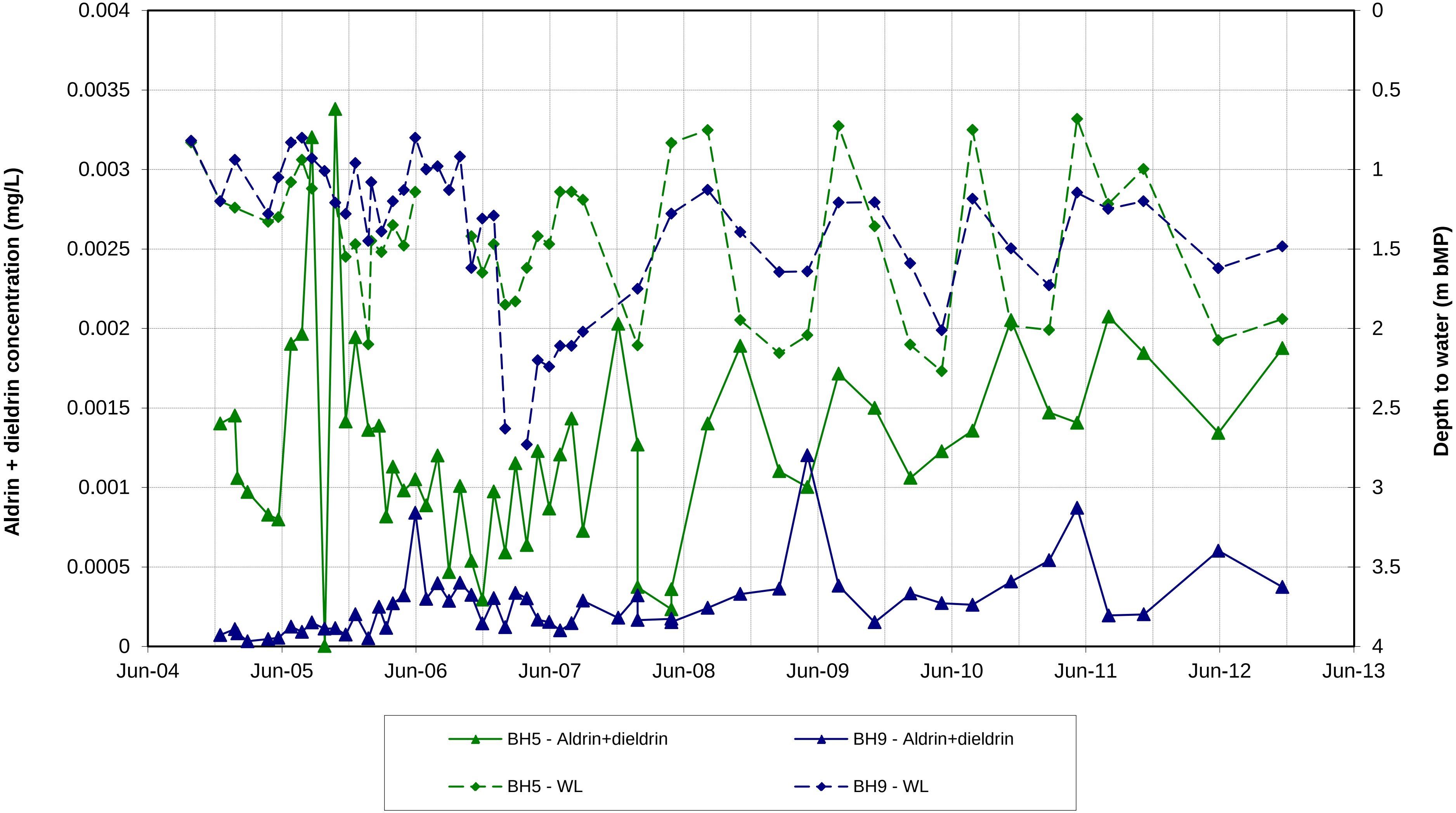


Figure 14. Aldrin + Dieldrin vs Water Levels in BH5 and BH9

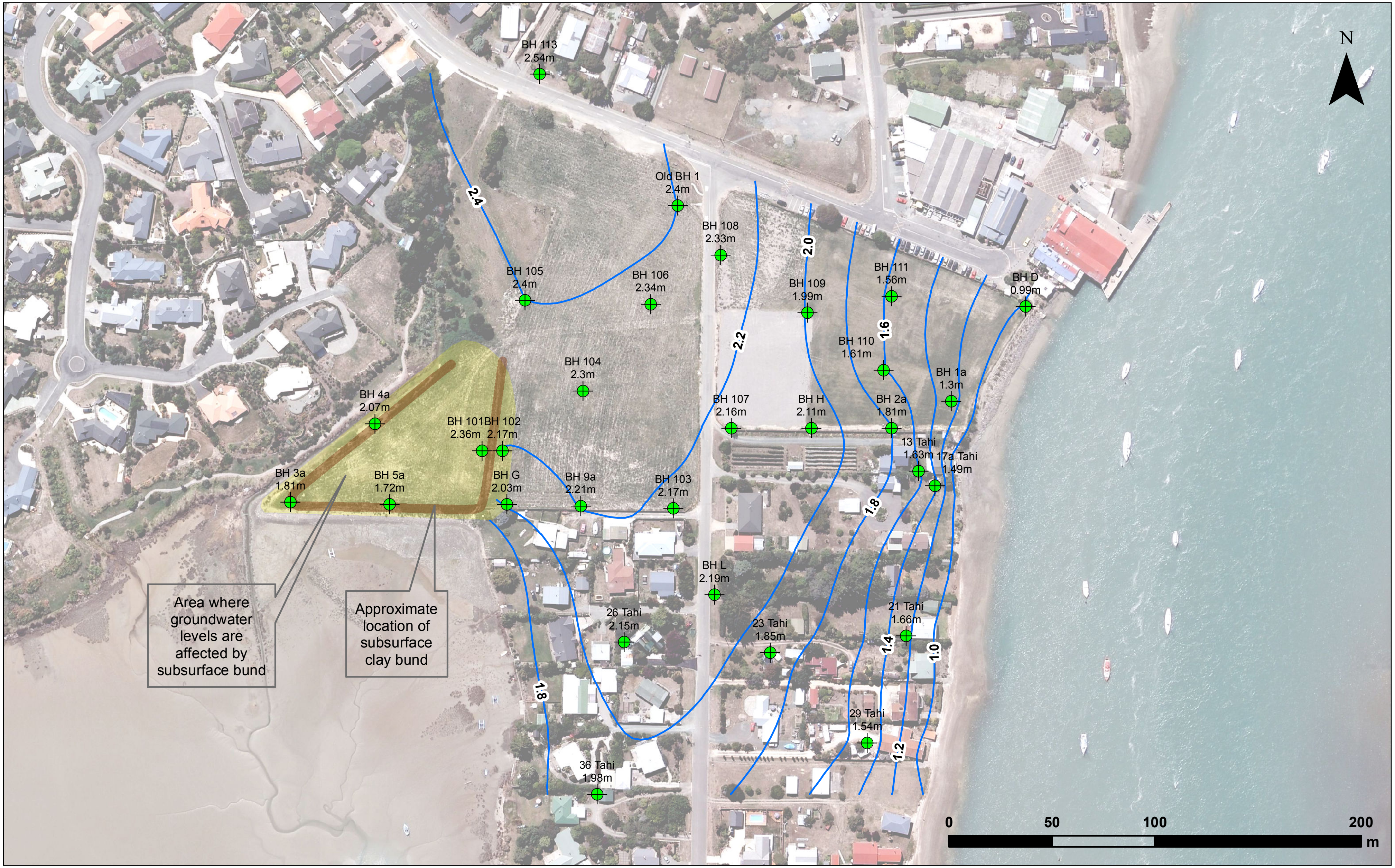


Figure 15: Groundwater levels and contours on 19 November 2012 (values in metres above mean sea level)

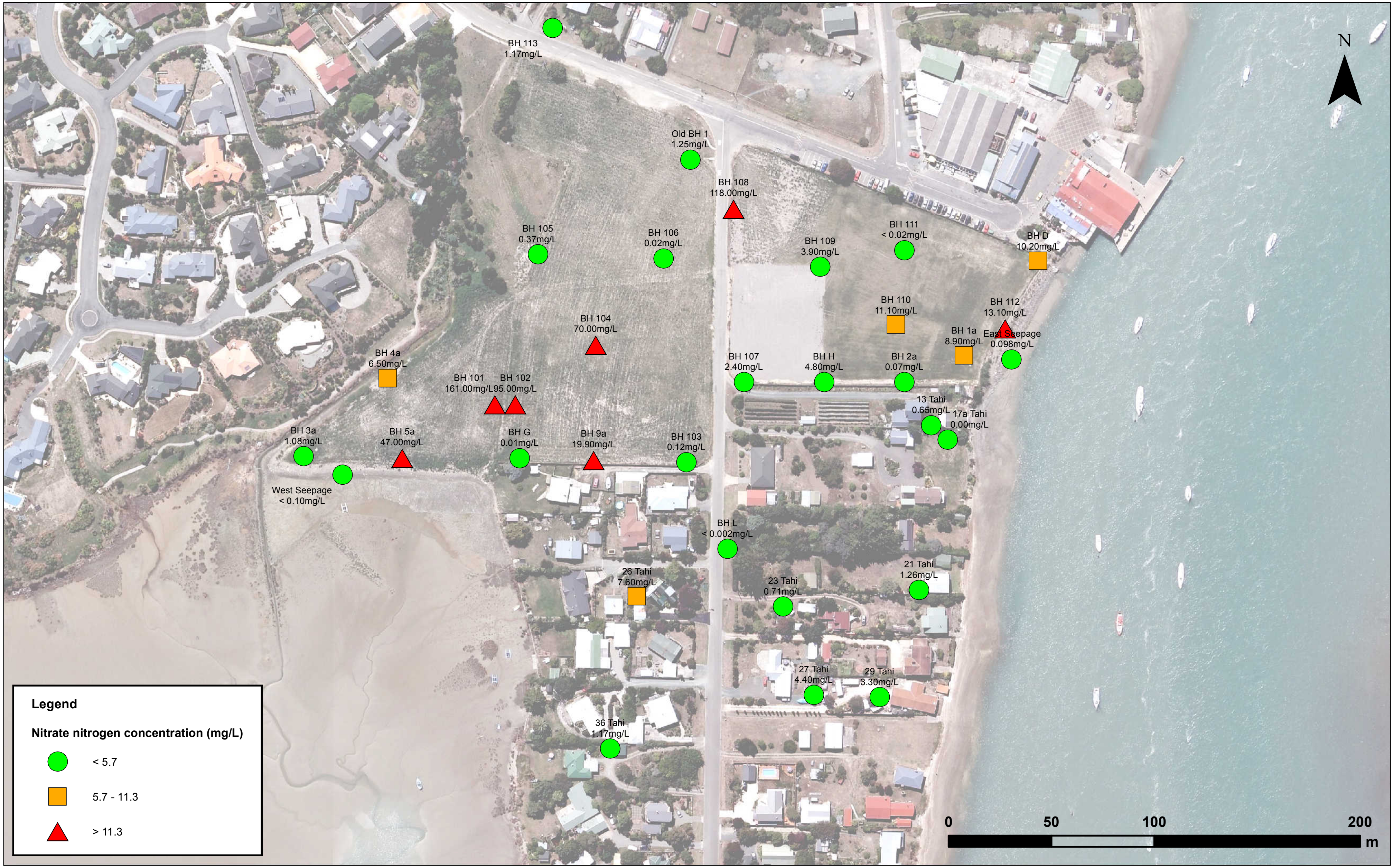


Figure 16: Nitrate nitrogen concentrations in November 2012

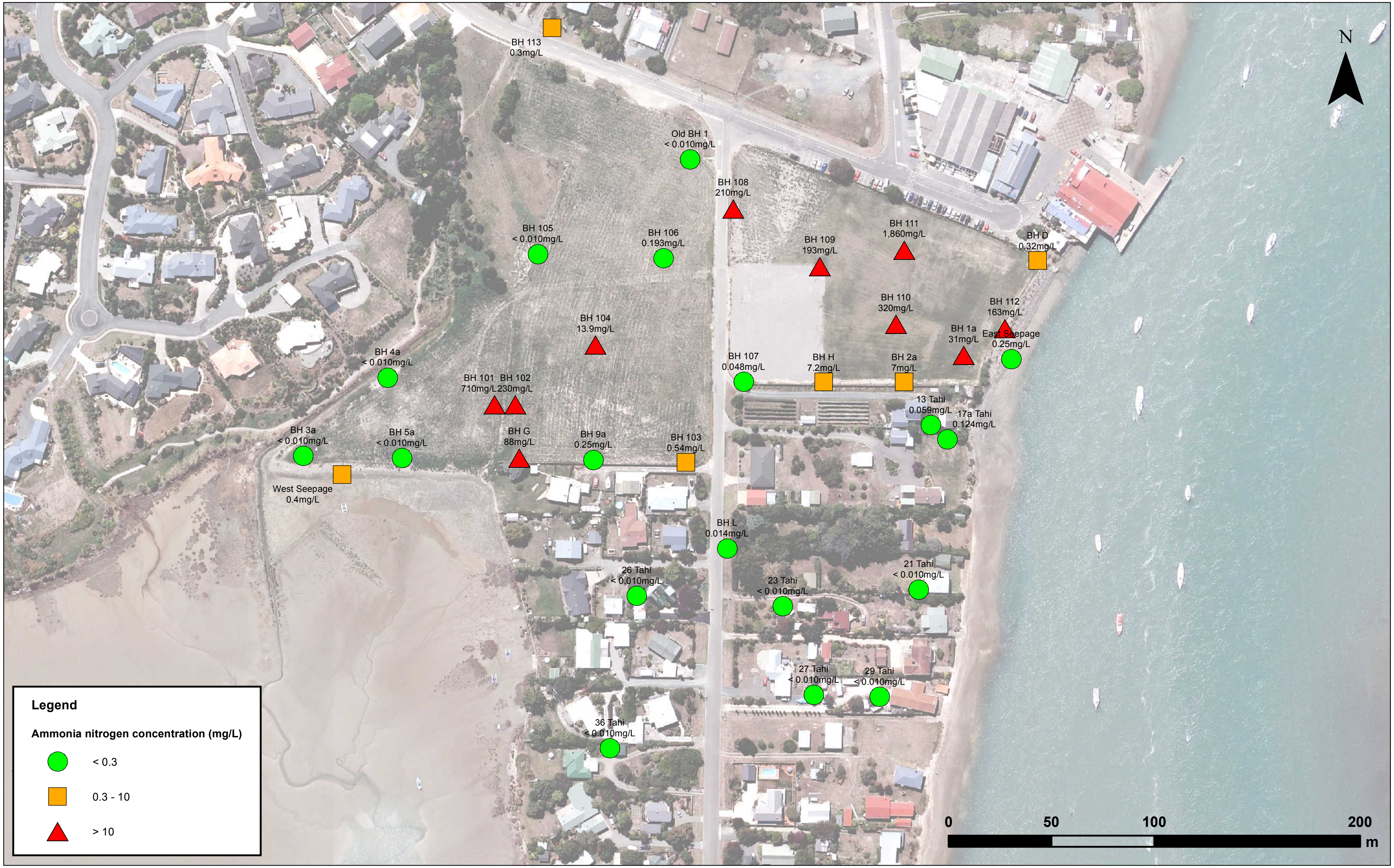


Figure 17: Ammonia nitrogen concentrations in November 2012

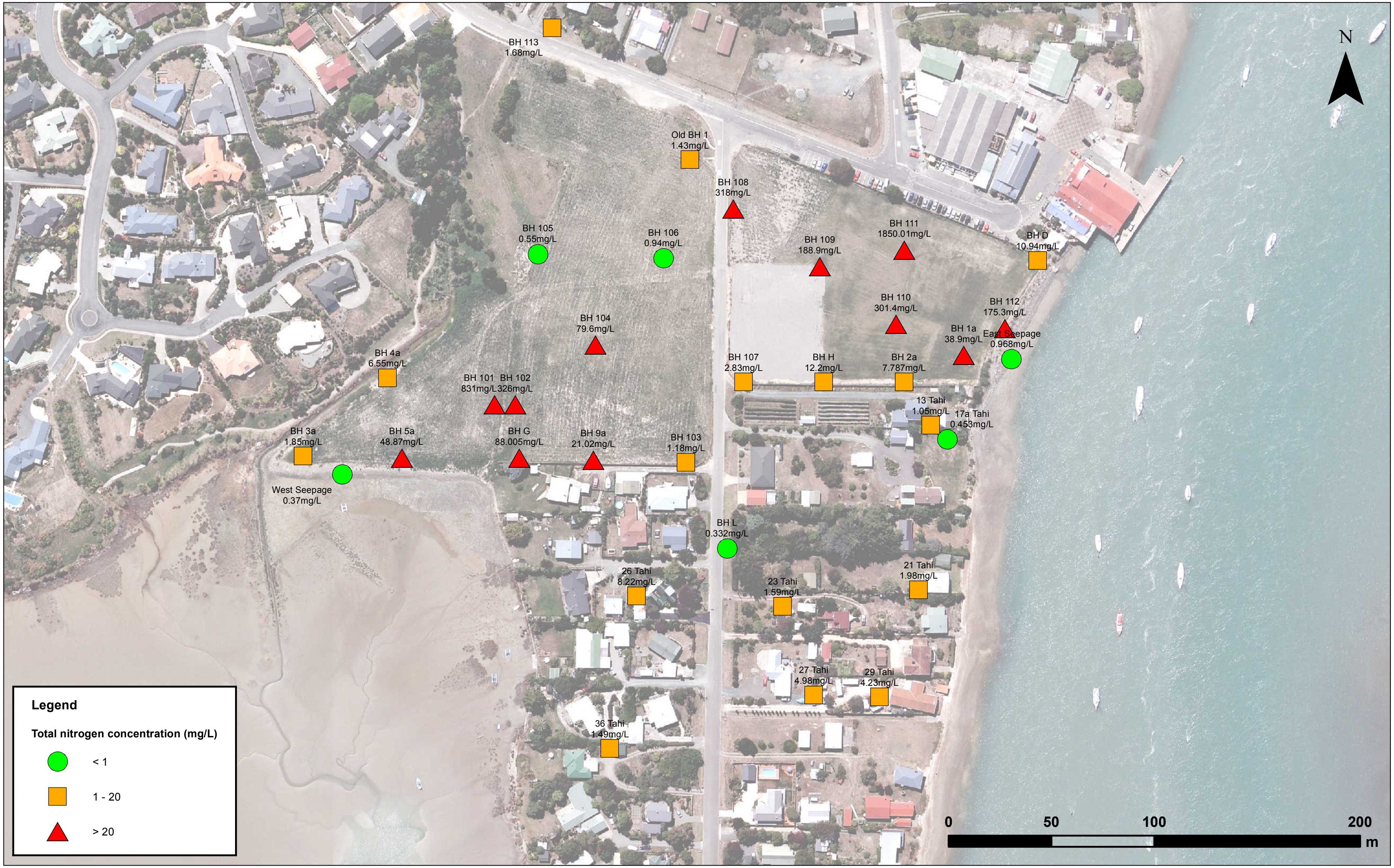


Figure 18: Total nitrogen concentrations in November 2012

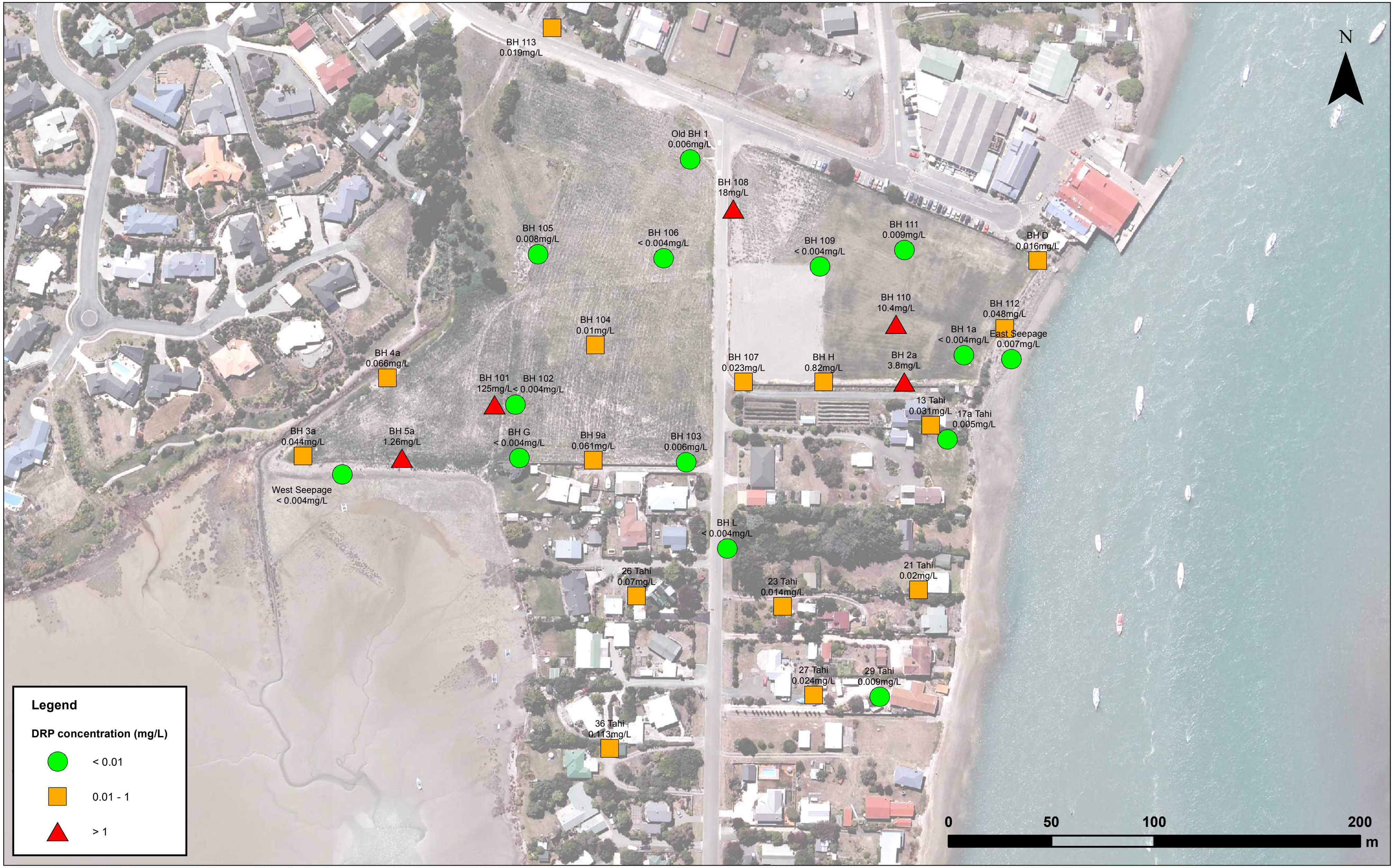


Figure 19: Dissolved reactive phosphorus concentrations in November 2012

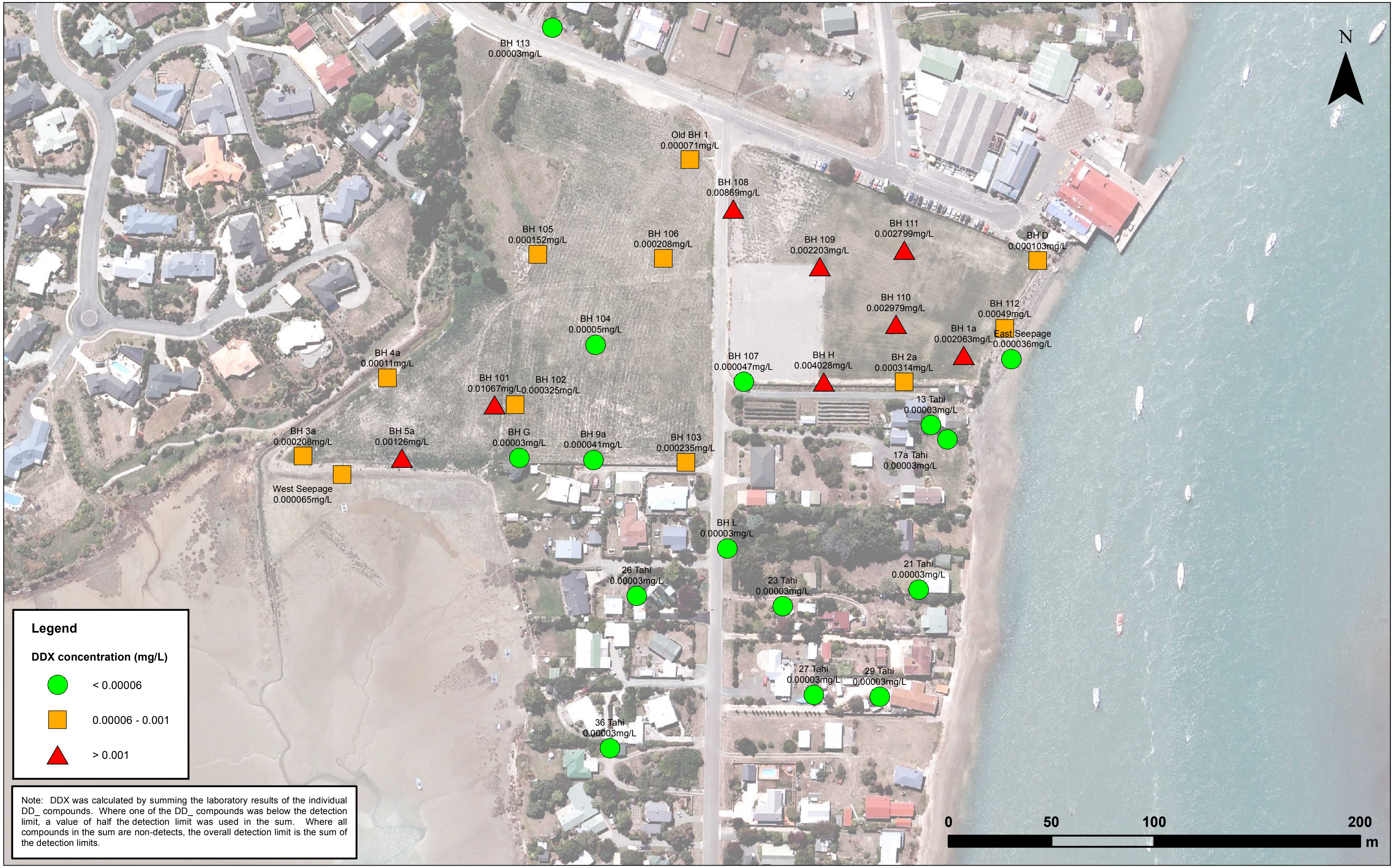


Figure 20: DDX concentrations in November 2012

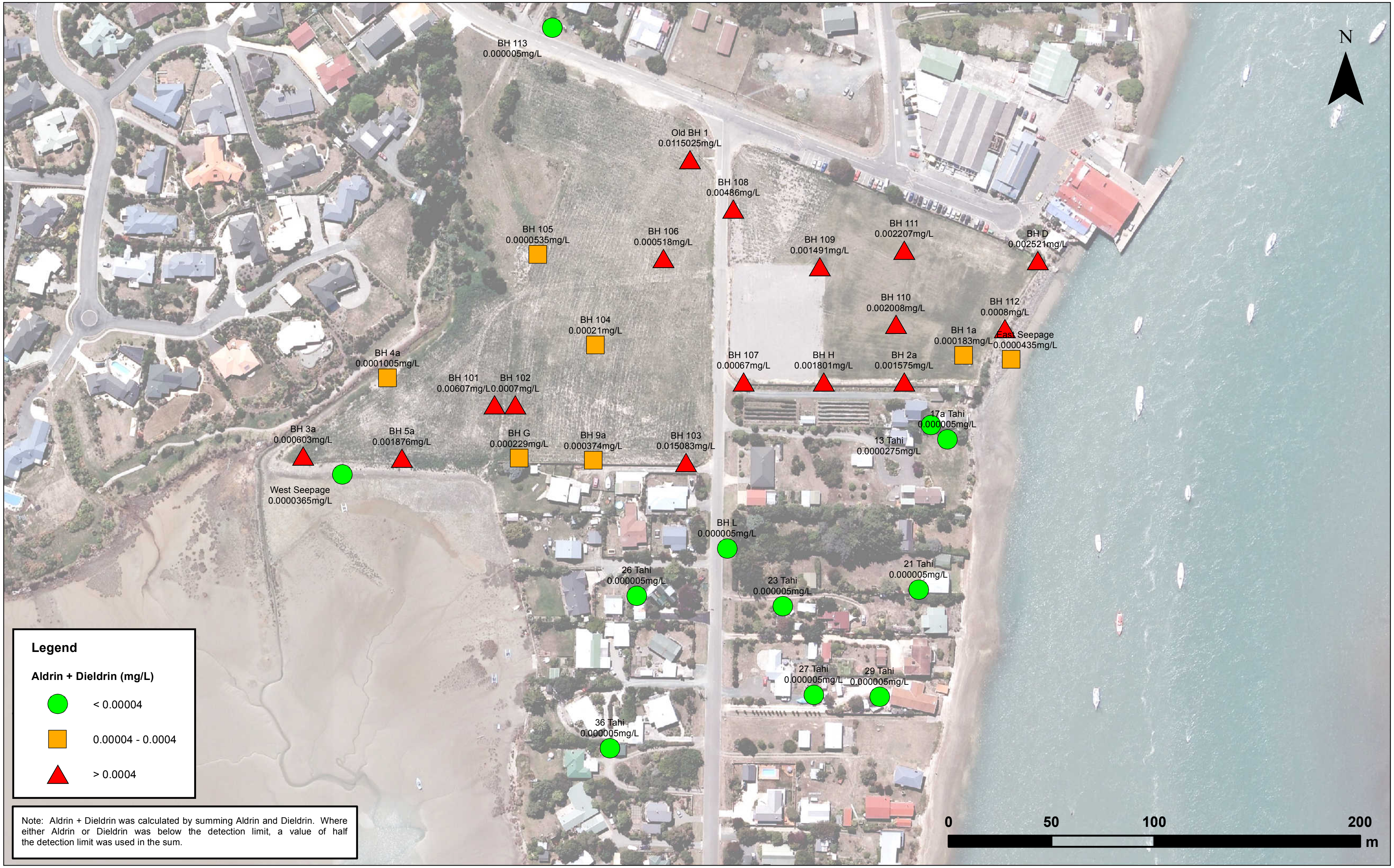


Figure 21: Aldrin + dieldrin concentrations in November 2012

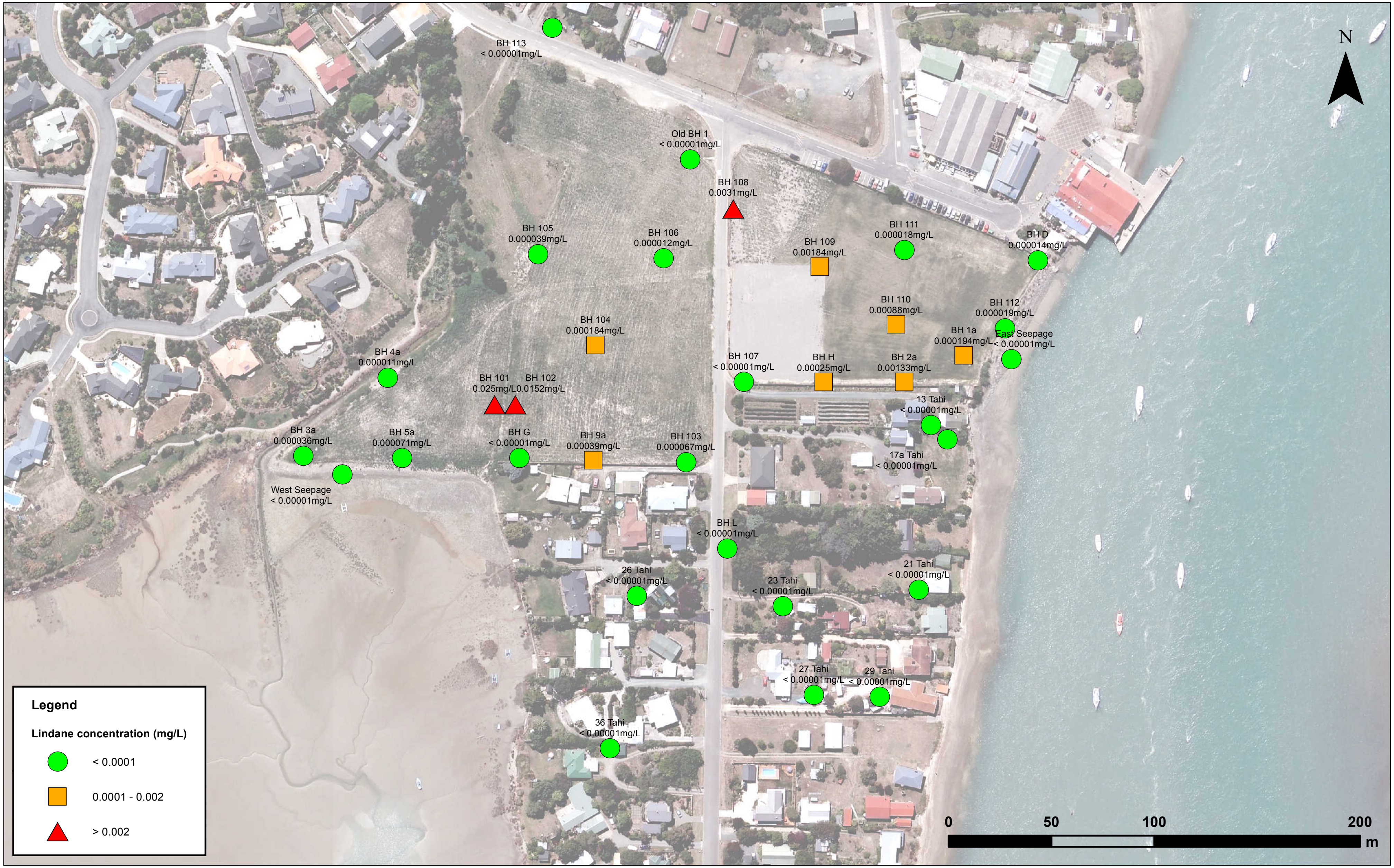


Figure 22: Lindane concentrations in November 2012

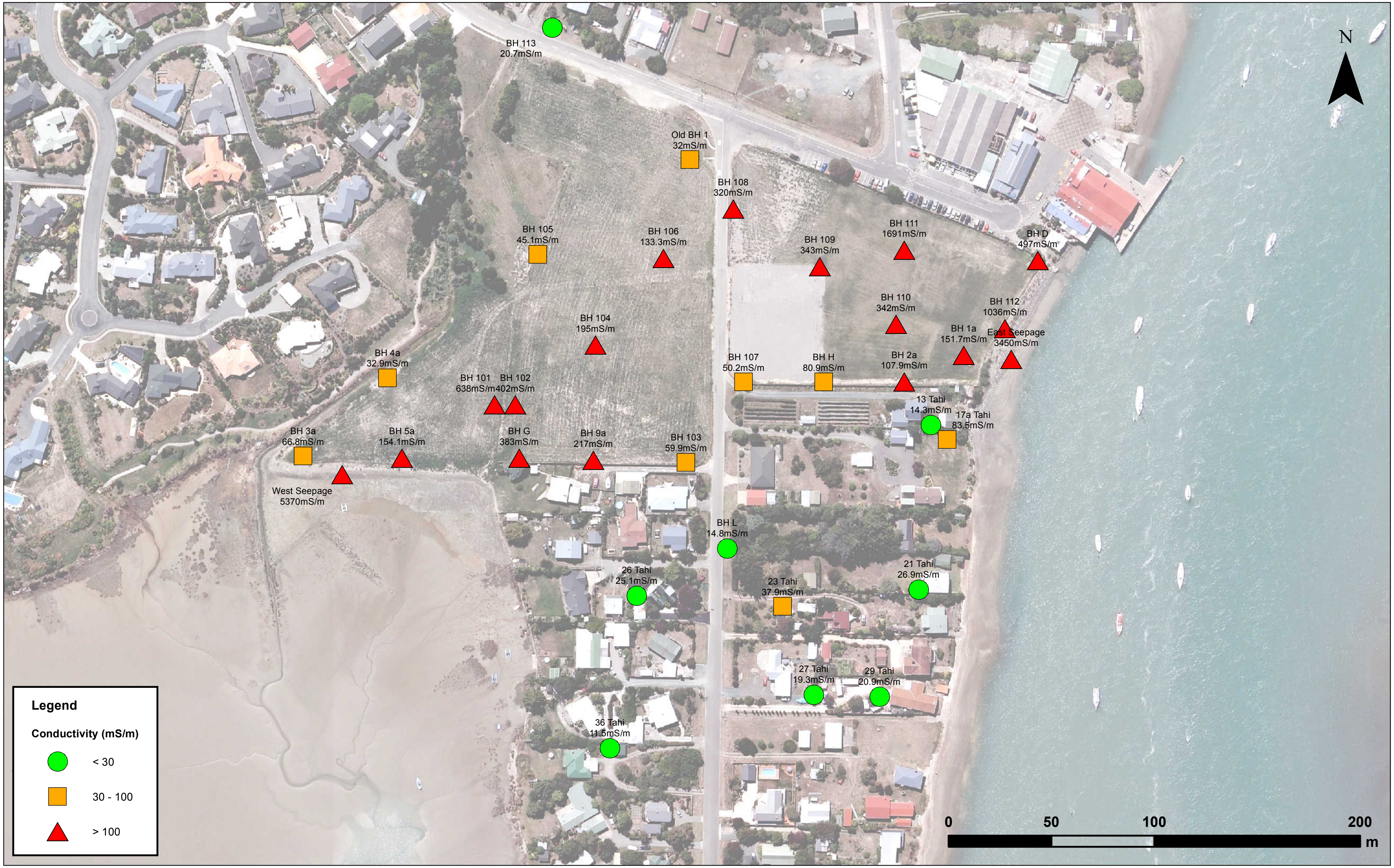


Figure 23: Conductivity values in November 2012

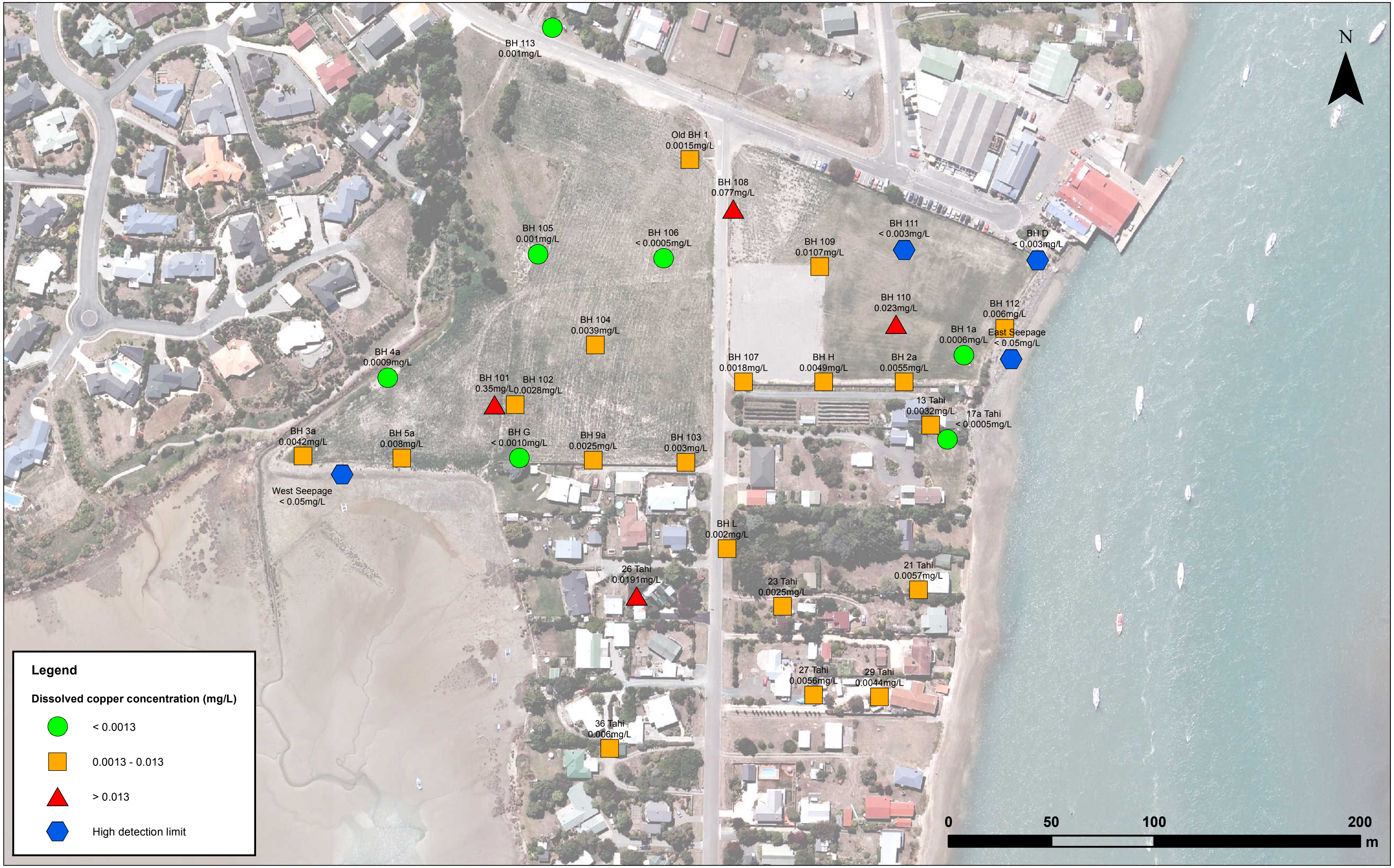


Figure 24: Dissolved copper concentrations in November 2012

Mapua

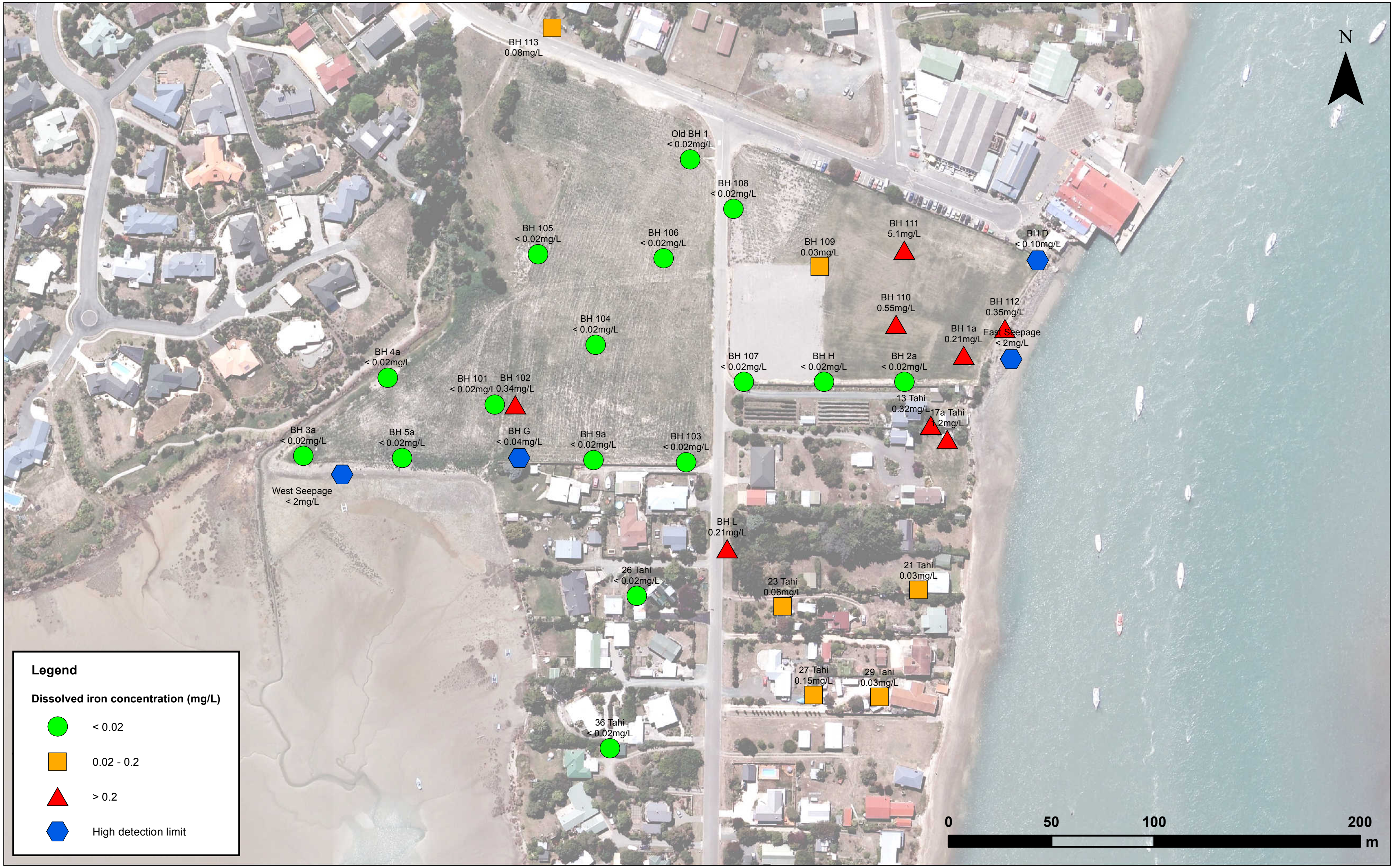
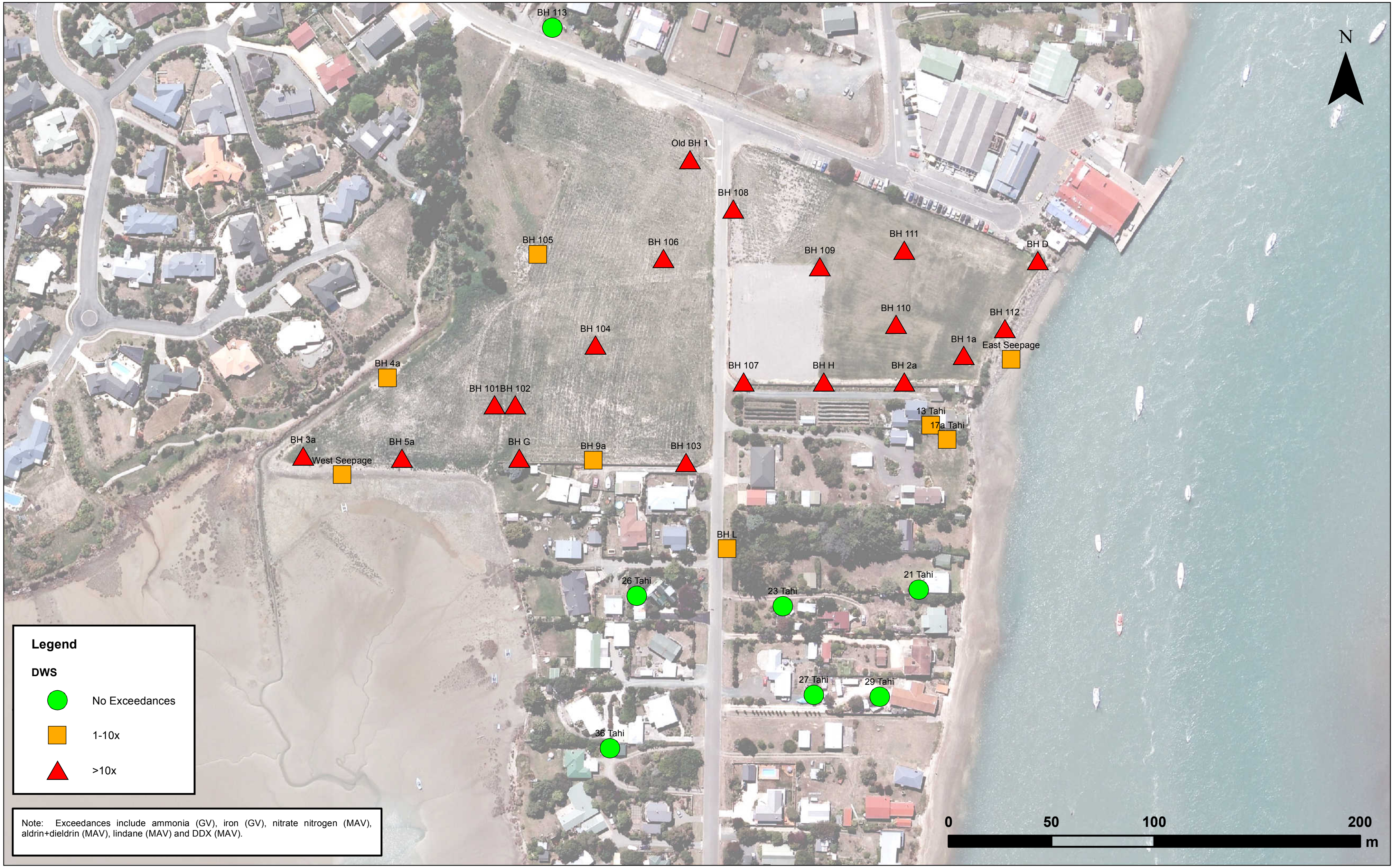


Figure 25: Dissolved iron concentrations in November 2012



Note: Exceedances include ammonia (GV), iron (GV), nitrate nitrogen (MAV), aldrin+dieldrin (MAV), lindane (MAV) and DDX (MAV).

Figure 26: Exceedances of Drinking Water Standards in November 2012

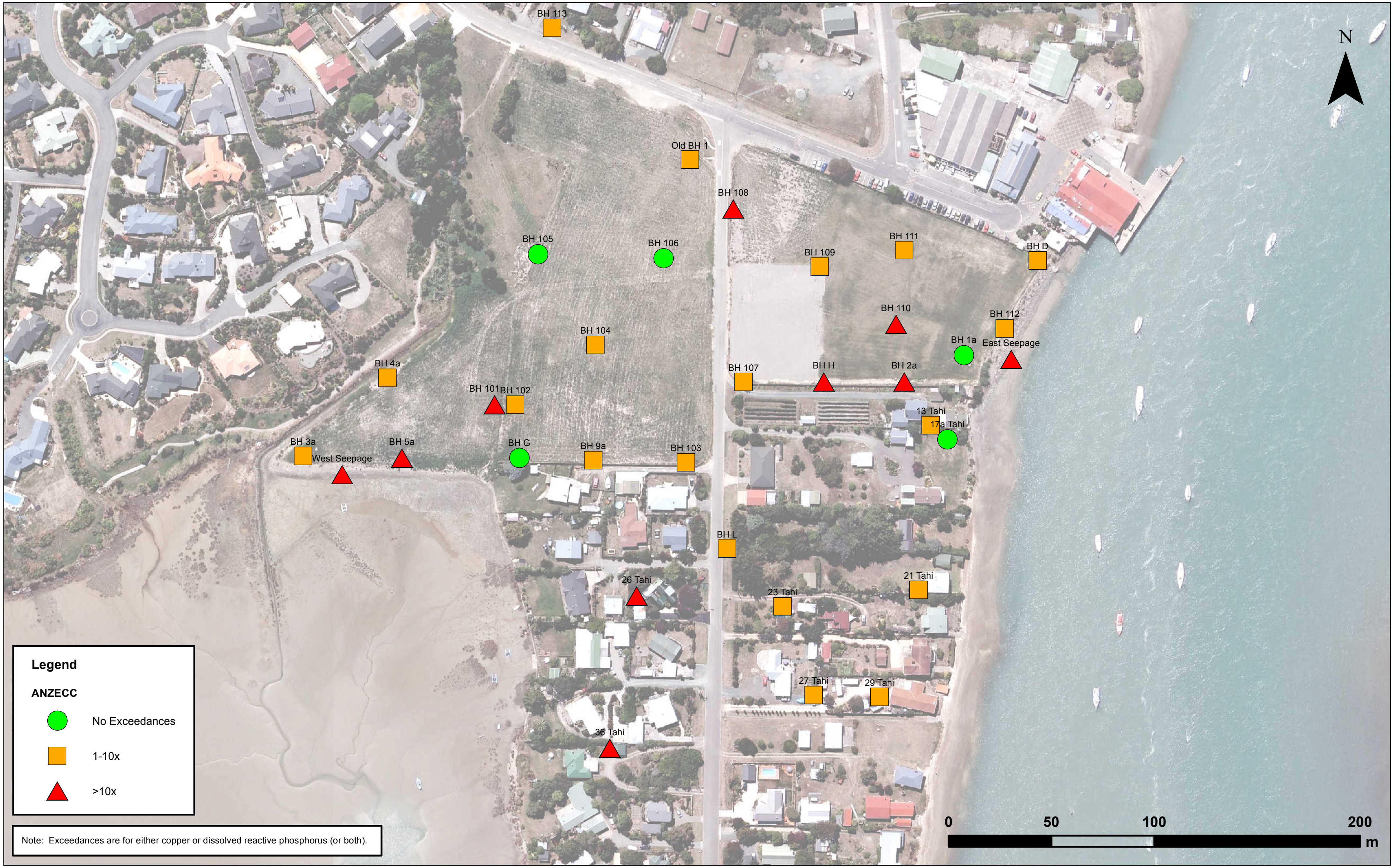


Figure 27: Exceedances of ANZECC Guidelines in November 2012