PATTLE DELAMORE PARTNERS LTD
40 Hammersmith Drive, Wigram, Christchurch
PO Box 389, Christchurch, New Zealand

Tel: +3 363 3100 Fax: +3 363 3101
Web Site http://www.pdp.co.nz
Auckland Wellington Christchurch

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23 March 2012

Ms Jenny Easton
Tasman District Council
Private Bag 4
RICHMOND 7050

Dear Jenny

GROUNDWATER MONITORING AT FORMER FCC SITE, MAPUA – FEBRUARY 2012 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 in the more recently drilled bores. The groundwater sampling that is the subject of this letter review was carried out by Tasman District Council (TDC) during February, May, August and November 2011.

Monitoring Programme

In our review of groundwater monitoring at the Mapua FCC Site (PDP, 2011), we proposed the following monitoring programme:

(i) a transducer to monitor water levels and electrical conductivity in BH110;

(ii) quarterly monitoring in:

- BH108
- BH109
- BH110
- BH1A
- BH101
- BH102
- BH5A
- BH9A

These quarterly samples to be analysed for:

- turbidity
- pH
- electrical conductivity
- nitrate-N

- ammoniacal-N
- DDX
- ADL

(iii) annual monitoring in:

- BH1A
- BH2A
- BH4A
- BH5A
- BH9A
- Old BH1
- BHG
- BHH
- BHL
- BH101
- BH102
- BH103
- BH104
- BH108
- BH109
- BH110
- BH111
- BH112
- BH113
- 13 Tahi Street
- 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 recommended to be analysed for the full suite of parameters included in the previous sampling rounds.

The quarterly monitoring has been carried out for all the proposed wells in February, May, August and November 2011. All the recommended parameters were measured. The annual monitoring was carried out in November 2011 for all the proposed wells with the exception of 15 (now 17a) Tahi St and the east and west estuary coastal seepages. Six additional wells were sampled in November 2011 (BH3A, BH105, BH106, BH107, BHD and 17 Tahi St). All the recommended parameters were measured. A transducer to measure water levels and electrical conductivity was not installed in BH110 as that recommendation was not supported by the site auditor.

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. 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 has one exceedance of the MAV in February 2011 (25 mg/L), with the remaining concentrations between 0.004 and 1.49 mg/L. BH5 recorded concentrations between 62 and 189 mg/L. Figure 2a shows the boreholes that have typically displayed lower nitrate-N concentrations. Both BH1 and 13 Tahi Street remain at stable, low concentrations;
- Figure 3 shows ammonia-nitrogen concentrations. The bores with elevated concentrations (BH1 and BH2) have shown a small decrease over the last year. Those bores with lower ammonia-N concentrations (Figure 3a) show stable concentrations in BH5, BH9 and 13 Tahi Street.
- 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) continued to fluctuate significantly during the last year. The remaining bores (BH2, BH9 and 13 Tahi St) showed stable concentrations over the last year.
- Figure 6 shows aldrin + dieldrin concentrations, which have been relatively stable over the last year. The highest concentrations occur in BH5 and BH2 and remain at similar concentrations to those measured during the remedial works. All of the regularly sampled wells except for 13 Tahi St are above the MAV in the Drinking Water Standards (0.00004 mg/L).
- Figure 7 shows lindane concentrations, which have decreased significantly since the remedial works and have been stable over the last year. Only one of the samples (BH1 in May 2011) exceeded the MAV in the Drinking Water Standards (0.002 mg/L) on only one occasion during the last 12 months.
- 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.

- 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 2011 sampling round, dissolved iron was measured in BH1 (1.9 mg/L) and 13 Tahi St (0.11 mg/L). Dissolved iron was not detected 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 fluctuated within 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 BH5, DDX in BH1 and BH5 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 tending to lag behind the groundwater level peaks.

More Detailed Quarterly Monitoring

During the last 12 months a new set of bores has been monitored at quarterly intervals. Plots of the results from these last 12 months of monitoring are presented in Figures 15 to 21 and are discussed below.

Figure 15 shows the depths to water in these quarterly measured bores, which were relatively low in February 2011 and at a higher and more stable level for the following three quarters.

Nitrate-N (Figure 16). BH9A, BH102, BH108, BH110 and BH5A show a similar range of somewhat erratic fluctuations. Even greater fluctuations occur in BH101. A gradual increase has occurred in BH109 (up to 38 mg/L) and very low concentrations (<0.4 mg/L) in BH1A.

Ammonia-N (Figure 17). Large and erratic fluctuations occur in three wells, which from high to low are: BH101, BH110 and BH102, with the highest values in BH101 and BH102 associated with a low groundwater level. More stable trends show increases in BH108 and BH109, decreases in BH1A and very low concentrations (<0.5 mg/L) in BH5A and BH9A.

DDX (Figure 18). Large and erratic fluctuations in BH108, BH101, BH5A and BH110. A more stable pattern of fluctuations in BH109, BH1A and BH102. Low concentrations, well below the Maximum Allowable Value in the Drinking Water Standards, in BH9A.

Aldrin + Dieldrin (Figure 19). Large and erratic fluctuations in BH101. More stable fluctuations in the following boreholes, in decreasing order of concentration: BH108, BH110, BH5A, BH109, BH102, BH9A and BH1A.

Lindane (Figure 20). Large and erratic fluctuations in BH101 and BH102. More stable fluctuations in BH108, BH110, BH1A, BH109, BH5A and BH9A.

Electrical Conductivity (Figure 21). Bores showing erratic fluctuations are, in order of decreasing magnitude: BH101, BH110, BH102, BH108 and BH9A. More stable trends are shown by BH109 (increasing), BH5A (variable) and BH1A (decreasing).

Those bores showing the more erratic fluctuations in chemical concentrations are likely to occur near areas where sources of contamination are variably affected by groundwater levels and/or pulses of recharge, although there is no consistent pattern associated with the measured water levels. The largest fluctuations occur most commonly in

BH101, BH102 and BH110, and to a lesser extent in BH108, BH5A and BH9A. More stable concentrations occur in BH1A and BH109.

The quarterly monitoring also indicates that the November sampling does not always coincide with the highest concentrations. As noted in our previous report, continuous monitoring of electrical conductivity in an indicator bore would provide a better understanding of the recharge pattern and concentrations of dissolved contaminants throughout the year.

Piezometric Survey

The elevation of the groundwater table within the on-site monitoring bores for the most recent monitoring round (7 November 2011) is plotted in Figure 22. They show that levels are similar to the high groundwater levels measured in late July 2010, with most of the groundwater discharging 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

During the November 2011 sampling round a wider range of wells was sampled, which allows a more detailed picture of the distribution of chemicals within the area to be defined. Figures 23-34 have been prepared to show the patterns that exist. 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 500mm of soil (the highest groundwater level measured in BH101 is 0.45 m below ground level).

- **Nitrate-Nitrogen**

  Figure 23 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 2010 results, there are mixed changes. In general, the latest concentrations appear to be higher for bores located to the north and south and lower for the bores located in the centre of the site.

  Eight of the 32 wells sampled in November 2011 had nitrate-N concentrations above the MAV (11.3 mg/L), with the highest concentration (other than for bores BH101 and BH102) recorded in bores BH5A and BH108 (both 110 mg/L).

  Of the domestic bores sampled, 26, 27 and 29 Tahi St have elevated concentrations (between 5.6 and 13.5 mg/L). These concentrations are significantly higher than the concentrations measured in November 2010 (which were between 0.53 and 5.3 mg/L) and may indicate a local source of nitrate occurring in that area, perhaps related to wastewater or fertiliser use. In particular, Figure 24 shows the layout of utilities in the area and a wastewater pipe that could be a source of leakage and nitrogen contamination to boreholes at 26, 27 and 29 Tahi St. Widespread migration of nitrate from the site through the groundwater system is unlikely as elevated concentrations were not recorded in BHG, BH9A, BH103, BHL and 23 Tahi Street, all of which occur between the site and the properties at 26, 27 and 29 Tahi Street. The possibility exists for a discrete preferential migration pathway from the site along the trench of the wastewater pipe and this should be checked by obtaining invert levels for the pipe relative to measured groundwater levels, coupled with more detailed sampling at times when the water table might be intercepting the trench of the wastewater pipe.

- **Ammonia-Nitrogen**

  Figure 25 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.

  There has been no consistent change since November 2010, with some bores showing increased concentrations and others showing lower concentrations. The results show elevated concentrations occur in both the east, around bore BH111 (1,010 mg/L in November 2011, up from 620 mg/L in November 2010), and west of the site, around bore BH101 (760 mg/L in November 2011, down from 1,130 mg/L in November 2010).

  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 26 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.

  The total nitrogen concentrations show the same general trend as for nitrate-N, with generally higher concentrations in the north and south compared to November 2010 and generally lower concentrations in the centre of the site.

  The results indicate that the vast majority of on-site wells have elevated nitrogen concentrations, indicating the ongoing discharge of groundwater seepage to the Waimea Inlet and the Mapua Channel at concentrations above ANZECC guidelines for marine waters.

- **Dissolved Reactive Phosphorus**

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

  Figure 27 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 similar to the concentrations in November 2010. Variable concentrations occur across the site, with some low and non-detectable values, and other bores showing localised high concentrations (up to 16.1 mg/L in BH110). As with nitrogen, the concentrations indicate that the groundwater discharge from the site continues to exceed ANZECC guidelines.

- **DDX**

  Figure 28 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).

The November 2011 concentrations tend to be slightly lower than for November 2010. The results show variable DDX concentrations within the site. The variation in concentrations within the site is most likely due to the localised effects of soils with elevated DDX concentrations.

- **Aldrin + Dieldrin**

Figure 29 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 2010, with some bores showing increased concentrations and others showing lower concentrations. The results show that 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). The highest recorded concentration in November 2011 was 0.01245 mg/L in bore BH103. All of the domestic wells sampled in November 2011 had concentrations below the MAV.

Dieldrin was measured in two of the offsite bores during the November 2011 sampling round – 13 Tahi St (0.000012 mg/L) and 26 Tahi St (0.000005 mg/L). The presence of dieldrin in these two bores may be due to the migration of dieldrin from the site, however, it is worth noting that the measured concentrations are at or close to the laboratory detection limit (0.000005 mg/L).

- **Lindane**

Figure 30 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 2010, with some bores showing increased concentrations and others showing lower concentrations. The results show elevated concentrations occurring to the east of the site. There were no exceedances of the MAV during the November 2011 sampling round, except for bores BH101 and BH102 in the clay bund. Apart from these two bores, the highest concentration was recorded in BH108 (0.00199 mg/L in November 2011, down from 0.0028 mg/L in November 2010).

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.

Lindane was not detected in any of the domestic bores in the November 2011 sampling round.

- **Conductivity**

Figure 31 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 conductivity value recorded at bore BH111 (1,060 mS/m). The values show a similar pattern to those measured in November 2010.

Figure 32 shows a plot of total nitrogen versus electrical conductivity in the regularly sampled bores, as well as values from BH110. There is a general trend of higher nitrogen concentrations with high conductivity and for that reason we remain of the view that a transducer to provide a continuous record of water level and electrical conductivity in bore BH110 would provide a useful indicator of the variability in leaching of the chemicals throughout the year, which is information that is not available from four discrete samples per year.

- **Copper**

  Figure 33 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 have generally increased across the site, with more points in the high (red) category than in November 2010. The highest concentration was measured in bore BH108 (0.075 mg/L in November 2011, up from 0.07 mg/L in November 2010). The upgradient control bore (BH113) is also slightly elevated (0.0013 mg/L).

- **Iron**

  Figure 34 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 2010, with some bores showing increased concentrations and others showing lower concentrations. The results show elevated concentrations occurring through the centre of the site, with the highest concentration recorded in bore BH G (26 mg/L in November 2011, down from 50 mg/L in November 2010).

Overview

The patterns shown in Figures 23-34 indicate a continuing impact from the site soils on the underlying groundwater. Figures 35 and 36 show exceedances of Drinking Water Standards and ANZECC guidelines respectively and Tables 1 and 2 below indicate the chemicals and magnitude of the exceedance. The shaded cells in Table 1 indicate an exceedance of a Maximum Allowable Value (MAV) in the Drinking Water Standards, whereas the unshaded cells in Table 1 indicate an exceedance of an aesthetic Guideline Value (GV).

Table 1: Exceedances of DWS - November 2011					
Borehole	**Chemicals (Chemical, Rate of Exceedance)**				
BH 1A	Aldrin+Dieldrin, 4.3x	Dissolved Iron, 9.5x	Ammonia, 28x	DDX, 1.5x	
BH 2A	Aldrin+Dieldrin, 34x	Ammonia, 9.1x			
BH 3A	Aldrin+Dieldrin, 11x				
BH 4A	Aldrin+Dieldrin, 4.2x				
BH 5A	Aldrin+Dieldrin, 46x	Nitrate, 9.7x	DDX, 1.6x		
BH 9A	Aldrin+Dieldrin, 5.1x				
BH 101	Aldrin+Dieldrin, 160x	Ammonia, 633x	Nitrate, 24x	Lindane, 11x	DDX, 13x
BH 102	Aldrin+Dieldrin, 22x	Ammonia, 93x	Nitrate, 10x	Lindane, 4.9x	
BH 103	Aldrin+Dieldrin, 311x				
BH 104	Aldrin+Dieldrin, 2.5x	Dissolved Iron, 5.8x	Ammonia, 2.4x		
BH 105	Aldrin+Dieldrin, 4.1x	Nitrate, 2.0x			
BH 106	Aldrin+Dieldrin, 12x	Dissolved Iron, 8.6x			
BH 107	Aldrin+Dieldrin, 20x				
BH 108	Aldrin+Dieldrin, 79x	Ammonia, 150x	Nitrate, 9.7x	DDX, 7.0x	
BH 109	Aldrin+Dieldrin, 33x	Ammonia, 165x	Nitrate, 3.4x	DDX, 2.9x	
BH 110	Aldrin+Dieldrin, 80x	Dissolved Iron, 1.3x	Ammonia, 400x	DDX, 6.7x	
BH 111	Aldrin+Dieldrin, 18x	Dissolved Iron, 8.6x	Ammonia, 842x	DDX, 1.3x	
BH 112	Aldrin+Dieldrin, 10x	Ammonia, 66x			
BH 113					
BH D	Aldrin+Dieldrin, 44x	Nitrate, 2.5x			
BH G	Aldrin+Dieldrin, 6.6x	Dissolved Iron, 130x	Ammonia, 12x		
BH H	Aldrin+Dieldrin, 50x	Ammonia, 4.3x	DDX, 1.1x		
BH L					
Old BH1	Aldrin+Dieldrin, 258x				
13 Tahi					
17 Tahi	Dissolved Iron, 9.4x				
21 Tahi					
23 Tahi					
26 Tahi					
27 Tahi	Nitrate, 1.2x				
29 Tahi					
36 Tahi					

Table 2: Exceedances of ANZECC - November 2011		
Borehole	**Chemicals (Chemical, Rate of Exceedance)**	
BH 1A		DRP, 8.6x
BH 2A	Dissolved Copper, 8.5x	DRP, 490x
BH 3A	Dissolved Copper, 2.5x	DRP, 4.7x
BH 4A	Dissolved Copper, 5.5x	DRP, 9.8x
BH 5A	Dissolved Copper, 11x	DRP, 187x
BH 9A		DRP, 8.4x
BH 101	Dissolved Copper, 192x	DRP, 5800x
BH 102	Dissolved Copper, 2.3x	
BH 103	Dissolved Copper, 2.5x	DRP, 1.2x
BH 104	Dissolved Copper, 5.3x	DRP, 3.0x
BH 105	Dissolved Copper, 1.9x	DRP, 3.6x
BH 106	Dissolved Copper, 1.1x	
BH 107	Dissolved Copper, 1.5x	DRP, 2.5x
BH 108	Dissolved Copper, 58x	DRP, 1370x
BH 109	Dissolved Copper, 11x	
BH 110	Dissolved Copper, 15x	DRP, 1610x
BH 111		
BH 112	Dissolved Copper, 4.6x	DRP, 7.6x
BH 113		DRP, 1.9x
BH D	Dissolved Copper, 1.2x	DRP, 2.5x
BH G		
BH H	Dissolved Copper, 3.3x	DRP, 133x
BH L	Dissolved Copper, 1.3x	DRP, 3.4x
Old BH1	Dissolved Copper, 1.5x	
13 Tahi	Dissolved Copper, 2.2x	DRP, 1.5x
17 Tahi		
21 Tahi	Dissolved Copper, 2.5x	DRP, 2.1x
23 Tahi	Dissolved Copper, 2.0x	DRP, 2.0x
26 Tahi	Dissolved Copper, 2.4x	DRP, 8.9x
27 Tahi	Dissolved Copper, 7.6x	DRP, 1.9x
29 Tahi	Dissolved Copper, 3.1x	
36 Tahi	Dissolved Copper, 7.5x	DRP, 27x

Figure 35 and Table 1 show that all of the bores within the site had exceedances of the Drinking Water Standards in November 2011, with most wells having an exceedance of more than ten times the standards. Of the domestic wells, only 17 Tahi St and 27 Tahi St had exceedances of the Drinking Water Standards in November 2011.

Figure 36 and Table 2 show that all of the bores, except for BH111, BHG and 17 Tahi St, had exceedances of the ANZECC guidelines in November 2011. Most of the wells exceeded the ANZECC guidelines for both dissolved copper and dissolved reactive phosphorus.

In summary, the last 12 months have shown a generally more settled groundwater chemistry. Of the regularly sampled wells, the main variations still occurring are:

- nitrate-N in BH5;
- DDX in BH1 and BH5;
- aldrin + dieldrin in BH2 and BH5.

Some wells show significant variations in concentration throughout the year and the November sampling round does not necessarily reflect the peak concentration.

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.

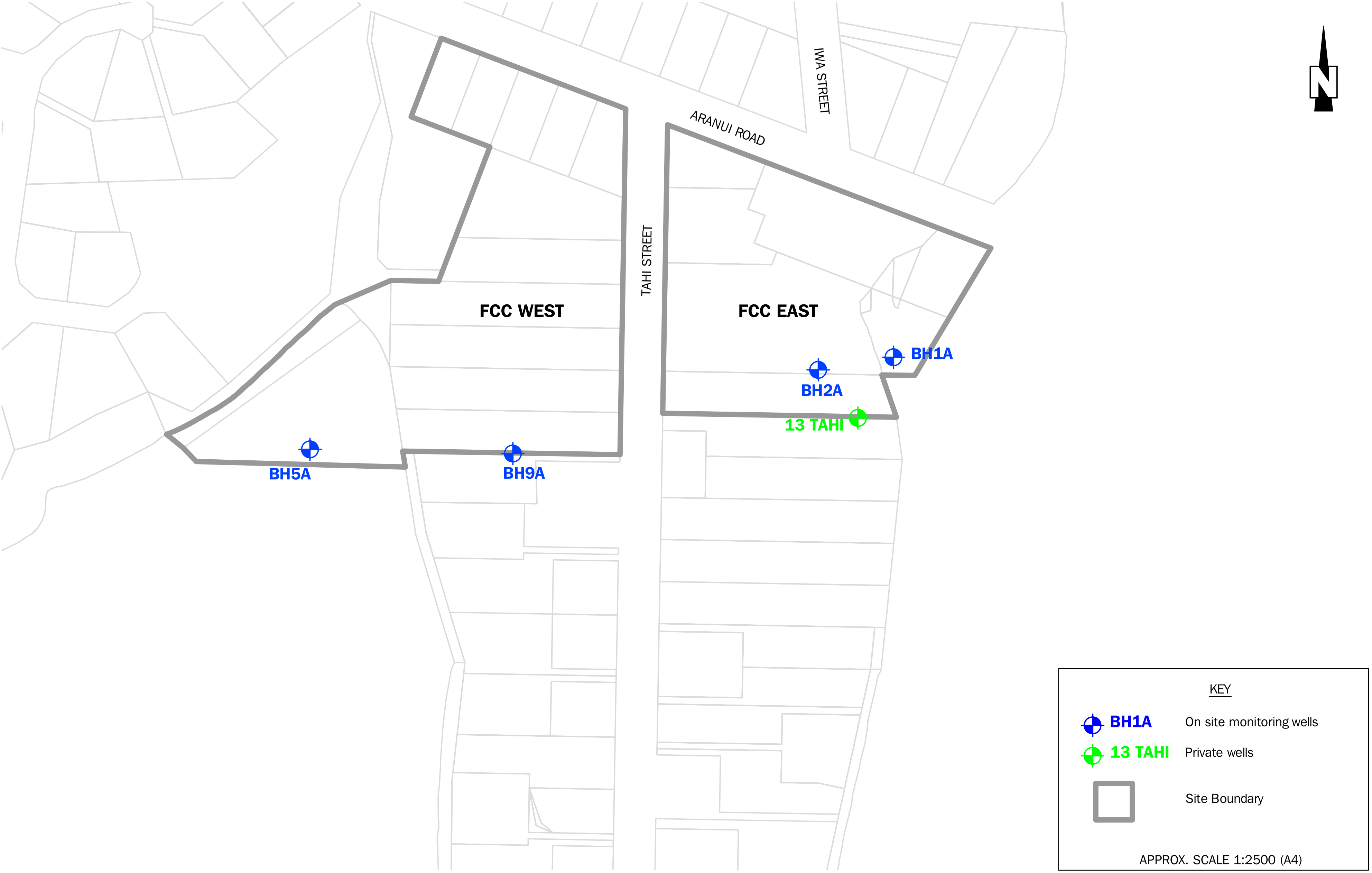
We trust you find these comments helpful. Please contact us if you wish to discuss any of the information contained in this letter.

Yours sincerely

PATTLE DELAMORE PARTNERS LIMITED

Jeremy Sanson and Peter Callander

Encl.



Source: Cadastral information derived from LINZ data.

Figure 1 : LOCATION OF REGULARLY MONITORED WELLS

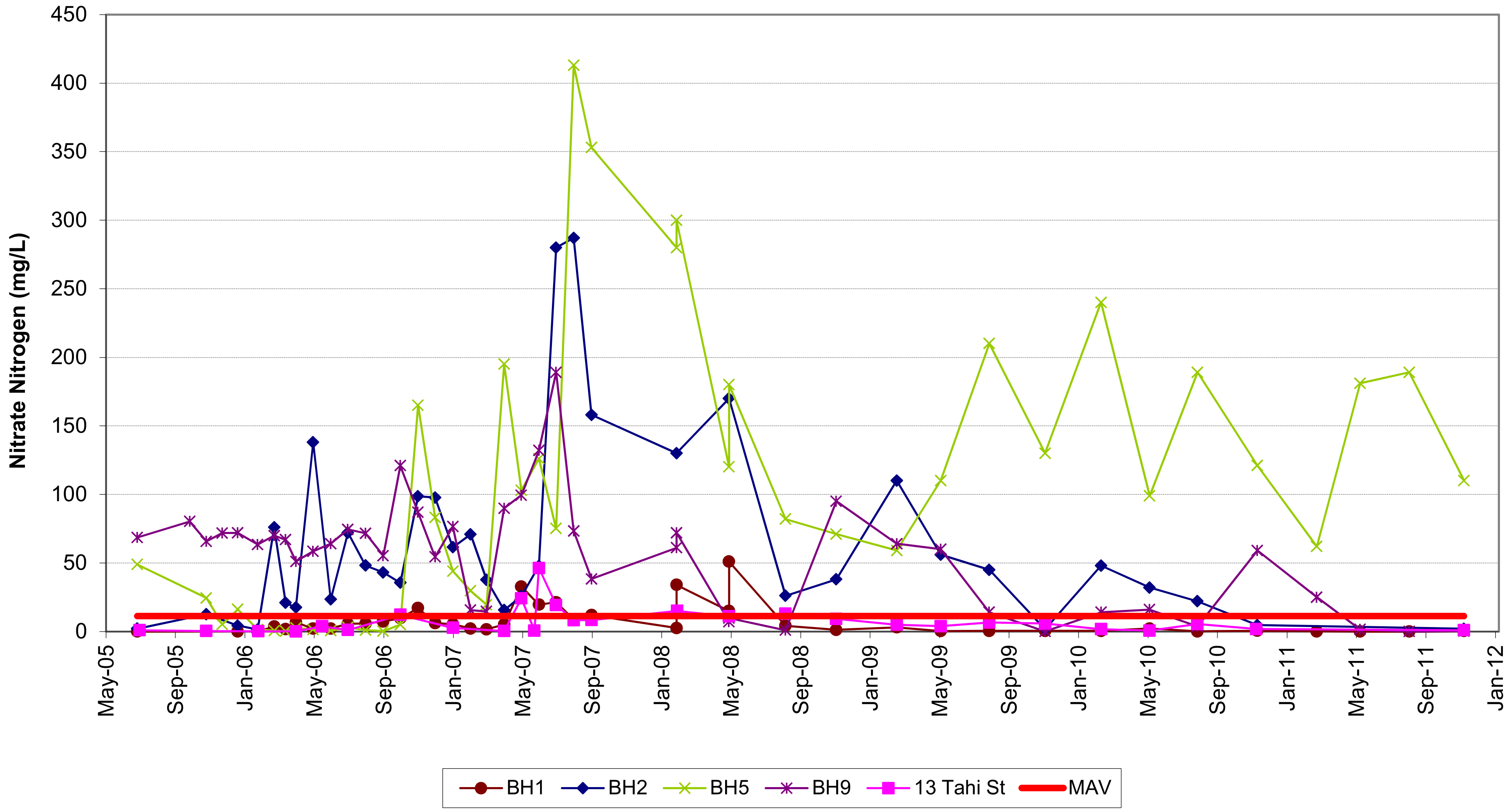


Figure 2. Nitrate-N
MAV DWSNZ 11.3 mg/L

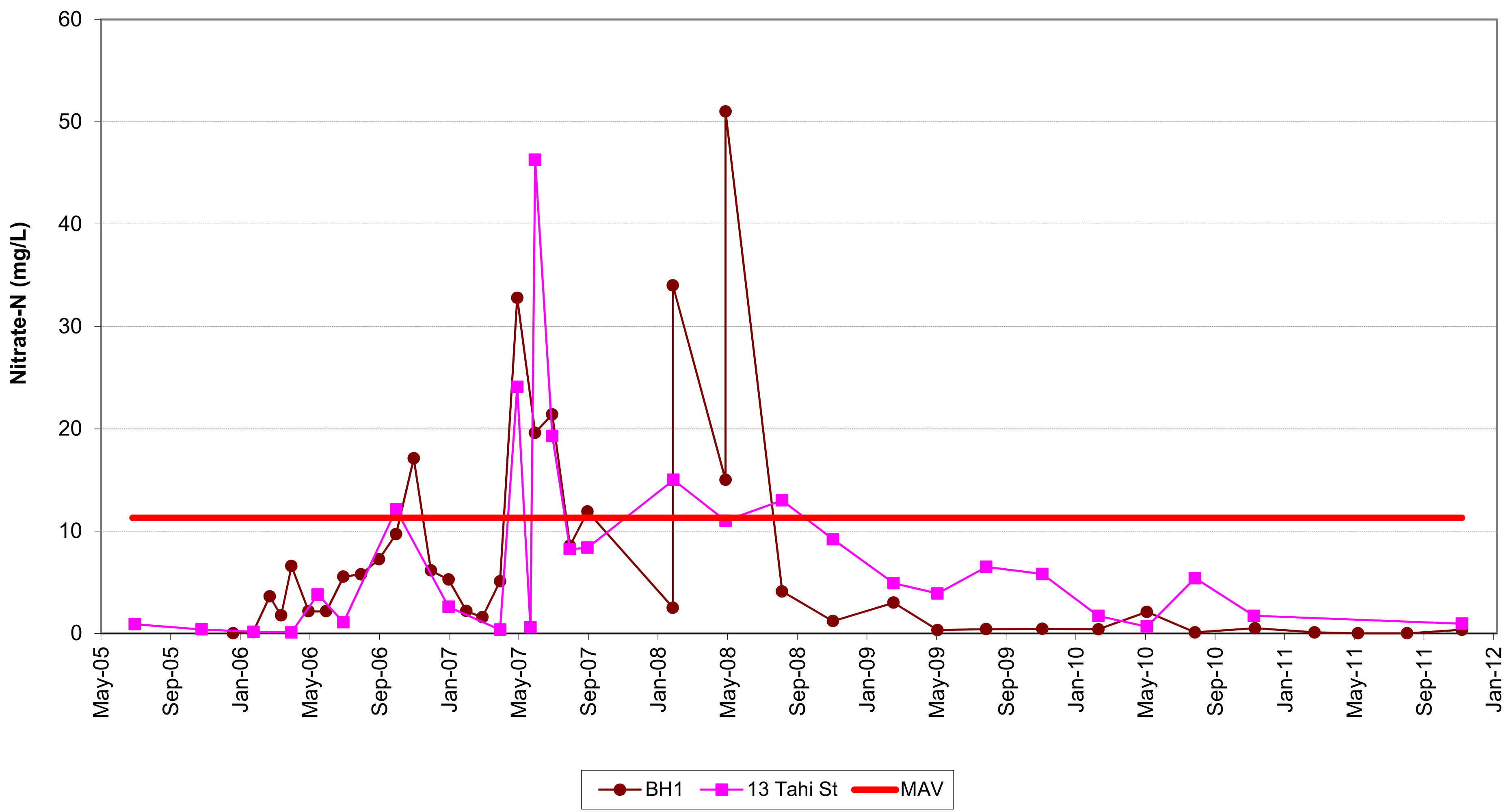


Figure 2a. Nitrate-N
MAV DWSNZ 11.3 mg/L

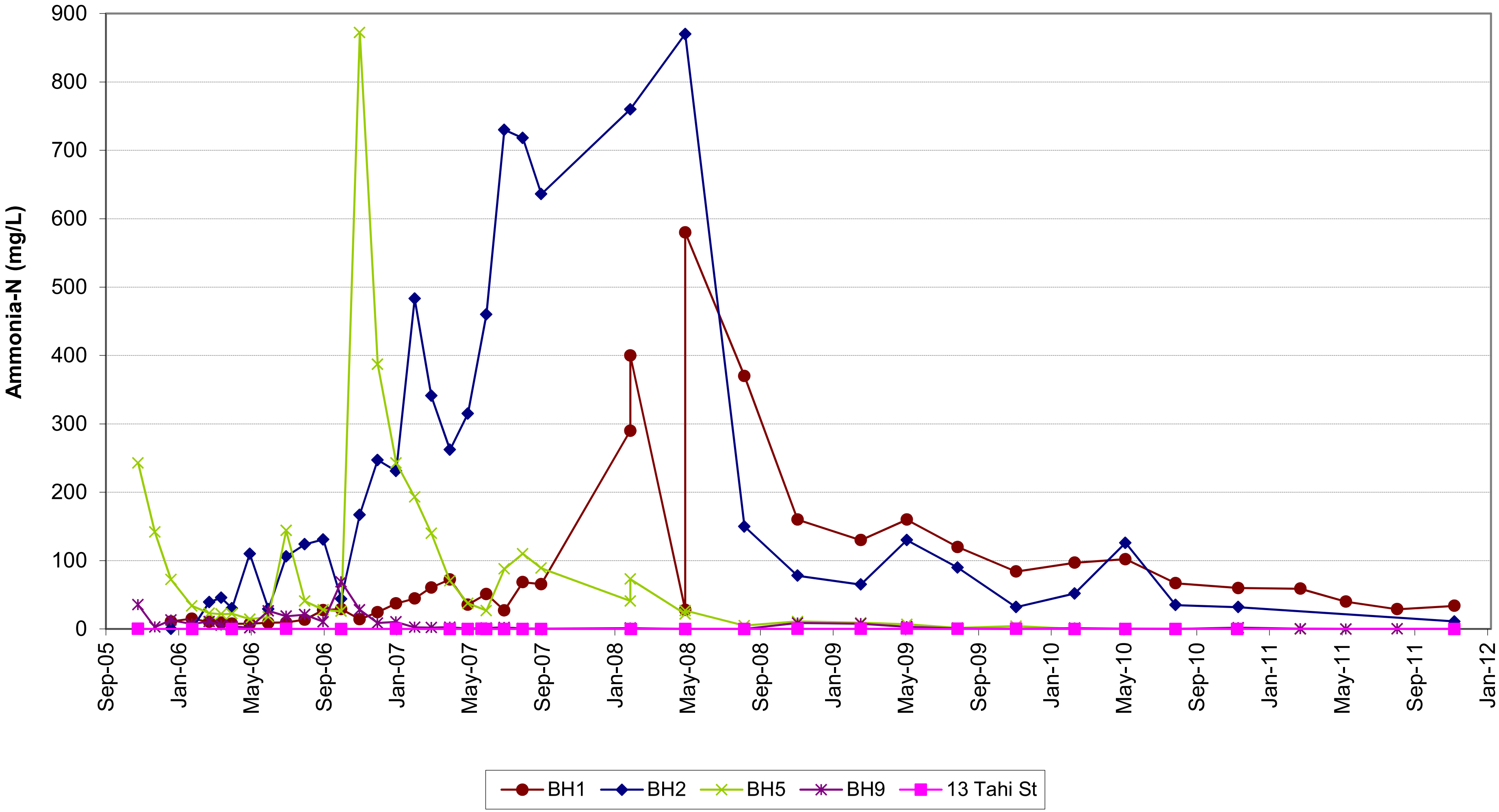


Figure 3. Ammonia-N
GV Aesthetic DWSNZ 1.2 mg/L; Aquatic Ecosystem Guideline 0.71mg/L

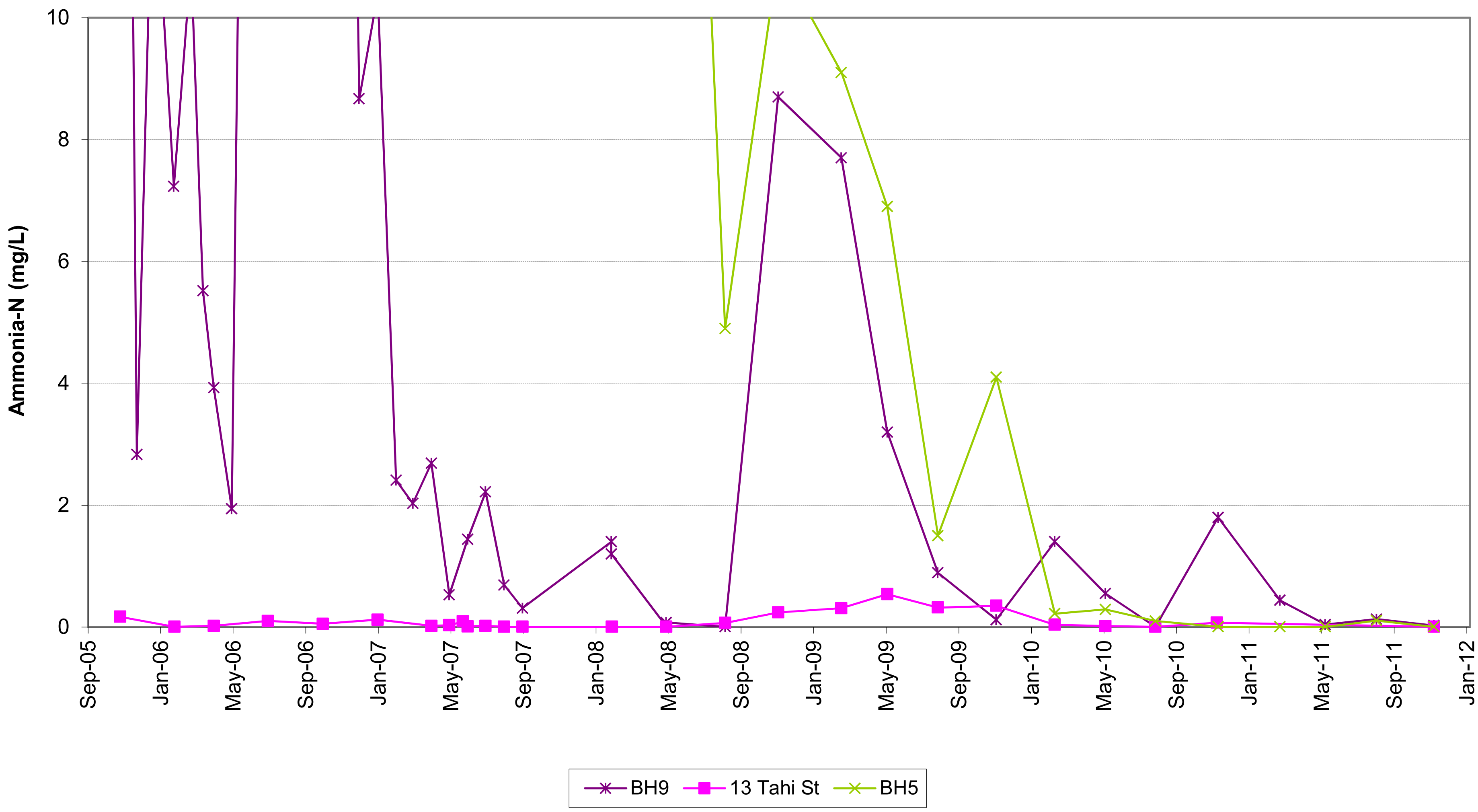


Figure 3a. Ammonia-N
GV Aesthetic DWSNZ 1.2 mg/L

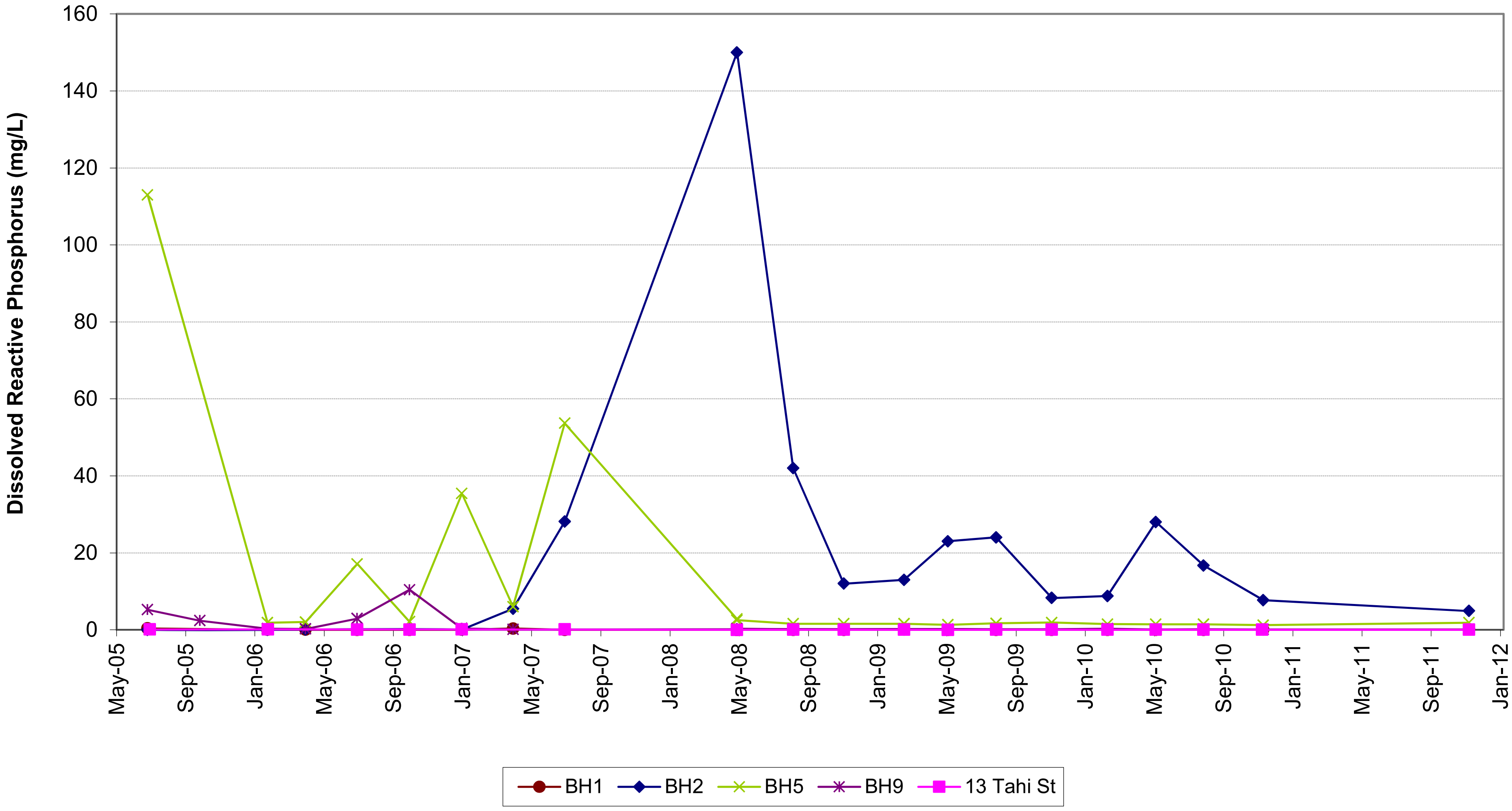


Figure 4. Dissolved Reactive Phosphorus
Aquatic Ecosystem Guideline 0.01 mg/L

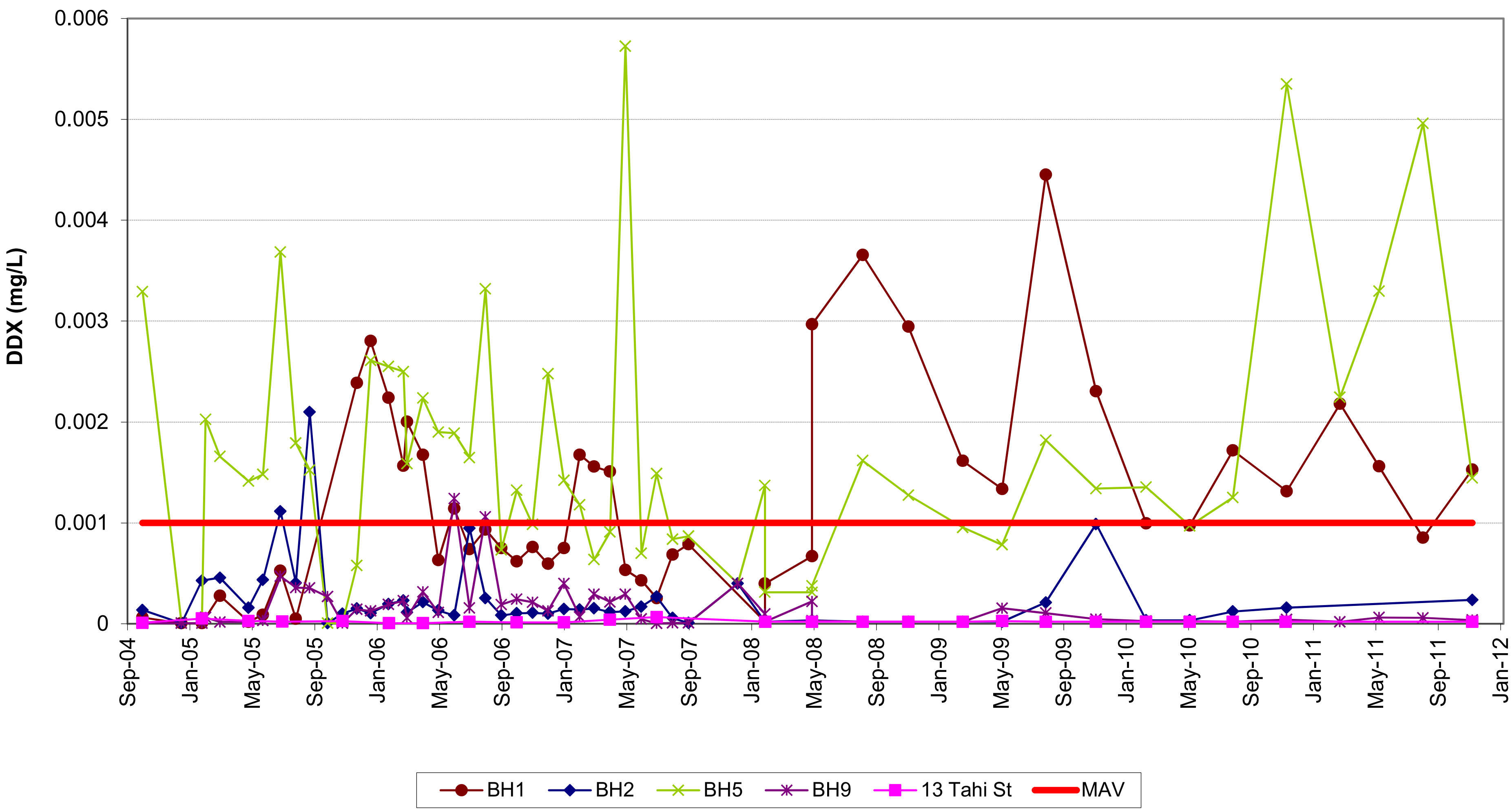


Figure 5. DDX
MAV DWSNZ 0.001 mg/L

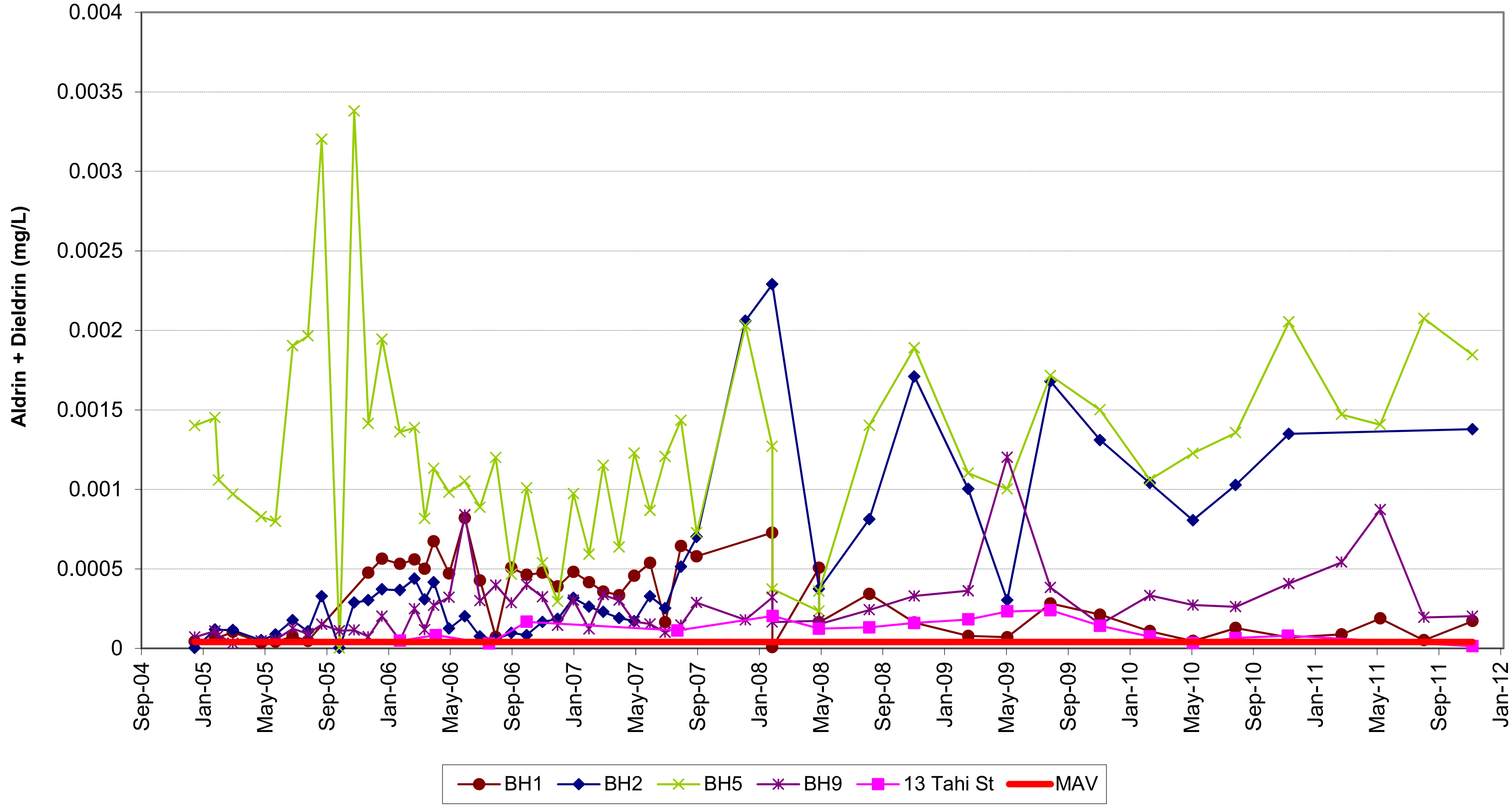


Figure 6. Aldrin + Dieldrin
MAV DWSNZ 0.00004 mg/L

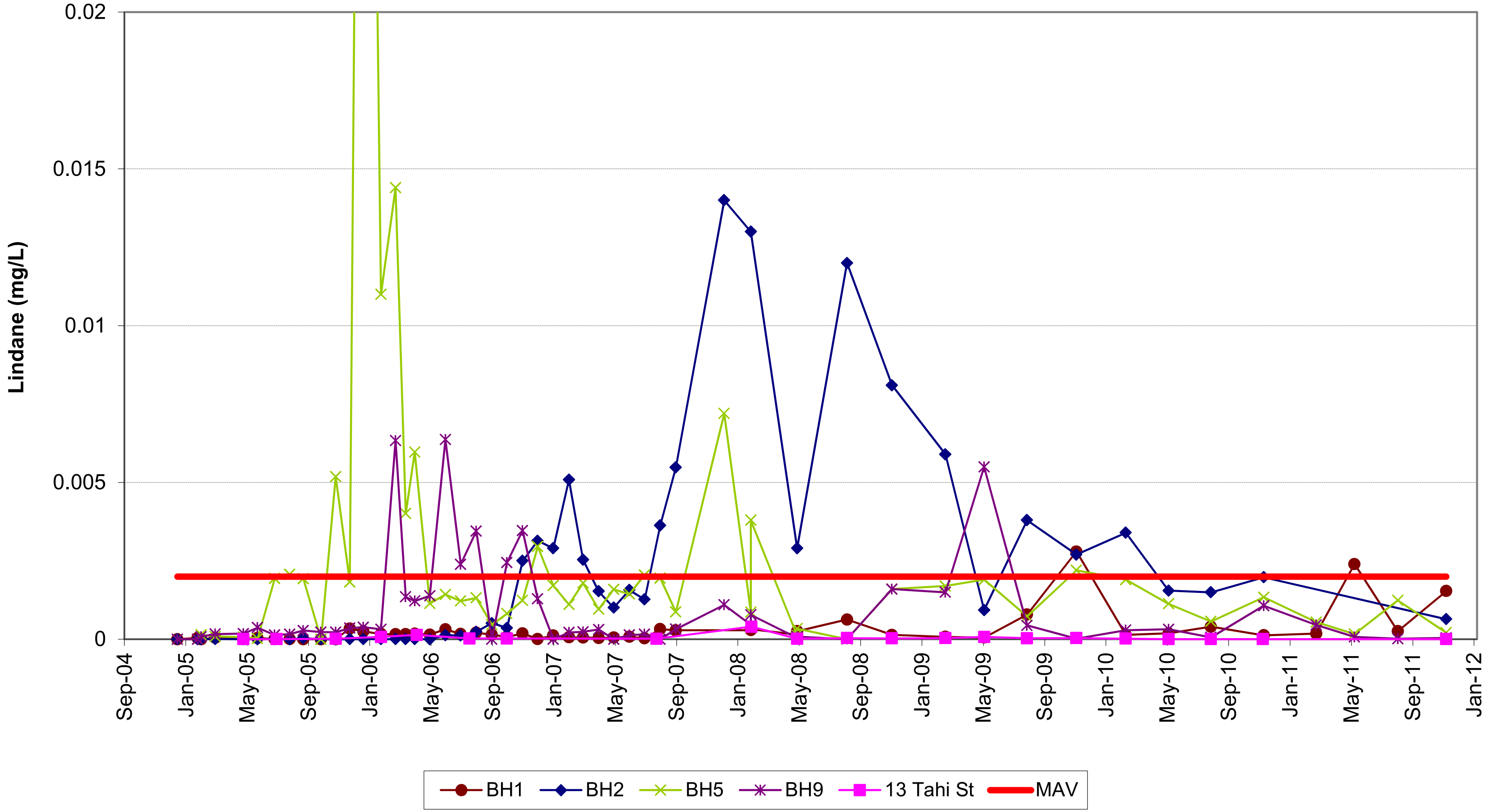


Figure 7. Lindane
MAV DWSNZ 0.002 mg/L

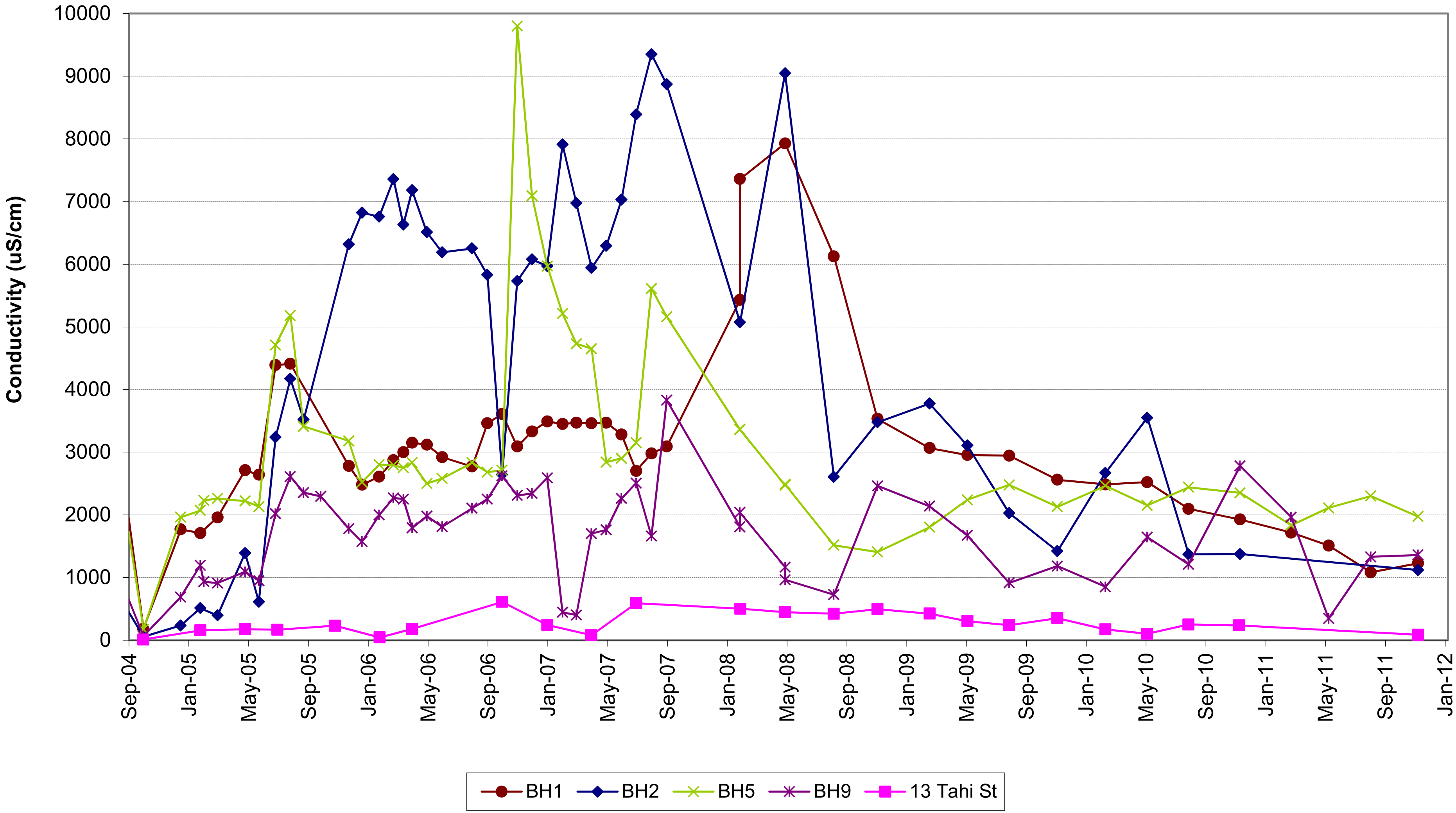


Figure 8. Conductivity

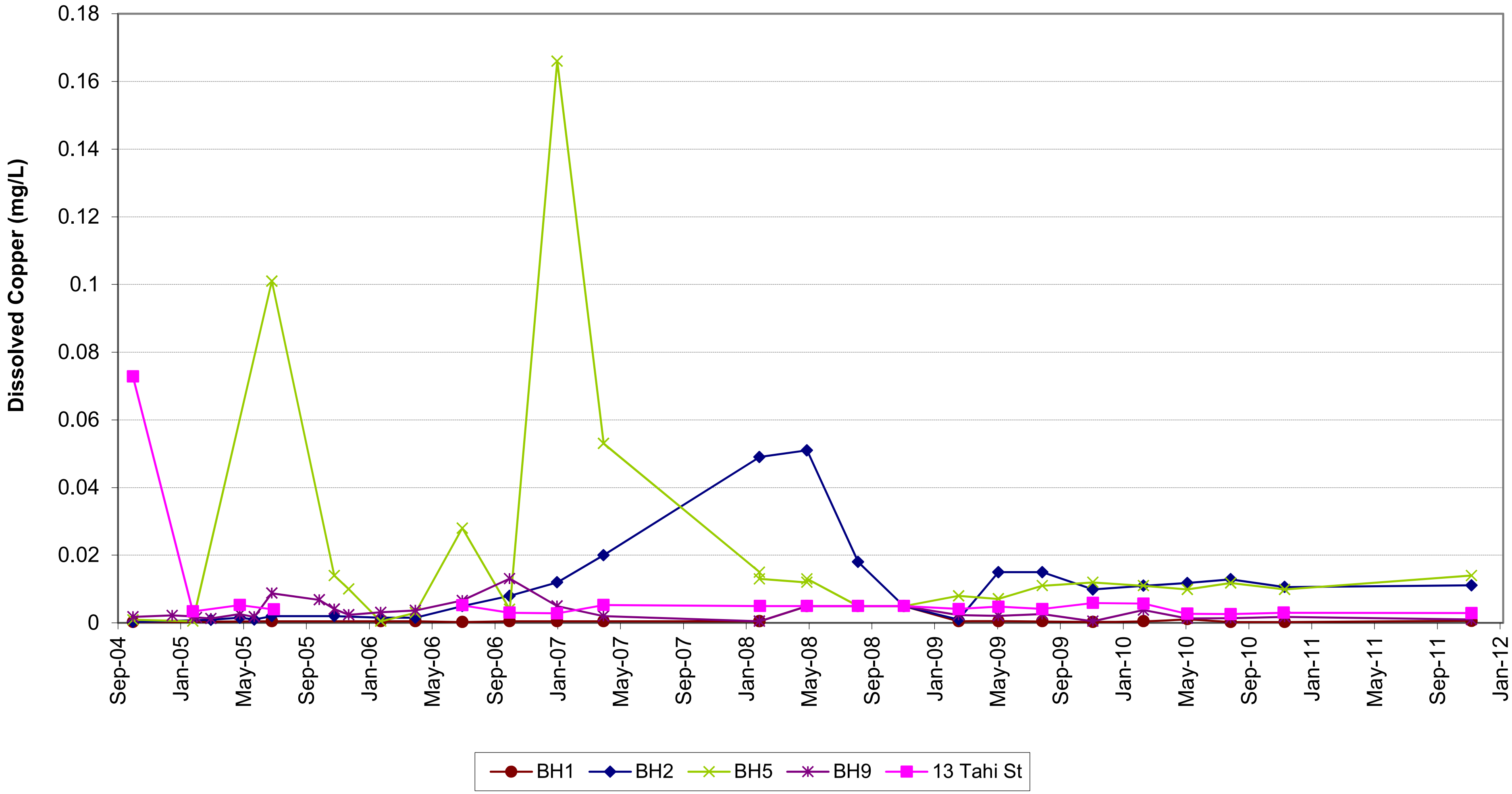


Figure 9. Dissolved Copper
MAV DWSNZ 2 mg/L, ANZECC Marine Guideline = 0.0013 mg/L

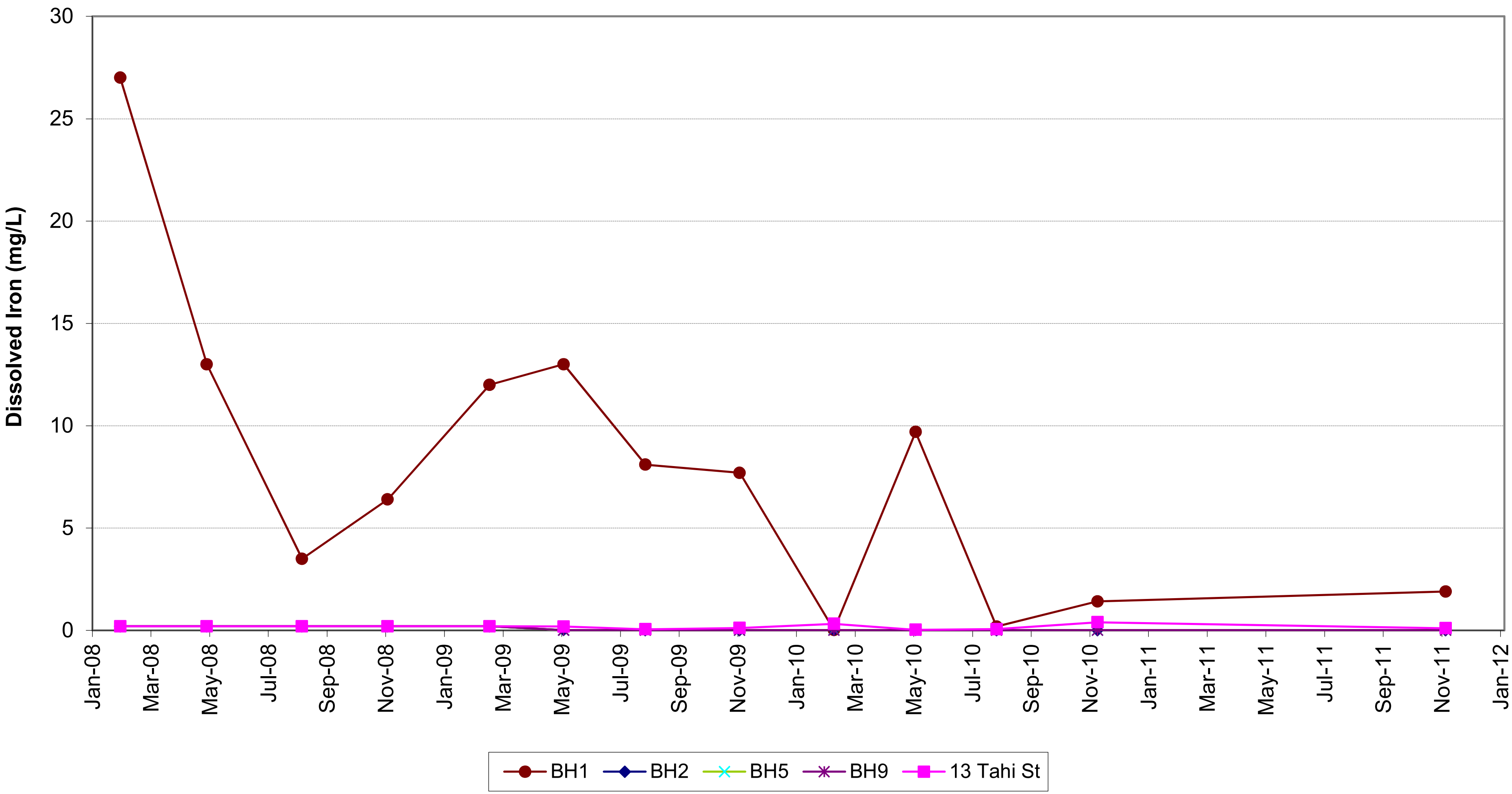


Figure 10. Dissolved Iron
Aesthetic Guideline Value DWSNZ 0.2 mg/L

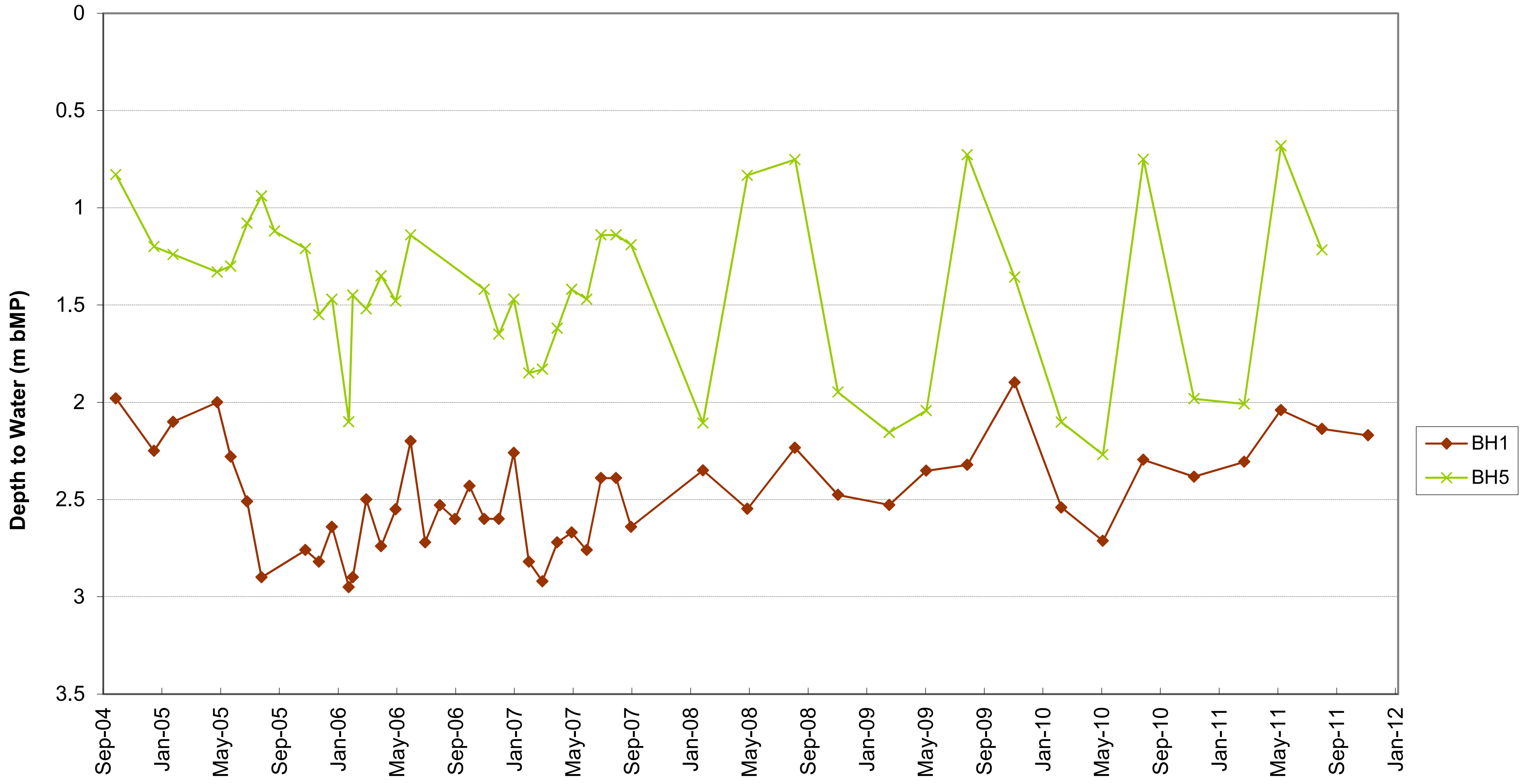


Figure 11. Water Level Plot

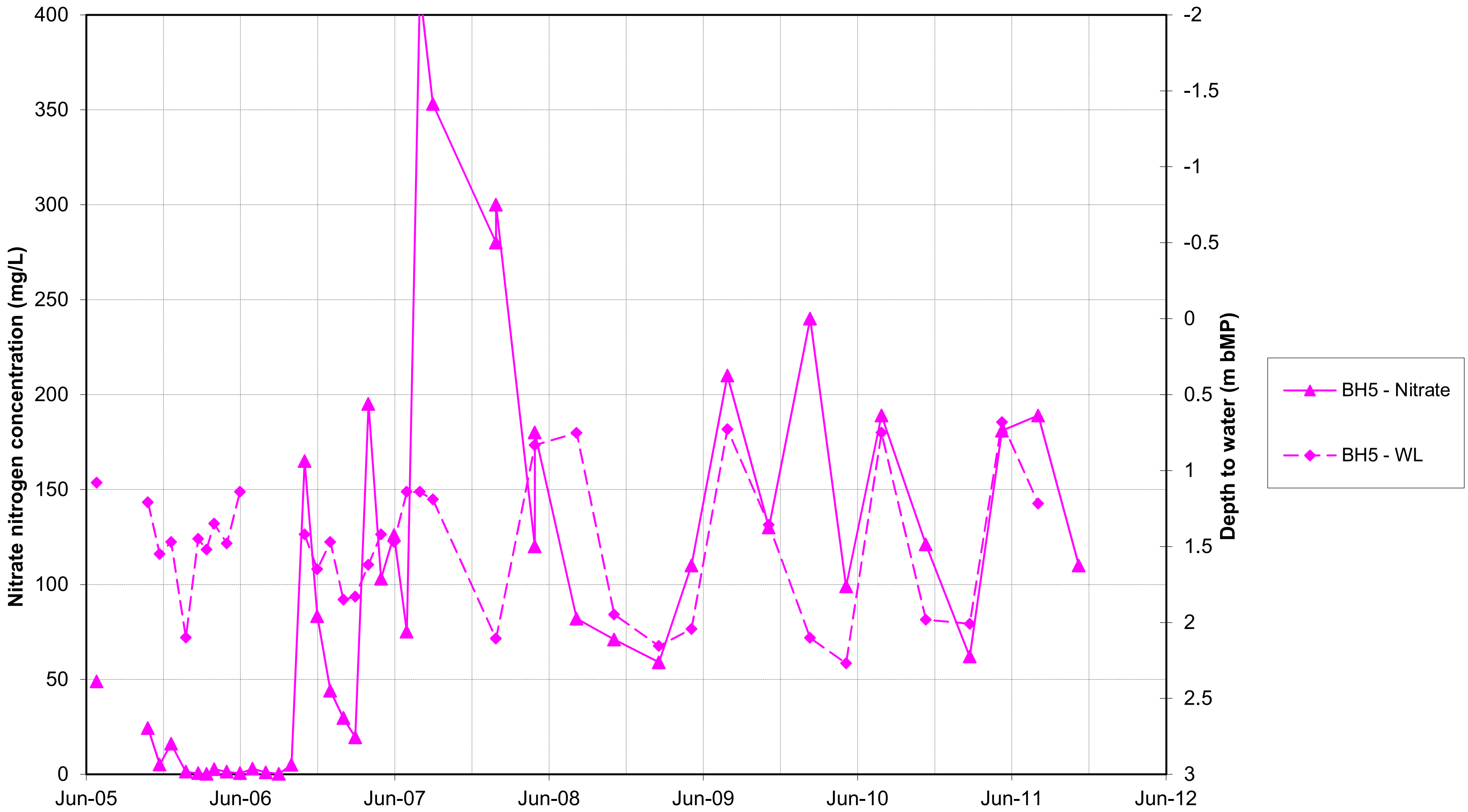


Figure 12. Nitrate vs Water Levels in BH5

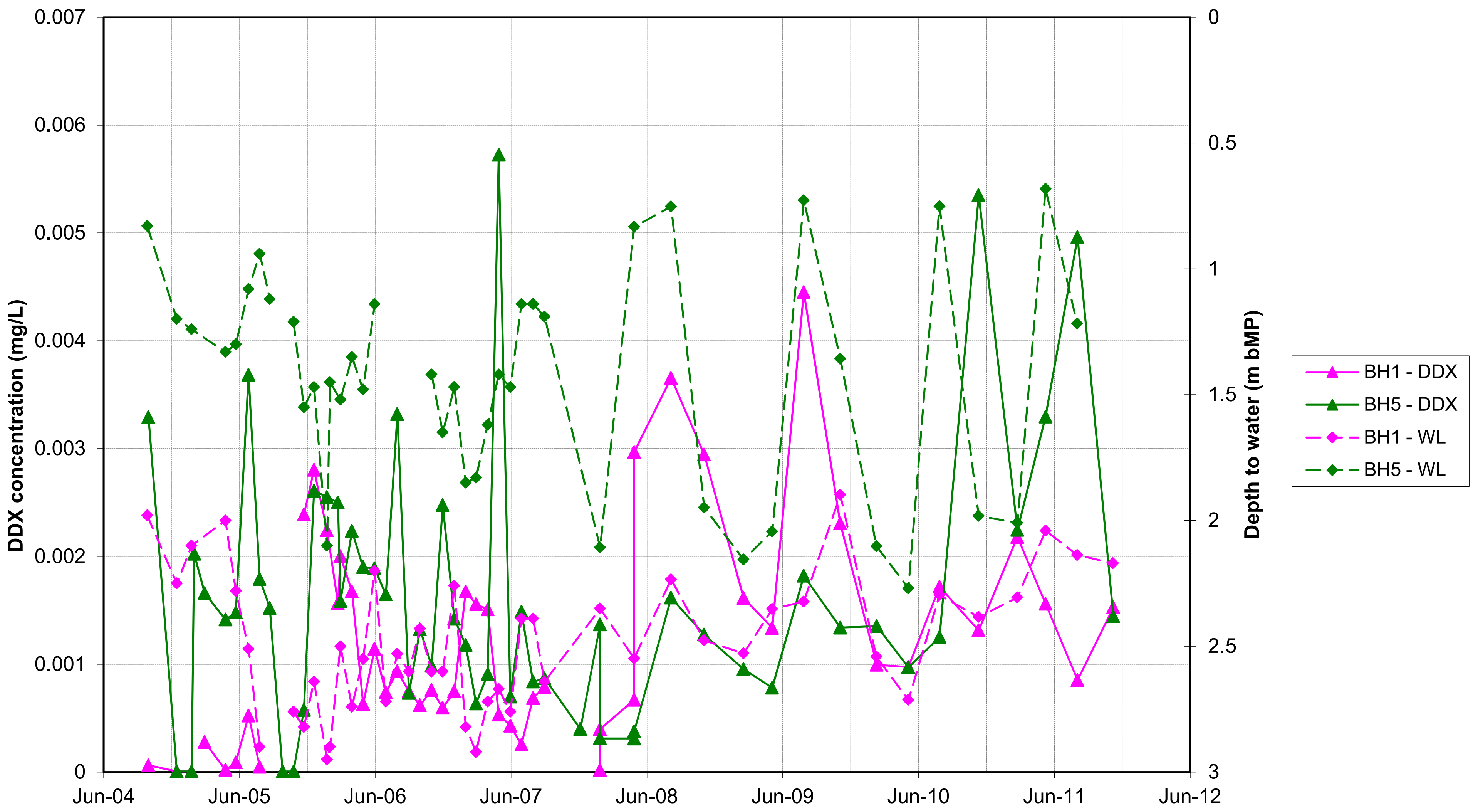


Figure 13. DDX vs Water Levels in BH1 and BH5

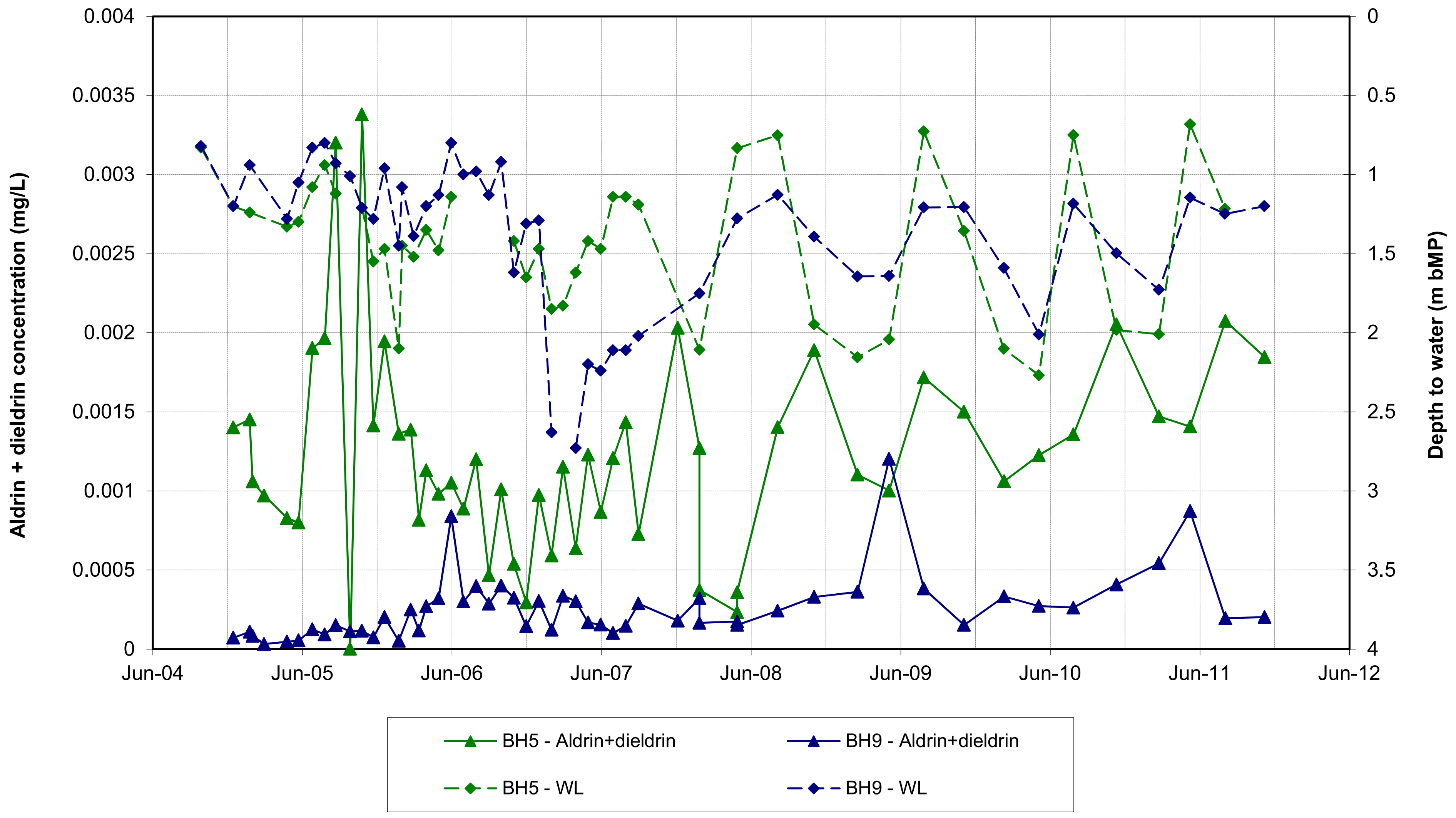


Figure 14. Aldrin + Dieldrin vs Water Levels in BH5 and BH9

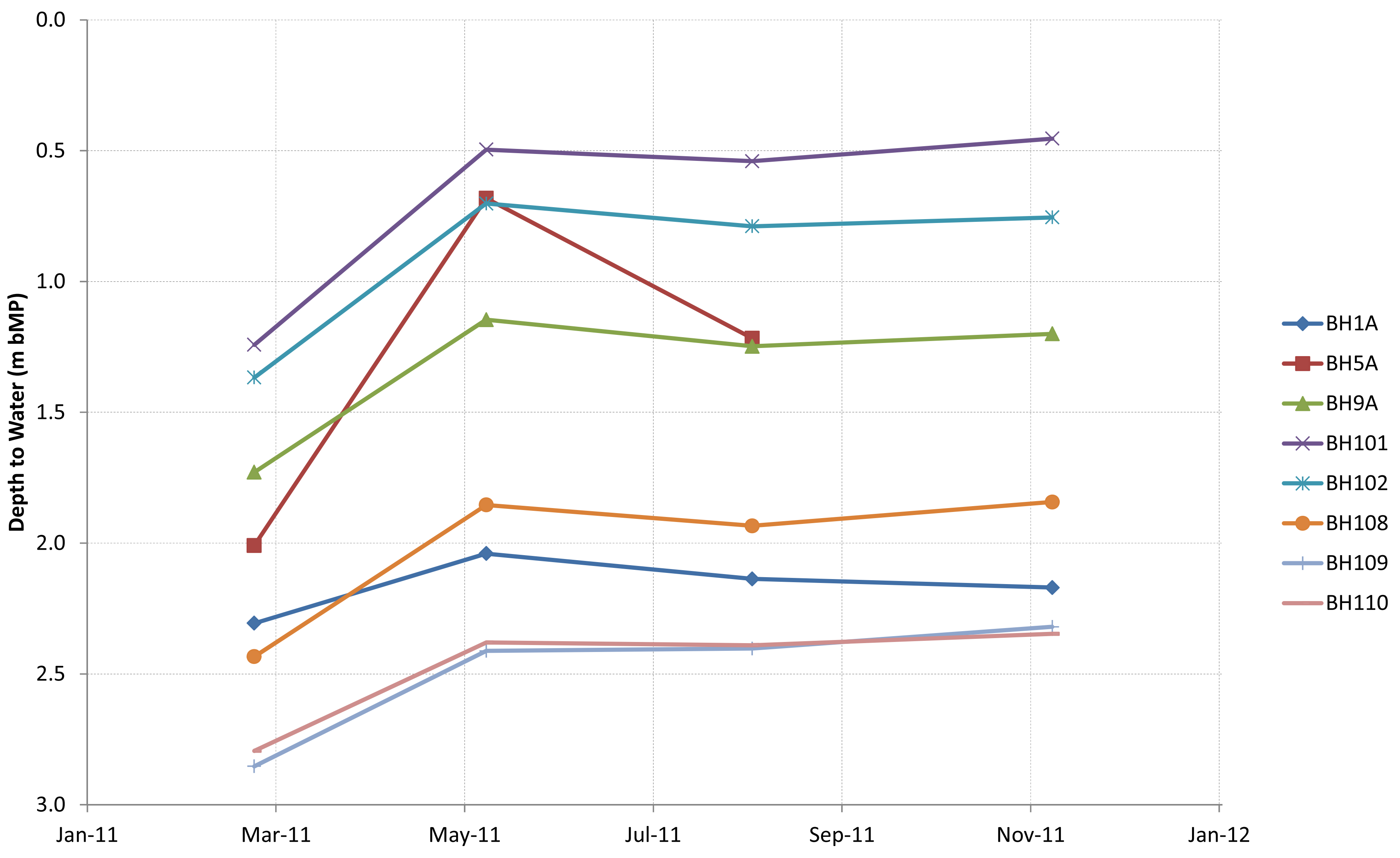


Figure 15. Water Levels in Quarterly Monitored Wells

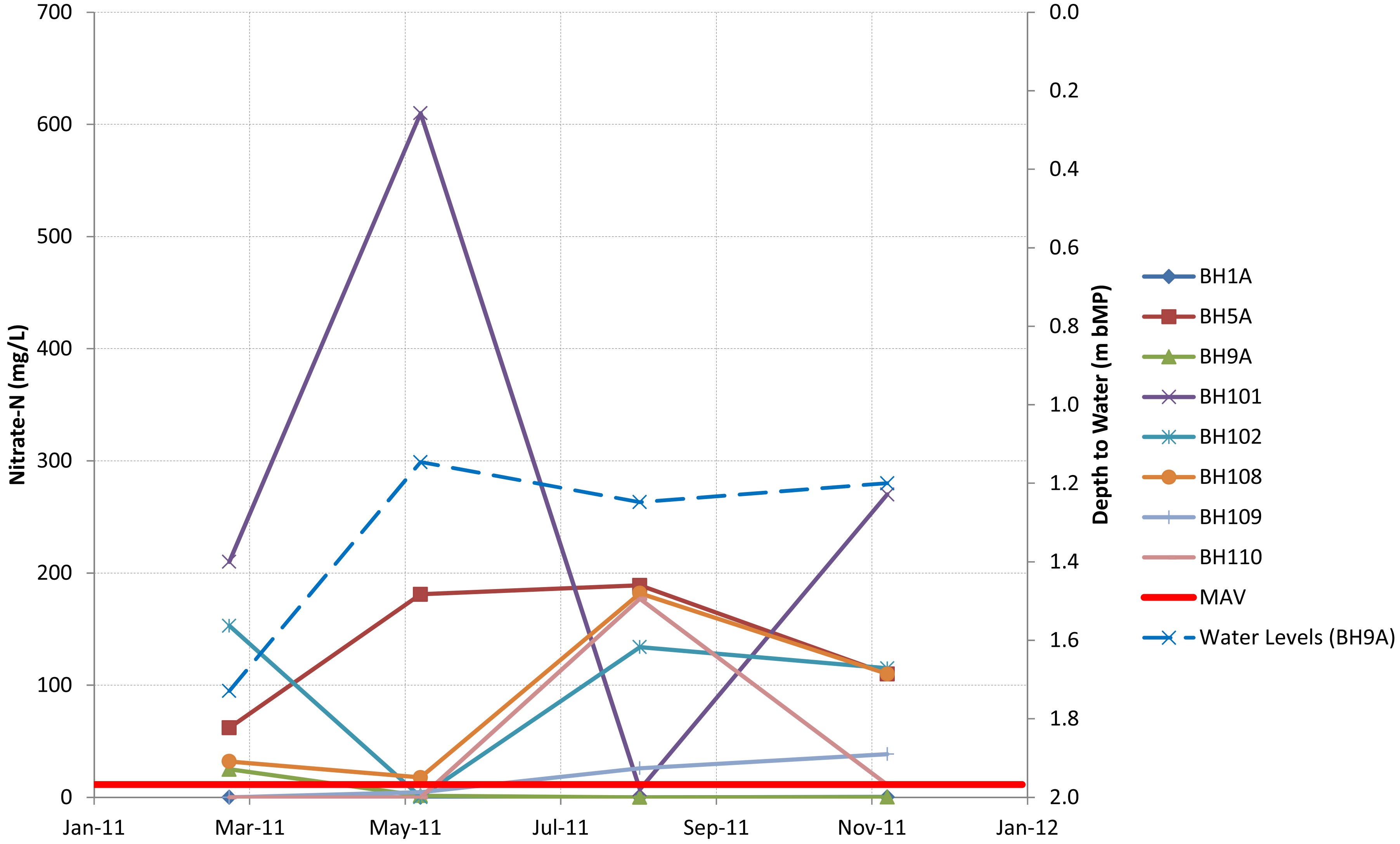


Figure 16. Nitrate-N Concentrations in Quarterly Monitored Wells

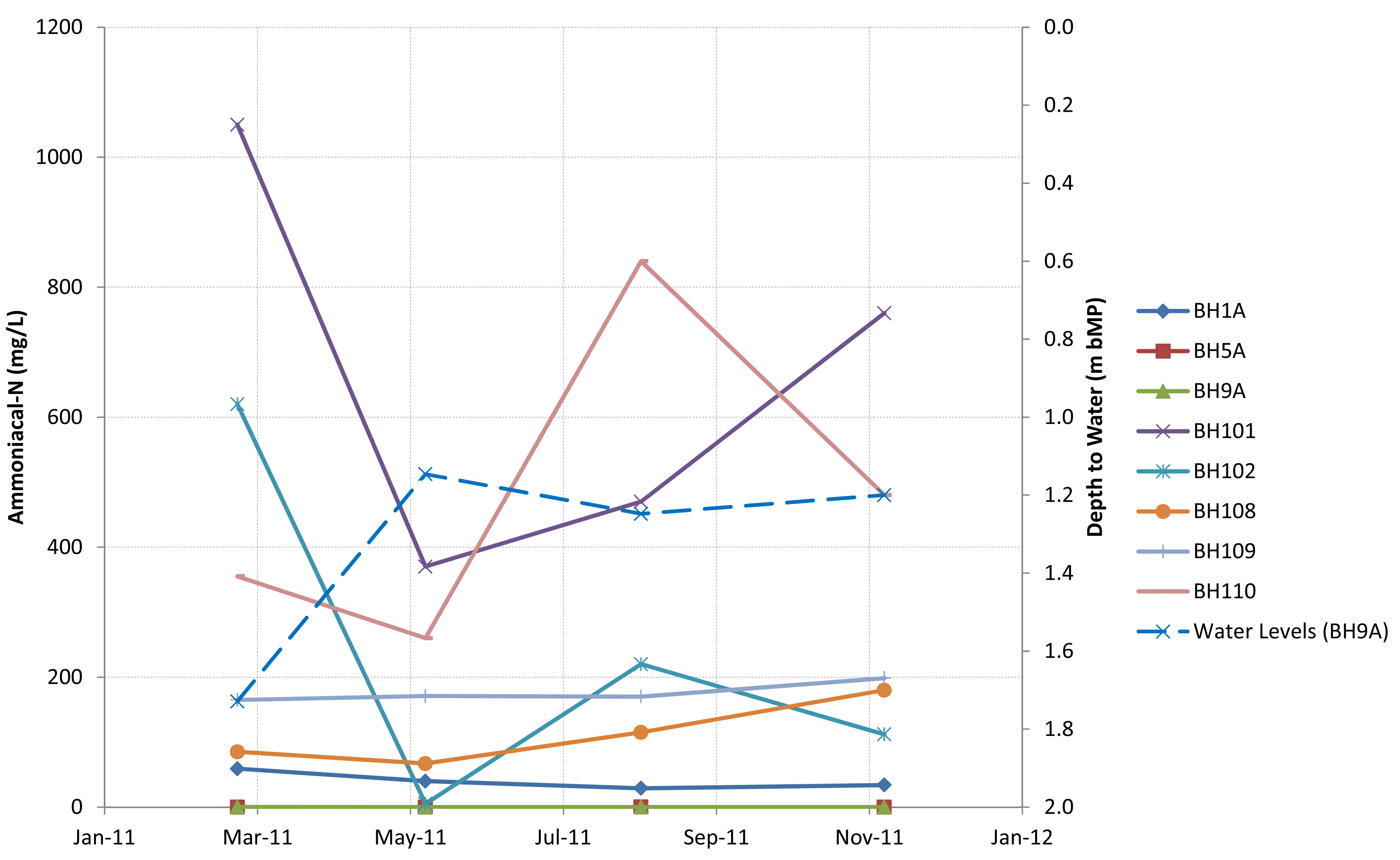


Figure 17. Ammoniacal-N Concentrations in Quarterly Monitored Wells

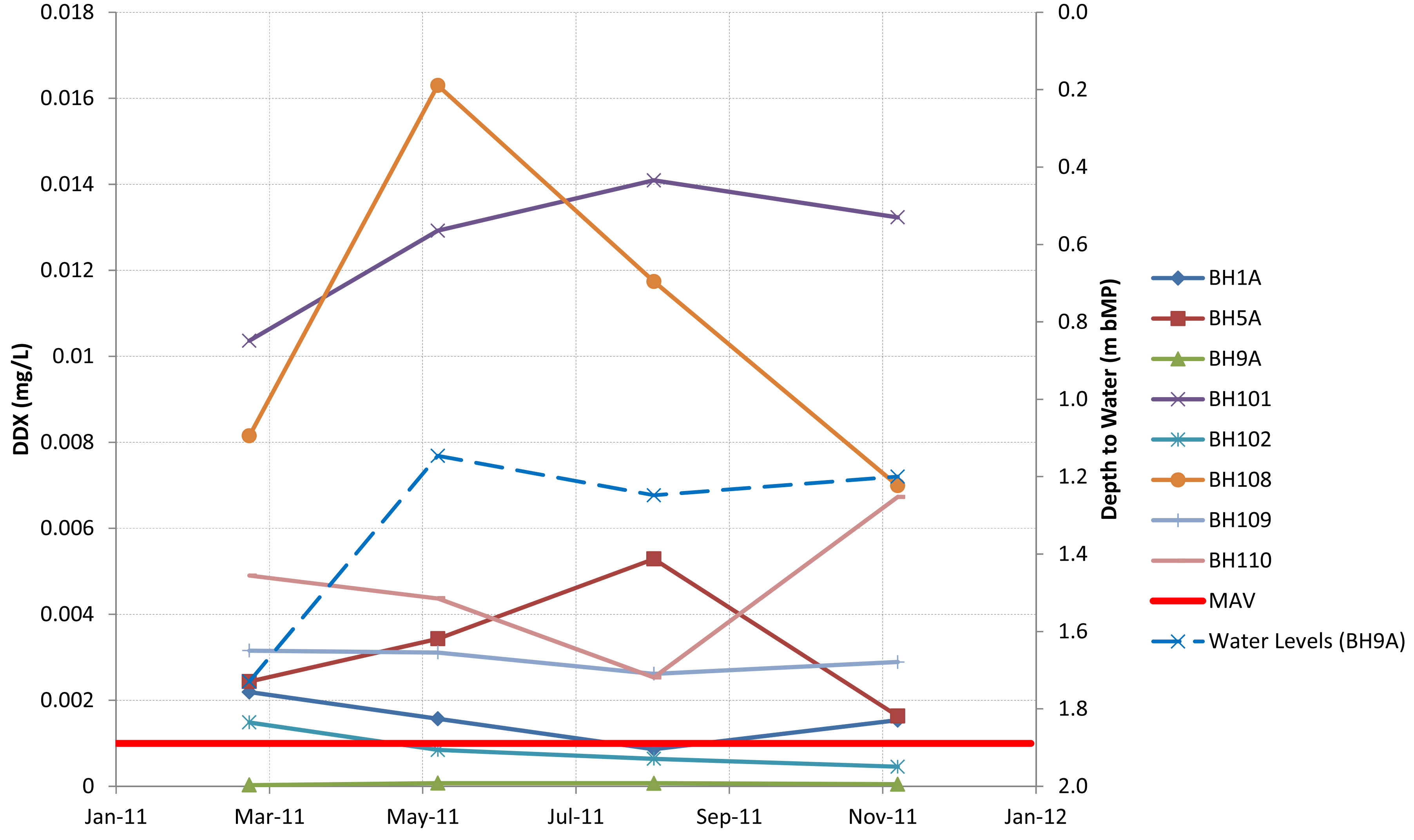


Figure 18. DDX Concentrations in Quarterly Monitored Wells

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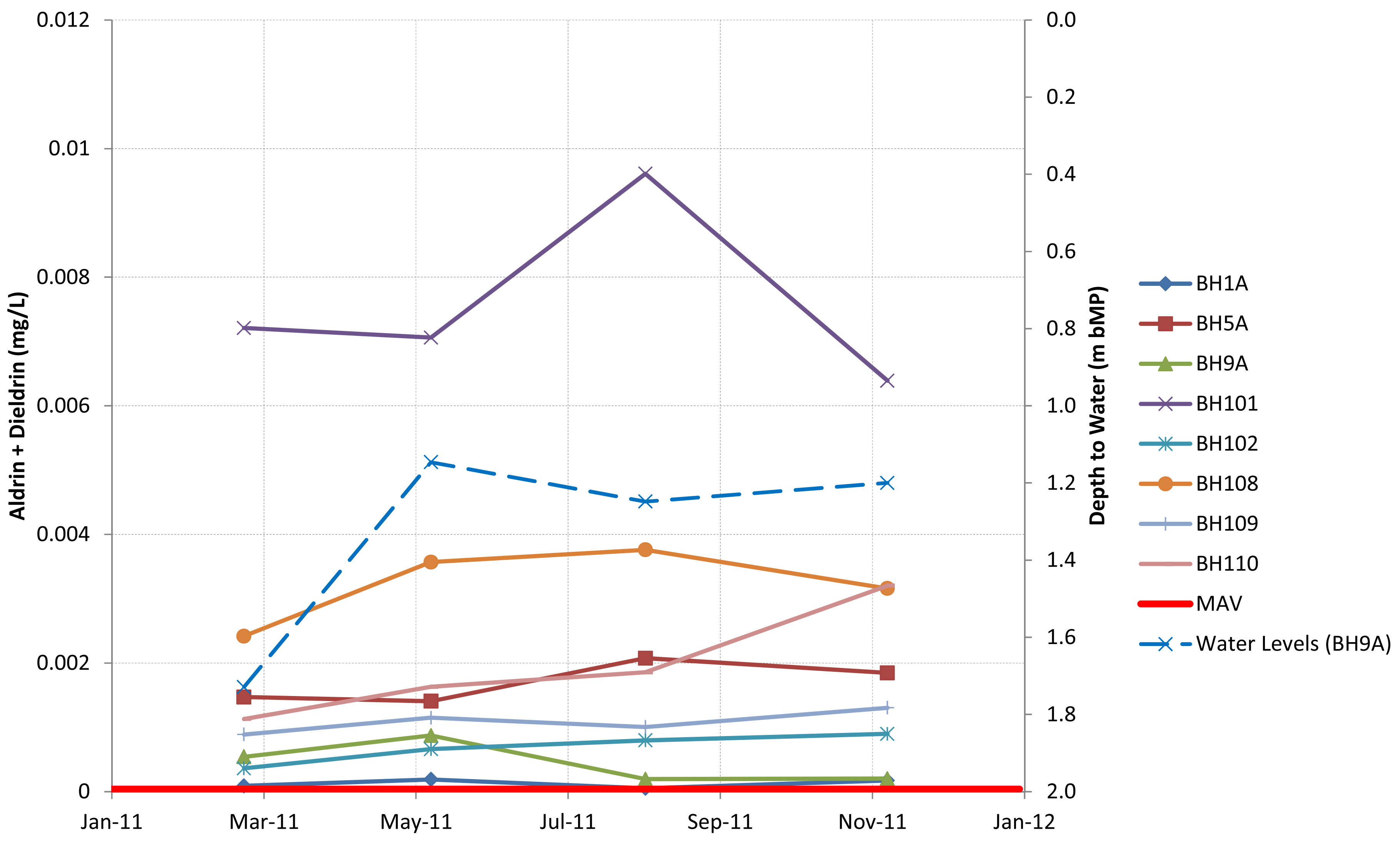

Figure 19. Aldrin + Dieldrin Concentrations in Quarterly Monitored Wells

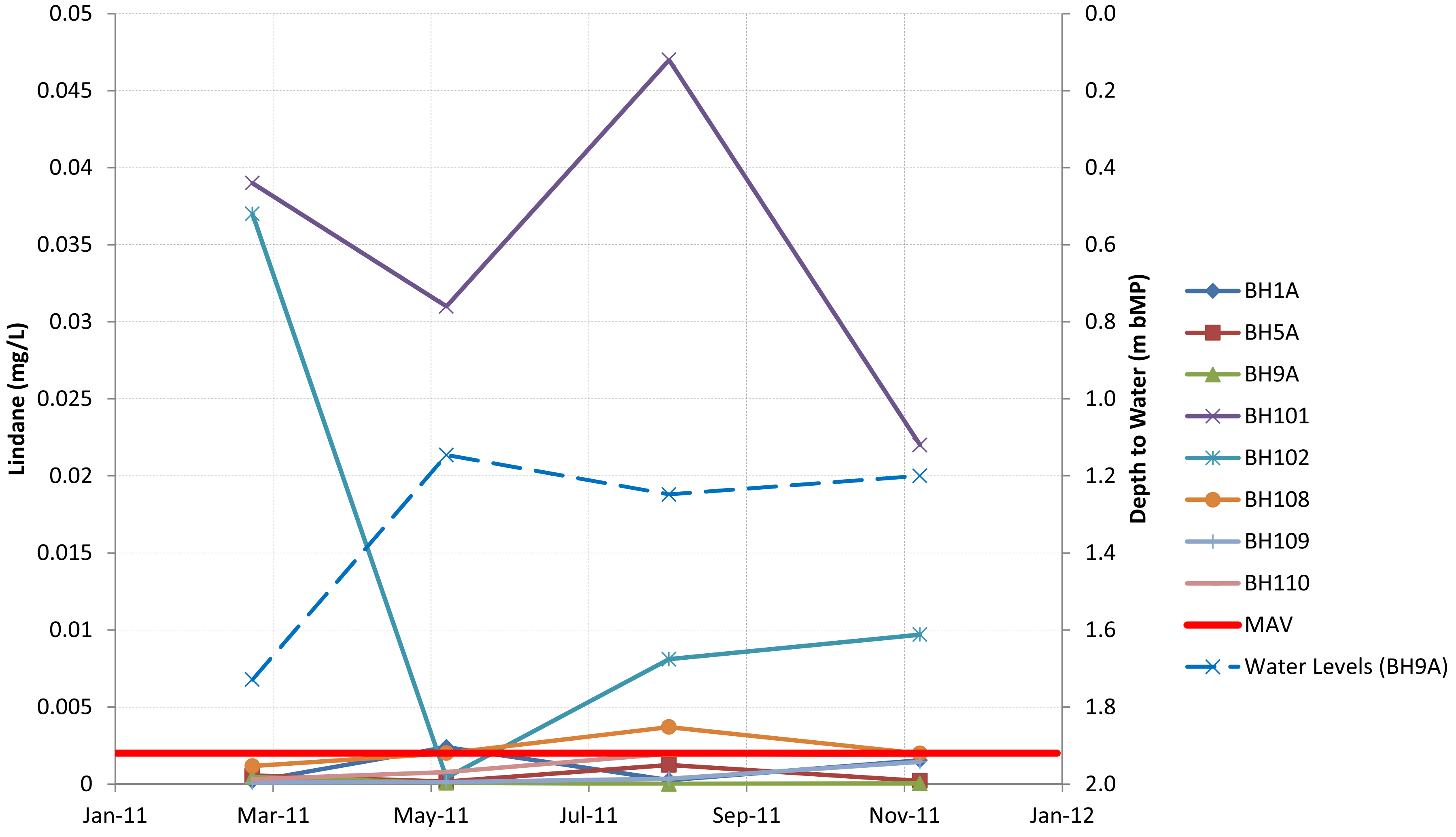

Figure 20. Lindane Concentrations in Quarterly Monitored Wells

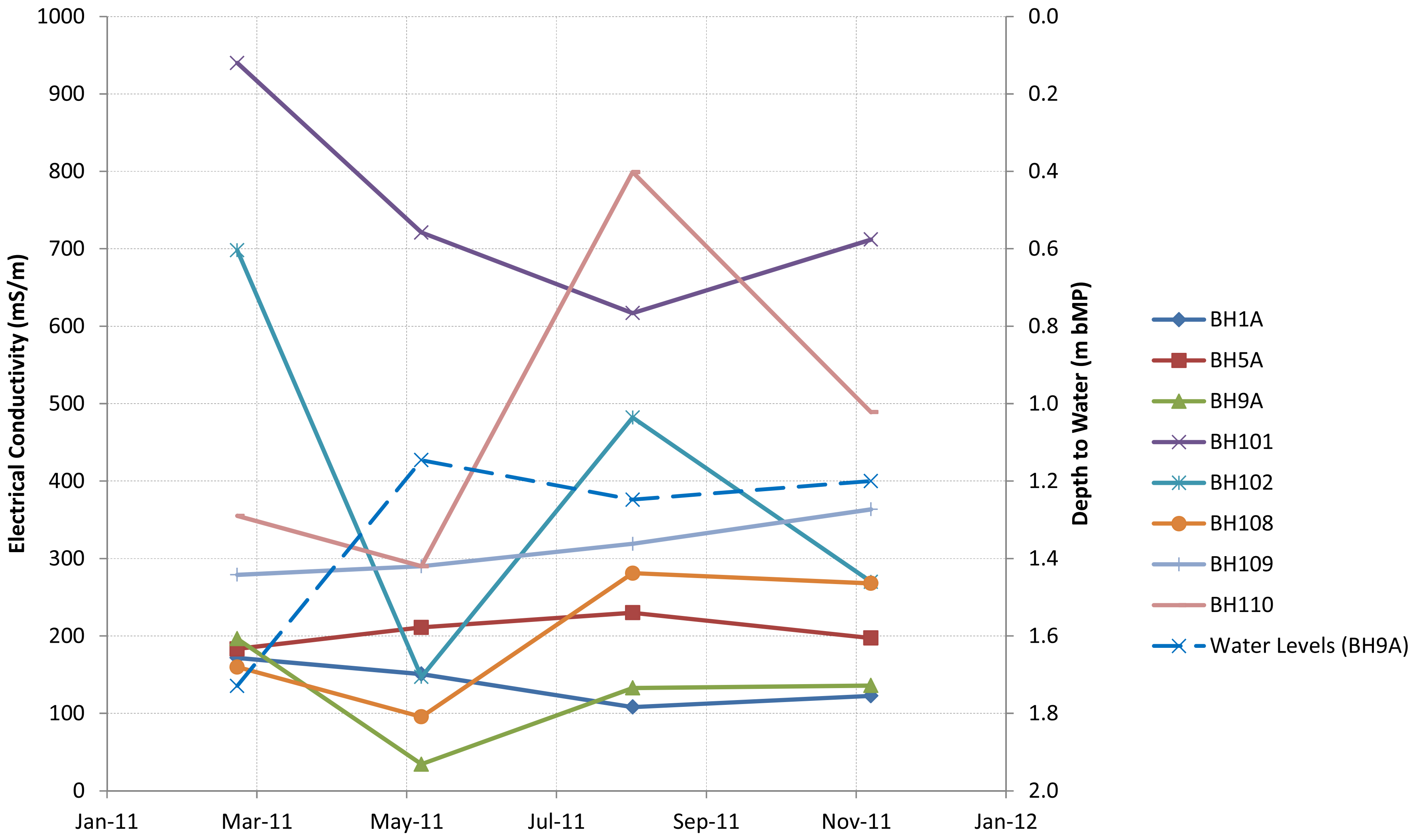

Figure 21. Conductivity Values in Quarterly Monitored Wells

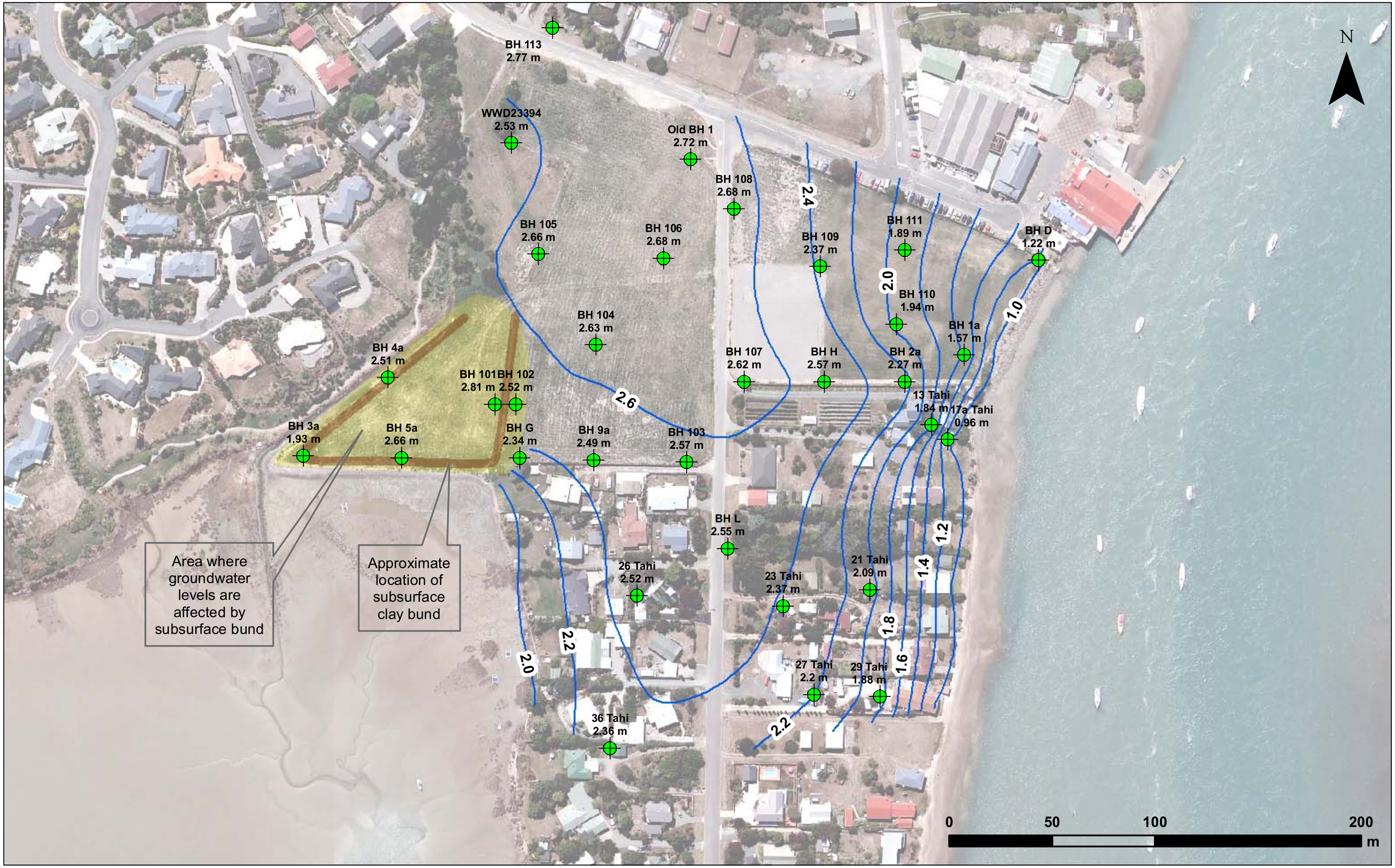

Figure 22: Groundwater levels and contours on 7 November 2011 (values in metres above mean sea level)

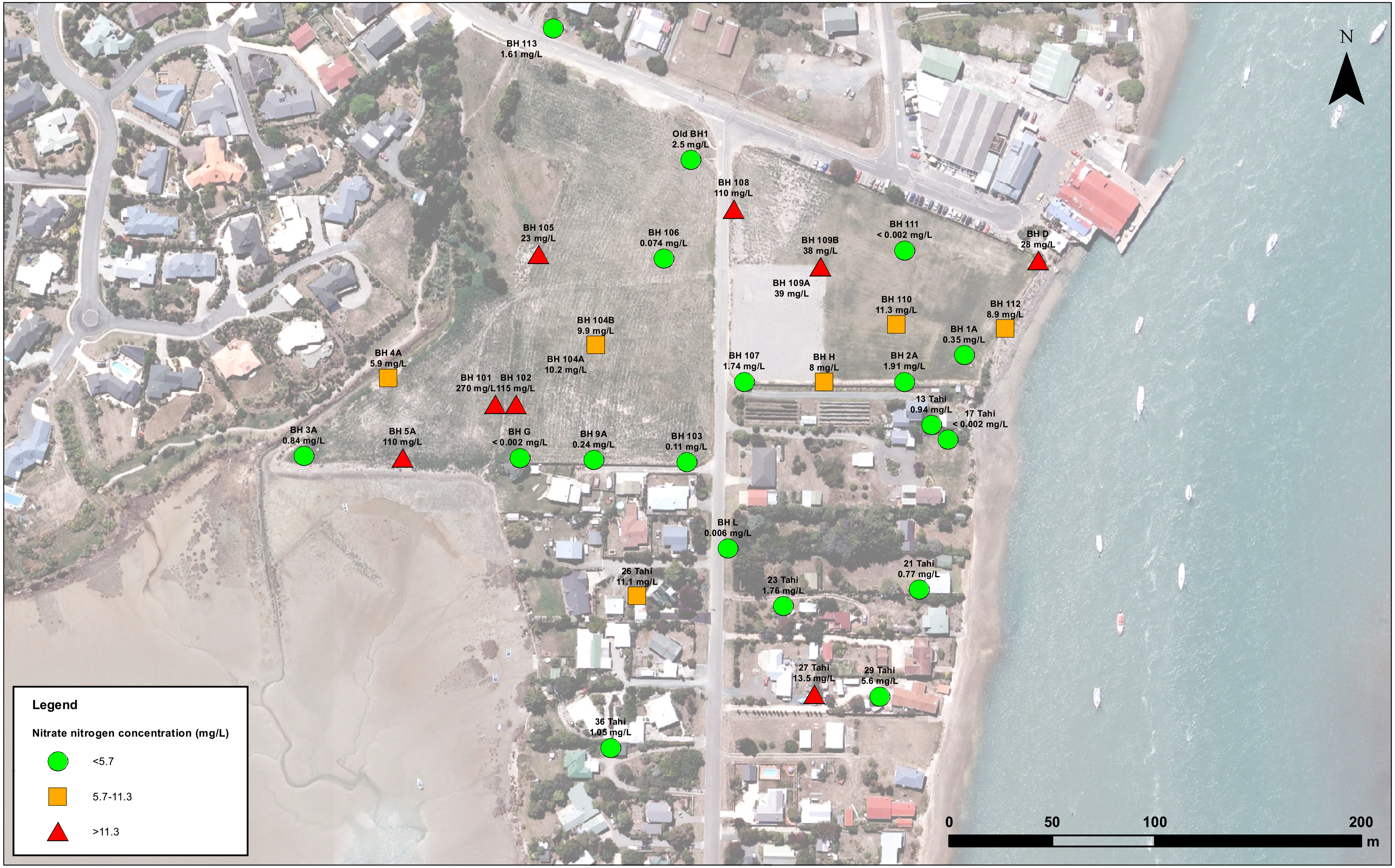

Figure 23: Nitrate nitrogen concentrations in November 2011

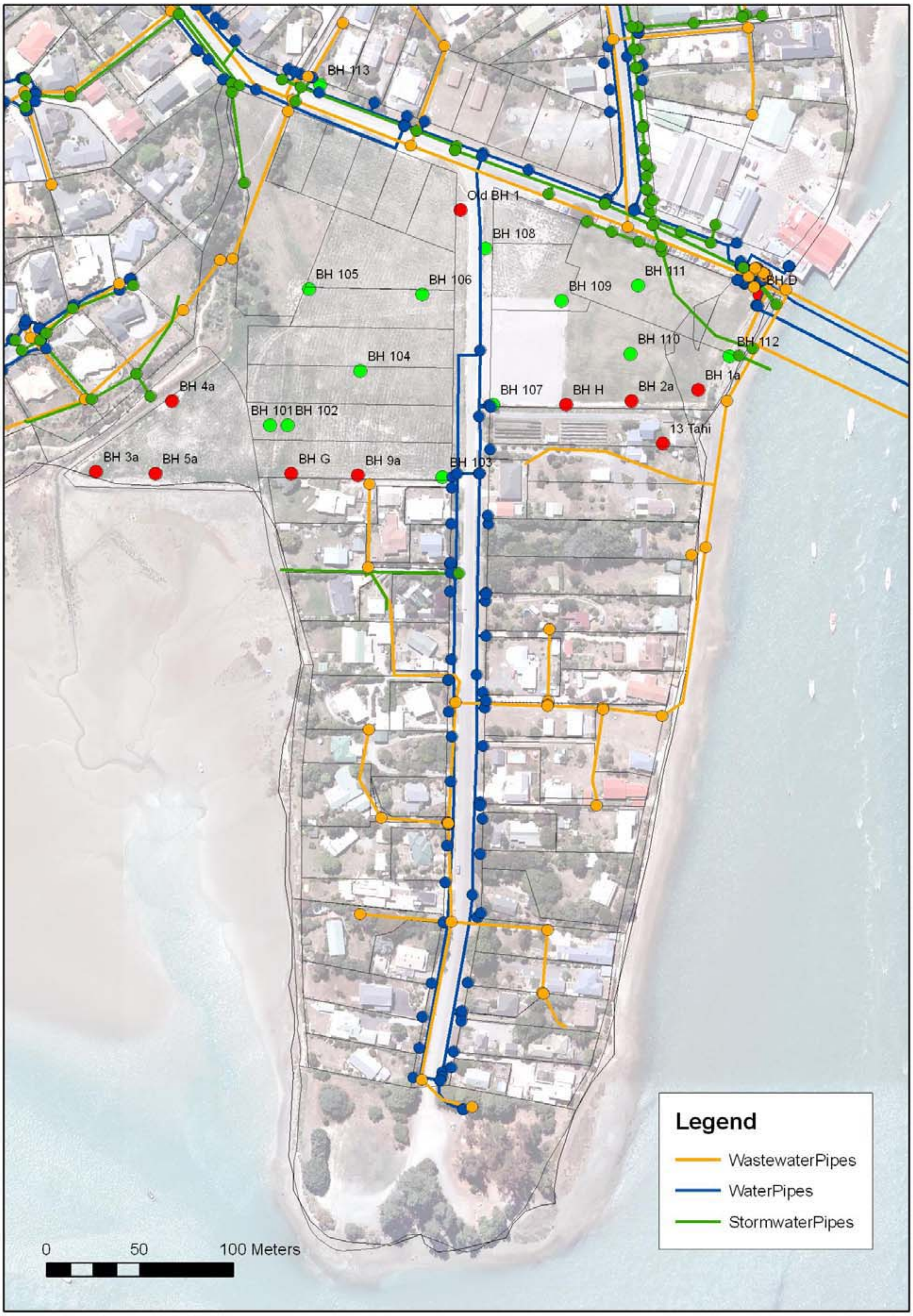

Figure 24: Location of Utilities

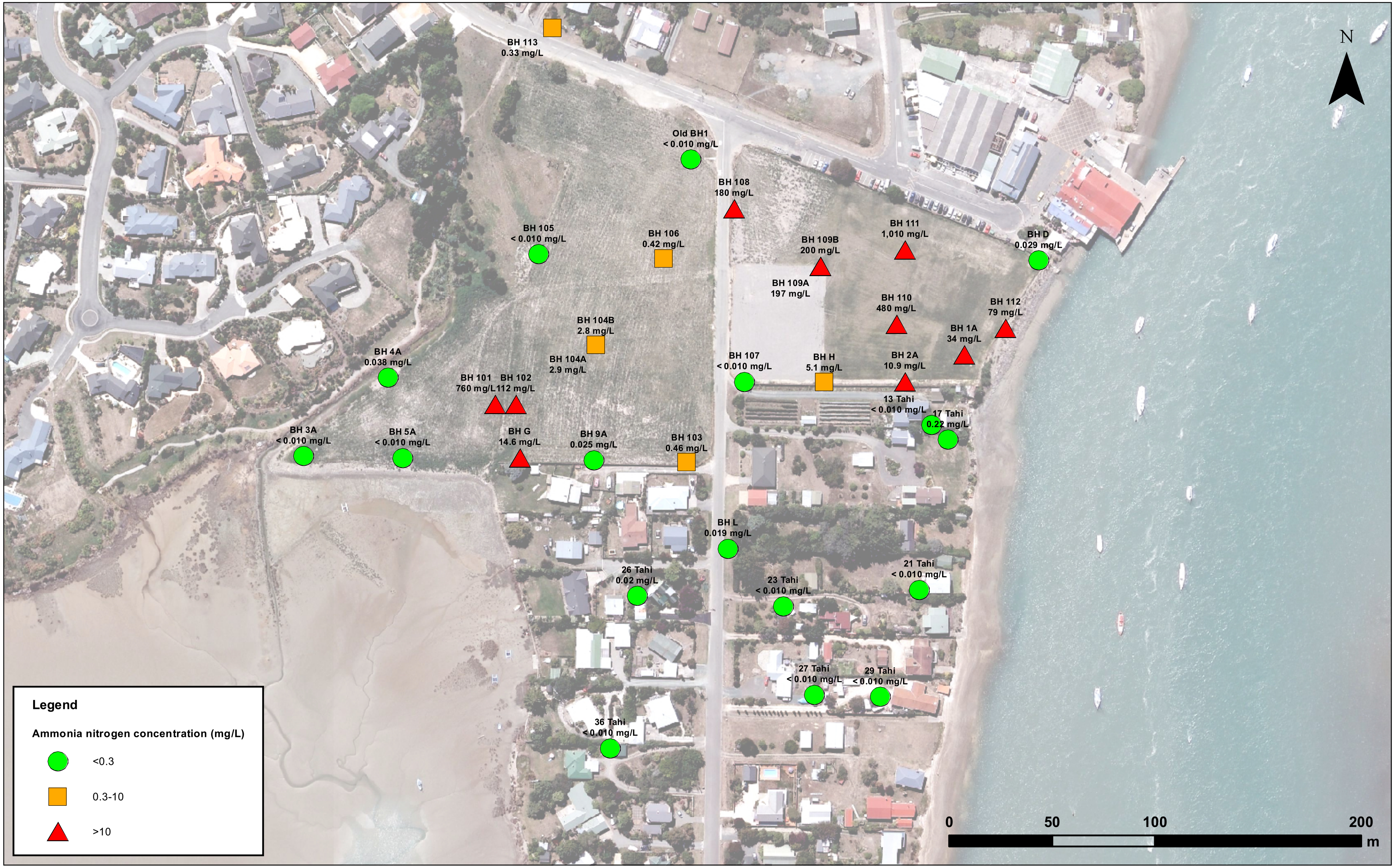

Figure 25: Ammonia nitrogen concentrations in November 2011

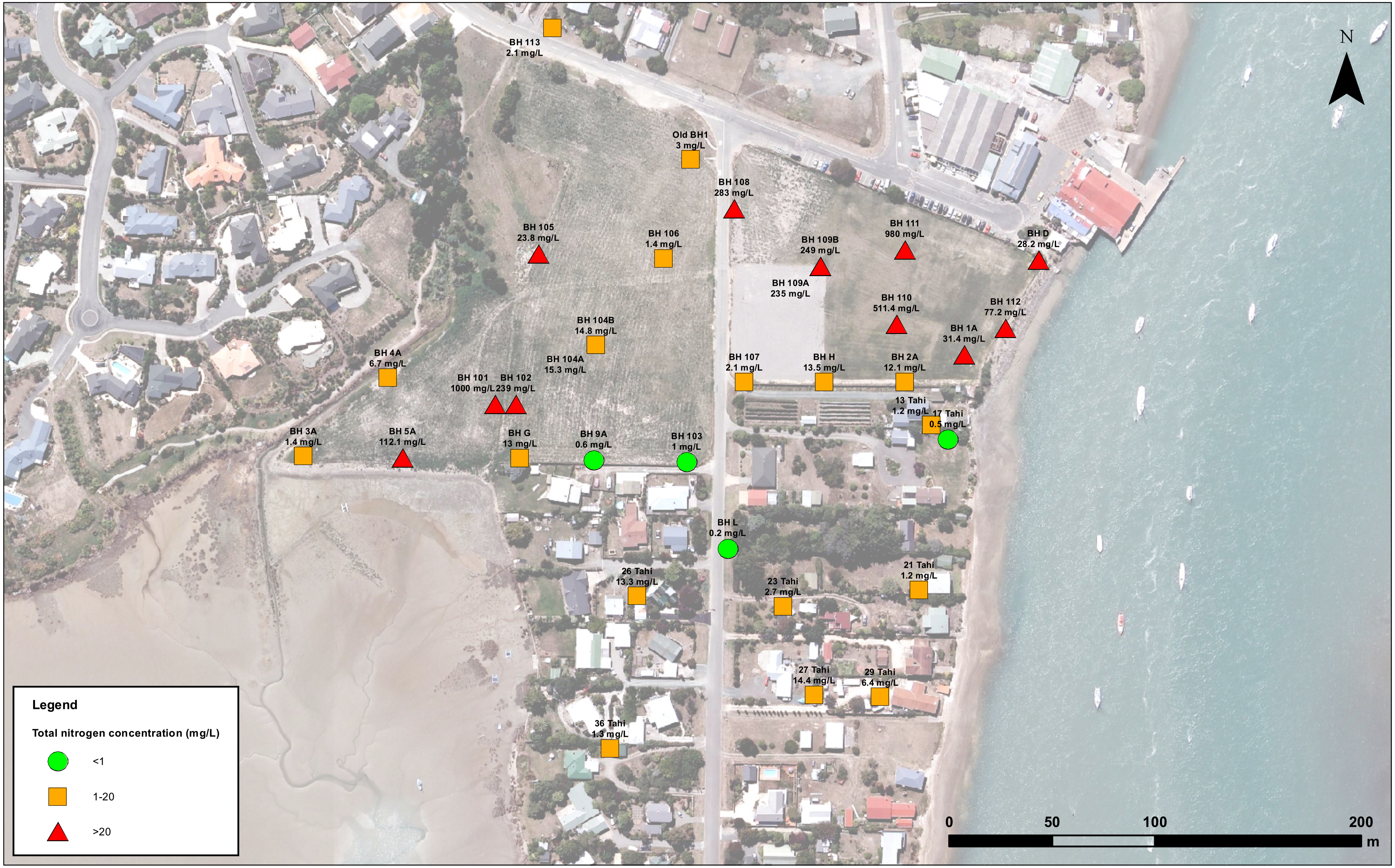

Figure 26: Total nitrogen concentrations in November 2011

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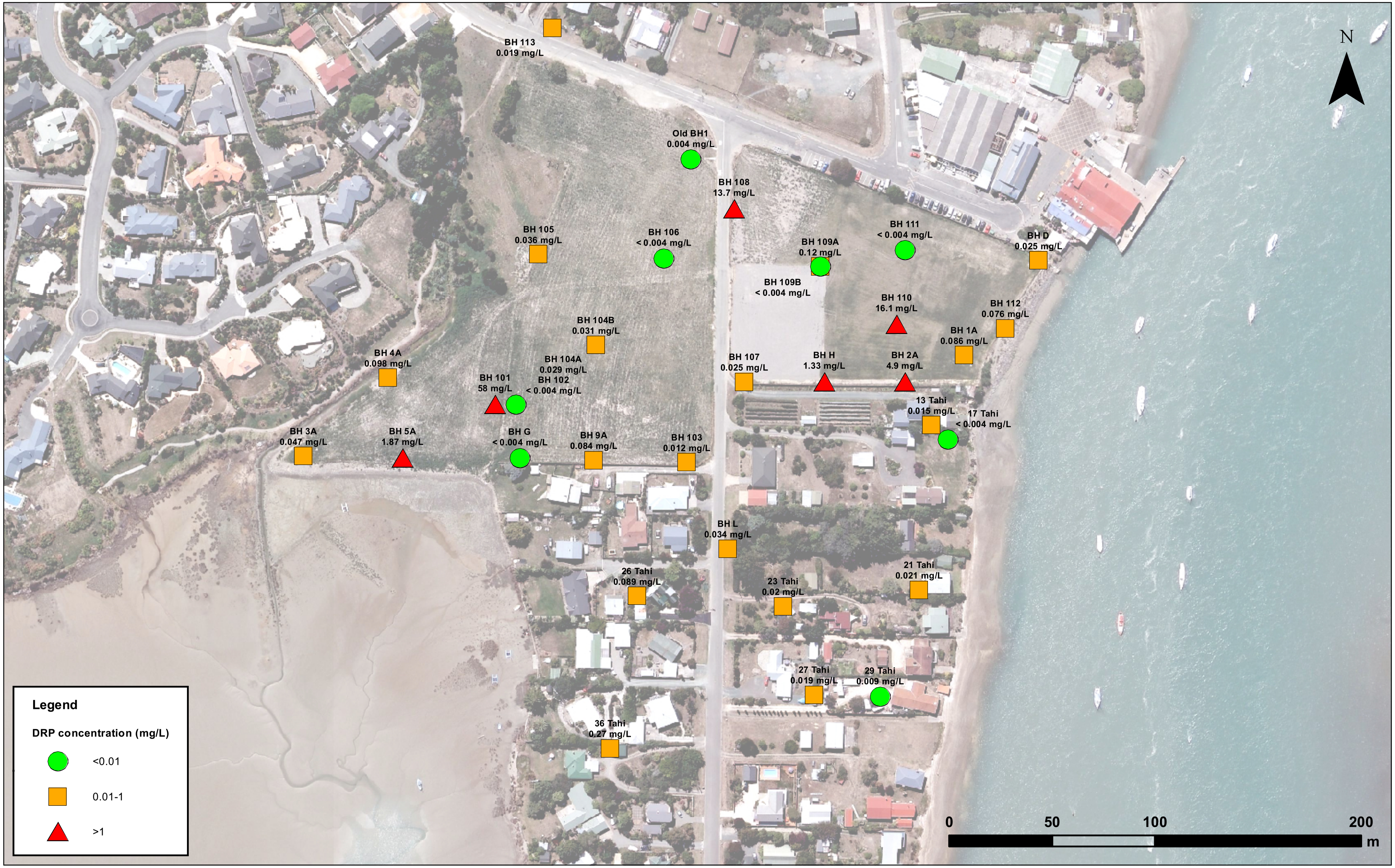
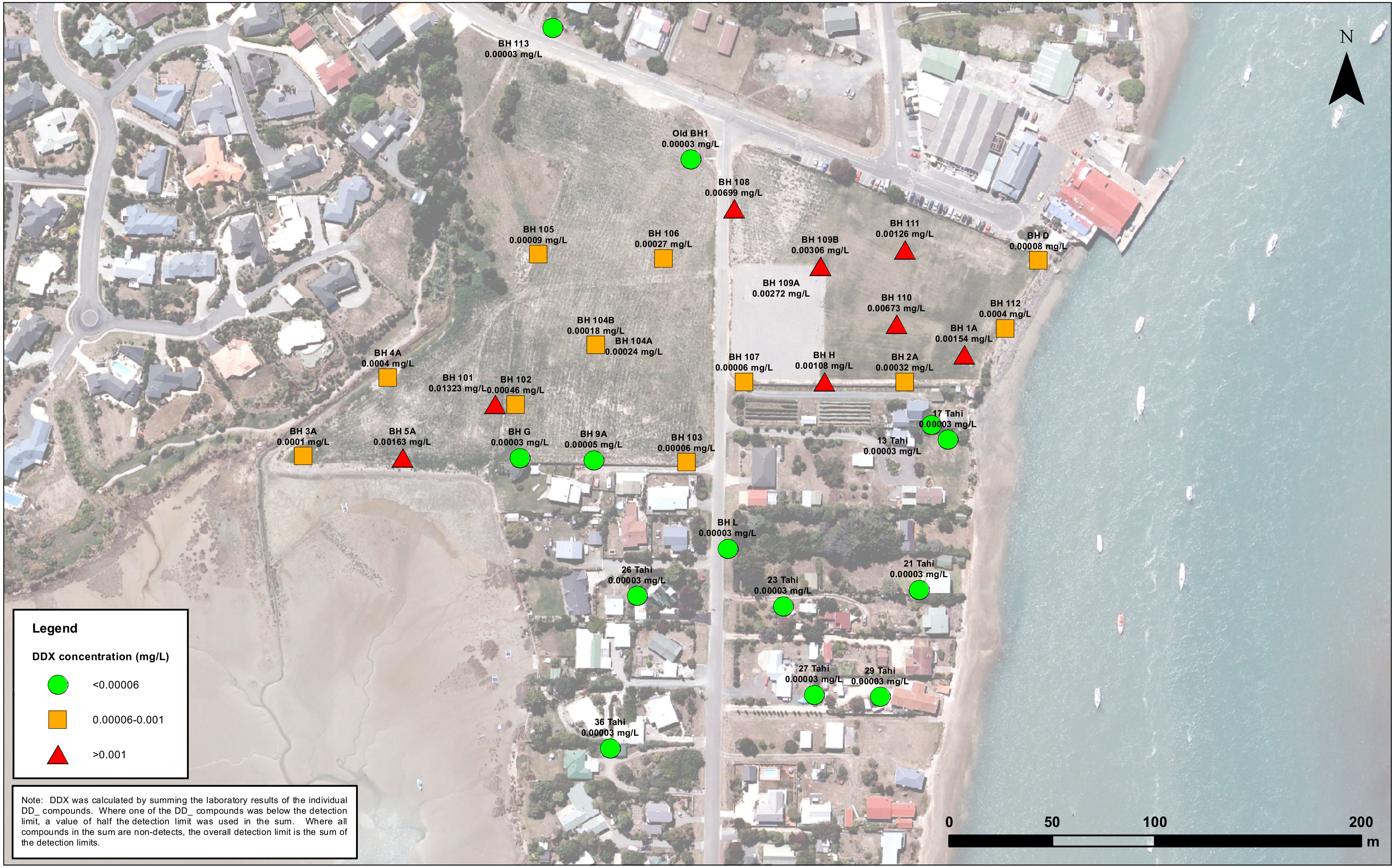


Figure 27: Dissolved reactive phosphorus concentrations in November 2011



Note: DDX was calculated by summing the laboratory results of the individual DD_ compounds. Where one of the DD_ compounds was below the detection limit, a value of half the detection limit was used in the sum. Where all compounds in the sum are non-detects, the overall detection limit is the sum of the detection limits.

Figure 28: DDX concentrations in November 2011

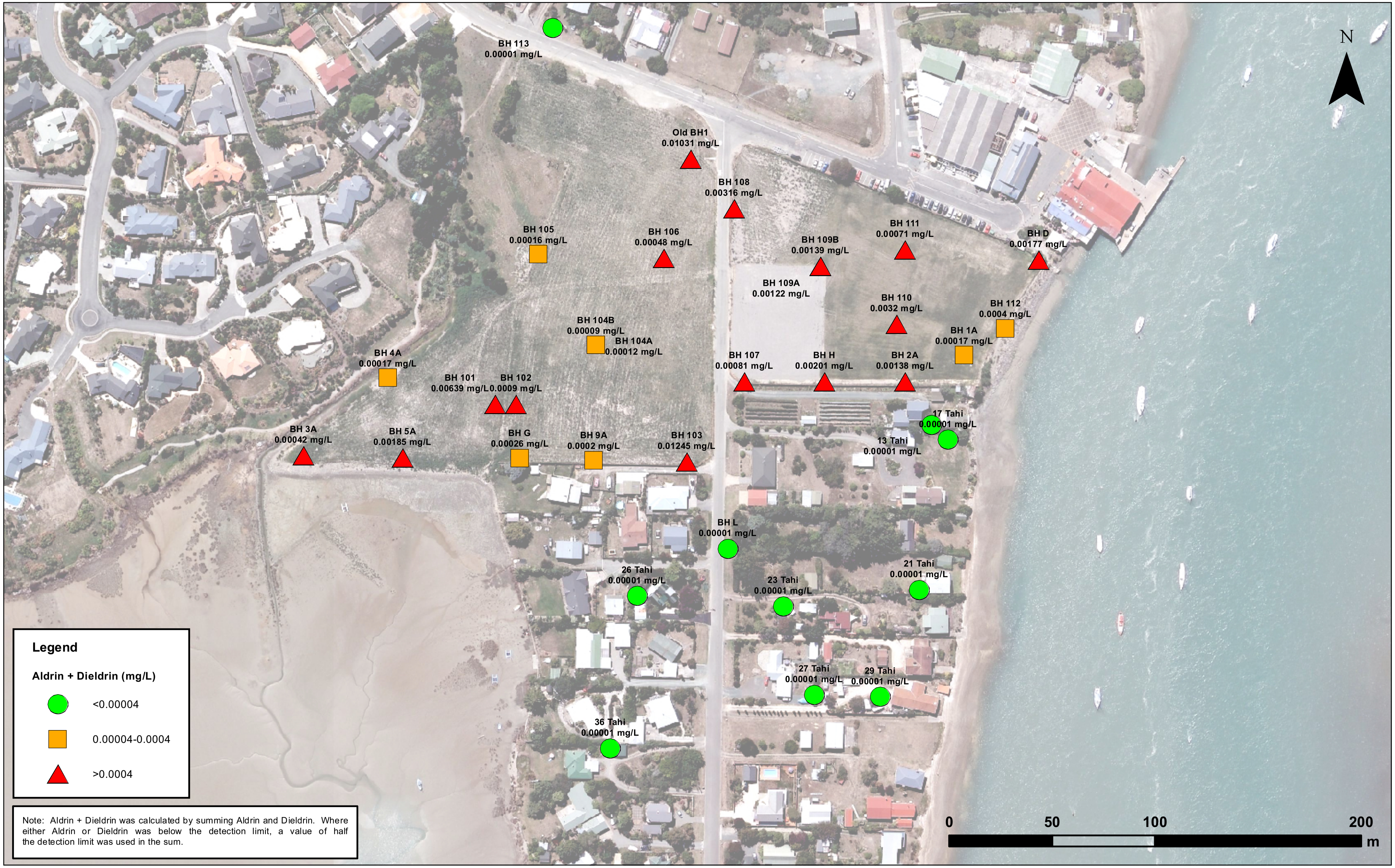


Figure 29: Aldrin + dieldrin concentrations in November 2011

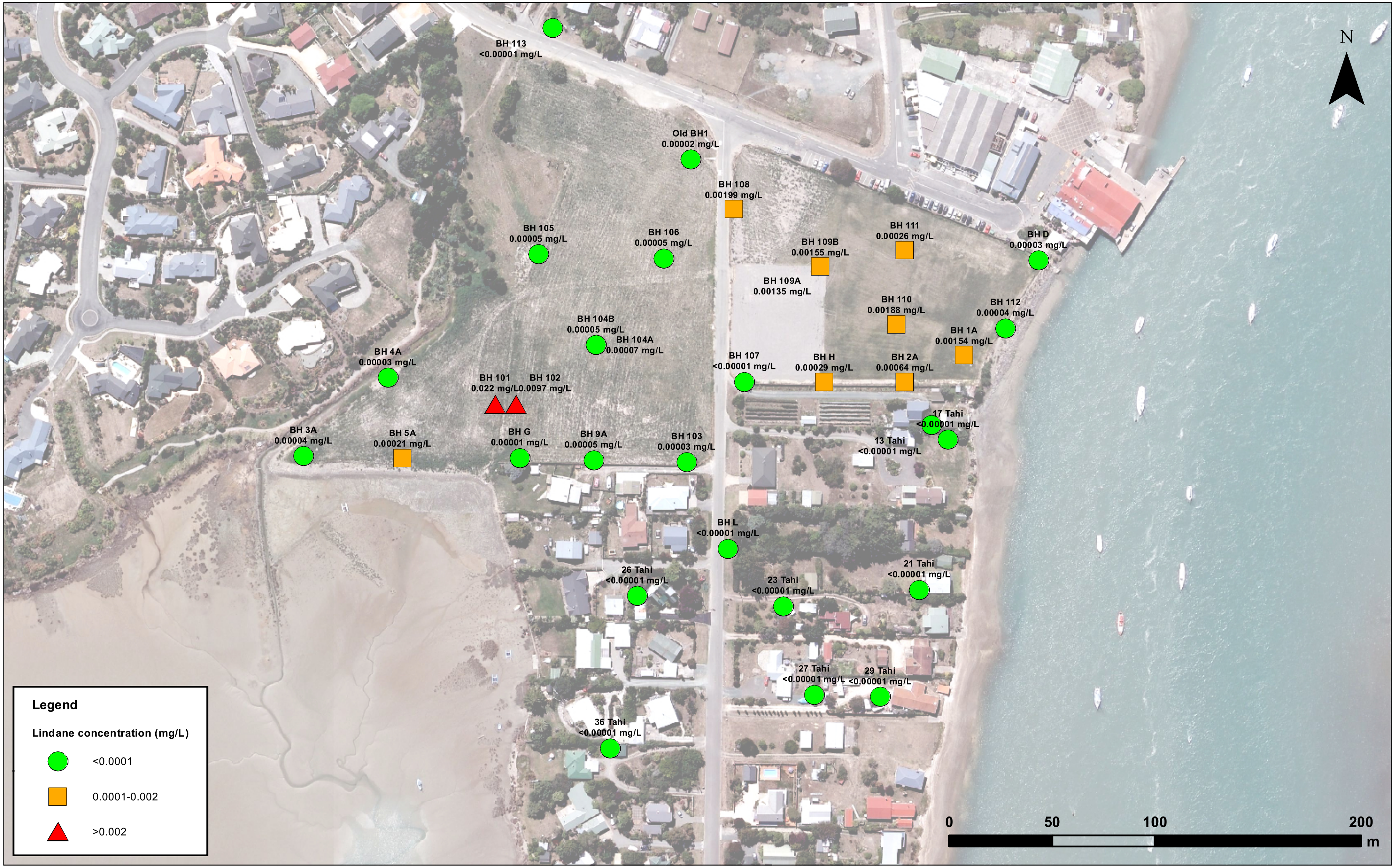


Figure 30: Lindane concentrations in November 2011

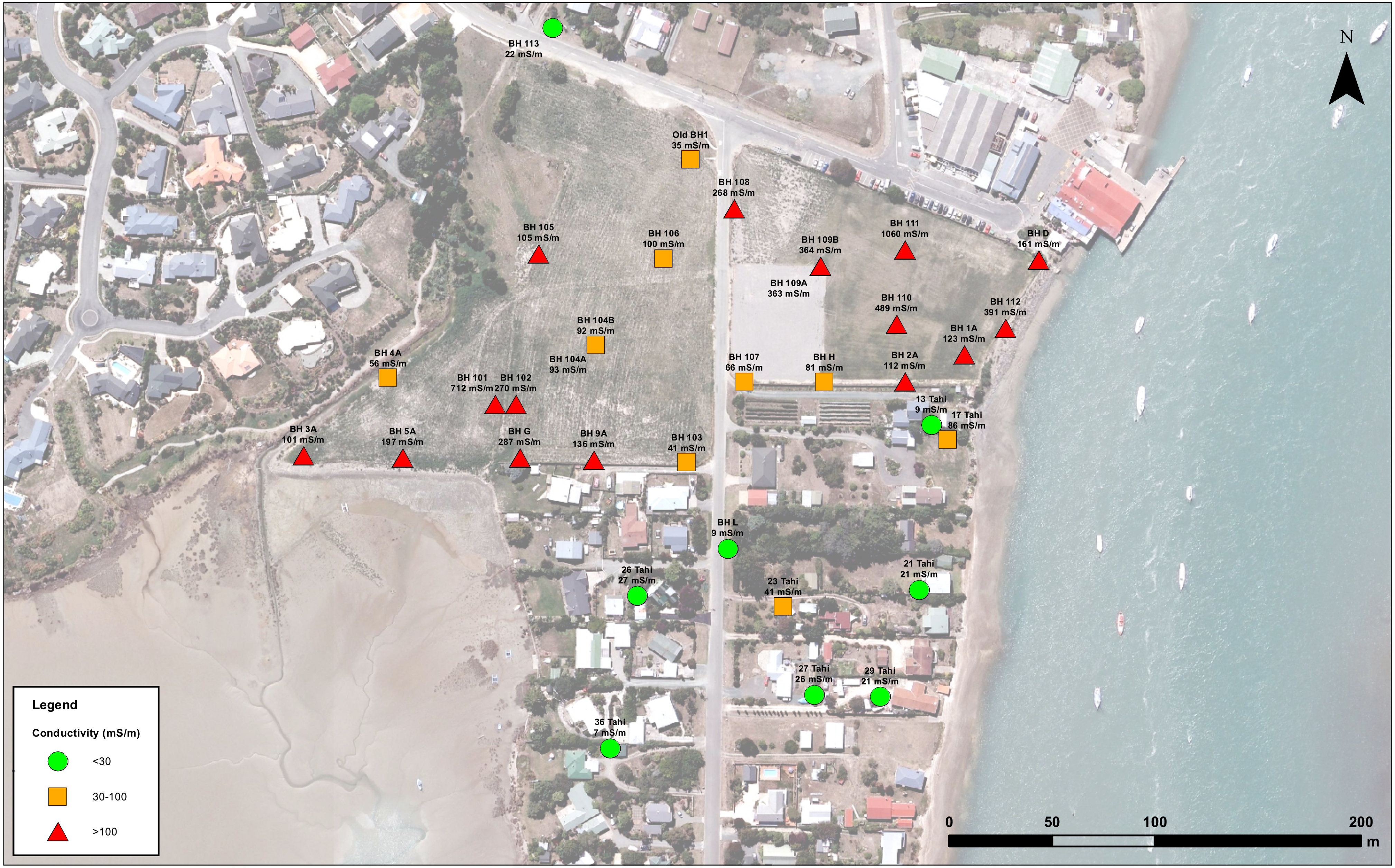


Figure 31: Conductivity values in November 2011

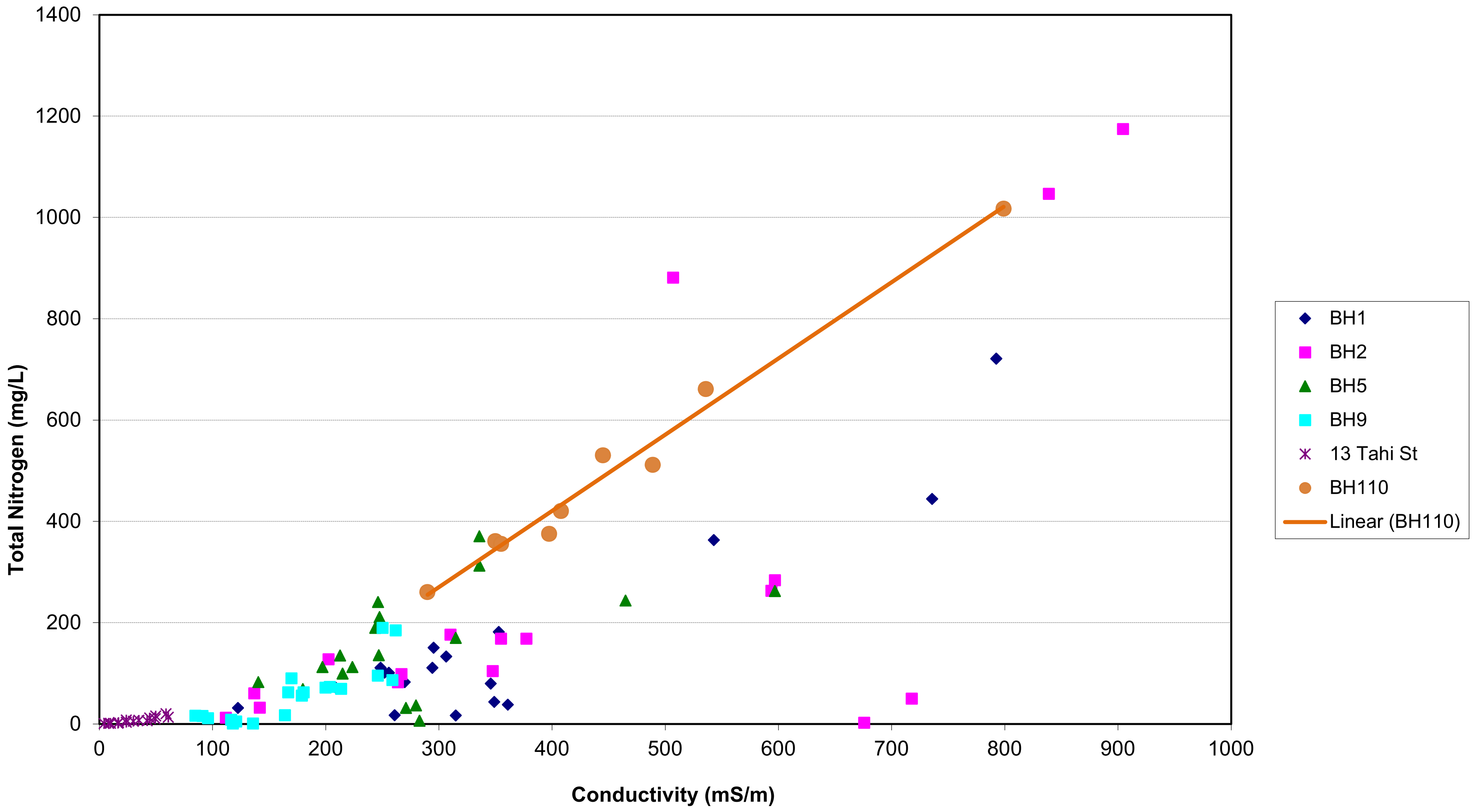


Figure 32. Conductivity vs Total Nitrogen for Regularly Sampled Wells and BH110

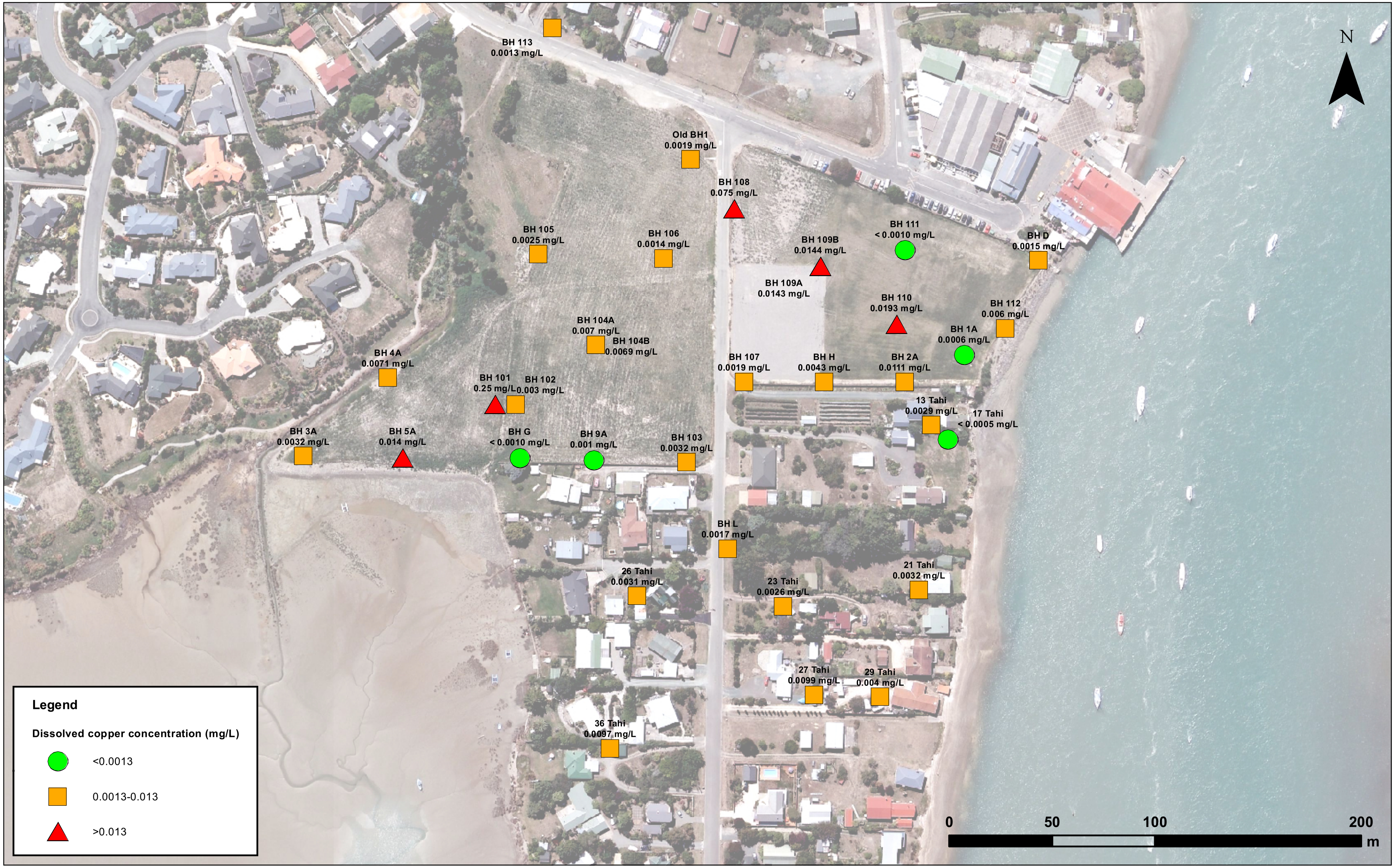


Figure 33: Dissolved copper concentrations in November 2011

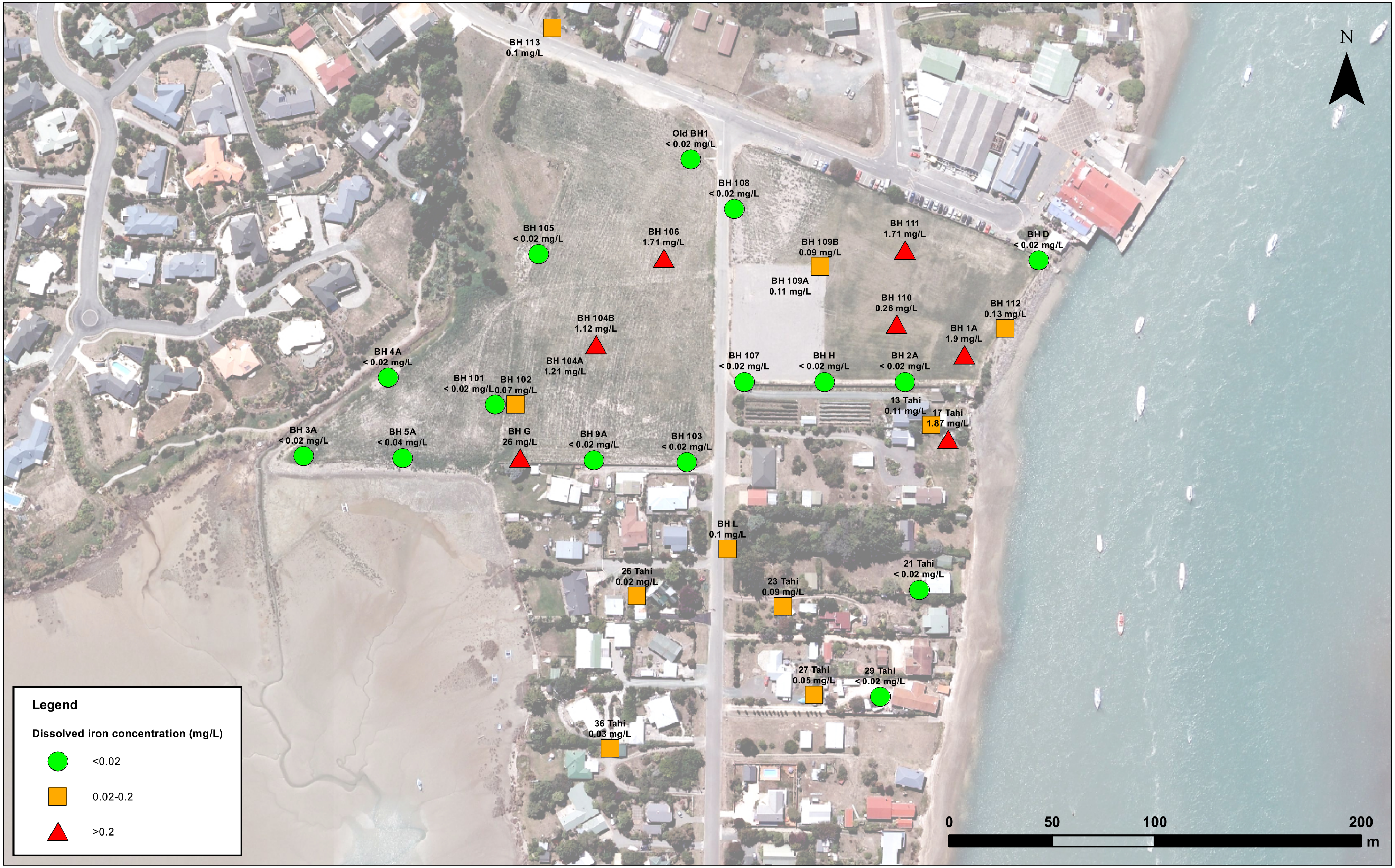
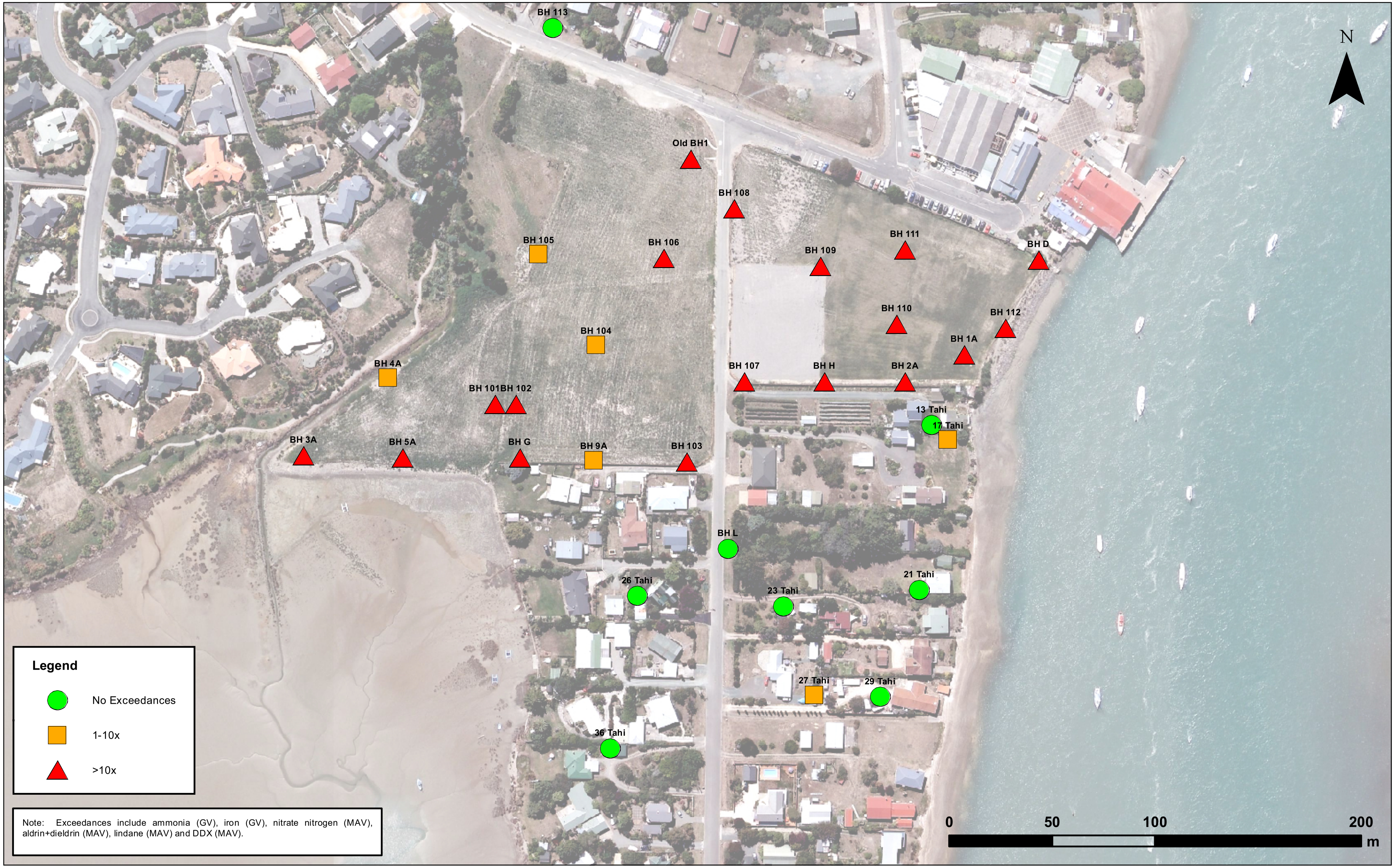


Figure 34: Dissolved iron concentrations in November 2011



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

Figure 35: Exceedances of Drinking Water Standards in November 2011

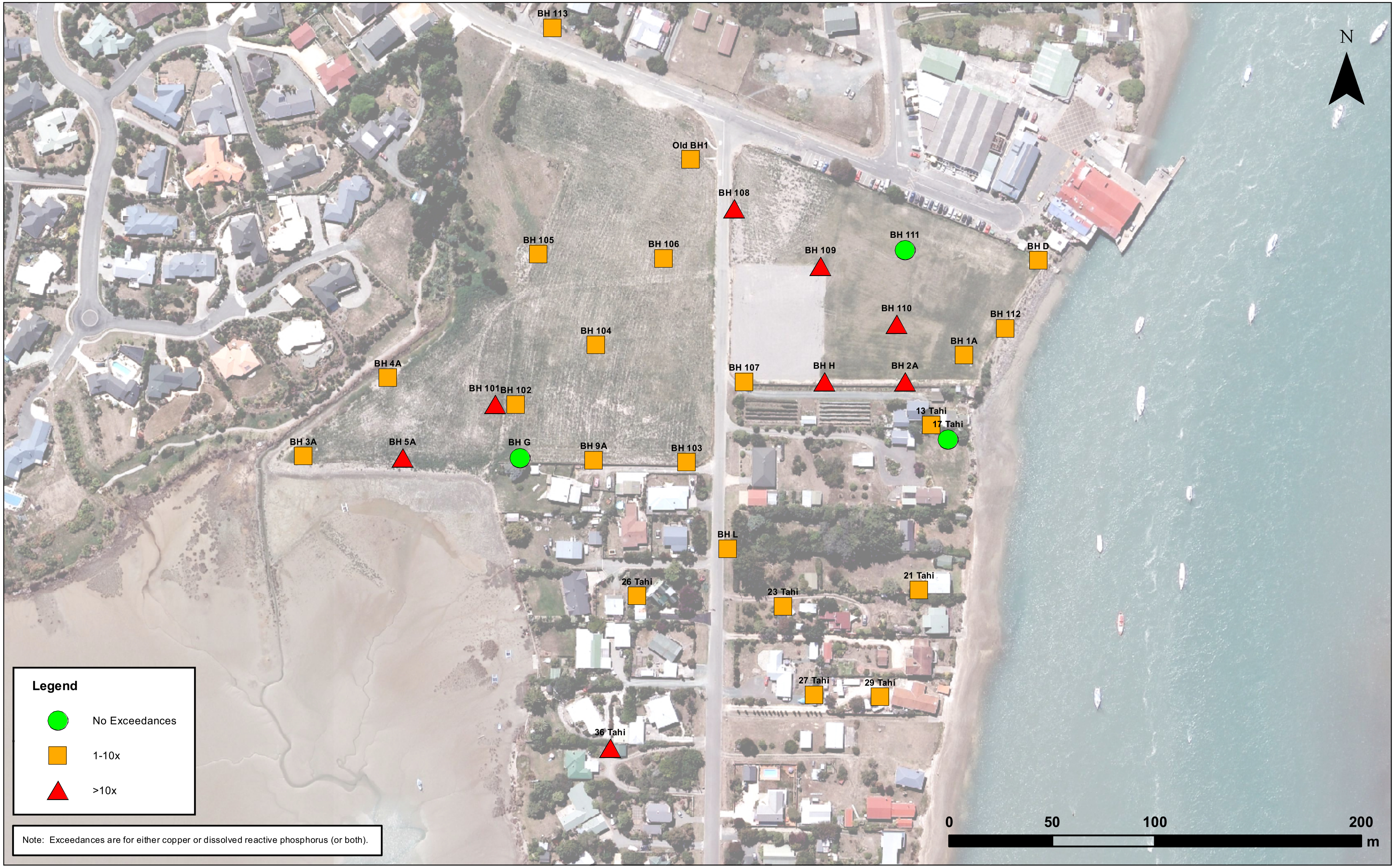


Figure 36: Exceedances of ANZECC Guidelines in November 2011