



**INACTIVE PRODUCTION ROCK SITES AND QUARRIES
2013 ANNUAL REPORT**



Hecla Greens Creek Mining Company

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1.0 Executive Summary

This annual report has been prepared by Hecla Greens Creek Mining Company (HGCMC) in accordance with the mine's General Plan of Operations Appendix 11, Attachment C. Monitoring data summaries are presented for five inactive production rock sites (1350, 960, Mill Backslope, Site C and Site E) and five quarries (Pit 405, Pit 6, Pit 174, Pit 5 and Pit 7). Pit 5 was the most recent active quarry and is now part of the Northwest Tailings Expansion area. A discussion of the 2.5 mile roadcut on the B Road is also included in this report.

This report is separated such that all aspects of the inactive production rock sites are discussed first in Section 2 followed by discussion of the quarries in Section 3. Information that is pertinent to both sections is generally not repeated but is discussed in the most relevant section and identified by reference in the other section.

Acid base accounting (ABA) results from grid samples collected at inactive production rock sites beginning in 2002 support previous investigations. The sites contain a mixture of acid generating and acid neutralizing rock. All inactive sites have drainage dominated by near-neutral waters having sulfate and metals concentrations consistent with exposed production rock. Base flows at inactive site sample locations are low (generally less than 10 gpm).

The exposures in the rock quarries generally contain far less pyrite and carbonate than production rock. Each of the five quarries has zones of pyritic rock exposed in the pit walls; however, the volume of runoff from these zones is relatively small. Lower sulfide contents and smaller surface areas yield a lower flux of oxidation products from quarries compared to production rock sites. However, buildup of acidic oxidation products on overhanging exposures can produce low rinse pH values. Water monitoring indicates that metal loading from pit walls is also lower than loading from production rock sites. Historical metal loading identified in the drainage from Pit 5 does not appear to be solely associated with the pit walls and may reflect influences from the previous water treatment plant as well as construction activity in the area. Pit 5 has been completely backfilled by the Northwest Tailings Expansion and drainage from this area is captured by the tailings area containment system and routed for treatment prior to discharge under the HGCMC APDES permit AK-004320-6. Authority over the federal permitting, compliance and enforcement NPDES program transferred to the State (ADEC) in November of 2010 for the mining industry.

Removal activities at the inactive production rock 1350 Site continued in 2013. Through previous investigations, HGCMC determined that removal of the production rock for disposal in the underground mine as backfill was the preferred alternative for reclamation/closure of the 1350 Site. Removal activities commenced in 2005 and have continued on an intermittent seasonal basis, dictated by the rate at which material can be placed underground. A new temporary storage pad was constructed on Site 23 in 2013 to replace the previous pad constructed in 2008. The temporary storage pad allows material to be removed from the 1350 Site over a short duration during the drier summer months, thus minimizing potential impacts from the excavation and haulage activities and enabling the establishment of vegetation for stabilization of the disturbed areas. Material from the temporary storage pad is hauled to the underground on a year-round basis. In 2013, approximately 5,645 bank cubic yards (bcy) of material was removed from the 1350 Site, bringing the total volume removed since 2005 to approximately 39,473 bcy.

2.0 Inactive Production Rock Sites

2.1 Introduction

The term production rock (or waste rock) refers to material removed during mine development to access ore for mineral extraction. Production rock is typically highly mineralized, but due to its composition it is not amenable to the same mineral processing techniques as the ore. It is therefore disposed of as a mine waste product. Several sites were utilized for disposal of production rock during the early operations of the Greens Creek Mine, including the 1350 Site, 960 Site, Mill Backslope, Site C and Site E. The site locations are shown on Figure 2.1. (*Note: The 960 Site, Mill Backslope and Site C are located within or adjacent to the 920 Area indicated on Figure 2.1*). These sites have been inactive since 1994 or earlier, with Site 23 being the only currently active production rock site. The initial reclamation plan called for engineered covers to be constructed on each site to prevent acid generation and potential long-term water quality impacts. HGCMC currently plans to remove all of the production rock from each site for placement underground as backfill or disposal in the tailings facility. Removal activities were initiated in 2000 and have continued intermittently as mining operations allow. However, complete removal of some sites cannot occur until final cessation of mining operations due to the need to protect/maintain site infrastructure. A monitoring program is in place to evaluate potential impacts from each site on water quality and the acid generation potential of the material.

This section of the report provides a summary of all operational and monitoring activities performed at inactive production rock sites in 2013. Refer to GPO Appendix 11 for a detailed description of the facilities and associated monitoring requirements. Aspects of the inactive Site D are covered in the Tailings and Production Rock Site 2013 Annual Report (HGCMC 2014), which also covers the adjacent active production rock Site 23. Summary statistics for HGCMC's inactive production rock sites are presented in Table 2.1.

Table 2.1 Summary Statistics for Inactive Production Rock Sites
 (ND=no data)

	Inactive Sites				
	1350	960	Mill Slope	Site C	Site E
Years Active (approx.)	1978-1985	1987-1988	1987-1988	1987-1988	1988-1994
Acreage	5	1	20	2	10
Approx. Total Original Volume (yds)	60,000	10,000	ND	50,000	270,000
Approx. Volume Removed (yds)	39,473	16,000	1,500	0	101,400
Approx. Volume Remaining (yds)	24,900	ND	ND	50,000	168,600

Water quality monitoring locations associated with Site E are shown on Figure 2.2. Acid-base accounting (ABA) data associated with the inactive production rock sites are illustrated on Figures 2.3 and 2.4. Composite flow and water quality data are summarized in Figures 2.5 to 2.19 for all inactive production rock sites except Site E, which are summarized separately in Figures 2.20 to 2.34. A general summary of trends is discussed in this introductory section, followed by individual site discussions in the subsequent sections.

The results of ABA sampling and water monitoring through 2013 are consistent with previous investigations (KGCMC 1994, & 2004; Shepherd Miller 2000; ADEC 2003). These investigations concluded that some of the material is potentially acid generating but that the vast majority of the material continues to maintain a pH greater than 6.0, and that sensitive receiving areas continue to be adequately protected. This report serves as an annual follow-up to these previous investigations and generally does not repeat data and information presented in these reports, unless doing so provides continuity and clarity.

Figure 2.3 compares acid potential (AP) with neutralization potential (NP) for samples collected from the surface of the inactive sites. The sites were constructed prior to development of the classification protocol that HGCMC currently uses for segregation of production rock. Symbols in Figure 2.3 represent actual laboratory data points. Lines indicating the currently utilized production rock classes are shown on Figure 2.3 for reference only. Figure 2.3 shows the distribution of potentially acid generating (upper left half of figure) and potentially acid neutralizing (lower right half of figure) samples. Many samples from Site E have more neutralization potential than those from other sites, reflecting a greater proportion of argillite in the material. Samples from the Mill Backslope and the 1350 Site generally have a higher acid generation potential than those from the other sites. Reclamation activities at the 960, 1350 and Site E have removed significant quantities of potentially acid generating material from these sites.

Figure 2.4 shows the results of rinse pH relative to net neutralization potential (NNP) for the five inactive sites. Most samples produced a rinse pH greater than 6.0; however, each site has produced at least two samples with rinse pH values less than 5.0. This is consistent with the distribution of NNP values and the duration of waste rock exposure. ABA sampling occurs at the surface of the piles where oxidation rates are greatest. Drainage from the inactive sites remains near neutral because the bulk of the material in the piles contains sufficient carbonate to neutralize the acidity formed by pyrite oxidation near the pile surface. There are a few cases where samples produced a low rinse pH and high NNP. This is likely a result of accumulated acidic oxidation products in the fines fraction of the sample and remaining carbonate minerals in the coarse fraction.

Flow data presented in Figures 2.5 and 2.20 show that flows at most of the sample locations are generally low (less than 10 gpm) with the exception of Site E. Some of the flow data were collected as part of the APDES stormwater monitoring program. Collected during or following storm events, flow data from these locations (e.g. Site E, 356; 960 Site, 347 and 570) represent short-term maximum flow values in response to relatively large precipitation events. Lack of significant flow from inactive sites is a positive characteristic because it reflects minimization of potential off-site impacts.

Figures 2.6 and 2.21 show pH data from sampling locations associated with the inactive sites. Lower pH values can represent influences from pyrite oxidation and/or organic acids from muskeg and forest soils. The data show that the vast majority of the site drainage remains above pH 6.0. Drainage from the Mill Backslope consistently shows the lowest pH due to the quantity of pyritic rock. The drainage from this area is collected and routed to water treatment facilities prior to discharge at the permitted outfall. For a brief period in 1998 and 1999, acidic conditions began developing at the 960 (sites 347 and 570). Hecla's predecessor Kennecott Greens Creek Mining Company (KGCMC) applied lime and removed approximately 1,000 cubic yards of oxidized pyritic rock from the site in 2000. The pH of the drainage quickly rebounded and has remained near-neutral since 2000. Removal of additional Site 960 material in 2003, 2004 and 2005 is discussed below in Section 2.3. The material removal activities may also be responsible for the pH of 8.1 measured at the 960 site in 2005. This is the highest recorded for this site. Fresh

carbonate mineral surfaces exposed during the excavation and the placement of the toe buttress may have contributed to the higher pH values observed. Alkalinity data presented in Figures 2.7 and 2.22 are consistent with the pH results in Figures 2.6 and 2.21. Drainage from the inactive sites continues to maintain measurable alkalinity provided by dissolution of carbonate minerals.

Conductivity data are shown in Figures 2.8 and 2.23. Conductivity indicates the amount of dissolved constituents in the water. Samples showing higher conductivity values usually have elevated sulfate, calcium and magnesium (hardness) concentrations, reflecting influences from sulfide oxidation and carbonate mineral dissolution. Water that has contacted production rock is expected to have higher conductivity values than background waters. Drainage from the 960 (Sites 347 and 570) shows a substantial decrease in conductivity following removal of the production rock. The decreasing trends apparent in Figures 2.8 and 2.23 are the result of decreasing reactive surface area available for oxidation and dissolution. The reactive surface area decreases as reactants are consumed and mineral surfaces become coated with oxidation products. The results for sulfate, magnesium and hardness, shown in Figures 2.9 and 2.24, 2.10 and 2.25, and 2.11 and 2.26, respectively, correlate with conductivity results and are consistent with the concept of generally decreasing or static reactive surface area.

The data for zinc, copper, lead, cadmium, nickel, arsenic, iron and manganese are presented in Figures 2.12 to 2.19 and Figures 2.27 to 2.34. Sample results that were less than the detection limit are plotted at one half the detection limit value. While this allows the results to be plotted on a logarithmic scale, it causes non-detect results with high detection levels to appear more concentrated than they actually are. Detection limits have varied with time and are often evident on the graphs as horizontal groupings of symbols. The results for metals generally correlate with conductivity values. Zinc concentrations reflect the higher solubility of this element relative to the other metals at near-neutral pH conditions. Manganese concentrations are elevated at most of the inactive sites, indicating the generation of secondary products from localized redox and buffering reactions as well as this metal's higher solubility in the prevailing pH conditions. Metal loads from inactive sites have either remained relatively constant or decreased with time. The decrease in metal loading is attributed to the reduction of reactive surface area discussed above. Site 960 showed elevated copper, zinc and cadmium concentrations in 2004. This was likely due to the removal of production rock from the area, which exposed additional production rock materials in the base of the road, and rerouted additional water sources into the sampling area, confounding comparative water sampling with pre-removal data. Post removal Site 960 data in 2005-2011 have shown a decrease in most metal concentrations, with close to an order of magnitude decrease in cadmium, nickel, manganese and zinc.

2.2 1350 Site

The 1350 Site is located at 1,350 feet above mean sea level (AMSL), up-slope from the main portal and concentrator facility (Figure 2.1). The site contained an estimated 60,000 cubic yards of material derived from advancement of the 1350 portal, which began in 1978 and continued intermittently through 1985. Waters collected near the adit opening are redirected back into the mine water collection system. Flow from the site is low, generally less than 10 gpm, and the drainage remains near-neutral. Other characteristics of the drainage (Figures 2.9 to 2.19) include a sulfate load, generally low metal concentrations, and localized iron staining. The results of ABA sampling demonstrate that although some of the rock is potentially acid generating, the majority of the material remains near-neutral. Small areas containing rock with the greatest pyrite content have produced acidic oxidation products, but they are limited in extent and do not have a significant effect on the pile drainage. Monitoring in Greens Creek, below the confluence with the 1350 drainage, indicates a small but detectable influence from this site.

After evaluating reclamation alternatives for the 1350 Site, it was determined that removal of the production rock for disposal in the underground mine as backfill was the best option to achieve closure of the site. Removal activities commenced in 2005 and have continued on an intermittent basis. Removal is performed during the drier summer months to minimize erosion and sediment production from the excavation and haulage activities. There was no removal in 2006, 2009 or 2012 due to limited availability of space underground and/or at the temporary storage pad at Site 23. From 2005 through 2013, a total surveyed quantity of 39,473 bcy of material has been removed from the 1350 Site. Of this total, approximately 5,645 bcy was removed in 2013. A photograph of the area where the 2013 removal activities occurred is presented as Figure 2.35.

A temporary storage pad for the 1350 material was constructed at Site 23 in 2008. Prior to building this facility, the 920 remuck area was used as the temporary storage area before hauling underground as backfill. The remuck area has a limited capacity of 700 cy and is available only on a seasonal basis. The temporary storage pad at Site 23 allows material to be hauled underground on a year-round basis, thus expediting the 1350 removal process. The temporary storage pad was lined to provide containment of storm water drainage, which is routed to water treatment facilities prior to discharge at the permitted outfall. The 1350 material is also blended with lime during placement on the storage pad to ensure neutralization of acidic oxidation products.

In order to accommodate changes to the Site 23 configuration, which is the only active production rock storage facility for the mine, it was necessary to construct a new storage pad for the 1350 material in 2013. The new storage pad was constructed to the same design specifications for liner placement and containment of pile drainage as the previous pad, and has a storage capacity of approximately 8,500 cubic yards. Figure 2.36 shows a photograph of the new temporary storage pad following completion of the 2013 removal activities.

An area of hydrocarbon contaminated soil was encountered during 2010 and 2011 removal activities. This contamination was believed to be associated with the 1978 camp fuel tank spill. Approximately 25 cy of soil was excavated (to bedrock) and disposed of offsite during 2010, with an additional 315 cy excavated in 2011. If additional contamination is encountered during future removal activities, then the material will be disposed of in accordance with state and federal regulations.

The benefits of the removal activities are evident in the monitoring data for Site 307, which showed a decreasing trend in conductivity and sulfate concentrations (Figures 2.8 and 2.9). An improvement has also been seen in the water quality at Site 13, but to a lesser extent. This is likely due to production rock up-gradient of this site that has not yet been removed. The goal for 2014 is to remove an additional 11,400 cy of material, the majority of which is directly up-gradient of Site 13. After 2014 removal activities, it is estimated that approximately 13,500 cy of production rock will remain. This material will not be available for removal until final closure of the mine due to the need to retain access to the Raise Bore that is a key component of the mine ventilation system.

Four samples were collected for ABA analyses in 2013. Two samples showed negative NNP results (-47.7 and -85.6) and were collected from production rock that is targeted for removal in 2014. One sample was from production rock that is not targeted for removal until final closure and showed a positive NNP value (+84.3). The last sample was collected from where material was removed in 2013 and confirmed that the production rock was successfully removed. This sample showed low sulfur content and had a NNP result of +21.5.

2.3 960 Site

The 960 Site is located just above the 920 Portal on the road to the 1350 level. Approximately 10,000 cubic yards of production rock were placed at the site in 1987 and 1988 during development of the 920 Portal and access road to the 1350 level. Placement was terminated when signs of slope instability developed below the site. Approximately 1,000 cy of rock were removed from the site and placed at Site 23 or underground as backfill in 2000. The remaining additional material removed in 2003, 2004 and 2005 is discussed below.

ABA sampling and water monitoring data were consistent with those of earlier reports (KGCMC 1994 and Shepherd Miller 2000) indicating that some of the rock was potentially acid generating. Intermittent periods of acidification have occurred, although the drainage from the site currently continues near-neutral. Hecla's predecessor KGCMC applied lime to the site while material was being removed in 2000. Higher metal concentrations (e.g. zinc, Figure 2.12) are attributed to influences from localized accumulations of acidic oxidation products. The 960 Site is relatively small in extent (1 acre) and drainage flows are low (typically well below 5 gpm). Monitoring in Greens Creek below the 960 Site historically showed some influence from this site or other upgradient sites on water quality.

Approximately 10,000 cy of material were removed from the 960 Site and placed in underground workings in 2003. An additional 5,000 cy of oxidized material and associated underlying soil were removed in 2004. In May and June of 2005, additional road sub-base production rock material was found and removed. Butressing material was brought in as fill to ensure road stability. The site was then recontoured and allowed to naturally reseed with native species.

The 960 Site showed some elevated copper, zinc and cadmium concentrations in 2003 and 2004 (Figures 2.12, 2.13 and 2.15). This was likely due to the removal activities, which exposed some additional production rock materials in the base of the road and altered drainage patterns. Comparison of pre- and post-removal monitoring data (Table 2.2) demonstrates that water quality of drainage from the 960 Site has improved considerably.

Table 2.2 Effects of Removal of 960 Site Production Rock (ND = Non-detect)

Site 347		Before Removal	After Removal	After Removal	After Removal	After Removal
Parameter	Unit	9/12/95	9/28/06	8/17/09	6/17/10	5/30/12
pH	s.u	6.1	7.6	7.5	7.3	7.7
Sulfate	mg/l (tot)	1300	161	230	136	119
Calcium	mg/l (diss)	412	64	102	64	56
Magnesium	mg/l (diss)	164	21	28	21	17
Iron	mg/l (diss)	5.5	0.2	ND	0.61	0.09
Manganese	mg/l (diss)	7.1	0.4	0.272	0.196	0.06
Zinc	mg/l (diss)	11	0.1	0.054	0.035	0.032
Lead	mg/l (diss)	0.004	ND	0.00008	ND	ND
Nickel	mg/l (diss)	0.3	0.005	0.007	0.0015	0.0016

A small volume of pyritic material remains within the road prism, as evidenced by localized iron staining. An ABA sample of this material collected in 2013 showed a NNP of -30.3 (tCaCO₃/kt) and a paste pH of 3.6. HGCMC plans to remove this material during final reclamation of the 1350 access road following cessation of mining operations. The 960 Site will continue to be monitored for water quality changes and potential impacts on Greens Creek.

2.4 Mill Backslope

A bench was cut into the valley floor at the 920 elevation providing level ground to facilitate construction of the Mill/concentrator facility in 1987. Glacial till excavated from the site was hauled to Site D and Site E. During construction of the Mill and related facilities, tension cracks developed above the excavated slope. Approximately 100 dewatering drains were drilled into the slope to lower the water table and reduce pore pressures. Two benches of production rock were placed on the lower half of the bank to buttress the slope and protect the drain manifold system. Pyritic rock was also used in the construction of an access road above the cut slope. Numerous piezometers were installed throughout the Mill Backslope at varying depths to monitor the pore water pressure.

A total of 28 ABA samples have been collected from the Mill Backslope rock cover and access road since 2002, including three samples collected in 2013. The results from this sampling (Figures 2.3 and 2.4) indicates that the majority of the rock is acid generating and has elevated sulfide content and low carbonate content. The low carbonate content is likely a combination of deficient initial composition and depletion of carbonate from the fines fraction through weathering.

Drainage from the Mill Backslope is a combination of groundwater intercepted by the dewatering drains, seepage from the surface expression of shallow groundwater, and surface runoff from precipitation. Historical monitoring of the dewatering drains showed that the groundwater generally has low conductivity and low metal concentrations, with the exception of iron. The results from the historical monitoring were presented in previous annual reports and are not repeated in this report. Surface runoff that contacts the production rock has a higher dissolved load, dominated by sulfate, calcium, magnesium, iron, zinc and other trace metals. Sample site MBS 341 was established in 2003 and represents a composite of the groundwater and surface runoff. As shown in Figures 2.6 through 2.19, this site typically has the lowest pH and highest metals concentrations of all inactive production rocks sites. Average flows from combined Mill Backslope sources are low (less than 10 gpm) and drainage is routed to water treatment facilities via a network of drains and lined ditches.

Collection and treatment of slope drainage remain the preferred near-term options for this site because removal of all of the production rock would destroy the dewatering system that maintains slope stability. Long term closure options for the slope include removing the pyritic material and either replacing it with non-pyritic fill or decreasing the slope angle to ensure long-term slope stability for closure.

Removal of the oxidized material on the Mill Backslope upper road occurred in 2005. Approximately 1,500 cubic yards were removed and disposed of underground. The upslope run-on diversion ditch was rebuilt using clean native fill (sourced from the backslope of Site 23) and lined with HDPE. A french drain was installed in the bottom of the ditch prior to installing the

liner. Replacement of the lower reach of this access road and diversion ditch above the 920 site was completed in 2006.

Routine monitoring of the Mill Backslope is primarily for geotechnical purposes. Water quality at site MBS 341 is monitored infrequently since all flow is captured and routed to water treatment facilities. Piezometers are monitored on a frequent basis to track trends in pore water pressure that could lead to slope instability. Survey hubs are also frequently monitored to detect any slope movement. The performance of the horizontal and inclined dewatering drains is assessed through periodic flow measurement. During a 2013 evaluation of the available data for the Mill Backslope, it was determined that there is a recent, slight upward trend in the pore pressure at a few of the piezometers. Flow measurements collected in 2013 were consistent with past measurements dating back to 1995, indicating that the dewatering drains continue to function adequately. There are no immediate concerns regarding the stability of the Mill Backslope. However, in 2014 HGCMC plans to install two new piezometers along the toe of the slope to replace ones that are broken and also conduct field investigations to more accurately assess the condition of select dewatering drains.

HGCMC continues to evaluate potential source areas for metal loading to Greens Creek. Previously, four areas were identified where intermittent seeps from the rock fill beneath the 920 site enter Greens Creek. The water quality data from these seeps was presented in previous annual reports and is not repeated here. The flow rates of these seeps were all less than 1 gpm at the time of sampling, and during subsequent visits they were found to be dry. HGCMC will continue to monitor the area below the mill and along Greens Creek for potential seeps. One action that was taken in 2013 was to reconstruct the collection trench that routes drainage to the pump-back caisson at the old Pond B berm area. The gravels in the previous collection trench had lost their porosity due to a buildup of iron hydroxide precipitates, thus reducing the volume of water reporting to the caisson. The new collection trench has increased the volume of water captured and pumped to water treatment facilities. Future monitoring will determine if this action had any influence on metal loading to Greens Creek.

2.5 Site C

Site C is located near the end of the B Road just below the 920 Mill/concentrator facilities. The site received production rock in 1987 and 1988 and currently contains approximately 50,000 cubic yards of material. Results of ABA analyses (Figures 2.3 and 2.4) indicate that some of the material is potentially acid generating, however the pH of the site's drainage remains near-neutral. The 860 safety building and assay lab have been constructed on this site, therefore removal of the material will not occur until final cessation of mining activities.

During construction of the assay lab, glacial till from Site 23 was placed over much of the exposed production rock. The Site 23 material is not potentially acid generating and reduces exposure of the covered production rock to precipitation and oxygen. A network of drains and catchments diverts surface water away from the underlying production rock. Two storm water retention ponds were constructed below Site C, the upper and lower Pond C, to contain sediments from Site C as well as from the B Road below the 920 area. The collected storm water is pumped to water treatment facilities and discharged at the permitted outfall.

A seepage area was identified in the lower Pond C that has been routinely monitored since 2002 as Site 308. Flow at this site is low (generally less than 1 gpm), remains near-neutral, and contains elevated manganese concentrations, as well as moderate sulfate, zinc, cadmium and iron

concentrations. Several corrective actions have been implemented between 2006 and 2012 in an effort to eliminate the seepage and reduce potential loading to Greens Creek. Actions taken are as follows:

- Accumulated sediments were removed from both the upper and lower ponds;
- A caisson and gravel drainage system were installed in lower Pond C to maintain the static water level at an elevation below the bottom of the pond;
- A liner, under drains, and new pump system were installed in upper Pond C to reduce flows into lower Pond C;
- An up-slope diversion was constructed to route clean, non-contact storm water to Bruin Creek and reduce flows into the Pond C system during runoff events; and,
- To the extent possible, storm water is diverted into the upper pond to minimize flows into the lower pond.

The monitoring data for Site 308 indicate a downward trend in sulfate, cadmium, lead and zinc concentrations, which may be attributable to the improvements made to the upper and lower ponds. This site will continue to be monitored.

2.6 Site E

Site E is located 4.6 miles up the B Road halfway between the Hawk Inlet port facility and the 920 Mill facility (Figure 2.1). Approximately 95,000 cubic yards of glacial till and 270,000 cubic yards of production rock were placed at the site from 1988 to 1994. The glacial sediments were excavated from the 920 site during construction of the Mill facility. Once the sediments were naturally dewatered in the placement cells constructed at this site, production rock materials were placed on top of those sediments at Site E. Flows from the site are minimal because it sits on a topographic high and only receives water from direct precipitation (e.g., no run-on or groundwater input). Water quality monitoring at Site 356, between Site E and the B Road (Figure 2.2), was initiated in 1995. The co-located Site 545 has been routinely monitored since 1998 as part of the Greens Creek Mine storm water monitoring program.

In late 2002 and in 2003, three new monitoring wells were installed and 13 new surface water sampling sites were established at Site E to better understand the potential pile influence on the area. Figure 2.2 shows the locations of these sites. Water quality data for the wells and eight of the 13 surface water sites are shown on Figures 2.21 to 2.34. One of the wells (MW-E-02-03) is completed in till to a depth of approximately 99 feet, and the two other wells are completed in gravels at 76 and 86 feet (MW-E-02-09 and MW-E-02-12). The eight surface water sites depicted in the figures represent water quality at the toe of the pile (sites 708, 709, and 710, along with the older site 356), two downgradient drainages (703 and 704) that report to Greens Creek, and two sites in Greens Creek, one upgradient of Site E (711) and one downgradient (712). Sulfate and metals concentrations are relatively high near the toe of the pile, but decrease as the distance from Site E increases. The downgradient site in Greens Creek (712) shows a slight increase in sulfate and zinc concentrations compared to the upgradient site (711). However, Greens Creek continues to meet Alaska water quality standards at both sites. Monitoring at Site E will continue until final reclamation is completed.

A total of 67 samples have been collected at Site E for ABA analyses since 2002, including 6 samples collected in 2013. The results from these samples (Figures 2.3) show that the majority of the production rock at Site E has substantial buffering capacity. Only 17 of the 67 samples (25%) had a greater acid potential than neutralizing potential, and the average NNP of all samples was

+108 tCaCO₃/kt. Only 7 samples had a rinse or paste pH below 6.0, and the majority of the samples had a pH greater than 7.0 (Figure 2.4). Monitoring of the seeps from the toe of the pile (Sites 708, 709 and 710) show that the pH remains neutral and stable, with no apparent trends. This indicates that oxidation and neutralization processes occurring in the pile are in a steady state and that depletion of the buffering capacity is not imminent.

Greens Creek compared the relative costs of recontouring and covering the pile versus consolidating it with one of the other surface facilities, and found that relocating the material to the surface tailings facility for co-disposal is the most economical and environmentally protective solution. The geotechnical feasibility of blending production rock with tailings was studied in 2005 (Klohn Crippen 2005). The long term performance of the production rock and tailings blend will also depend on the geochemical performance of the blend. Therefore, geochemical studies have tested the geotechnical-recommended blend ratios for chemical stability, metal leaching, and acid generation potential. For more information on the results of the co-disposal geotechnical and geochemical studies, see the 2008 Tailings and Waste Rock Annual Report.

Removal of production rock material from Site E for disposal at the tailings facility commenced in 2006. Between 2006 and 2011, a total of approximately 101,400 cubic yards of material were removed from Site E. There was no removal in 2012 or 2013 due to a delay in the permitting process for the proposed Stage III Tailings Facility Expansion and the need to utilize the remaining permitted capacity for tailings disposal. HGCMC plans to remove the remaining production rock from Site E for disposal in the tailings expansion area. No additional haulage will occur until the required permits are issued for the tailings expansion and construction is underway.

The HGCMC Site E Removal: Waste Rock and Tailings Co-Disposal Plan was approved by the agencies and implemented prior to the commencement of removal activities in 2009. The Plan outlined additional BMP activities that would be instituted during active removal, including capturing and pumping of water to treatment from the work area. In 2010, a 0.9 acre-ft pond was constructed at the northwest corner of the pile to facilitate collection and pumping of pile drainage during removal. Runoff that accumulates in the pond continues to be pumped to the water treatment facility from May through October each year.

HGCMC anticipates recovery of the underlying dewatered glacial till material originally placed at this site from the Mill Backslope excavation. This till material will serve to enhance the barrier layer performance of future reclamation capping efforts. Once the production rock is removed, the till material will be assessed and consolidated/recontoured as needed. HGCMC expects to utilize the remaining Site E area for the storage of additional reclamation material, minimizing the need for future disturbances in other areas.

2.7 2.5 Mile B Road Cut

Pyritic rock was exposed in the road cut at 2.5 mile during construction of the B Road in 1988. Weathering has decreased the reactive surface area of pyrite grains in the outcrop, and precipitation of hydroxide coatings has further decreased the reactivity of the rock. HGCMC will use monitoring of Zinc Creek to determine if additional efforts are required at the road cut. HGCMC has determined that Site 8 (inactive FWMP site) is an appropriate monitoring point in Zinc Creek below the road cut to evaluate its effects on water quality. Very limited sampling has occurred at this site since 1995, but will be performed at least once per year in the future. Risks related to bear activity in the area will be evaluated during development of the monitoring

schedule. Two areas along the B road corridor were filled with material from the 2.5 mile B Road cut: 1.8 mile pullout and Zinc Creek Bridge Abutment.

1.8 Mile Pullout

Pyritic rock from the road cut at 2.5 mile B Road was used as fill for the 1.8 mile B Road pullout. HGCMC redirected road ditch water around the pad to reduce infiltration through the pyritic rock. HGCMC plans to continue monitoring this site, with removal of the pyritic material following removal of other higher priority sites.

Zinc Creek Bridge Abutment

Pyritic rock from the road cut at 2.5 mile B Road was also used as fill in the abutment of the Zinc Creek Bridge during road construction. Iron staining and poor quality runoff has been observed at the site. HGCMC maintains an APDES stormwater monitoring point at the site and has sampled the water composition of Zinc Creek above (Site 371) and below (Site 368) the bridge. Monitoring data (Table 2.3) demonstrate that the contribution of runoff has a detectable influence on the quality of Zinc Creek. The data indicate that concentrations are below water quality standard levels for constituents having practical quantification levels (PQL) low enough to compare to the standard. HGCMC applied lime to the fill in 2013. Additional treatments will be applied as needed prior to mine closure, when the pyritic rock will be removed with recovery and reclamation of the road. Sampling results from 2006 through 2013 show the pH values are not decreasing and the metals concentrations, with potentially the exception of iron, are not increasing with time.

Table 2.3 Zinc Creek Water Compositions

	Site	Date	pH	Cond	Alk	Mg	SO4	As	Cd	Cu	Fe	Mn	Ni	Pb	Zn
			s.u.	uS/cm	mg/l	mg/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Zinc Creek Below Bridge	368	Mar-06	7.1	121.3	42	3.7	11.9	0.3	<0.2	3.4	0.3	40	5.5	<0.1	12.0
	368	May-07	7.2	58.4	21	1.4	2.2	0.4	<0.2	0.9	59.7	3.0	2.1	0.1	8.6
	368	Dec-07	7.6	123.9	49	2.8	6.9	0.2	<0.3	1.0	120	12	2.7	<0.1	6.7
	368	Aug-09	6.8	80.4	34	2.3	4.8	0.5	0.1	2.0	<27	4.9	2.9	0.2	7.7
	368	Jan-10	7.6	101.0	<2	2.6	6.6	0.4	0.1	5.7	239	7.3	3.3	0.1	10.8
	368	Apr-11	6.6	114.0	32	2.8	8.5	0.6	<0.1	1.8	410	10.6	3.7	<0.1	12.0
	368	Sept-11	7.8	81.0	36	2.4	6.1	<0.5	<0.1	1.6	230	5.6	2.8	<0.1	8.0
	368	Jul-12	7.5	64	22	1.7	3.4	<0.2	<0.1	2.9	290	6.0	3.0	<0.1	12.0
	368	Mar-13	7.6	130	43	3.1	8.2	0.3	<0.1	2.7	240	8.4	2.6	<0.1	8.0
Zinc Creek Above Bridge	371	Mar-06	7.2	127.4	46	3.2	6.0	0.6	<0.2	0.6	0.0	2.7	2.3	0.1	2.4
	371	May-07	7.2	58.2	20	1.4	2.0	0.4	<0.2	0.8	51.7	2.4	2.1	0.2	9.0
	371	Dec-07	7.8	120.8	50	2.8	5.0	0.4	<0.3	0.7	<50	2.6	1.5	<0.1	4.1
	371	Aug-09	6.7	77.4	33	2.4	4.2	0.6	0.1	2.6	<27	2.4	2.9	0.1	6.6
	371	Jan-10	7.5	97.3	<2	2.4	5.2	0.4	<0.1	1.5	64.8	1.8	2.4	0.1	5.5
	371	Apr-11	7.5	107	35	2.4	4.3	<0.5	<0.1	1.0	50	1.8	1.7	<0.1	7.0
	371	Sept-11	6.8	79	37	2.4	4.2	0.5	<0.1	1.3	210	2.5	2.0	<0.1	6.0
	371	Jul-12	7.7	65	24	1.7	2.5	<0.2	<0.1	4.0	160	2.6	2.2	0.1	11
	371	Mar-13	7.7	125	45	2.9	5.0	0.4	<0.1	2.6	50	1.9	1.5	<0.1	5.0

3.0 Quarries

3.1 Introduction

This section of the HGCMC Annual Report is in accordance with the HGCMC General Plan of Operations (Appendix 11, Attachment C). Five quarry sites were developed in 1987 and 1988 to provide rock for constructing roads and other infrastructure at the Greens Creek facilities. All quarries are currently inactive and are being used to stockpile reclamation materials (rock, organic soils and glacial till). A summary of all operational and monitoring activities performed at these five quarry sites (borrow pits) in 2013 is provided. Refer to GPO Appendix 11 for a detailed description of the sites and associated monitoring requirements.

Summary statistics for HGCMC’s quarry sites are presented in Table 3.1. Flow and water quality data are summarized in Figures 3.1 to 3.15. The sites are discussed individually in subsequent sections. Refer to Figure 2.1 for site locations.

Table 3.1 Summary Statistics for Quarry Sites

	Quarries				
	Pit 405	Pit 6	Pit 174	Pit 5	Pit 7
Years Active (approx)	1987-1988	1987-1988	1987-1988	1987-2003	1987-1997
Acreage	3	3	2	Part of NW Tailings Expansion	4
Total Volume (cy)	17,000	22,800	10,000		107,000
Prod Rock/Other Vol (cy)	13,000	0	0		0
Reclamation Material (cy)	4,000	22,800	10,000		107,000

Acid Base Accounting data collected from 2002 to 2013 are summarized in Figures 3.16 and 3.17. Pit 405 and Pit 174 have significant exposures of potentially acid generating rock and produced several samples with acidic rinse pH. Pit 6 and Pit 7 produced samples showing a broad distribution of NNP and rinse pH, and Pit 5 generally produced acid neutralizing samples with alkaline rinse pH. Buildup of oxidation products (salts) on overhanging quarry walls was noted at each of the five quarry sites and may have contributed to the lower rinse pH readings for several samples.

Flow data for the quarry sites are presented in Figure 3.1. Much of the flow data prior to 2003 were collected during or shortly following storm events and represents maximum flow values. Recent flow estimates vary from 60 gpm to less than 1 gpm with most less than 10 gpm. The bowl-shaped geometry and low permeability of the quarry walls and floors tend to focus flow toward the entrance of the pits.

The amount of reactive surface area available for sulfide oxidation is considerably less for quarries than for production rock piles. Oxidation is limited to the non-coated outer face of the near-vertical quarry wall and near surface fractures. Lower sulfide contents and smaller surface area yield a lower flux of oxidation products from quarries compared to production rock sites.

Figure 3.2 shows pH data from the quarry site sampling locations. Since 1995 all but two samples have had a pH between 6.0 and 8.0. A pH of 5.8 was recorded from Pit 174; however, more recent samples from this site averaged about 6.7. Alkalinity data presented in Figure 3.3 are

consistent with the pH results, with all sites maintaining measurable alkalinity provided by dissolution of carbonate minerals. The lower alkalinity value from Pit 6 represents influences from organic acids derived from forest soils (note associated low conductivities of Pit 6 samples). Sample sites with the highest alkalinity are groundwater monitoring wells in Pit 5. Pit 5 generally shows a higher carbonate content and may also show influences from the water treatment plant which was located near Pit 5 until 2008.

Conductivity data are shown in Figure 3.4. Conductivity indicates the amount of dissolved constituents in the water. Samples having higher conductivity values usually have higher sulfate, calcium and magnesium (hardness) concentrations, reflecting influences from sulfide oxidation and carbonate mineral dissolution. Conductivity data are consistent with waters derived from freshly exposed low to moderately mineralized quarry rock. MW-T-01-07 has had considerably higher conductivity and sulfate concentrations, which may reflect an influence from the old Pit 5 water treatment plant. Past treatment plant upsets have contributed water to the area around the plant. However, in general since 2001, conductivity and sulfate concentrations in this well have decreased. The increase in sulfate concentrations in MW-T-01-09 in 2005 and 2006 may indicate the movement of the sulfate-rich water from the MW-T-01-07 area to the east. These wells and their relationship to the old treatment plant and the Tailings Facility are discussed in more detail in HGCMC 2003 Annual Report. HGCMC decommissioned the Pit 5 water treatment plant in 2008 to accommodate the Tailings Facility expansion. The results for sulfate, magnesium and hardness, shown in Figures 3.5, 3.6 and 3.7, respectively, correlate with conductivity results.

The data for zinc, copper, lead, cadmium, nickel, arsenic, iron and manganese are presented in Figures 3.8 to 3.15. Sample results that were less than the detection limit are plotted at one half the detection limit value. While this allows the results to be plotted on a logarithmic scale, it causes non-detect results with high detection levels to appear more concentrated than they actually are. Detection limits have varied with time and are often evident on the graphs as horizontal groupings of symbols. The results for metals generally correlate with conductivity values. Zinc and manganese concentrations reflect the higher solubility of these elements relative to the others at the near-neutral pH conditions. Dissolved metal loads from quarry sites have been consistently low and generally either remained fairly constant or decreased with time. The decrease in dissolved metal loading is attributed to a reduction of reactive surfaces as reactants are consumed and coatings form on mineral surfaces. Elevated total metal concentrations occur periodically in response to increased suspended solids during storm events. The storm water monitoring data are presented to provide a general indication of the effects of sediment loading, typically from road surfaces, and do not reflect dissolved loading from the quarry walls.

Closure options for pyritic pit walls are relatively limited. Since there are no proven long term surface treatments available, it is best to let naturally occurring coatings that have formed over the past 20 years continue to form. As the coatings form and the amount of available pyrite decreases, so too will the relatively small dissolved load generated by these surfaces.

3.2 Pit 405

Pit 405 is located at 7.6 mile on the B Road. The rock from this quarry was used for construction of the B Road and other mine infrastructure. Mine records indicate that approximately 13,000 cubic yards of production rock were backfilled into the quarry in 1988. The quarry received reclamation materials (colluvium and glacial till) in 1994, 1995 and 1998 for use in future reclamation projects. HGCMC drilled a hole through the fill material in June of 2005 to characterize the materials. The profile at the center of the pit from the surface down consists of approximately two feet of glacial till and organics (fill), 15 feet of sericitic phyllite (waste rock)

and 22 feet of grey silty till (fill). The foundation of the pit is fractured, pyritic, chloritic rock. A standpipe was installed to a depth of 37.5 feet below the drill pad surface, but difficulties encountered during installation may have affected its completion. Development and evaluation of the standpipe occurred in 2006; however, the casing was damaged in 2007. The well was repaired in 2008. The well was subsequently damaged, and later fixed and sampled again in 2012. Water quality results are shown in Table 3.2. The 2012 apparent increase in zinc is not accompanied by a concurrent increase in other metals, particularly cadmium, and may be a result of analytical/reporting error. The well is completed in pyritic bedrock so there may be some difficulty differentiating between contributions from quarry fill material and the bedrock itself.

Table 3.2 Water Quality Data Pit 405

Site	Date	Alk Tot mg/l	As ug/l	Cd ug/l	Cond Field umho	Cu ug/l	Fe ug/l	Hard mg/l	Mg mg/l	Mn ug/l	Ni ug/l	Pb ug/l	pH Field su	SO ₄ Tot mg/l	Zn ug/l
1043	11/4/08	124	0.33	<.2	658	0.74	88.6	300	16.5	2320	7.5	1.86	7.31	184	24.8
1043	10/18/12	117	0.5	0.1	612	<0.5	70	306	16.8	2030	4.1	3	7.29	170	281

Monitoring of drainage downgradient of the quarry (Figures 3.1 to 3.15) demonstrates that influences from the site are negligible. Barring a significant change in downstream water quality, the site will be reclaimed when the reclamation materials stored in the quarry have been utilized at other sites. The production rock in the quarry will either be removed or covered in-situ. Removal of the rock could prove detrimental as this would increase exposure of the now covered pyritic quarry wall.

3.3 Pit 6

Pit 6 is located at 4.6 mile on the B Road across from Site E. The quarry produced rock for construction of the B Road in 1987. Reclamation materials were hauled to the site from Site 23 and the 920 facility during various construction seasons. Monitoring of surface drainage from the pit access ramp indicates no significant influence from the pit walls or stored material. Reclamation materials will be used to reclaim other mine facilities. Approximately 3,800 cubic yards of reclamation materials from the backslope of Site 23 were hauled and stored at Pit 6 in September 2007. Reclamation material (6,500 cy) from the top of Site E was hauled to Pit 6 in 2009. Water quality at the stormwater sampling site at Pit 6 showed increases in total lead and zinc in 2009, potentially attributable to hauling the reclamation materials from Site E to Pit 6. Since 2010, lead and zinc levels have returned to within historical levels at this site.

3.4 Pit 174

Pit 174 is located at 3.3 mile on the B road and was used for road construction in 1987. The pit has been partially backfilled with reclamation materials that will be used to reclaim other site facilities. Drainage from the site has an average pH of 6.7 (Figure 3.2). Sulfate and metal concentrations in the pit drainage are moderate, however flows are generally low (typically less than 10 gpm during rain events). Iron staining periodically occurs in the drainage below the site which collects runoff from this quarry and surrounding areas. Once the stored reclamation materials (rock, organic soils and glacial till) are utilized, the site will be reclaimed. Reclamation goals include minimizing runoff from the exposed pit wall and covering as much of the exposed pyritic rock as possible by placing a wedge of glacial till at the base of the wall.

A runaway truck ramp was installed at Pit 174 following a haul truck incident at the site in 2006. The water tank was also moved from the quarry to the other side of the haul road to facilitate the emergency access route to the truck ramp.

3.5 Pit 5

Pit 5 was located in the northern portion of the Tailings Facility at 0.8 mile on the B Road, and until 2008 housed the water treatment plant. The Pit 5 water treatment plant was decommissioned in June of 2008. Rock from the pit was originally used for construction of roads and other surface facility infrastructure. Approximately 13,500 bank cubic yards of rock were quarried from Pit 5 in 2002. Peat and sand from excavation of the West Buttress in 1997 were moved to the east rim of Pit 5 in 2004 and 2005 for temporary storage prior to disposal in the tailings area. The material was hauled to the north end of the tailings pile in 2007. Between 2006 and 2008 approximately 268,110 cubic yards of shot rock were taken from Pit 5 in conjunction with the tailings expansion. The expansion of the Tailings Facility in the Pit 5 area was completed in 2008. The Pit 5 area is now an active tailings placement location (northwest area) which is underlain with an HDPE liner tied into the natural till underlying the tailings pile to the south.

The 2008 zinc levels in MW-T-01-07 and MW-T-01-09 showed an increase compared to historic years. This is likely due to the heavy construction and disturbance in the immediate area surrounding the wells. The zinc concentrations decreased in these two wells in 2009 and in 2010. Zinc levels since 2011 are similar to 2008 levels. Fluctuations in metal concentrations appear to be independent of major ion concentrations and may reflect changes in carbonate speciation and sorption/desorption mechanisms resulting from covering the quarry floor with a liner. During the construction activities at Pit 5, MW-T-01-08 was compromised and is no longer sampled.

Prior ABA analyses from pit walls indicate that the rock does not have the potential to generate acid, although it does contain small diffuse amounts of pyrite, often occurring as isolated euhedral cubes. The pit has been completely backfilled as part of the tailings expansion.

3.6 Pit 7

Pit 7 is located at 1.8 mile on the A Road between Hawk Inlet and Young Bay. The pit was initially developed in 1987 to support construction of the roads and other mine facilities. Pit 7 has been partially backfilled with peat and gravel material from the Tailings area, and tree stumps and reclamation materials derived during expansion of the tailings pile and development of the sand pit at 1.4 mile on the A Road. In 2008 crews stockpiled, crushed and hauled sorted material from the 1.4 mile sand pit to Pit 7. Despite iron staining on the south pit wall, iron staining observed in the drainage from the pit is mostly due to dissolution of iron-rich oxide coatings in the peat and gravel fill rather than from the pit walls themselves. Temporary hydroseeding of the peat has resulted in a productive grass cover of these materials. Monitoring results of drainage from the pit are shown in Figures 3.2 to 3.15. Relatively low sulfate concentrations (approximately 200 mg/l) and low dissolved metal values support the conclusion that limited sulfide oxidation is occurring at Pit 7. Dissolution of iron and manganese oxides in the fill stored in the pit has produced elevated concentrations of these metals in the drainage. Oxidation of the drainage and re-precipitation of the metals is expected in the constructed wetlands downgradient of the pit. Increases in total lead and zinc concentrations were observed in stormwater samples from Pit 7 (Site 521) in 2010. The increase in total metals was accompanied by a decrease in conductivity, which suggests that entrainment of sediments from the access road during the storm

event could be the source of the elevated metals. Since 2011, the zinc, lead, and conductivity results have returned to historical levels.

In 2011, crews stockpiled topsoil material in Pit 7 from the East Ridge Expansion development area at the Tailings Facility. Pit 7 currently contains 107,000 cy of reclamation materials to be used for capping at closure. Following removal of stockpiled capping materials for reclamation of other sites, the Pit 7 site will be contoured and hydroseeded.

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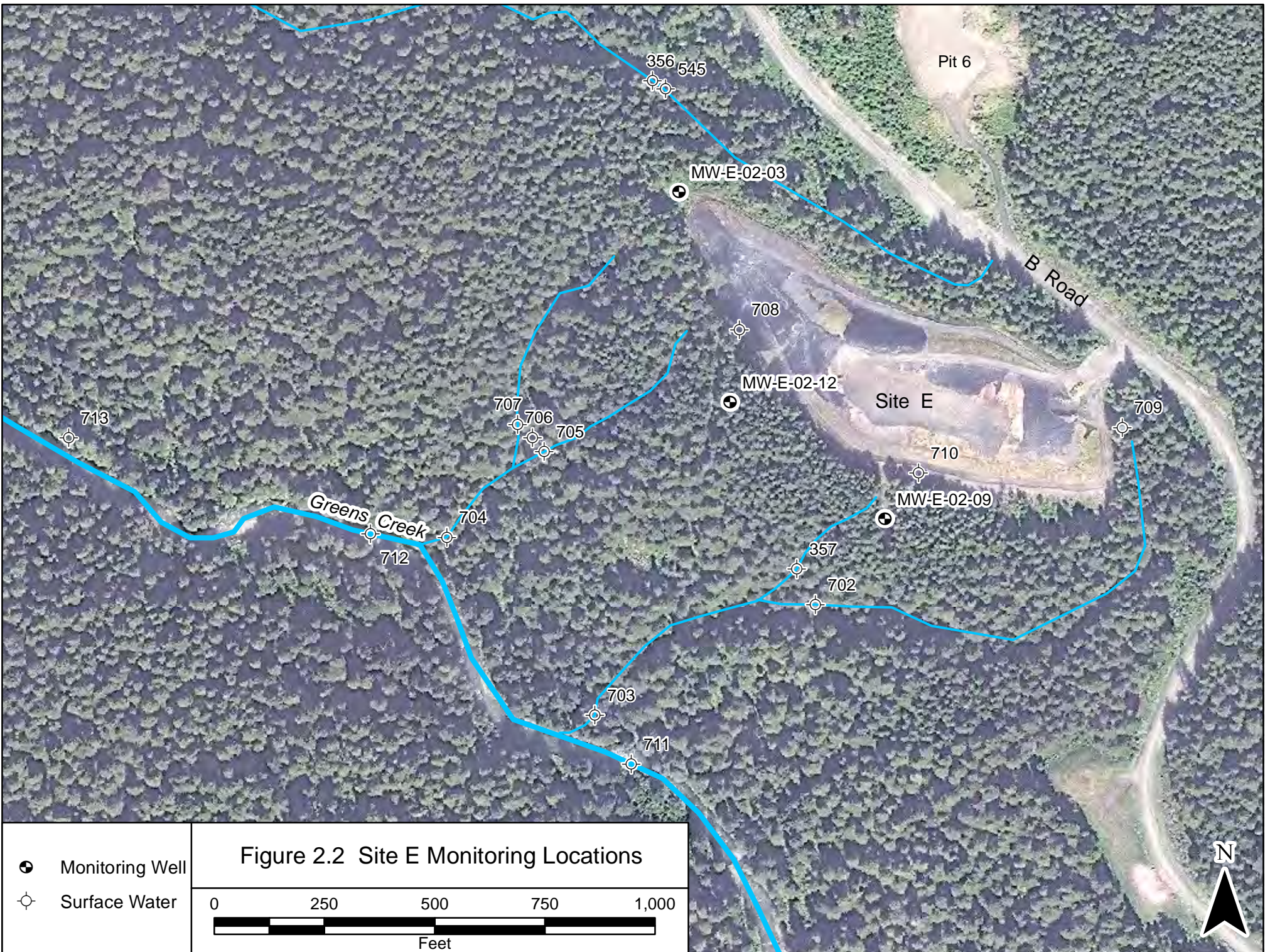
APPENDIX 1



Figure 2.1

GREENS CREEK SITE LOCATION MAP

Project No: MH000969.0001	Project Manager: E. Fernandez
Drawn By: J. Chen	Checked By: D. Helmericks



Pit 6

MW-E-02-03

B Road

708

MW-E-02-12

Site E

709

710

MW-E-02-09

Greens Creek

704

707

706

705

357

702

703

711

713

712

FIGURE 2.3 2002-2013 INACTIVE SITE ABA DATA

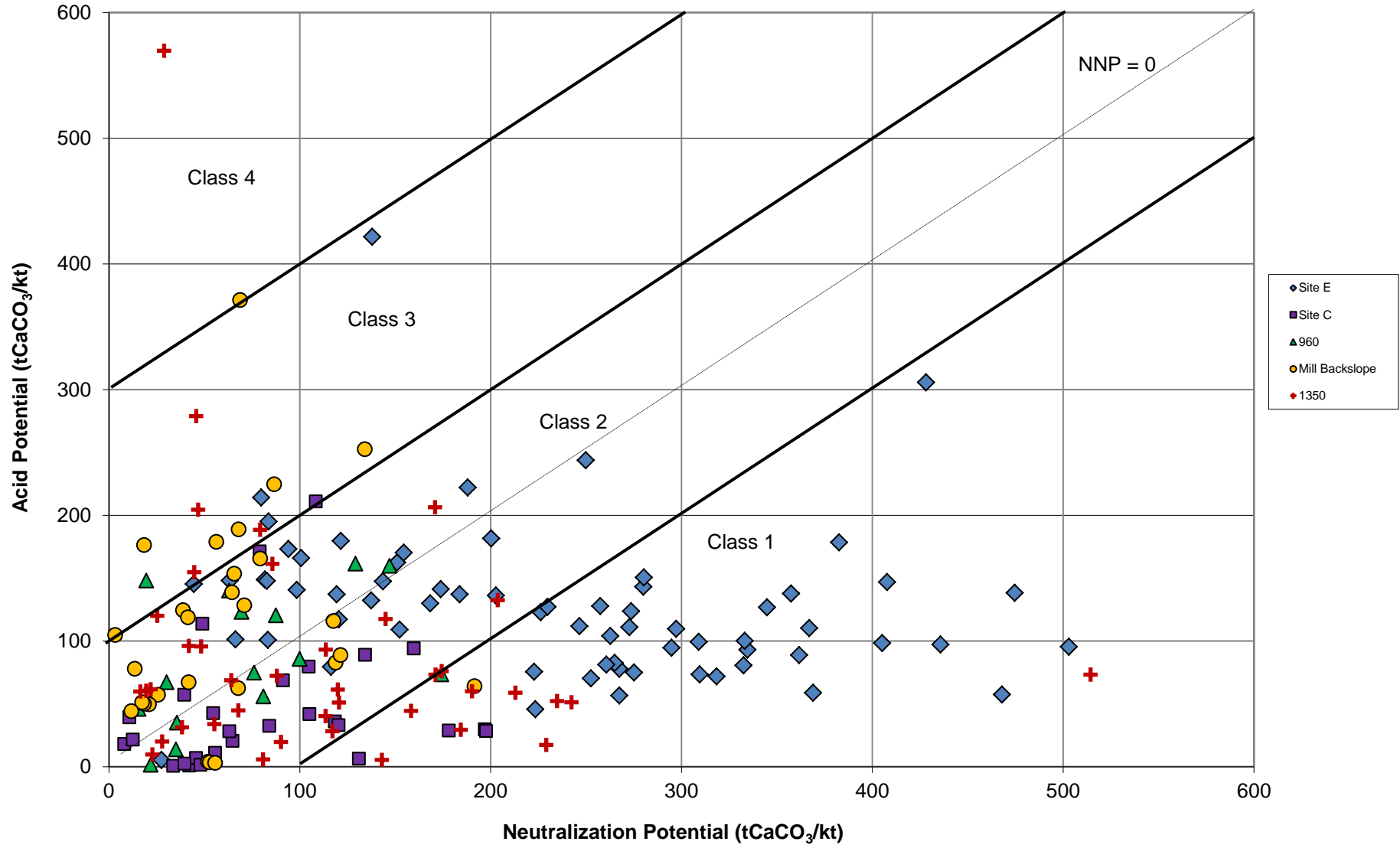


FIGURE 2.4 2002-2013 INACTIVE SITE ABA DATA (NNP vs pH)

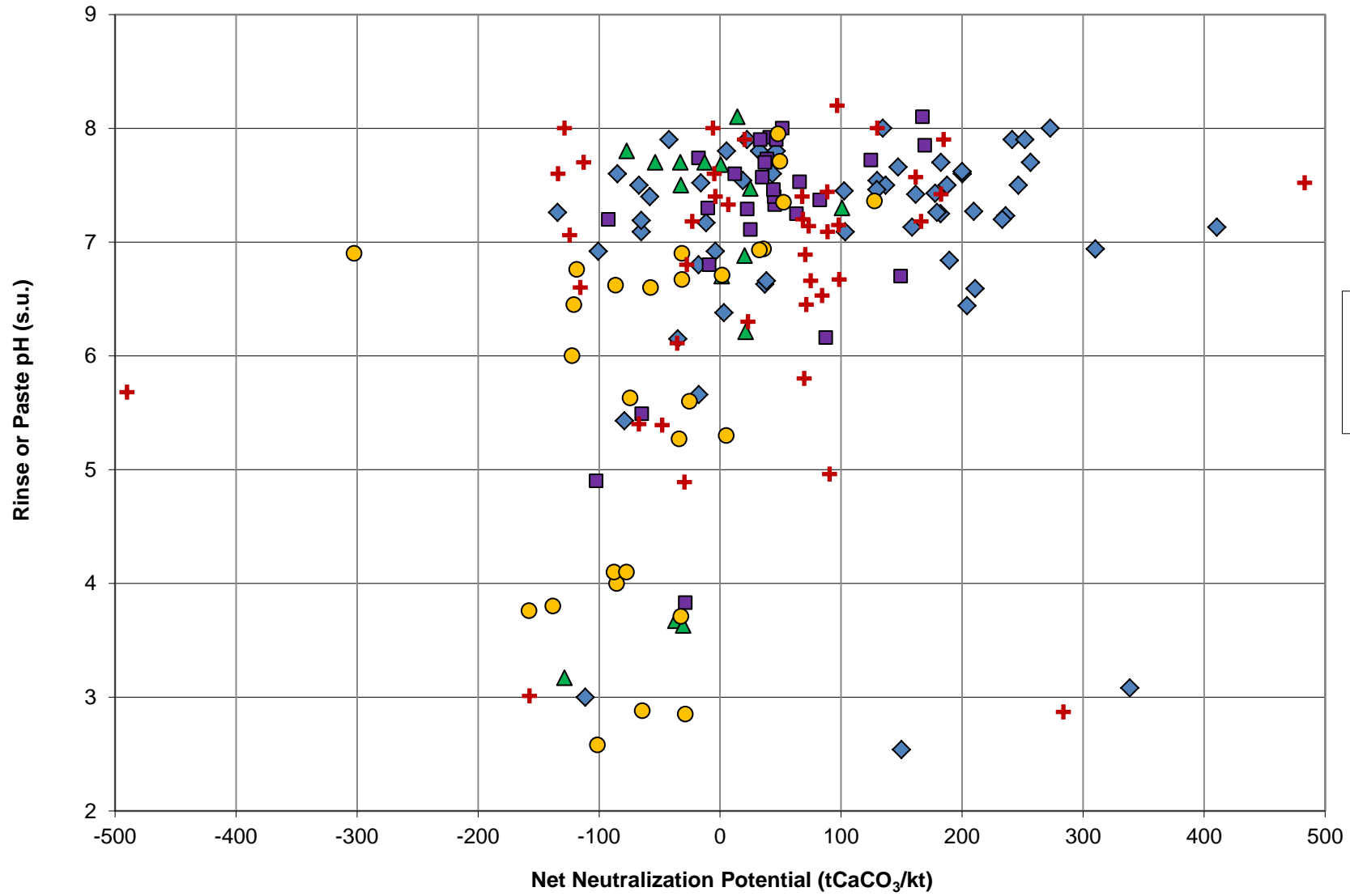


Figure 2.5 INACTIVE PRODUCTION ROCK SITE FLOW DATA

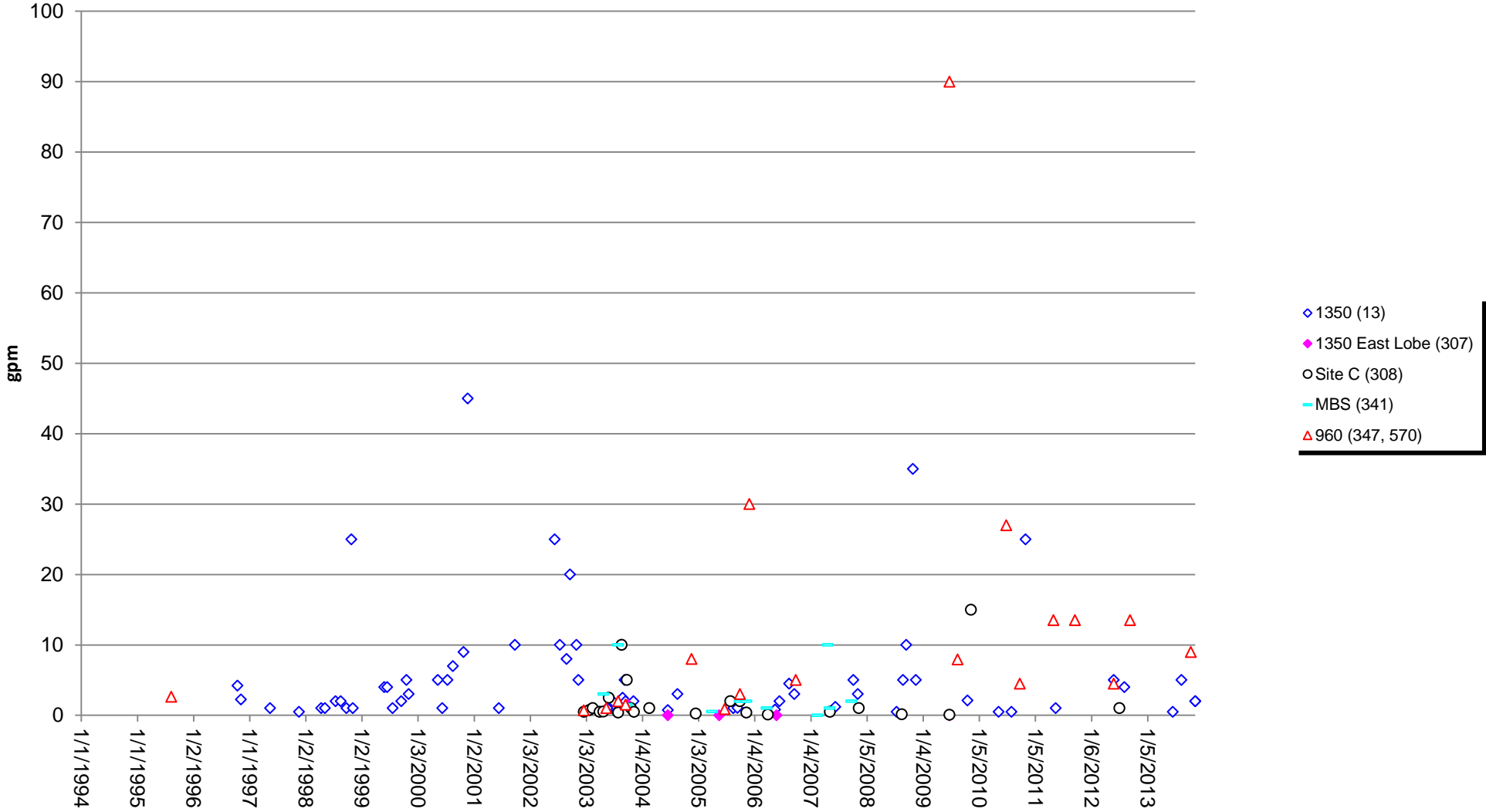


Figure 2.6 INACTIVE PRODUCTION ROCK SITE pH DATA

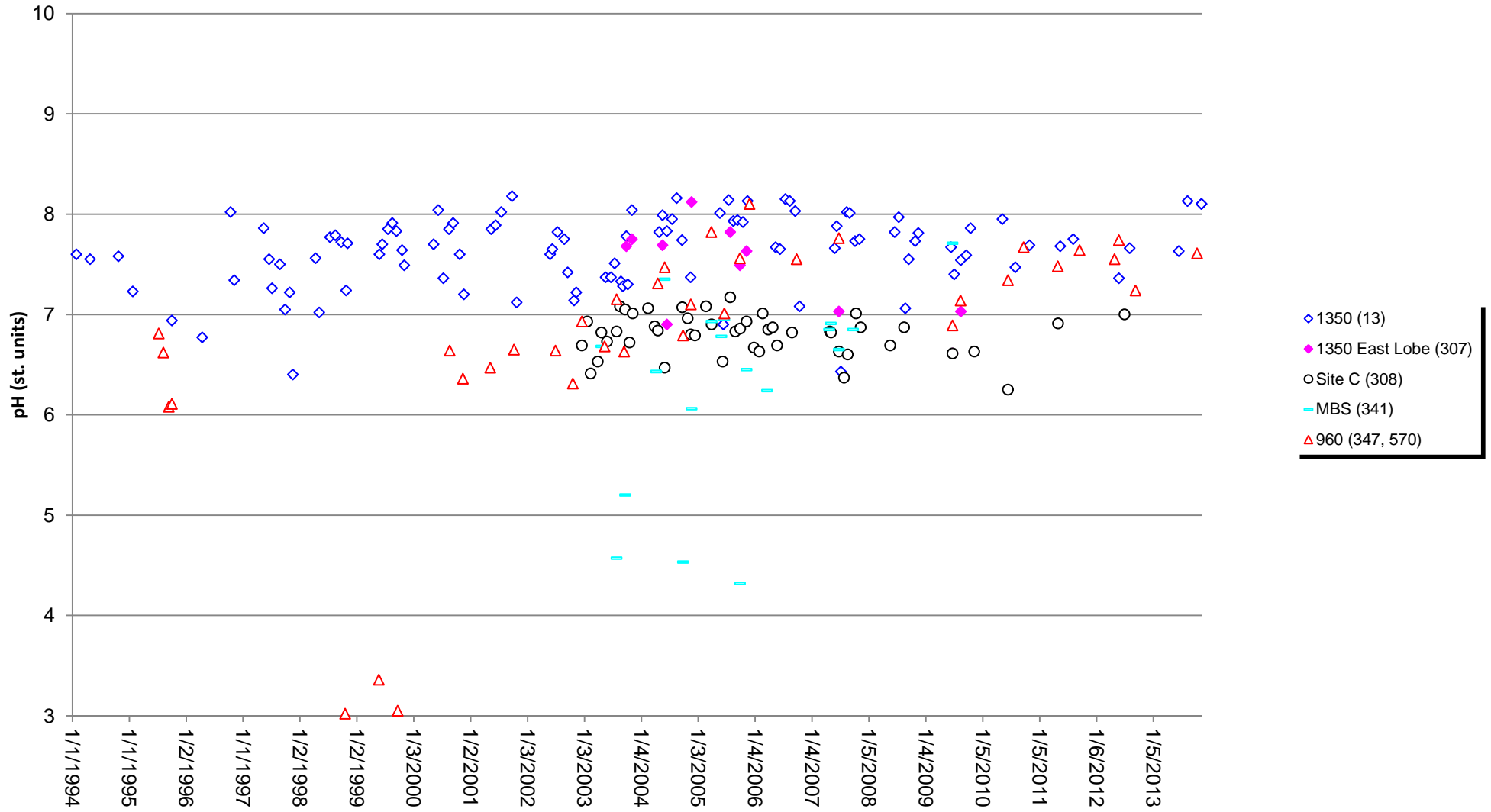


Figure 2.7 INACTIVE PRODUCTION ROCK SITE ALKALINITY DATA

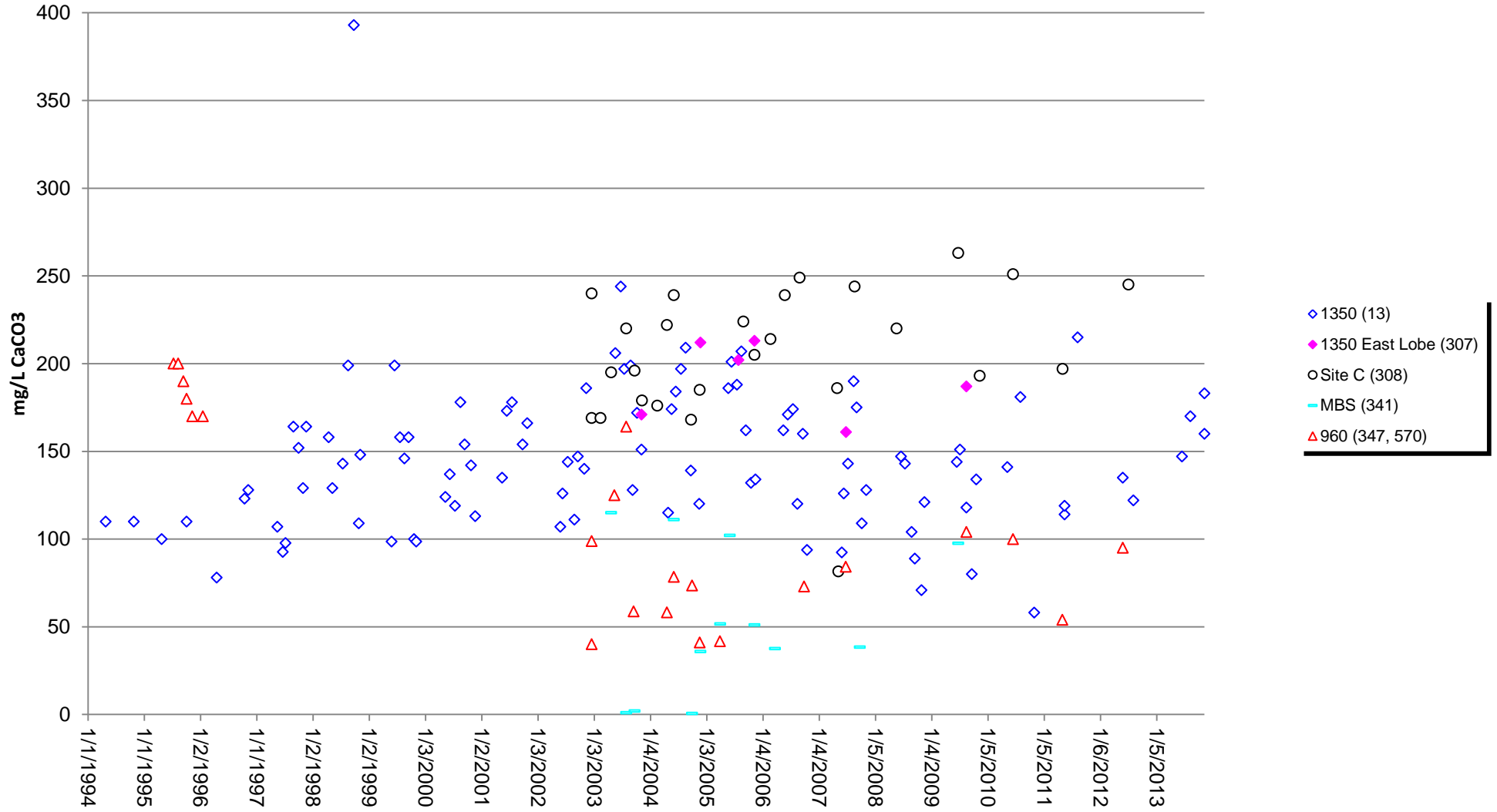


Figure 2.8 INACTIVE PRODUCTION ROCK SITE CONDUCTIVITY DATA

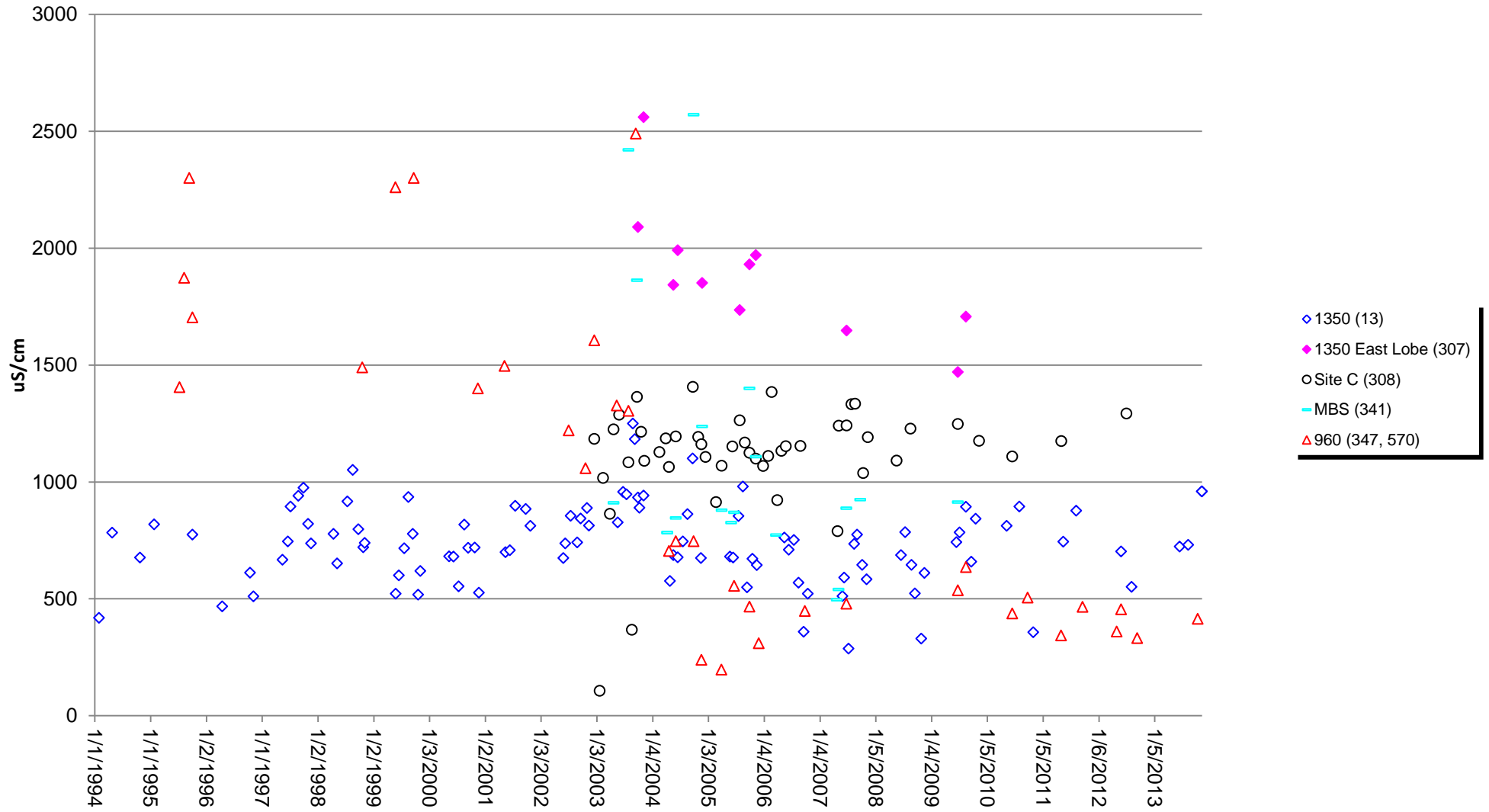


Figure 2.9 INACTIVE PRODUCTION ROCK SITE SULFATE DATA

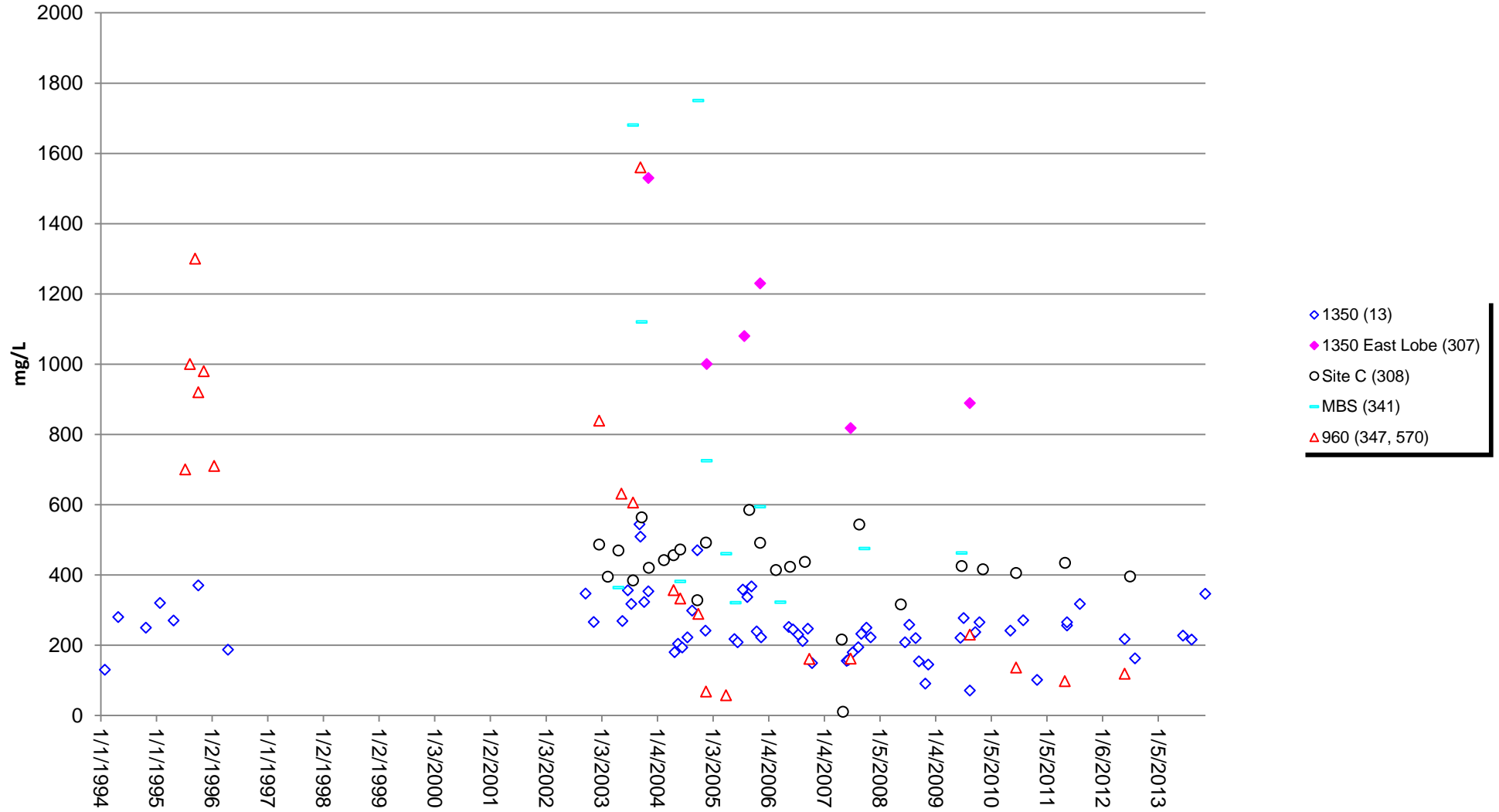


Figure 2.10 INACTIVE PRODUCTION ROCK SITE MAGNESIUM DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

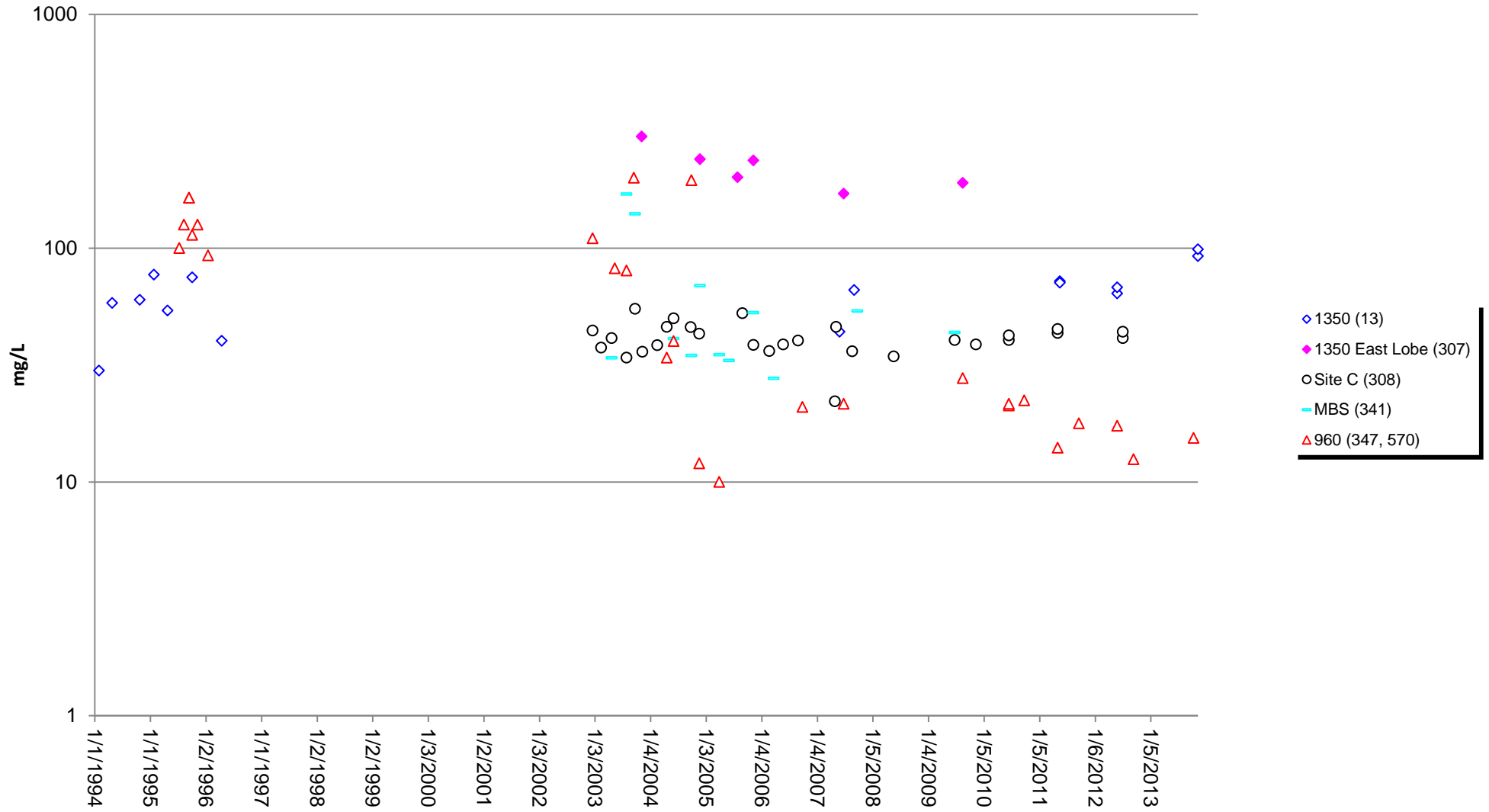


Figure 2.11 INACTIVE PRODUCTION ROCK SITE HARDNESS DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

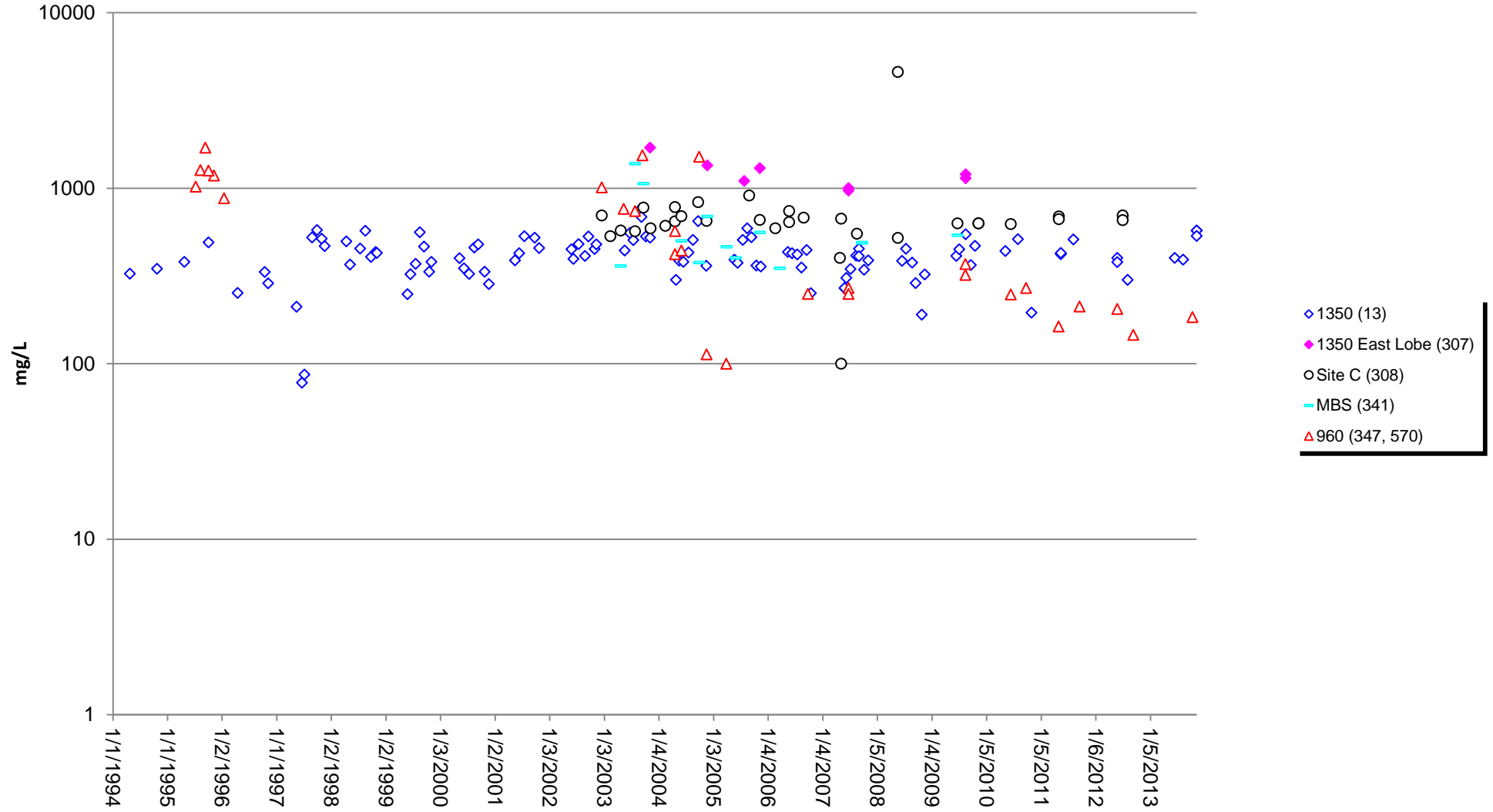


Figure 2.12 INACTIVE PRODUCTION ROCK SITE ZINC DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

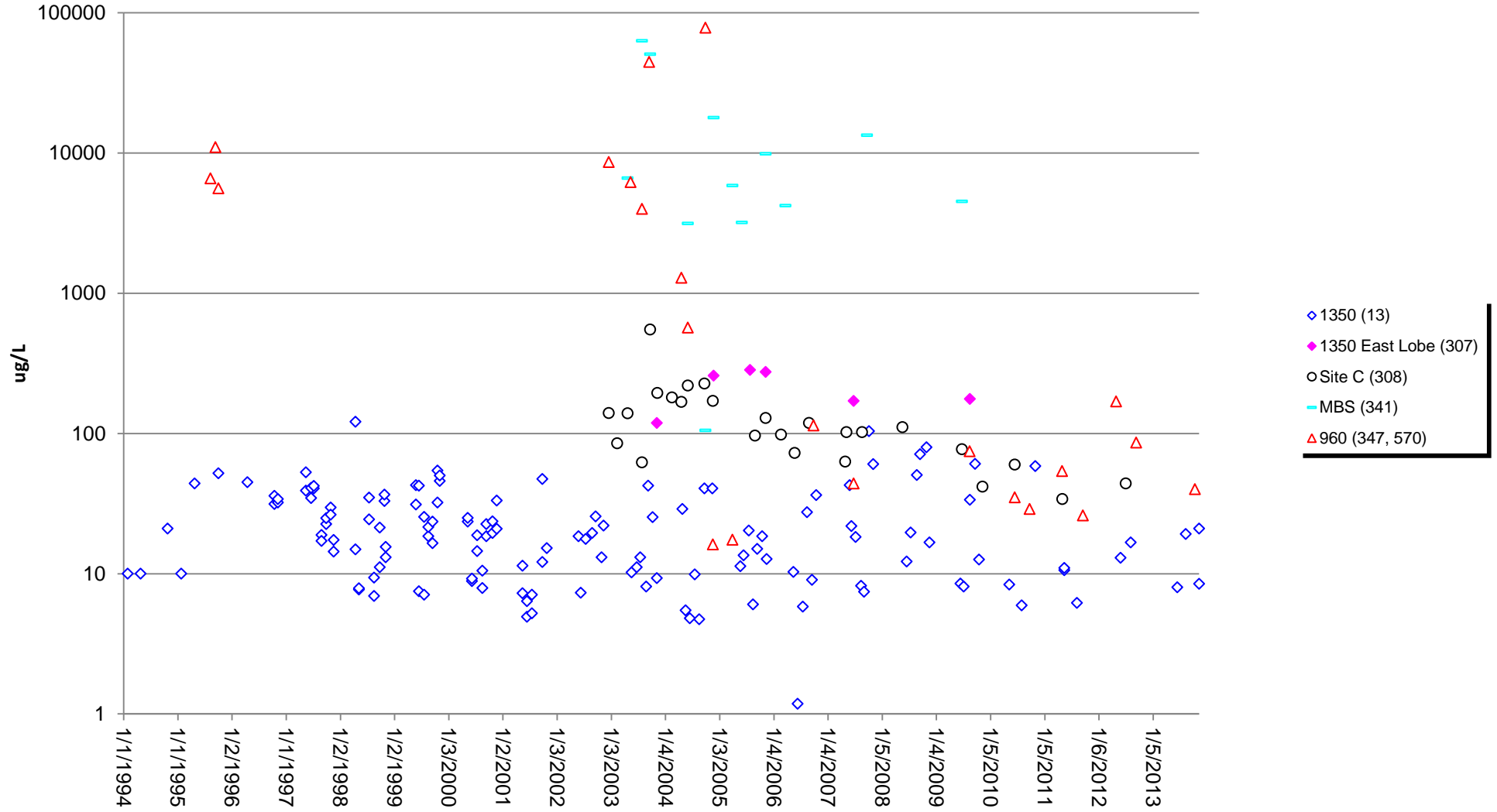


Figure 2.13 INACTIVE PRODUCTION ROCK SITE COPPER DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

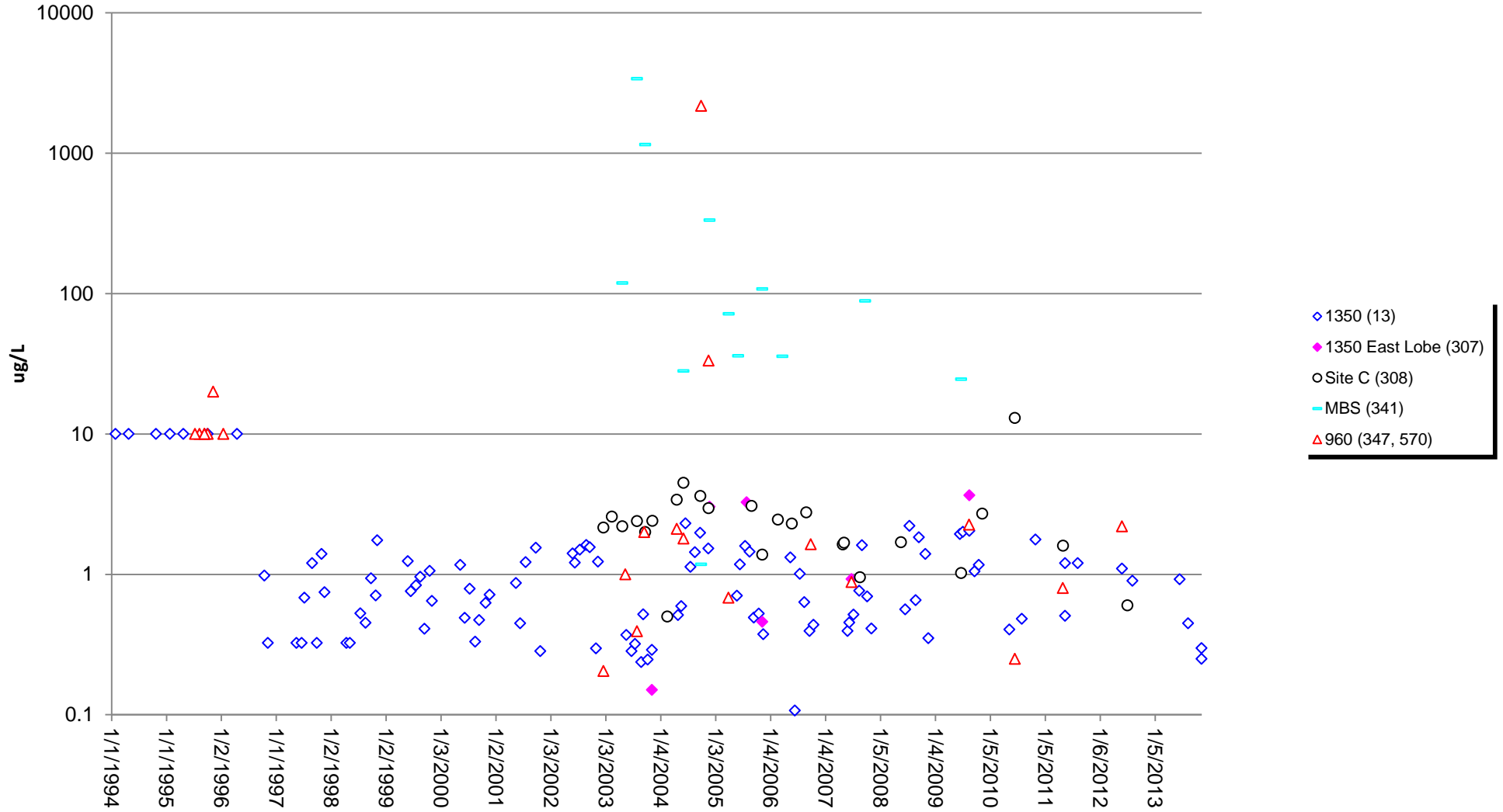


Figure 2.14 INACTIVE PRODUCTION ROCK SITE LEAD DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

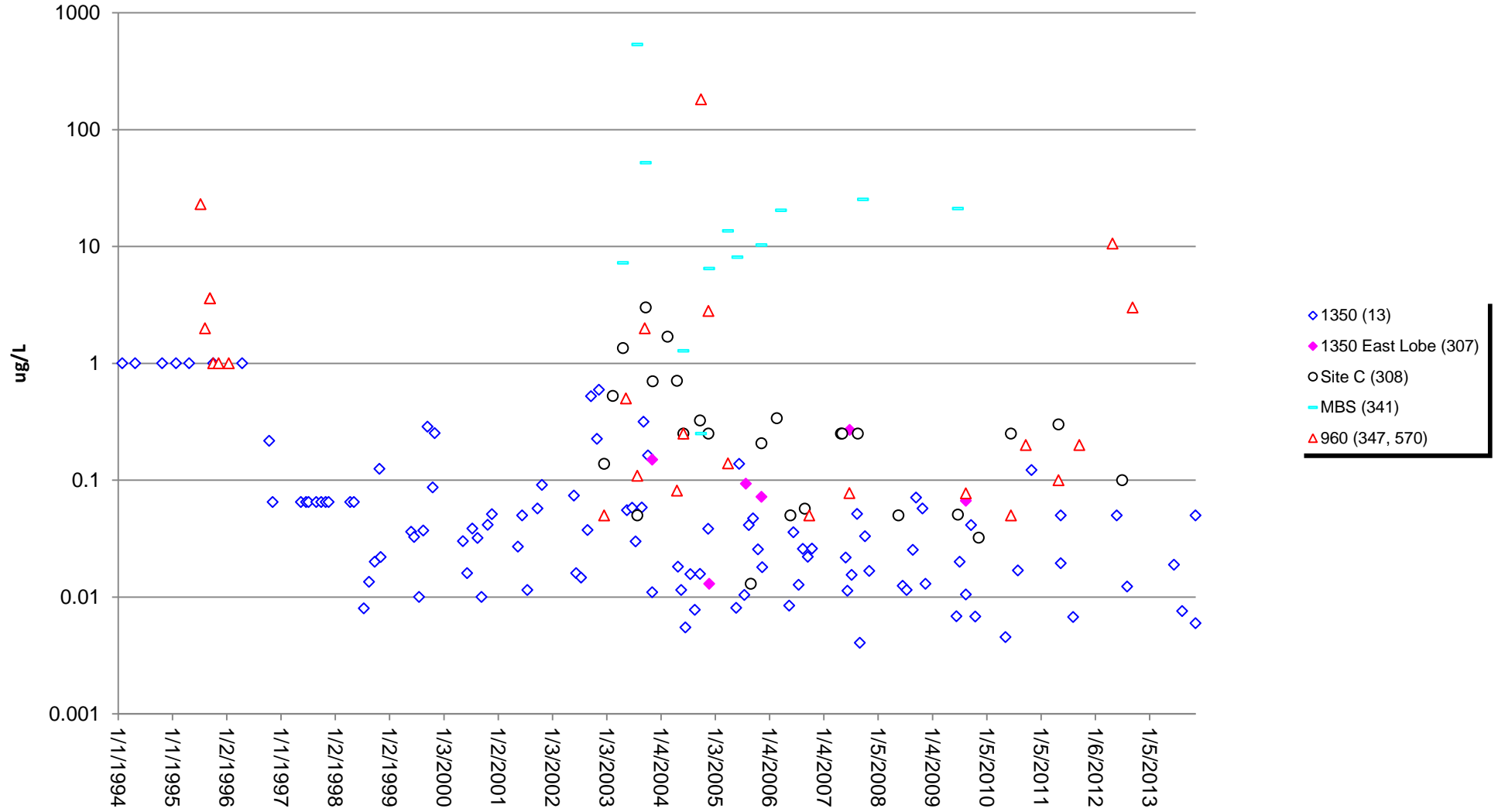


Figure 2.15 INACTIVE PRODUCTION ROCK SITE CADMIUM DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

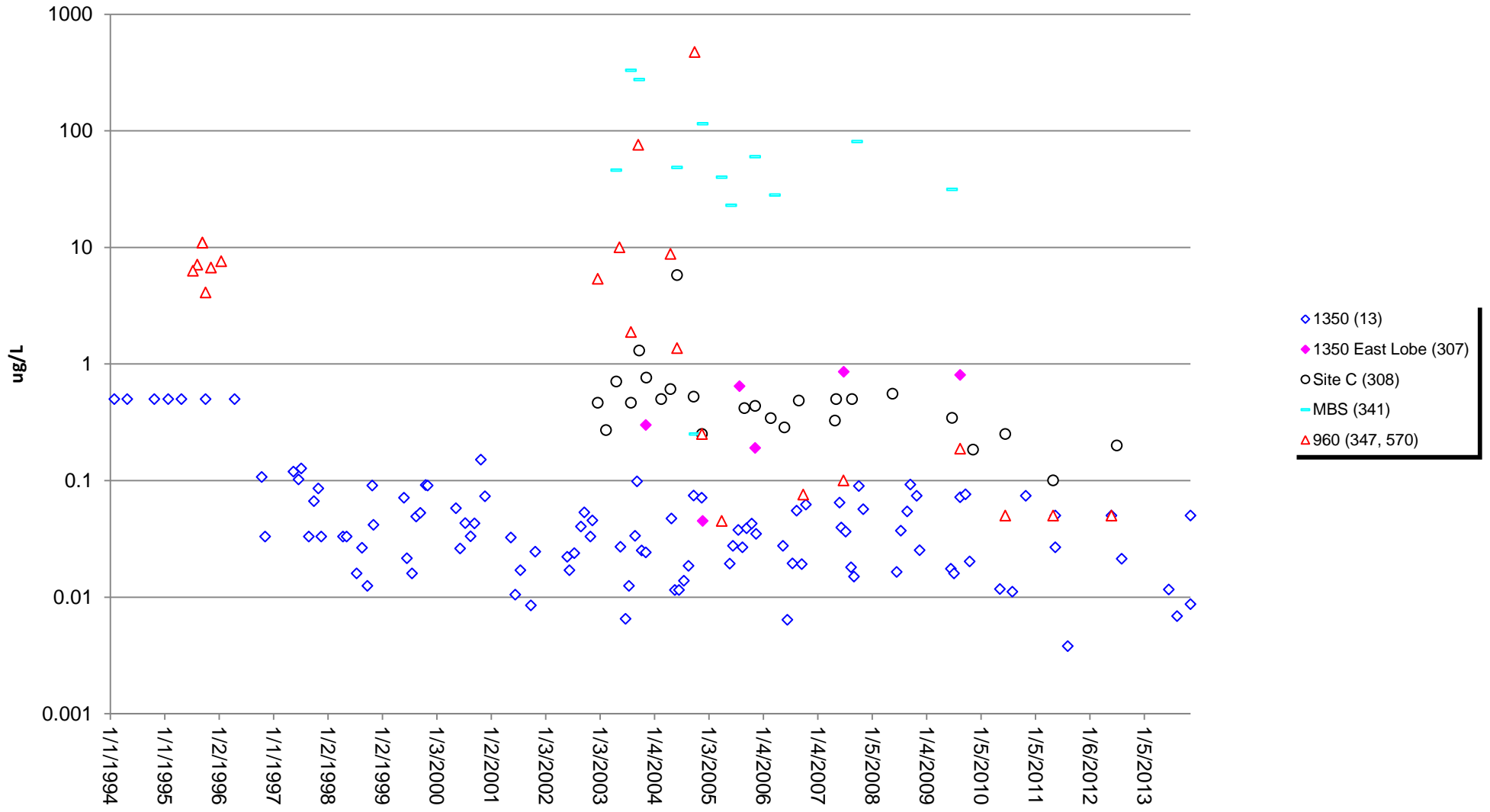


Figure 2.17 INACTIVE PRODUCTION ROCK SITE ARSENIC DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

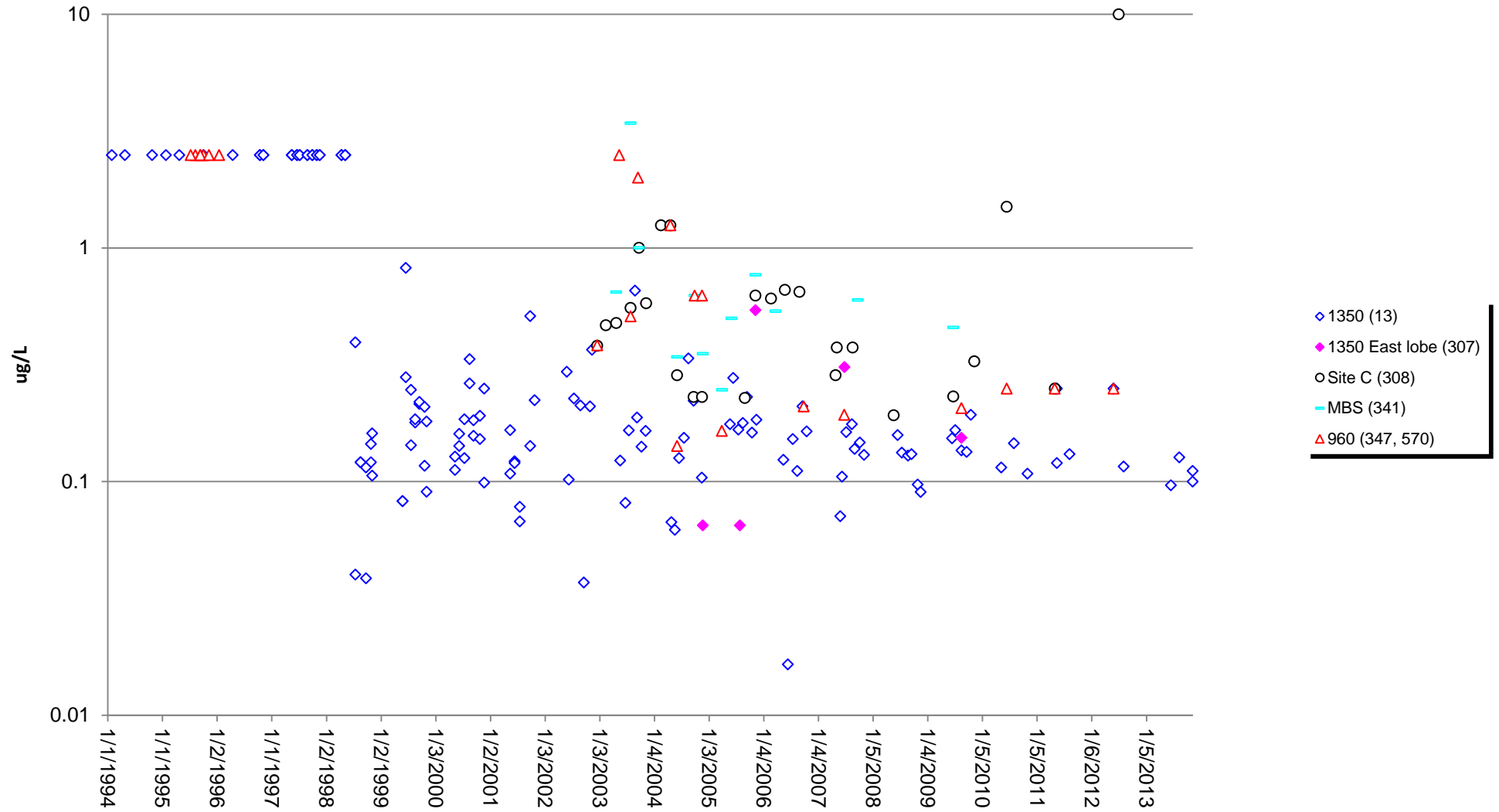


Figure 2.18 INACTIVE PRODUCTION ROCK SITE IRON DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

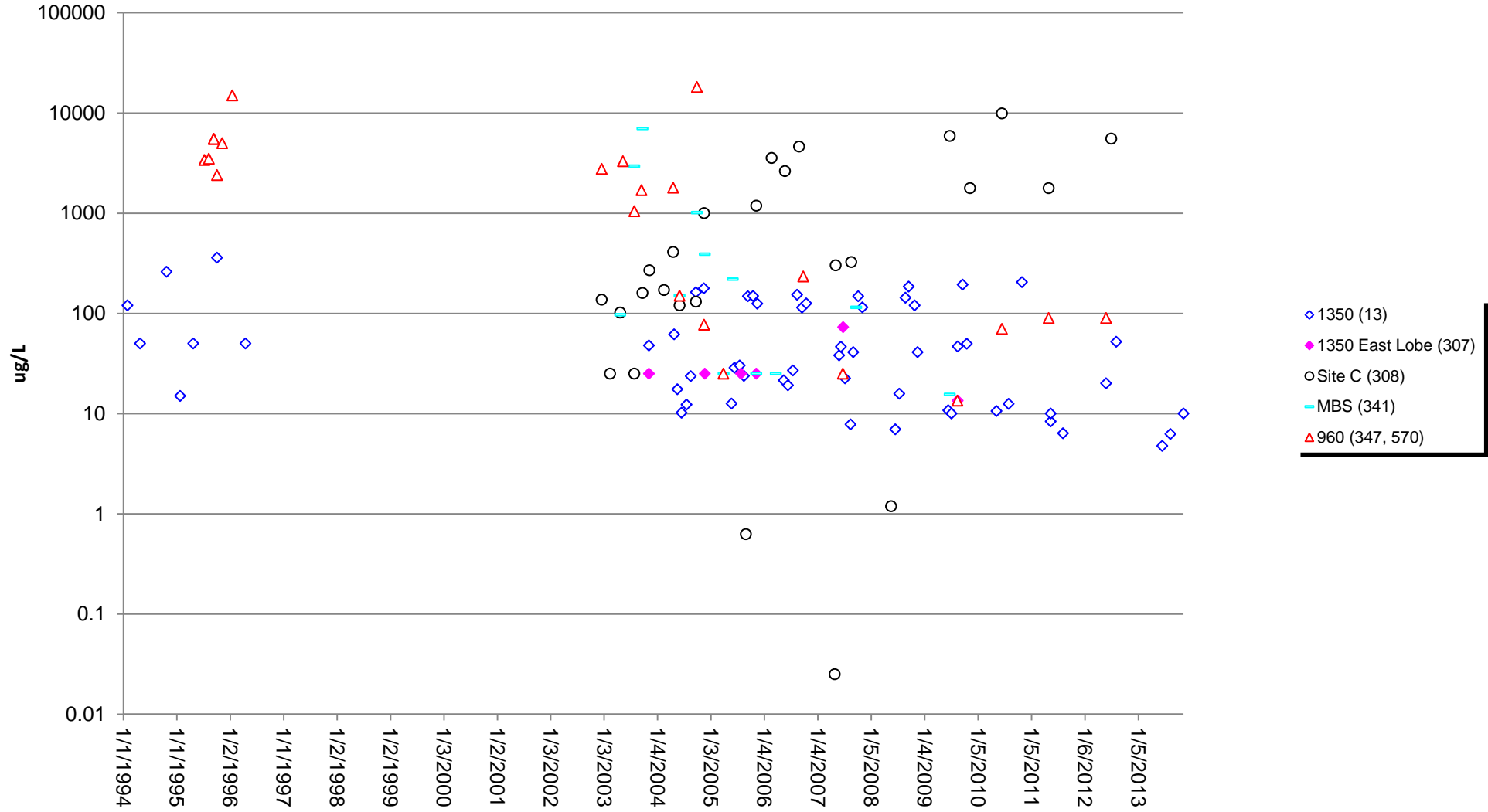


Figure 2.19 INACTIVE PRODUCTION ROCK SITE MANGANESE DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

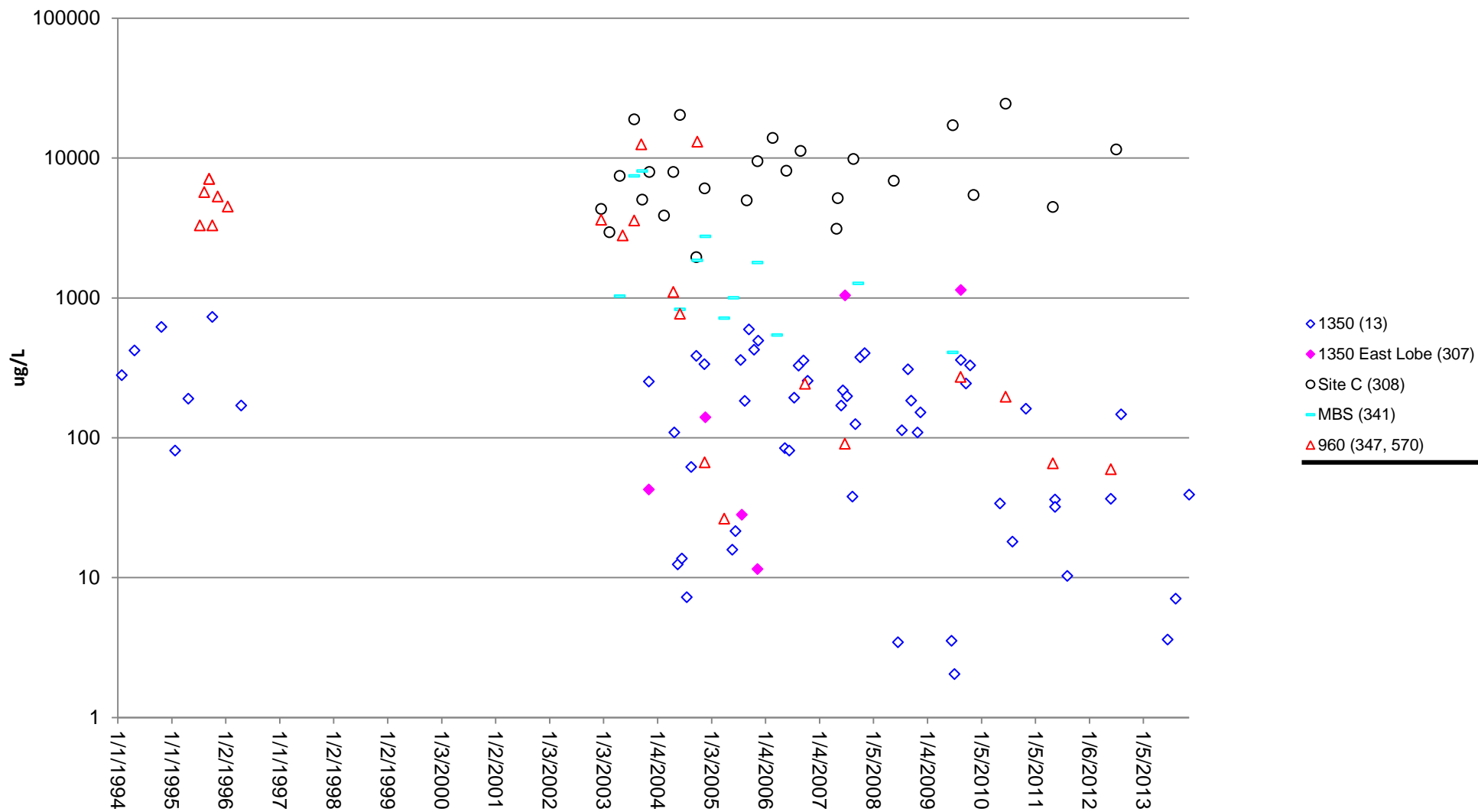


Figure 2.20 INACTIVE PRODUCTION ROCK SITE E FLOW DATA

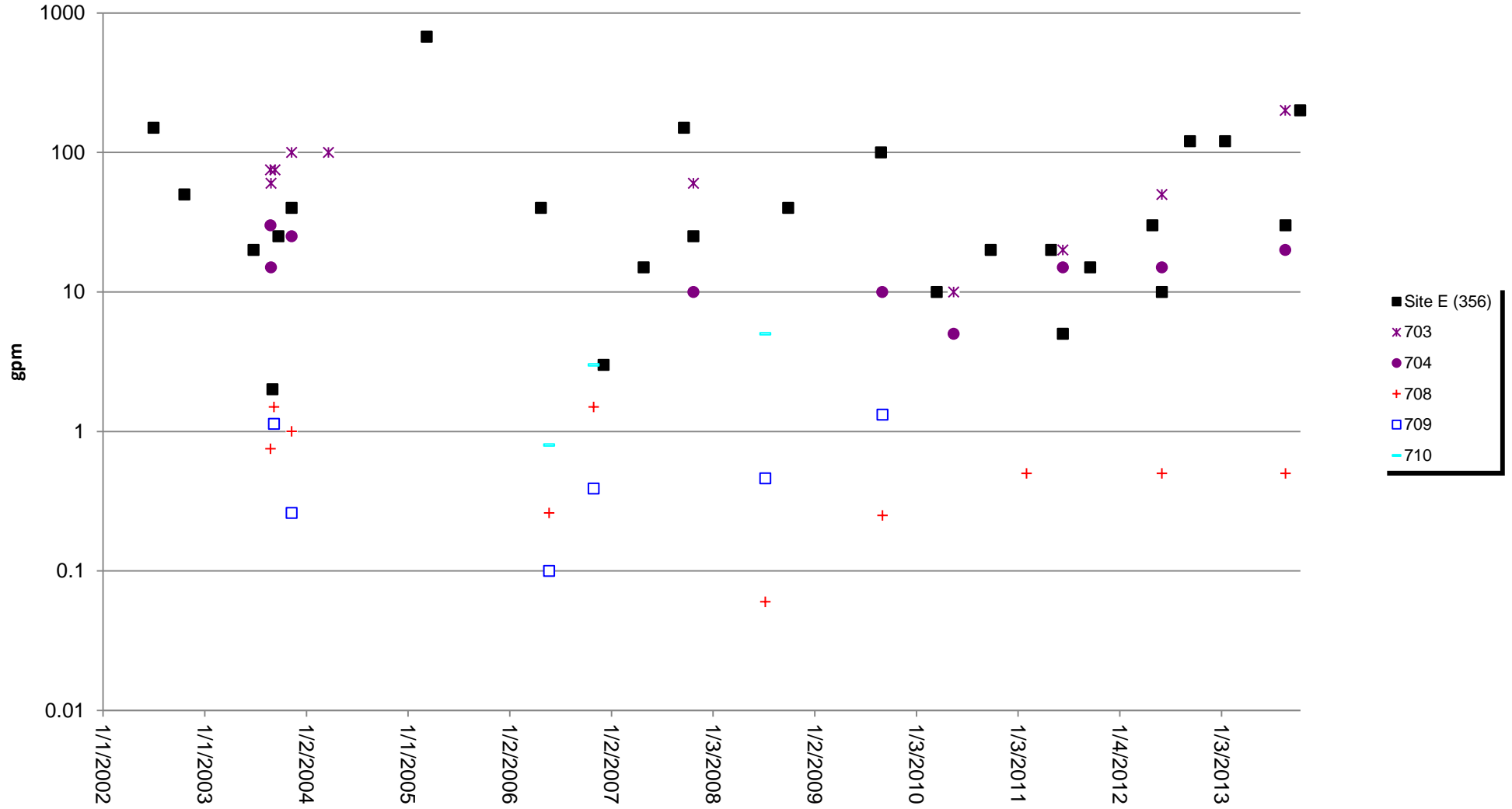


Figure 2.21 INACTIVE PRODUCTION ROCK SITE E pH DATA

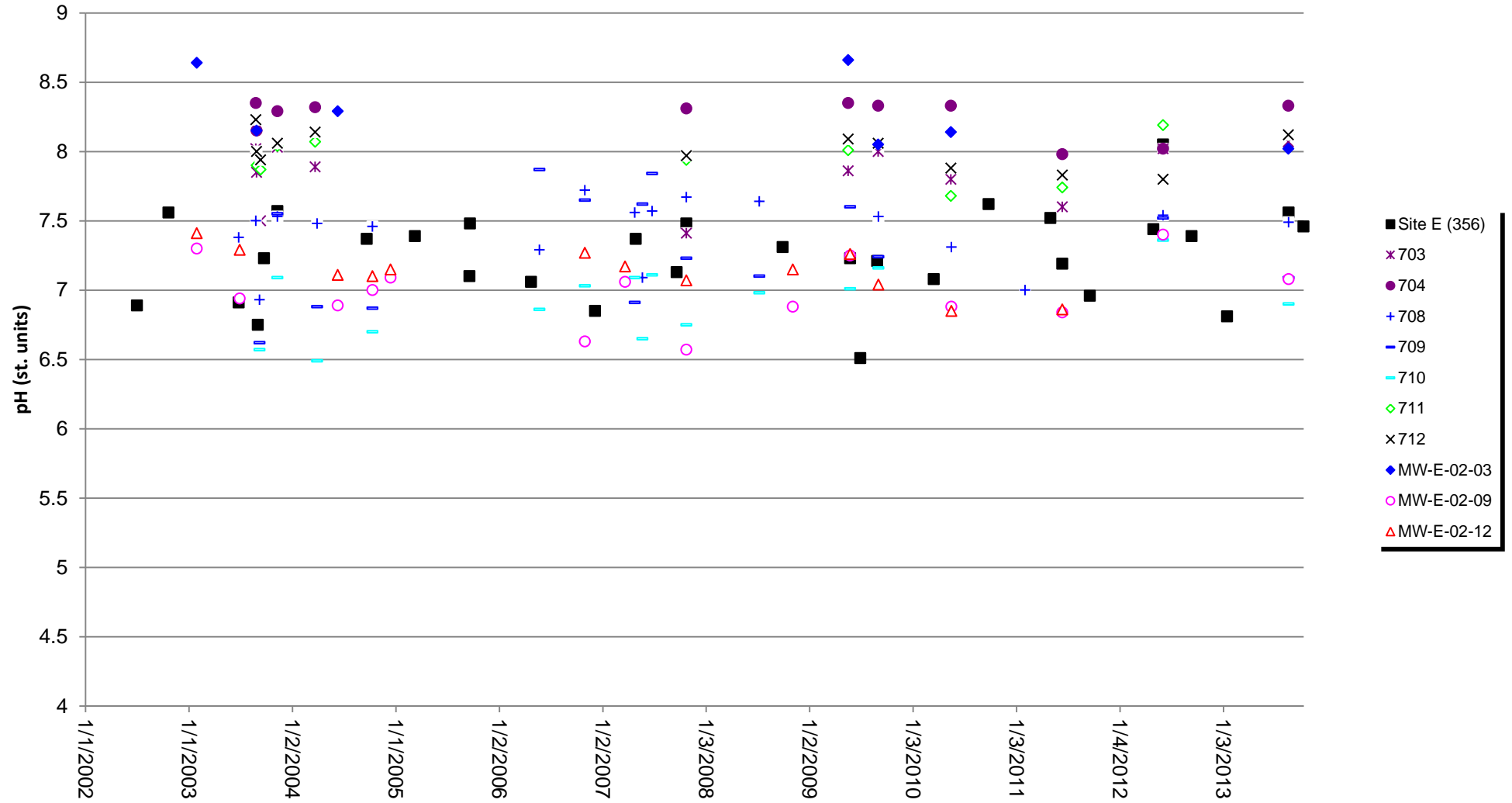


Figure 2.22 INACTIVE PRODUCTION ROCK SITE E ALKALINITY DATA

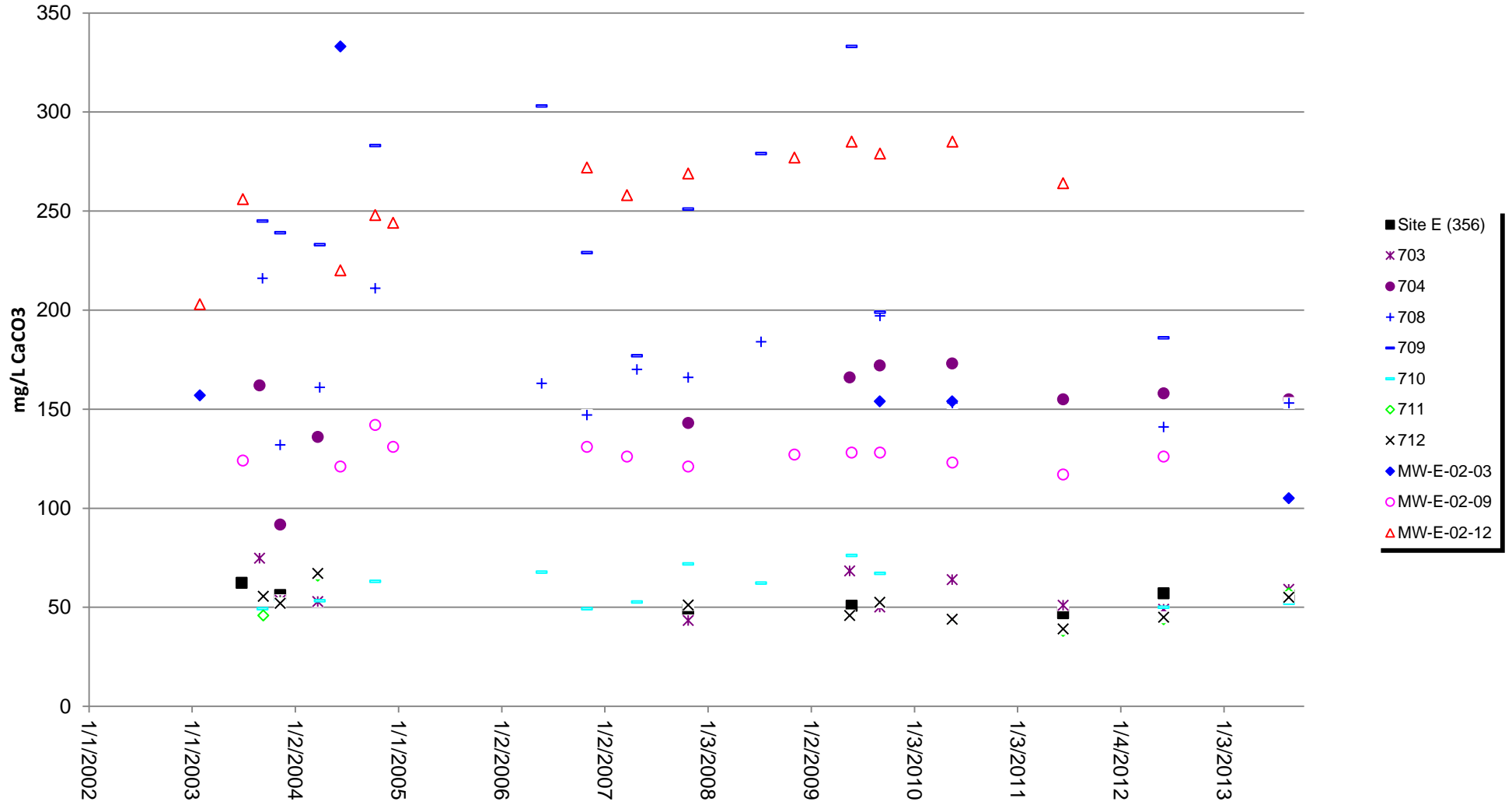


Figure 2.23 INACTIVE PRODUCTION ROCK SITE E CONDUCTIVITY DATA

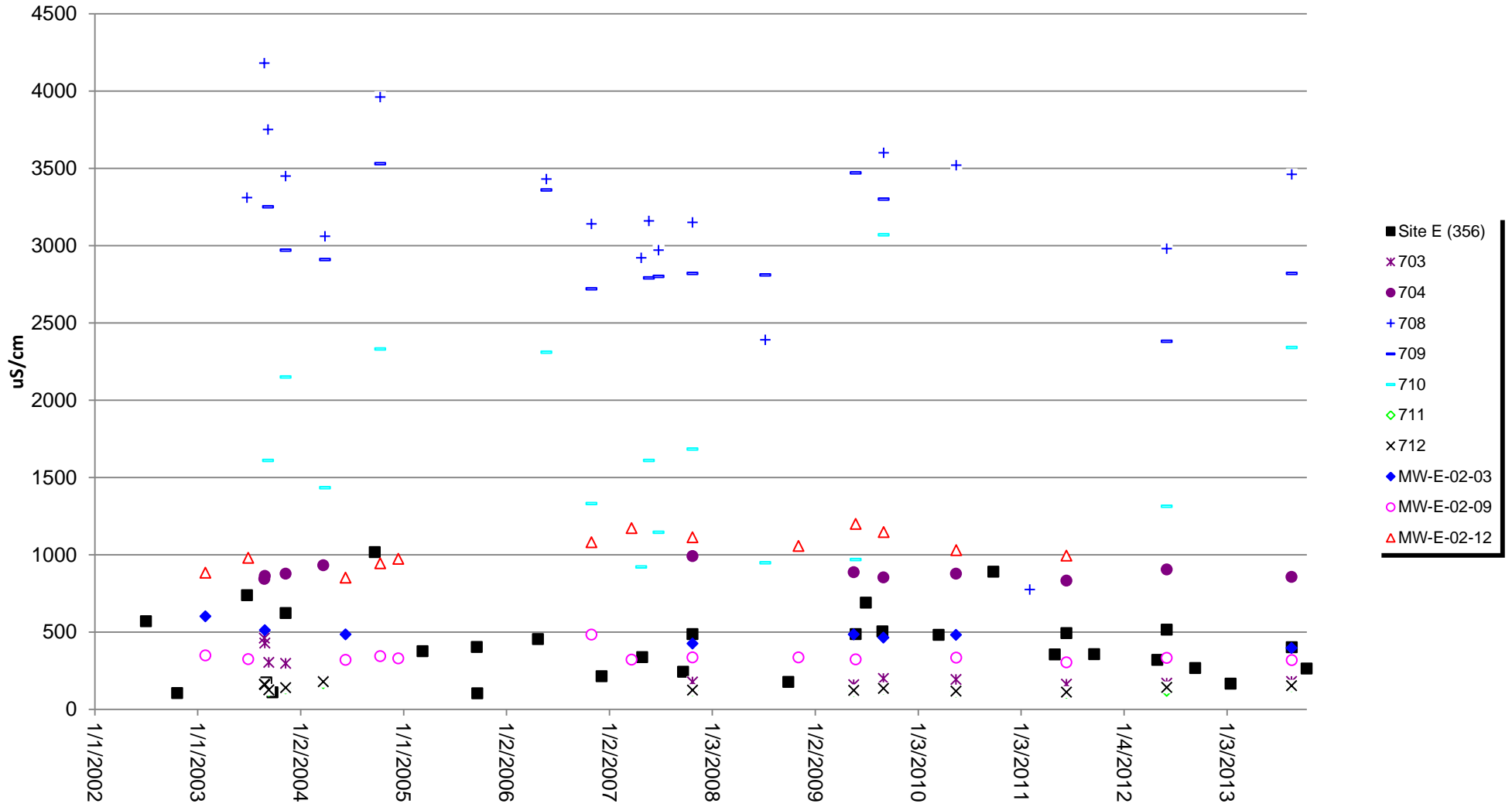


Figure 2.24 INACTIVE PRODUCTION ROCK SITE E SULFATE DATA

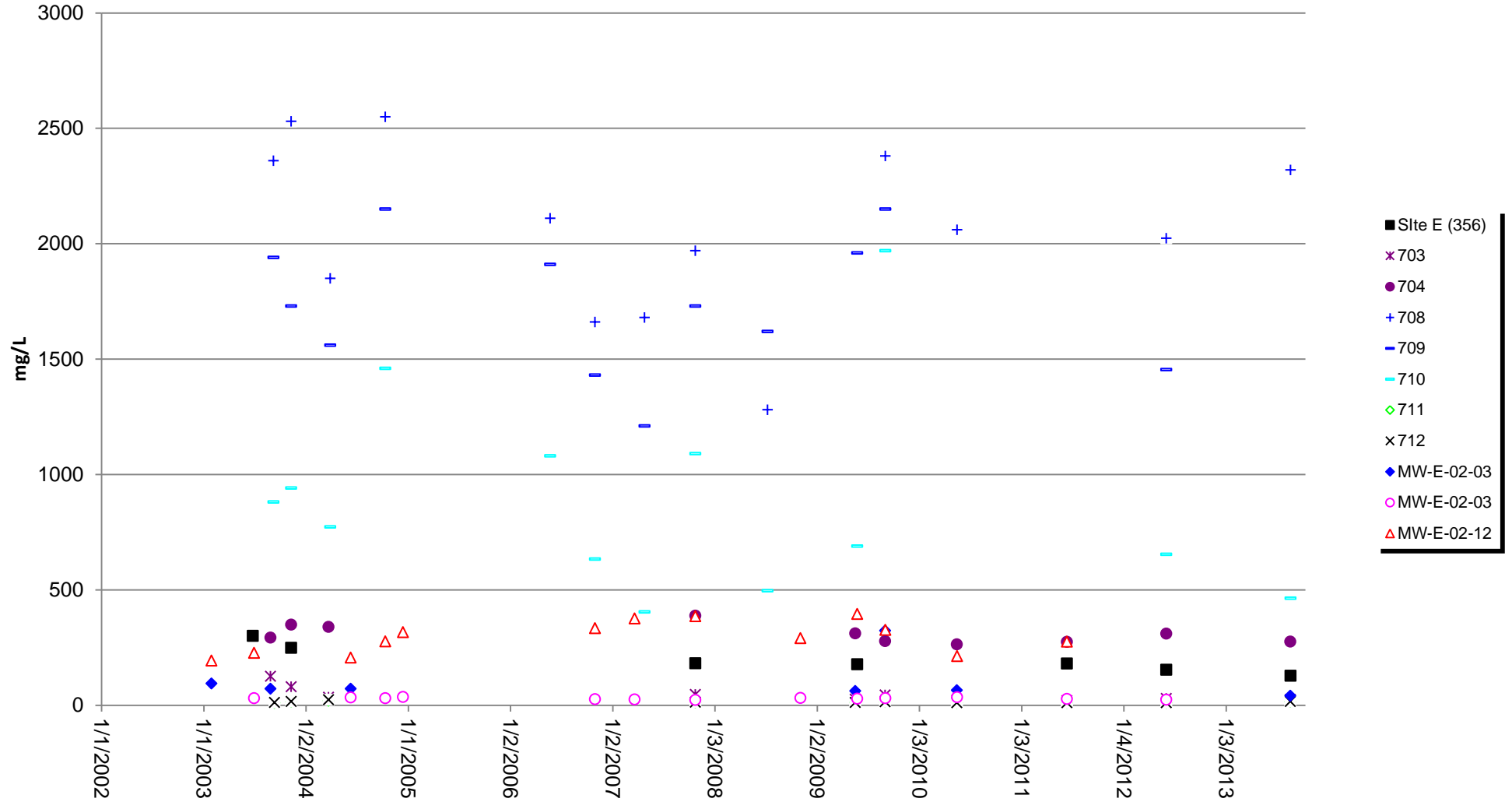


Figure 2.25 INACTIVE PRODUCTION ROCK SITE E MAGNESIUM DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

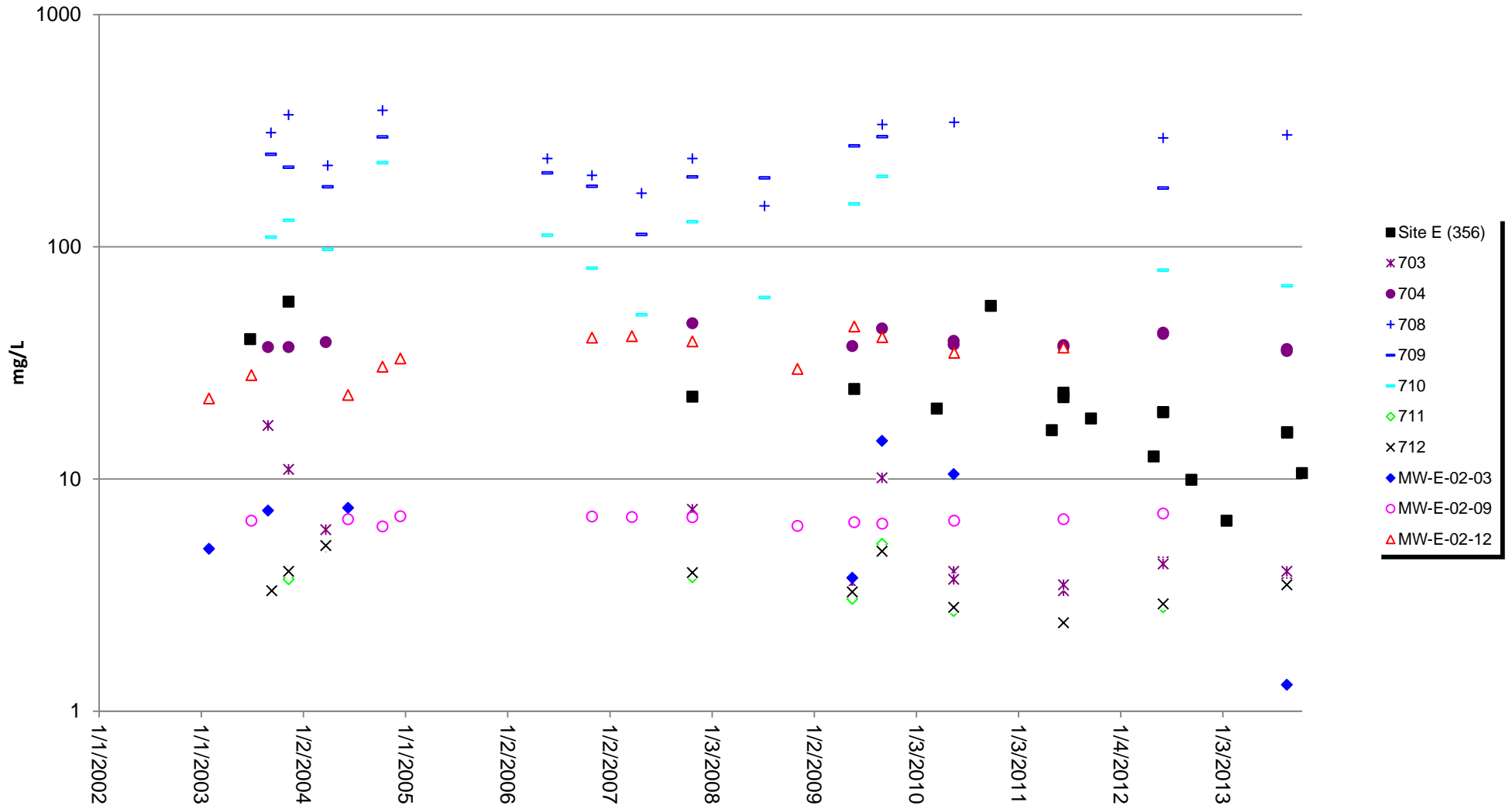


Figure 2.26 INACTIVE PRODUCTION ROCK SITE E HARDNESS DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

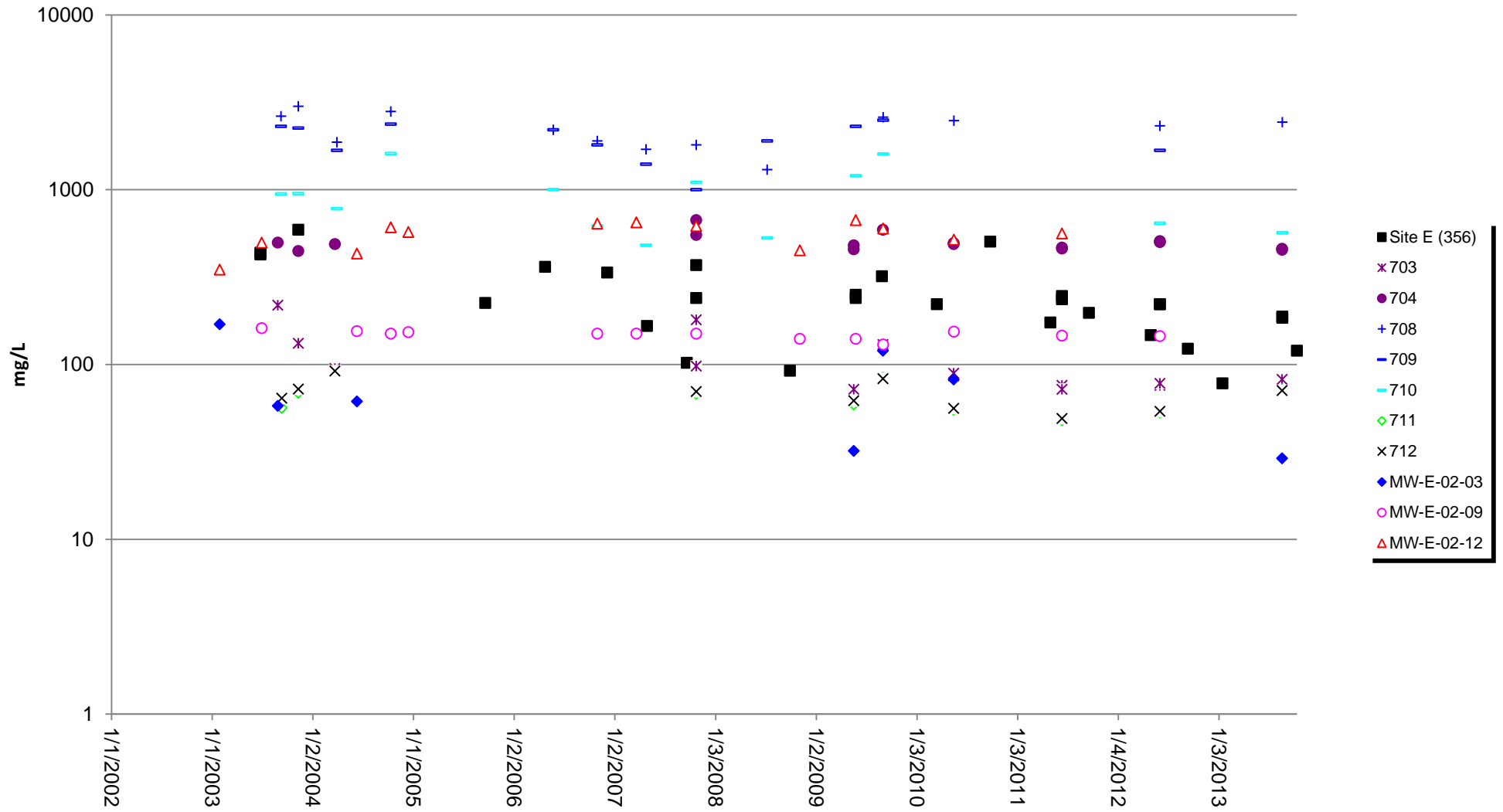


Figure 2.27 INACTIVE PRODUCTION ROCK SITE E ZINC DATA

Non-detect results are shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

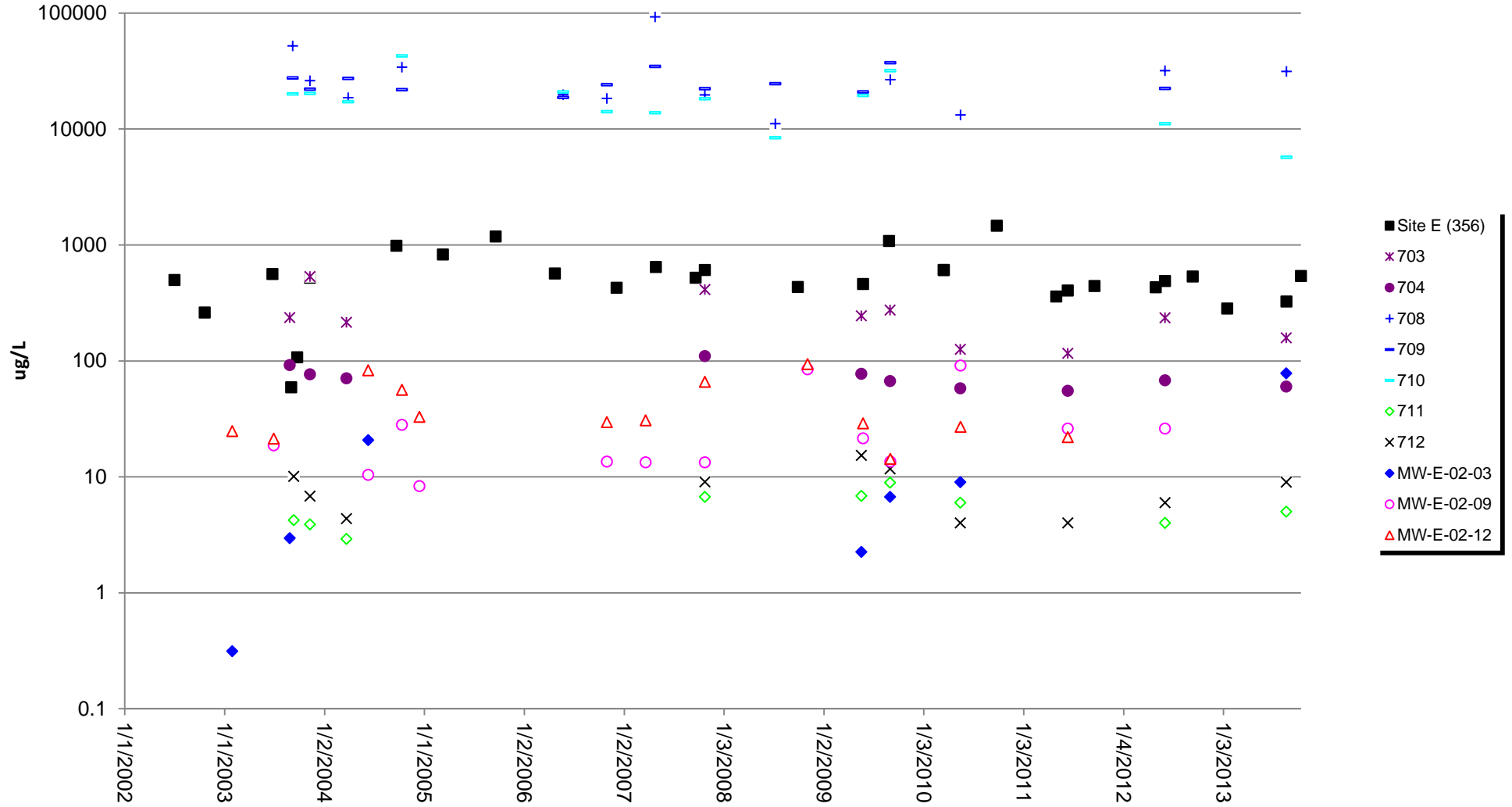


Figure 2.28 INACTIVE PRODUCTION ROCK SITE E COPPER DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

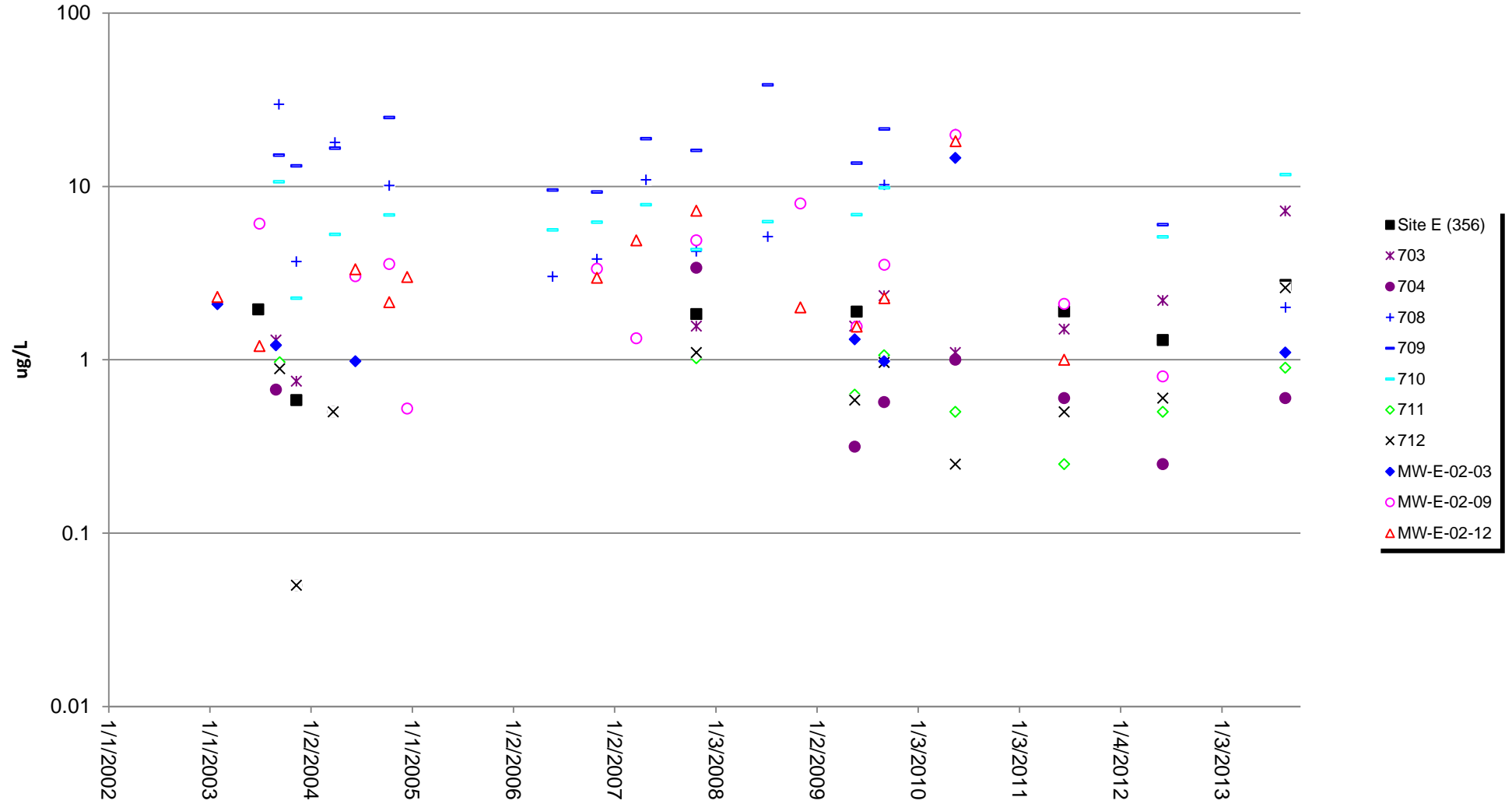


Figure 2.30 INACTIVE PRODUCTION ROCK SITE E CADMIUM DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

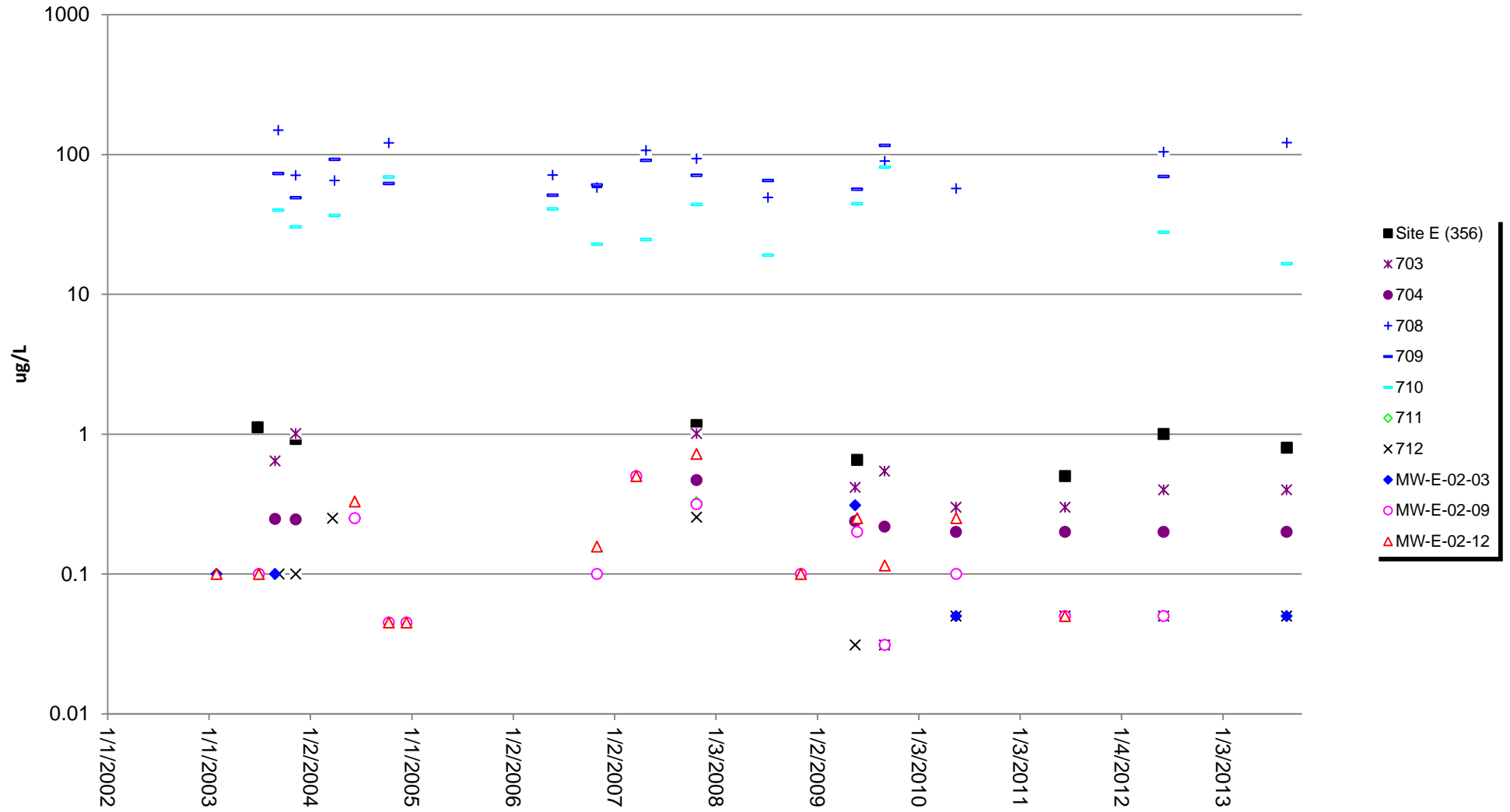


Figure 2.31 INACTIVE PRODUCTION ROCK SITE E NICKEL DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

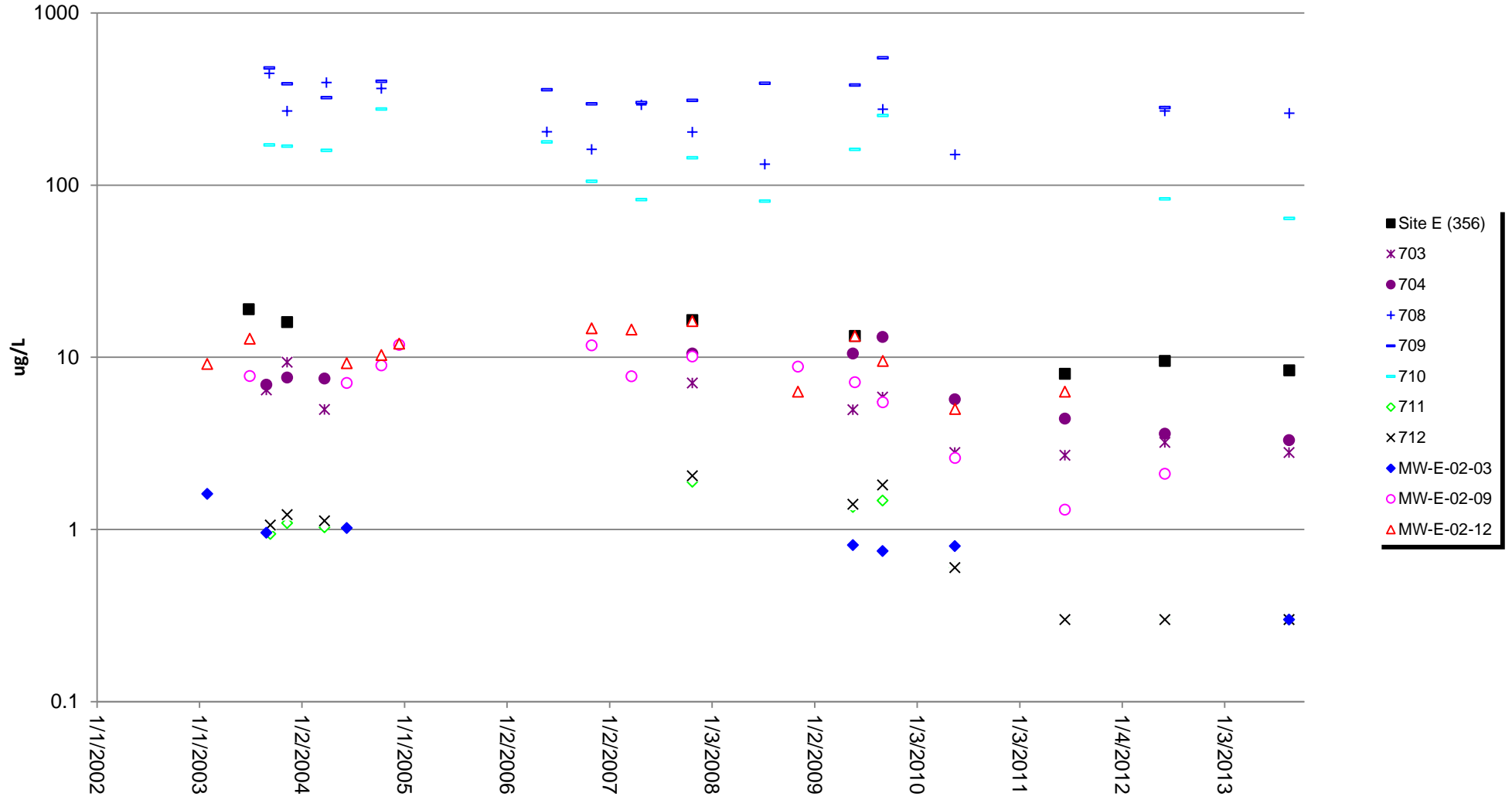


Figure 2.33 INACTIVE PRODUCTION ROCK SITE E IRON DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

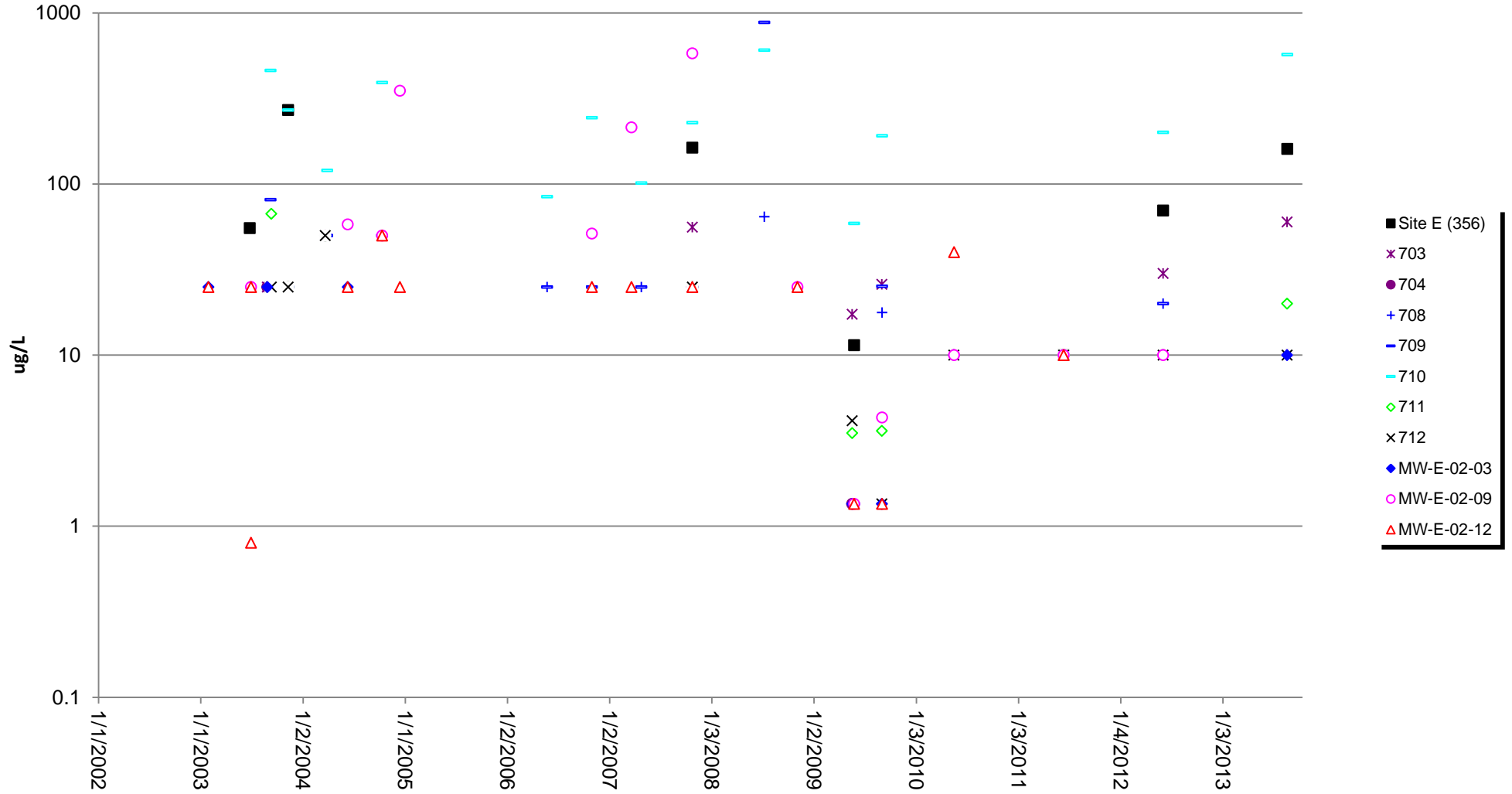


Figure 2.34 INACTIVE PRODUCTION ROCK SITE E MANGANESE DATA

Non-detect results are shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable

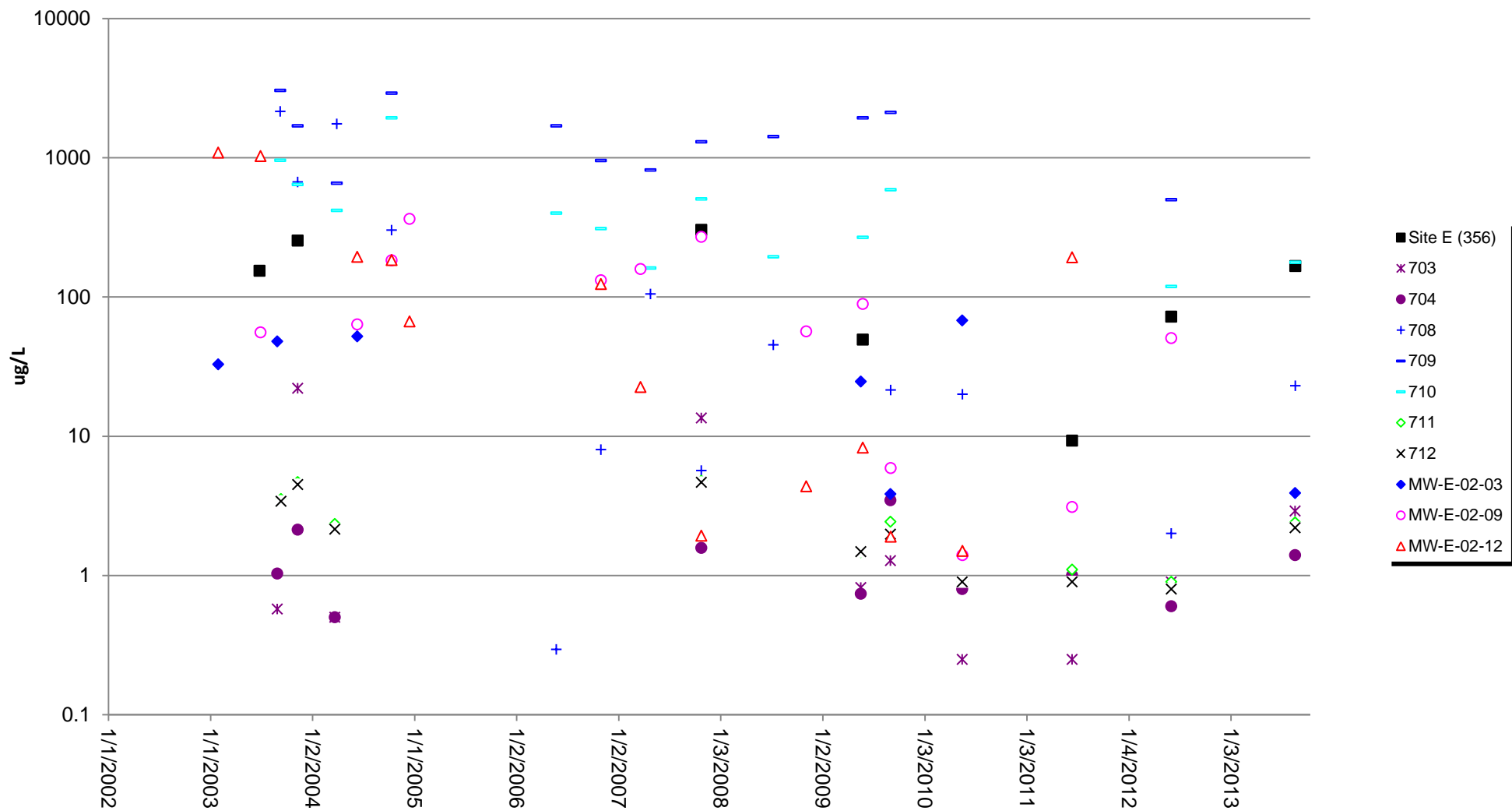




Figure 2.35: 1350 Site - 2013 Production Rock Removal Area



Figure 2.36: Site 23 Temporary Storage Pad for 1350 Material

Figure 3.1 QUARRY SITE FLOW DATA

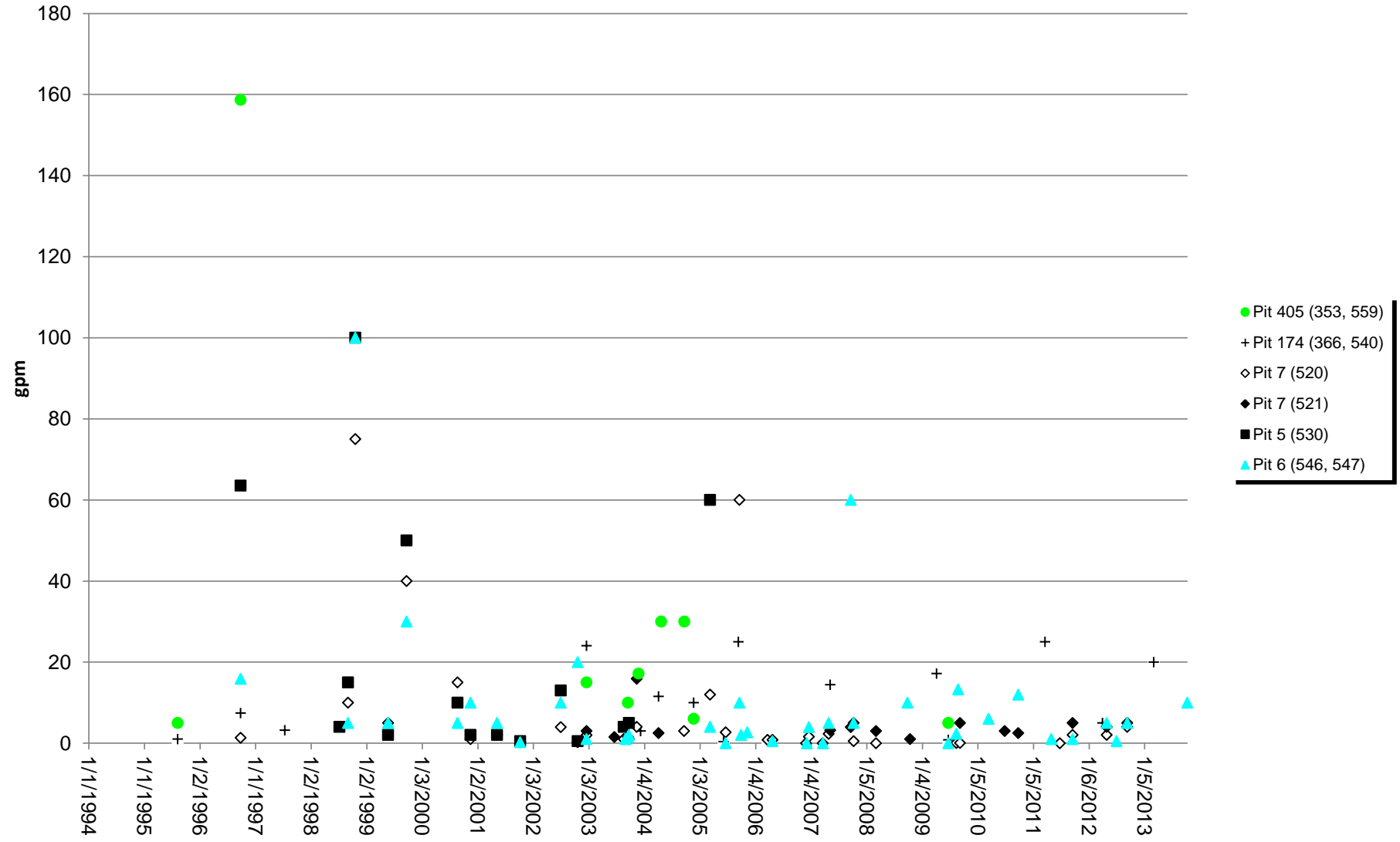


Figure 3.2 QUARRY SITE pH DATA

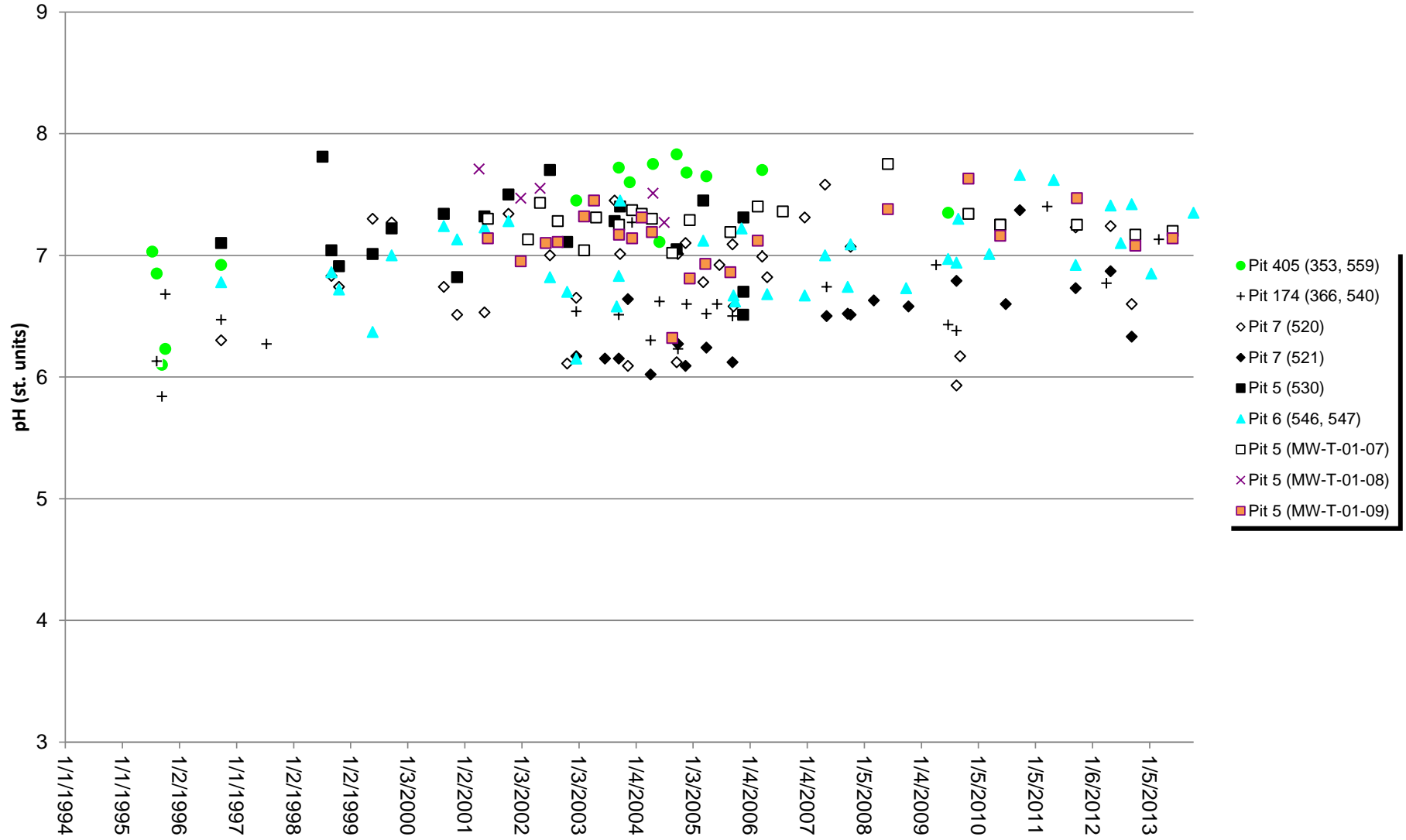


Figure 3.4 QUARRY SITE CONDUCTIVITY DATA

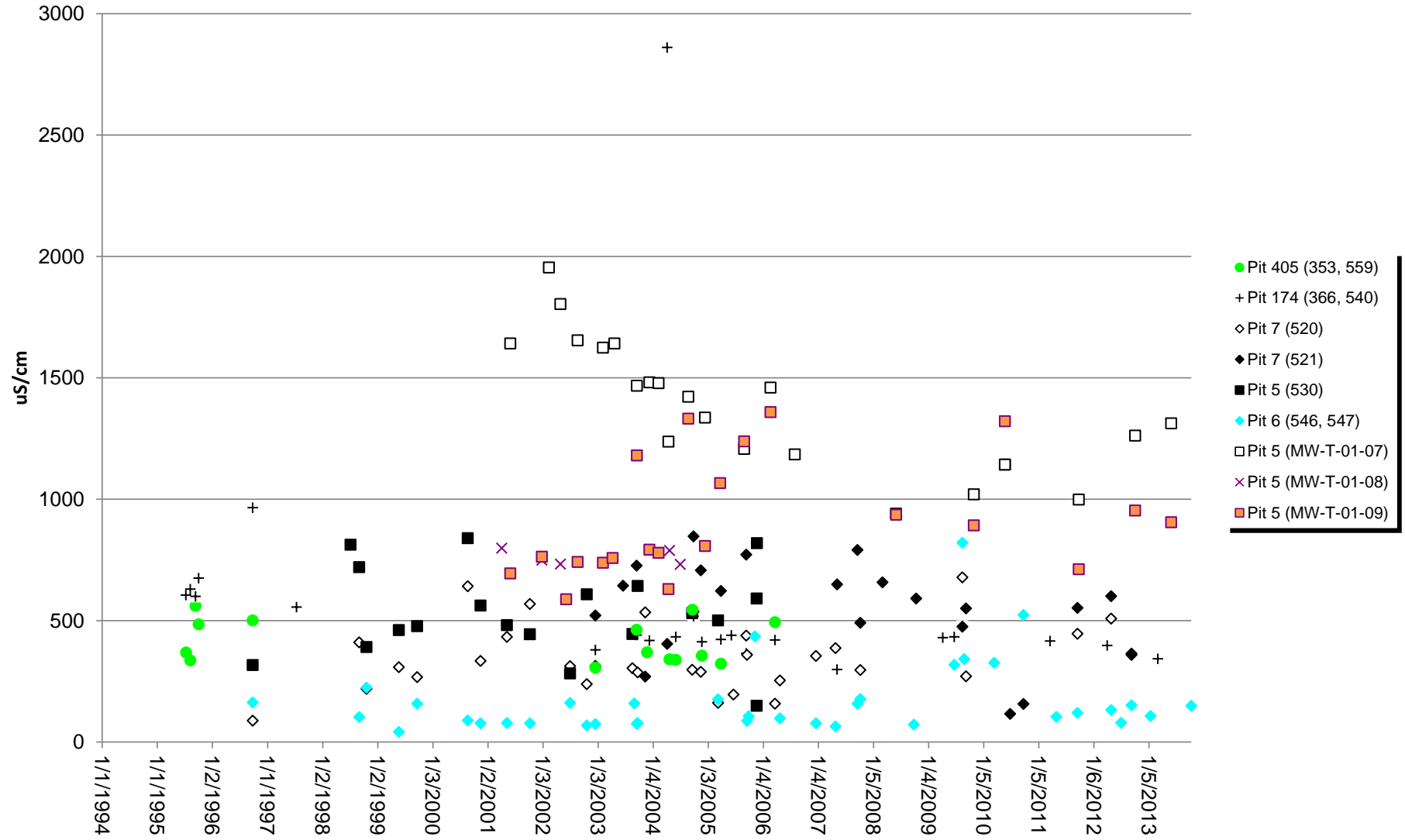


Figure 3.5 QUARRY SITE SULFATE DATA

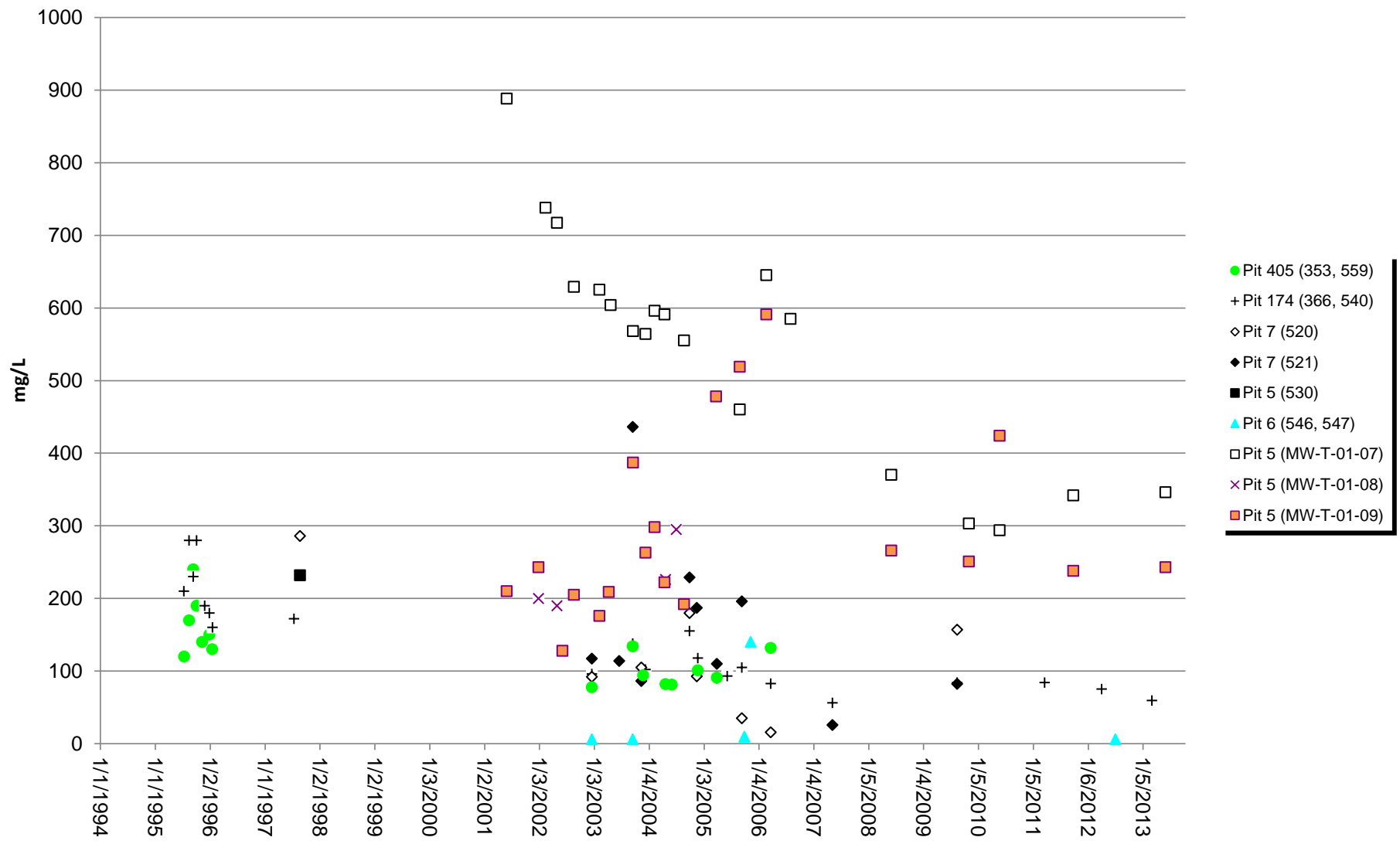


Figure 3.6 QUARRY SITE MAGNESIUM DATA

Non-detect results are shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

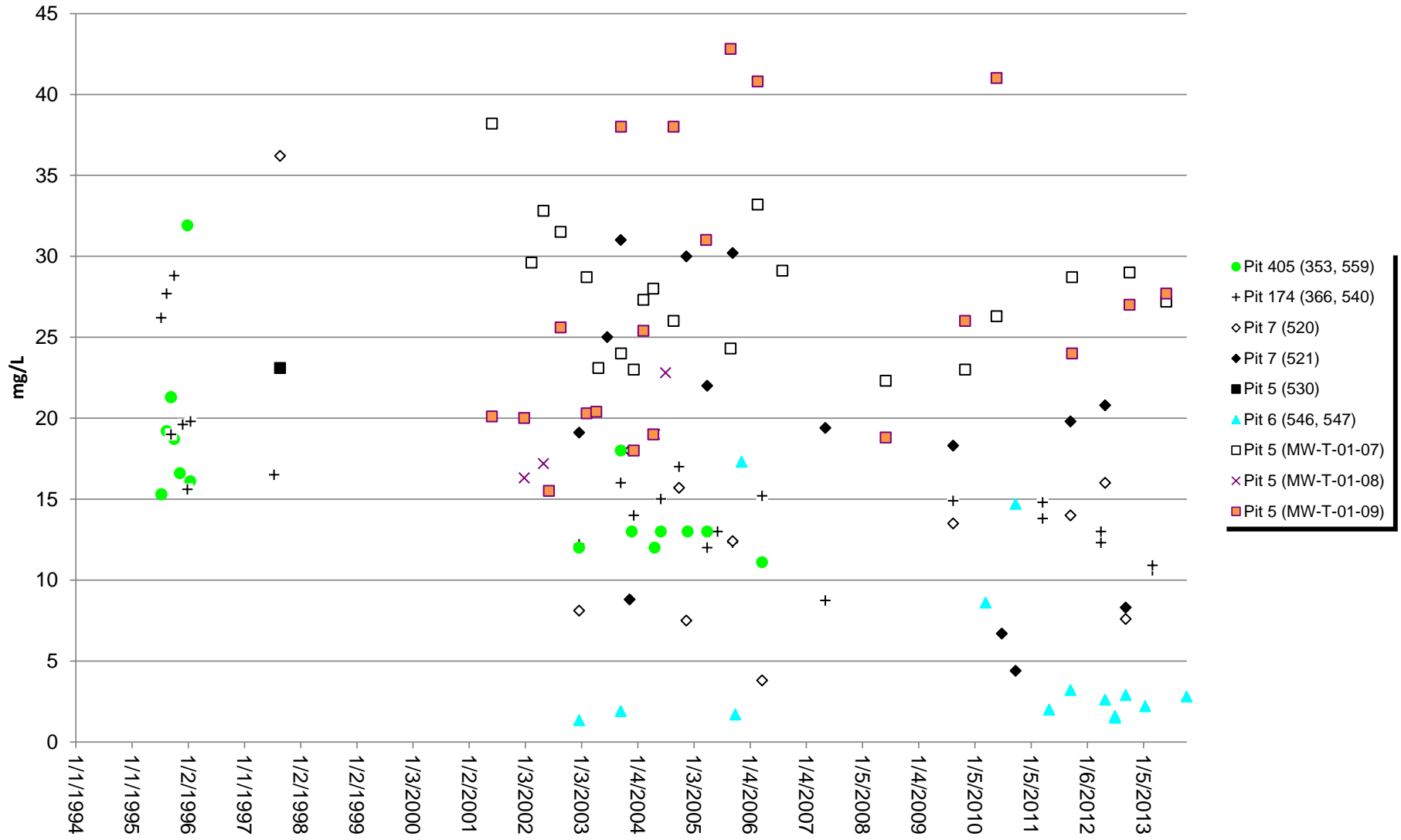


Figure 3.7 QUARRY SITE HARDNESS DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

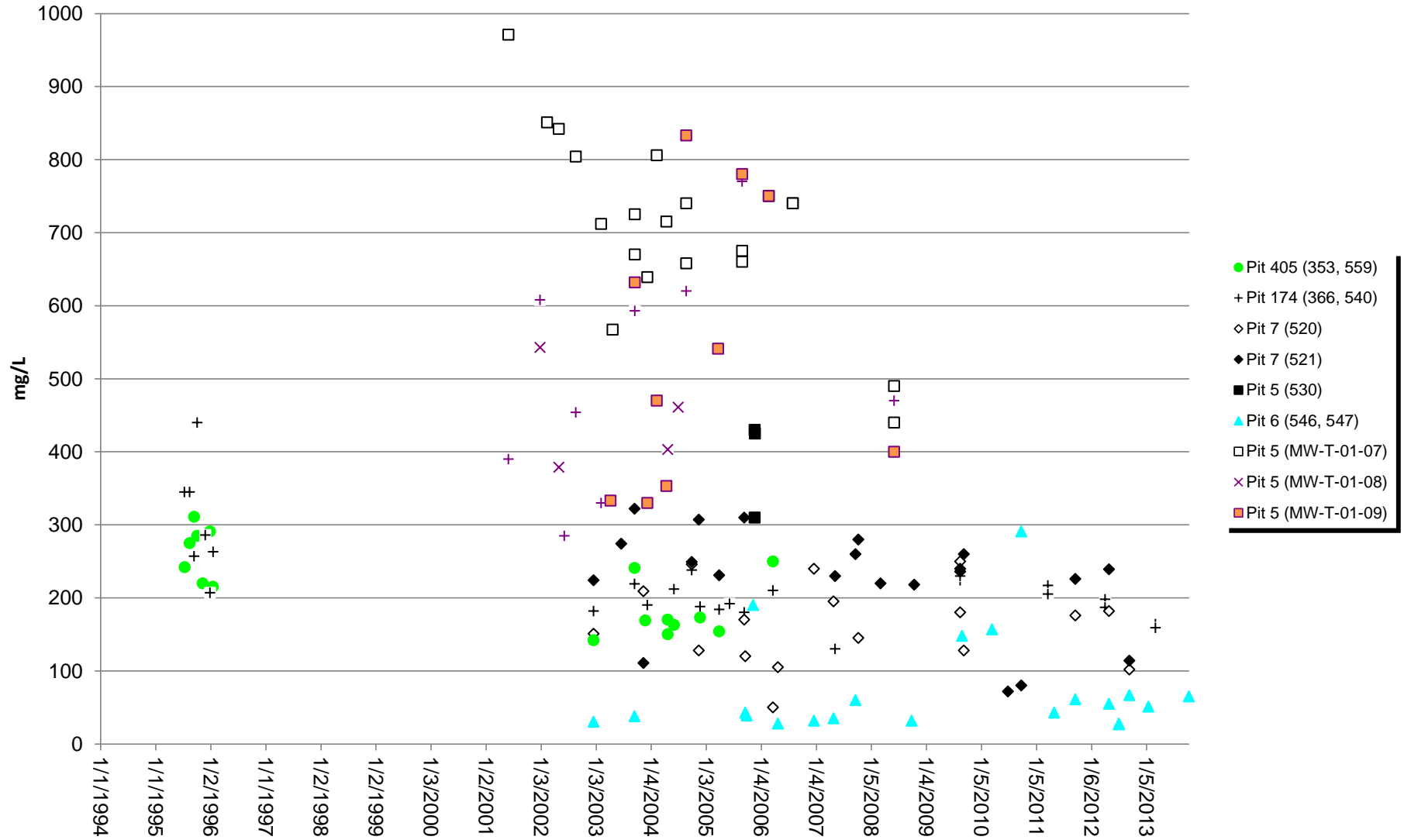


Figure 3.8 QUARRY SITE ZINC DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

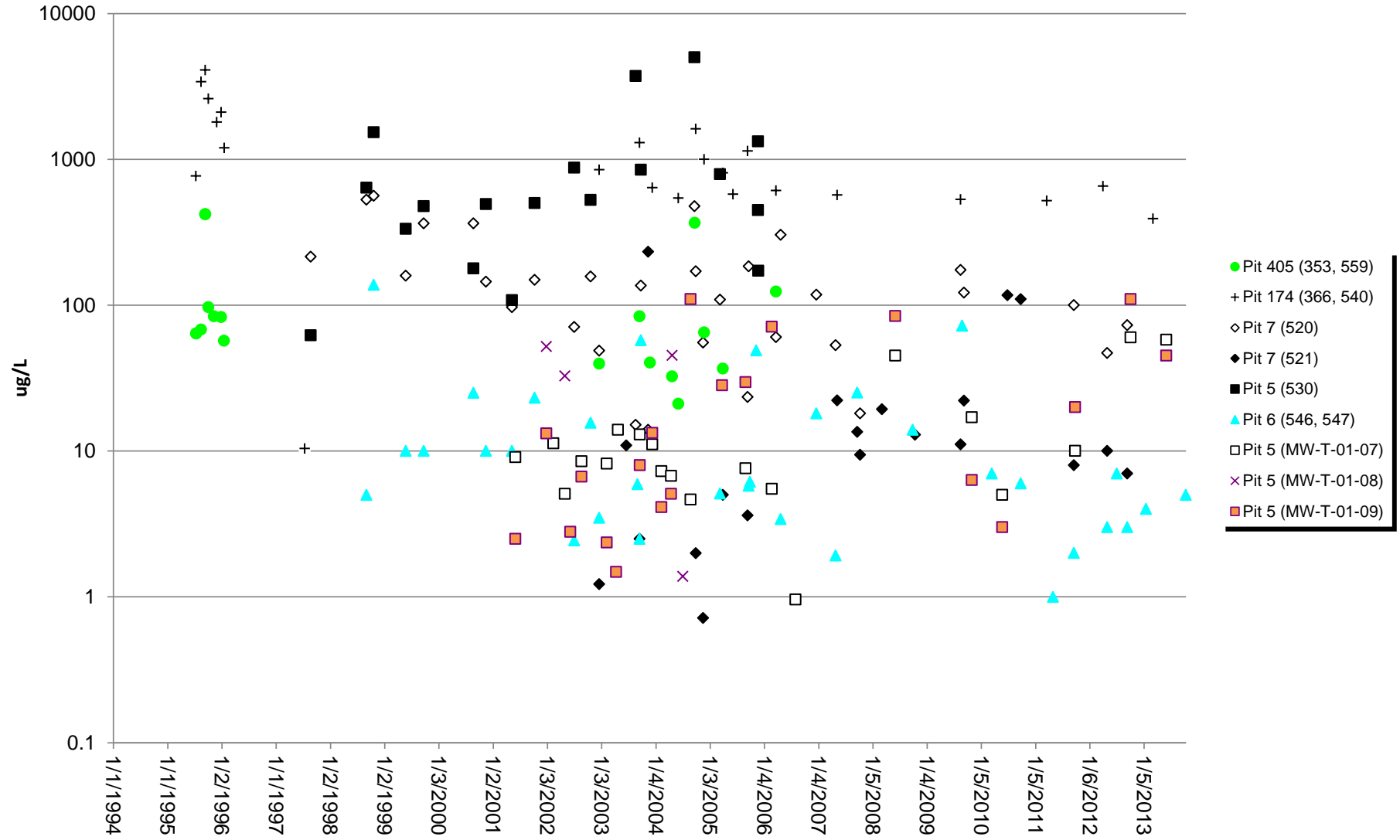


Figure 3.9 QUARRY SITE COPPER DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

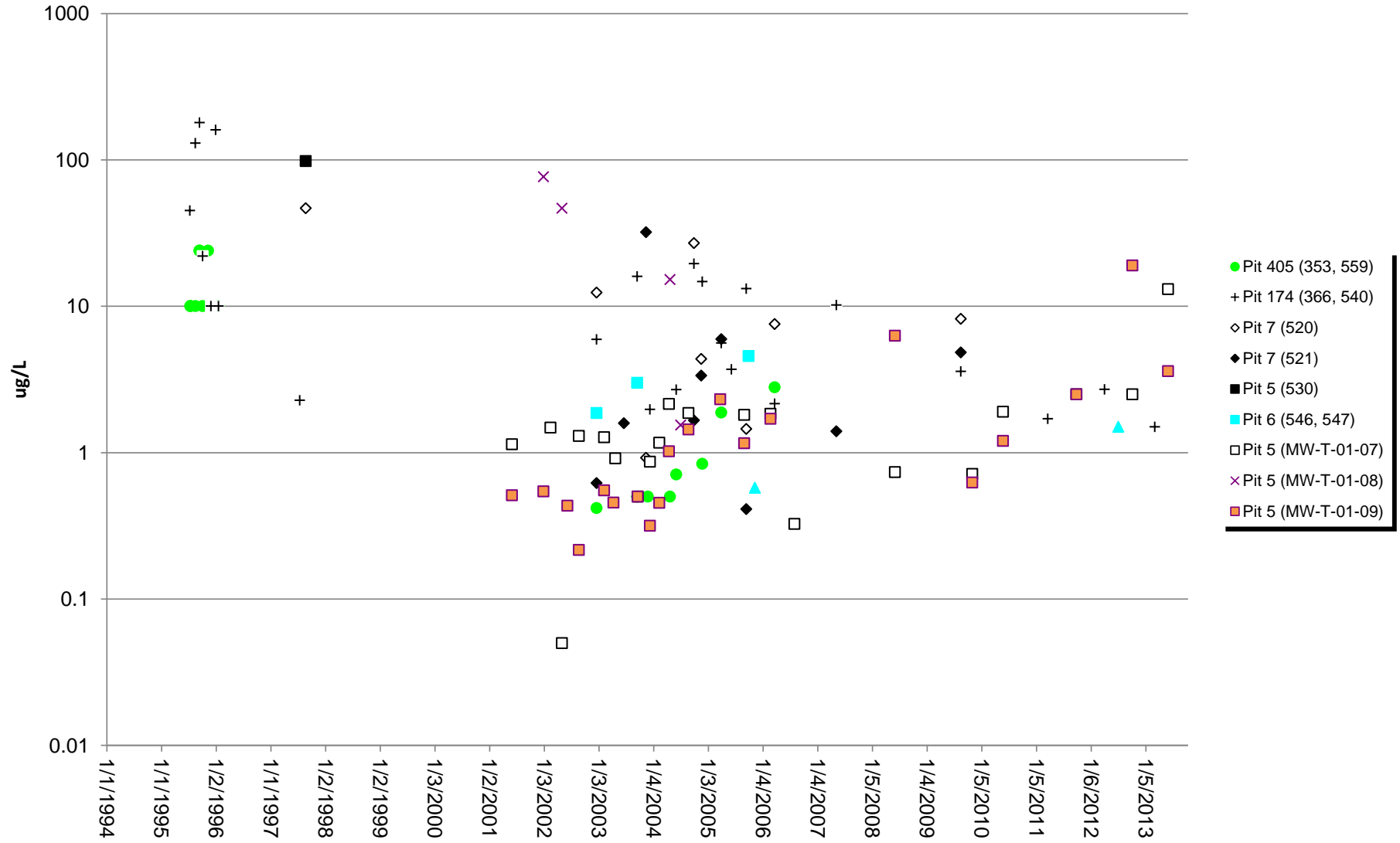


Figure 3.10 QUARRY SITE LEAD DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

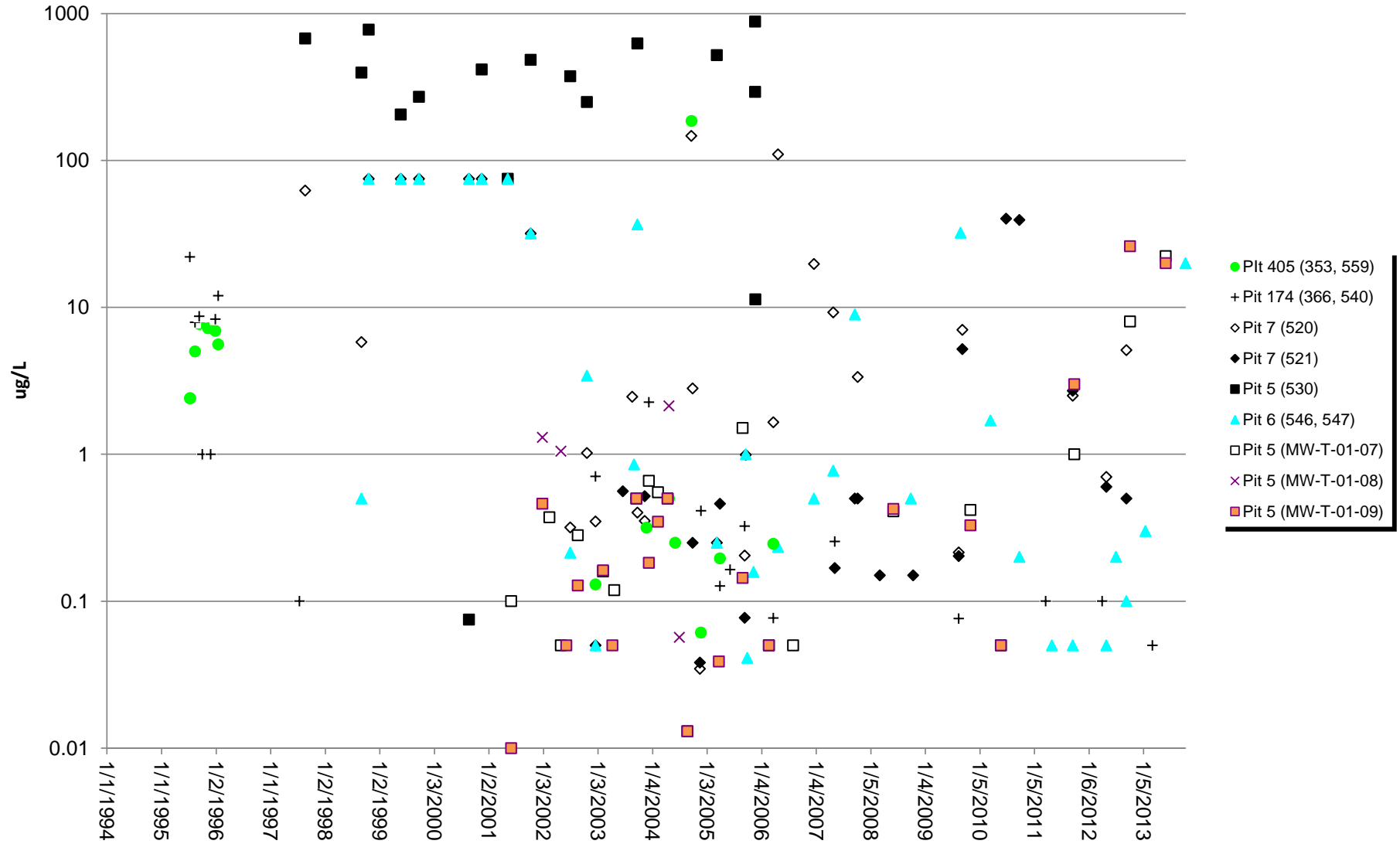


Figure 3.12 QUARRY SITE NICKEL DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

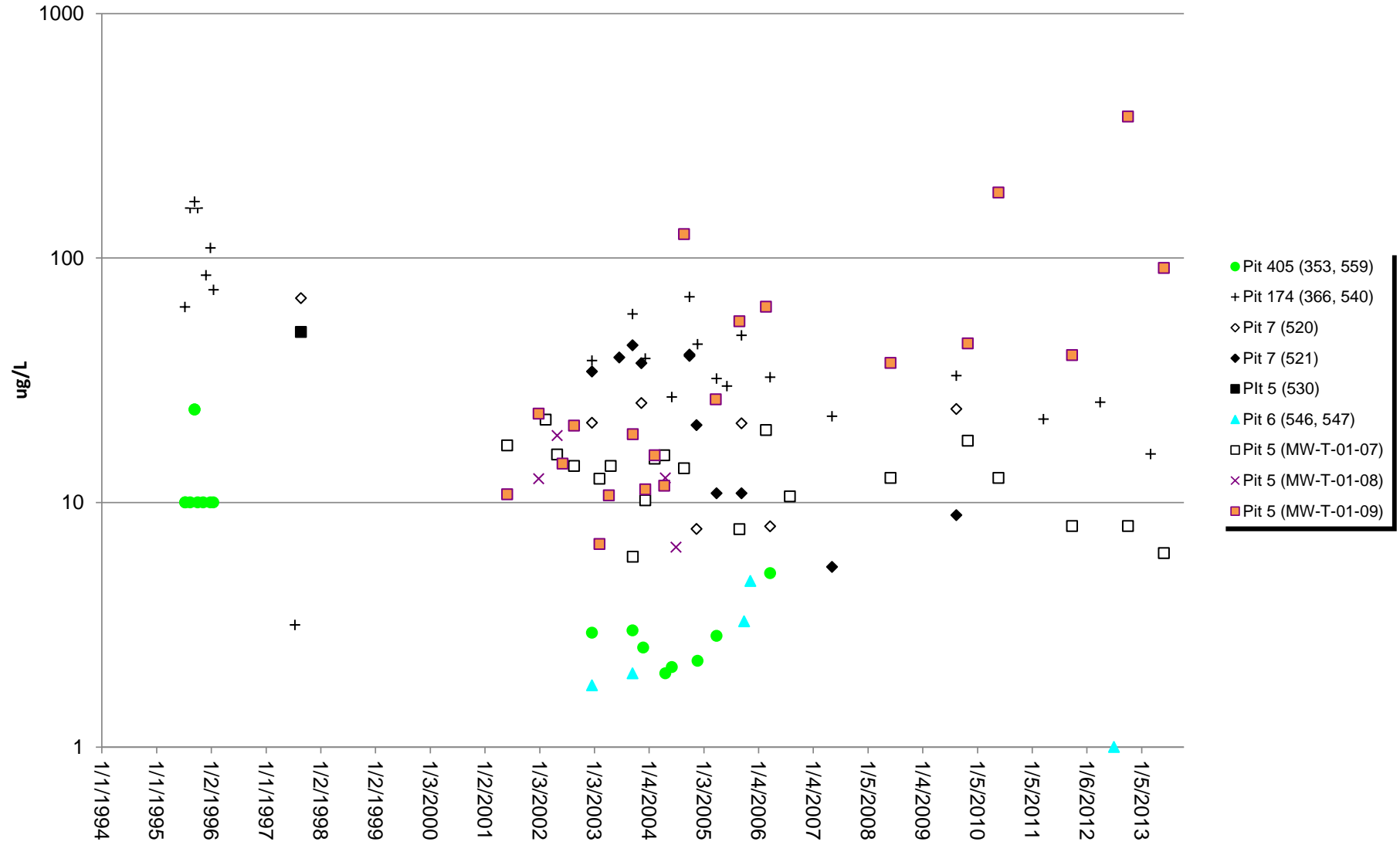


Figure 3.13 QUARRY SITE ARSENIC DATA

Non-detectable results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

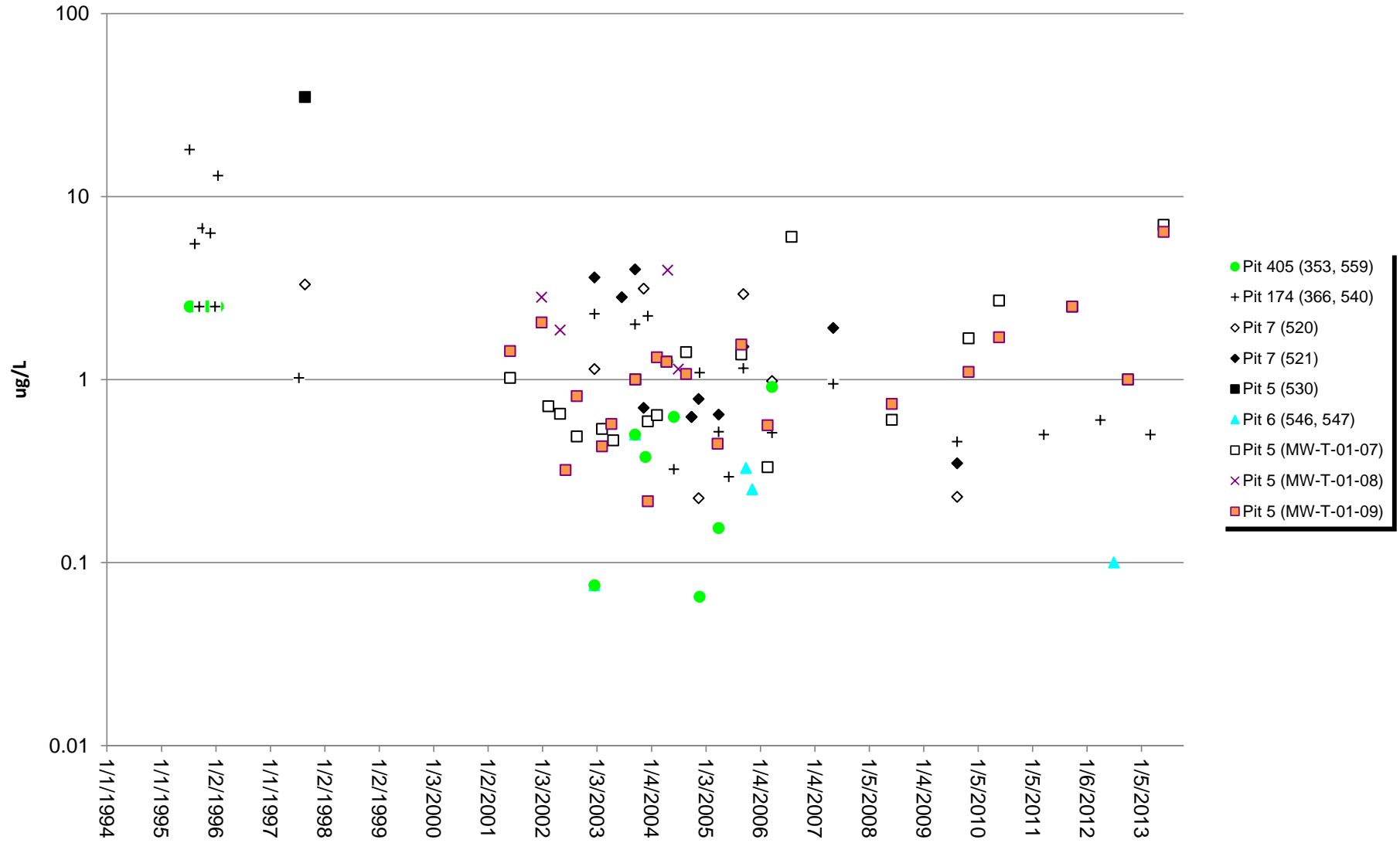


Figure 3.14 QUARRY SITE IRON DATA

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

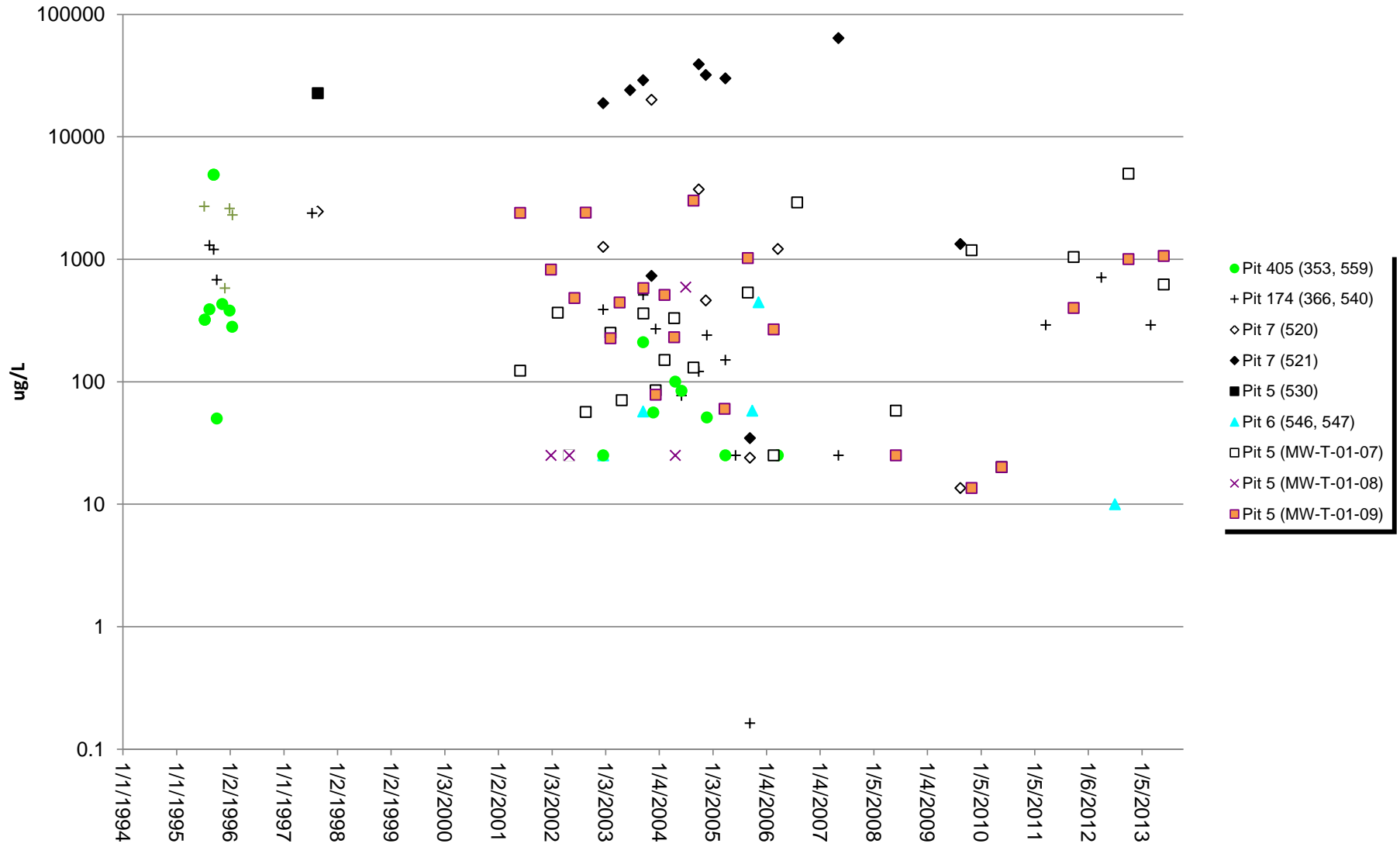


FIGURE 3.16 2002-2013 QUARRY SITE ABA DATA

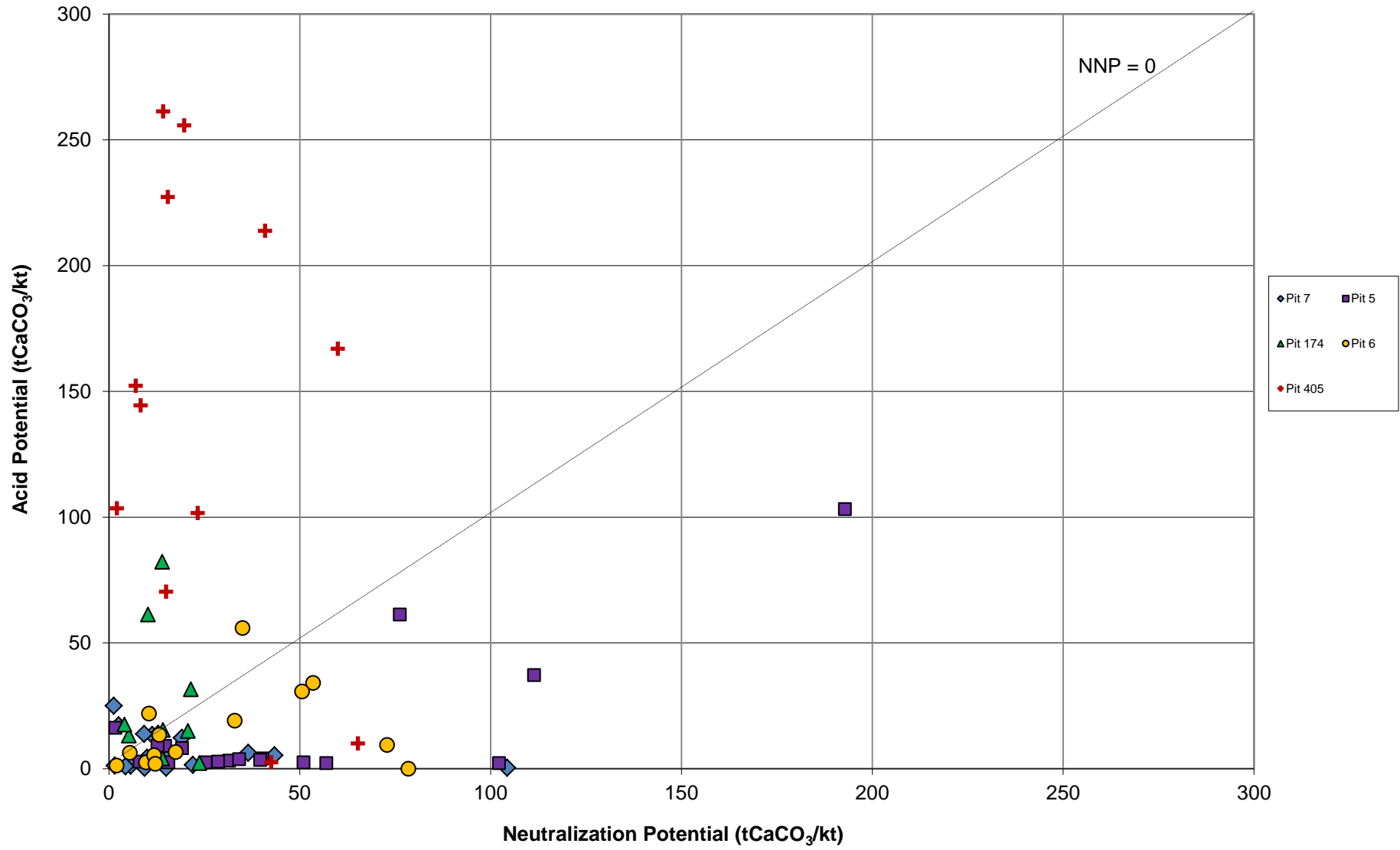


FIGURE 3.17 2002-2013 QUARRY SITE ABA DATA (NNP vs pH)

