ABSTRACT

Title of Thesis: COMPARISON OF BASE CATIONS IN STREAMS AND SOILS IN TWO SMALL WESTERN MARYLAND WATERSHEDS

Cynthia Giffen, Master of Science, 2005

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Hydrologic response, vegetation, nutrient cycling, and soil structure are some of the ecosystem properties affected when a watershed is strip-mined for coal and subsequently reclaimed. The present study sought to quantify the impacts of strip-mining and reclamation on the base cation pools and cycling within a watershed. To that end, a paired watershed study was conducted comparing a strip-mined watershed (TMat1) to a second-growth forested watershed (TNef1). Base cation input-output budgets were constructed for two watersheds using precipitation collection and stream sampling techniques. Soil base cation pools and cation exchange capacities were measured, and lysimeter samples were analyzed for calcium, magnesium, potassium, and sodium. In-stream silica concentrations were also measured to help discern whether base cation export was due to a silicate mineral weathering source or from the soil exchange complex. Although it was difficult to determine the source of base cations, TMat1 was

exporting vastly greater quantities of all four base cations than was TNef1. Mineral soil exchangeable Ca, Mg, and Na were significantly greater at TMat1, due to mining and exposure of mineral surfaces such as limestone and other bedrock. Mineral soil CEC was not significantly different between the two sites. Similarly, 15 cm deep lysimeters also had significantly higher levels of Ca, Mg, and Na at TMat1 than TNef1. From this research, it is clear that reclamation has not restored TMat1 to its original condition and that there is a large amount of base cation export to the stream in this watershed. Prolonged cation export could cause long-term nutrient depletion, but could also serve to neutralize mineral acidity associated with acid mine drainage and acid rain at TMat1.

COMPARISON OF BASE CATIONS IN STREAMS AND SOILS IN TWO SMALL WESTERN MARYLAND WATERSHEDS

By

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CHAPTER I. INTRODUCTION

Coal surface mining is a severe ecological disturbance that affects characteristics such as hydrology, vegetation, and soil structure of a site. Surface mining has disturbed over 2 million ha of land in the United States, most of which is in the area of the eastern US known as Appalachia (Zeleznik and Skousen 1996). Mine reclamation, as mandated by the Federal Surface Mining Control and Reclamation Act (SMCRA) of 1977, requires that mined lands be restored to their approximate original contour and that vegetative cover (i.e. trees, hay/pasture, or agricultural crops) must be established (Holl and Cairns 1994), unless variances are requested by landowners. Both soil structure and soil chemical properties are severely altered, as the process of surface mining includes removing all the soil above a coal seam, stockpiling the soil while the coal is extracted, and then spreading the stockpiled soil back across the site with heavy machinery (Williamson and Johnson 1994, Thomas and Jansen 1985). These processes create a homogenous solum with little or no horizonization. In light of the amount of land impacted by this disturbance and the drastic and varied results mining and reclamation can have, this thesis was part of a larger study that addressed some of the ecological effects of mining and subsequent reclamation activities.

This thesis evaluated the amounts of base cations (potassium, calcium, magnesium, and sodium) in the soil, soil solution, and streams of two small watersheds on Dan's Mountain, Allegany County, MD. This research is part of a research opportunity for collaboration in the Appalachians (ROCA) study seeking to identify and quantify differences between these two watersheds. Almost half of one watershed (referred to here as TMat1) was previously mined and reclaimed for hay or pastureland. The second watershed, (referred to here as TNef1), which served as a reference, was partially harvested for selected trees around the time TMat1 was mined and is currently forested. The larger collaborative study sought to determine if there were differences between TMat1 and TNef1, specifically in the areas of hydrology, ecology, soil and vegetation biogeochemistry, and atmospheric inputs.

Reclamation is not necessarily synonymous with restoration, renewal, or a return to the previous condition. The ecological integrity of TMat1 may or may not have been restored post-disturbance, depending upon the success of reclamation and subsequent changes over time since reclamation (i.e. soil horizonization, increases in species diversity, organic matter buildup, etc.). Ecosystem functioning, vegetation establishment and sustenance, and species diversity and richness are just a few indicators of ecosystem health, fertility, and integrity. The present study will attempt to assess the soil fertility of the two watersheds, based on the macronutrient base cations using a small paired watershed approach and TNef1 as a reference watershed.

The small paired watershed approach, shown to be particularly useful for studying nutrient dynamics by Likens and Bormann (1995), Johnson et al. (1991), and many others, uses the notion that hydrologic and nutrient input-output budgets are inextricably linked and can be used to quantitatively describe a watershed ecosystem. The watersheds must be underlain by impermeable substrate such that the only inputs are atmospheric deposition or biological activity. Therefore, by measuring the amount and chemistry of atmospheric inputs and the chemistry and flow of streamflow outputs, net gain or loss of nutrients can be calculated. Geologic inputs from weathering of silicate minerals may be inferred by measuring the output of silica in streamwater. Choosing watersheds with similar bedrock, size, location, slope, aspect, and topography enables the biogeochemical and hydrological input-output budgets to be compared with a good deal of confidence. This paired watershed study will focus on the role of base cation cycling in the soils and streams of theTMat1 and TNef1 watersheds.

In the present study, it is unlikely that the bedrock at TMat1 is impermeable due to the mining disturbance. Cracks and fissures exist in most bedrock, which violates the paired watershed framework assumption that watersheds are closed systems. However, in order to make any comparisons between watersheds, we must accept this assumption and try to quantify error associated with permeable substrate and uneven water balances. In this case, the surface soil at TMat1 is so compact that it is functionally impermeable, thus allowing me to accept this assumption for the purpose of this study.

A. LITERATURE REVIEW

Base cations (i.e. calcium, magnesium, potassium, and sodium) are nutrients important for plant health and growth in all types of ecosystems. In soils, these cations are typically adsorbed to soil particles due to the positive charge of the cations and the negative charge of soil minerals. They can be taken up by plant roots for use as nutrients important for cellular structure, function, and growth (Brady and Weil 1999; Spurr and Barnes 1992). Poorly weathered temperate soils almost always possess a negative charge on particle surfaces due to isomorphic substitution, thereby consistently attracting base cations to exchange sites on soil particles (Perry 1994). Highly weathered soils comprised of aluminum oxides can exhibit amphoteric behavior, where charge on the soil particles is a function of the soil pH.

Base cations have two primary natural sources: mineral weathering and atmospheric deposition (Schlesinger 1997, Likens and Bormann 1995, Velbel 1993). Other base cation sources are anthropogenically derived, including lime and other soil amendments. One study showed that mineral weathering accounts for >80% of the base cation input at Hubbard Brook in New Hampshire (Likens et al. 1981, Schlesinger 1997). In this review, I will address three features of base cations: chemical soil properties, importance to vegetation, and published levels or amounts in various ecosystems. I will also review literature detailing the ecological impacts of all types of disturbance, as surrogates for strip-mining and reclamation, because there is not much information about the ecological consequences of mining and reclamation in the peer-reviewed literature.

One disturbance ecology study by Arocena (2000), which subjected forest soils to organic matter removal and compaction treatments, is useful in a strip-mining context because these treatments are two of the direct effects of strip mining. While topsoil layers are retained separately and replaced during reclamation, most organic matter is not retained due to lack of vegetative stabilization on newly seeded sites and erosion of top layers due to runoff. Soil compaction and loss of organic matter have been shown to affect mineral weathering rates, nutrient mineralization and plant growth (Adams 1999, Arocena 2000, Johnson et al. 1991, Dahlgren and Driscoll 1994, Olsson et al. 1996). In addition, seedling germination and base cation concentrations in soils have been shown to decrease with increased soil compaction and organic matter loss (Arocena 2000, Olsson et al. 1996, Johnson et al. 1991, Johnson and Todd 1998). Arocena found a significant decline in calcium and potassium concentrations in soil solution due to complete forest floor removal, and a severe decline in the ability of the soil to supply calcium, magnesium, and potassium when the forest floor was removed and the soil was subjected to intense compaction (2000). With severe compaction and complete forest floor removal, accelerated weathering of soil minerals also occurred (Arocena 2000). I expected to observe similar or even more significant effects at the TMat1 site, based on the severity of the mining disturbance and the results of Arocena (2000).

Another surrogate for the mining disturbance is forest management such as clear-cutting. When an area is mined and reclaimed, all of the vegetation is removed and the regeneration that follows can be similar to regeneration following a clear-cut. Impacts of forest management on nutrient cycling are well understood, especially in northern hardwood forests. Both sites in the present study have been partially harvested at least once, and the mining disturbance at TMat1 is likely more severe but similar to that of a harvesting disturbance.

A review article by Ballard (2000) gives a brief overview of management impacts on northern forest soils, including nutrient removal due to different harvesting practices and mechanical disturbances (skidding, logging roads). Nutrient removals from soils following logging can be substantial and in some cases can compromise the site quality such that it will be nutrient-limited as a secondary forest (Ballard 2000). At Hubbard Brook, whole-tree harvesting of watershed 5 (watershed 6 was used as a control) in 1983 caused a decrease in cation exchange capacity (CEC) in the upper soil horizons (O_a and E), a decrease in base saturation in all horizons, but did not have an effect on exchangeable cation pools (Johnson et al. 1991). A spike in calcium, magnesium, and potassium concentrations in stream water at WS5 was observed for up to 2 years following harvest (Dahlgren and Driscoll 1994). However, stream water silica concentrations showed a moderately significant increase after harvesting (Dahlgren and Driscoll 1994).

Studies assessing the impact of forest harvesting in the central and southern Appalachians have found similar results to the studies discussed above. At Coweeta Hydrologic Laboratory in western North Carolina, soil cations (calcium, magnesium, and potassium) increased in the three years directly following commercial sawlog harvest (Knoepp and Swank 1997). Leaching losses from soils into streams due to harvesting have been reported to range from 110 eq $ha^{-1}yr^{-1}$ calcium and 66 eq $ha^{-1}yr^{-1}$ magnesium at Coweeta, to 35 eq $ha^{-1}yr^{-1}$ calcium and 33 eq $ha^{-1}yr^{-1}$ magnesium at Fernow Experimental Forest, WV (calculated from Adams 1999).

Mechanical disturbances from the logging process can result in soil compaction and increased bulk density, influencing soil water retention, decreasing soil aeration, drainage, and root penetration, and limiting soil infiltration capacity (Ballard 2000).

This decrease in aeration and pore size due to compaction tends to increase CO_2 from soil respiration, and with the addition of water, mobilize hydrogen and bicarbonate ions causing desorption of nutrient cations from the soil complex (Ballard 2000). This demonstrates that physical soil disturbance can impact chemical properties of soils.

Studies showing the effects of forest harvesting can be used as analogs for the mining disturbance, as there are few published studies of the ecosystem impacts of strip mining. A few mining studies, however, provide a range of values with which to compare the TMat1 site to in the present study.

Coal mining is a significant disturbance in the Midwestern US, and three studies conducted there have evaluated the base cation status of reclaimed mines. In Illinois, 8 sites ranging in age from 5 to 64 years post-mining, were analyzed for soil exchangeable base cations (<15 cm depth) (Thomas and Jansen 1985). Soil calcium ranged from 74-260 meq kg^{-1}, magnesium ranged from 16-47 meq kg^{-1}, potassium ranged from 1.6-6.4 meq kg^{-1}, and sodium ranged from 0.9-3.2 meq kg^{-1} (Thomas and Jansen 1985). Clay at these sites ranged from 16-34% of the < 2mm fraction (Thomas and Jansen 1985). In general, the younger sites (5-10 years old) had higher exchangeable base cation quantities and a higher percentage of clay in the upper soil (<15 cm) (Thomas and Jansen 1985). Soils at a reclaimed mine less than 5 years old in Indiana were analyzed for exchangeable bases, and the authors reported values of 62 meq kg^{-1} calcium, 22.9 meq kg^{-1} magnesium, 1.3 meq kg^{-1} potassium, and 0.7 meq kg^{-1} sodium in the upper 29 cm of soil (Bussler et al. 1984). These values are comparable to the study conducted in Illinois (Thomas and Jansen 1985).

A few studies have been conducted closer to our study sites in western Maryland. At two reclaimed sites in Ohio, both approximately 50 years post-reclamation, CEC ranged from 158-189 meq kg^{-1} (Zeleznik and Skousen 1996). In two studies conducted in western Pennsylvania, percent clay in nonreclaimed minesoils ranged from 10-35% (Ciolkosz et al. 1985) and from 16-28% in soils sampled 1-2 years post-reclamation (Bell et al. 1994). Soil exchangeable bases in western PA average 73 meq kg^{-1} for Ca, 14 meq kg^{-1} for Mg, 2.1 meq kg^{-1} for K, and 106 meq kg^{-1} for CEC (Bell et al. 1994). Based on the general disturbance studies and the studies specifically interested in the impacts of strip mining, I expect to see values at TMat1 in the range described here in response to the strip mining and reclamation disturbance.

More general information about base cations is necessary to preface the methods of the present study. Base cations are held within the soil on negatively charged particles called soil colloids or micelles, which include clays and humic materials (Brady and Weil 1999; Spurr and Barnes 1992). The internal and external structure of a clay particle, with its large surface-to-volume ratio, allows many cations to be attached (Barbour et al. 1987). Soil colloids carry a charge due to either (1) hydroxyls (OH-) or other functional groups releasing or accepting hydrogen ions or (2) cation substitution, in clay minerals, of cations of similar particle size but different charge (i.e., Mg^{2+} for Al^{3+} in smectites) (Brady and Weil 1999). This is termed ionic substitution and primarily arises from 2:1 silicate clays (Schlesinger 1997). Water is also held to these micelles, and its polar character causes the cations to be taken up by plant roots when water is absorbed (Brady and Weil 1999; Spurr and Barnes 1992). All of these cations are not held with equal strength by the soil colloids; they are held in the order Al>Ca>Mg>K>/=NH_4>Na, with aluminum being held most tightly (Brady and Weil 1999; Spurr and Barnes 1992). When cations move throughout the soil complex it is known as cation exchange.

Cation exchange, which refers to the replacement of adsorbed cations by other cations (Brady and Weil 1999), is the mechanism by which cations migrate on and off soil colloids and into soil water. Cation exchange may occur if (1) the replacement cation has greater ionic strength than the cation already adsorbed, and (2) by mass movement of water and ions through a soil after rain or snowmelt (Brady and Weil 1999; Spurr and Barnes 1992). Equilibrium of adsorbed cations on soil particles with cations in soil solution, and of anions in soil solution with cations in soil solution, is an ongoing process in the soil complex (Berger and Likens 1999). The soil property that quantitatively expresses the exchange that could take place in a particular soil is called the cation exchange capacity (CEC), and is defined as “the sum total of exchangeable cations that a soil can adsorb” (Brady and Weil 1999) or “the total negative charge in a soil” (Schlesinger 1997) and is customarily expressed in units of meq kg^{-1} or $cmol_c$ kg^{-1}. The equilibrium of cations in the soil with soil pore water can be drastically impacted by the amount and chemistry of the rainfall at a particular site.

Since the industrial revolution, the acidity of rainfall in the northeast US that can be attributed to pollution and further industrialization, has caused hydrogen ions (H^+) to replace nutrient cations on soil micelles (Spurr and Barnes 1992; Schlesinger 1997). This widespread ion replacement is potentially causing a base deficit in some soils and an efflux of base cations to streams (Johnson et al. 1985; Shortle and Bondietti 1992; Friedland and Miller 1999; Castro and Morgan 2000). It has been shown in other studies that any mobile ion input can cause or accelerate base cation export from soils, and enhance the mobilization of aluminum ions. As a result, soils and streams can become increasingly acidic, and terrestrial vegetation productivity can decline due to nutrient imbalances (Aber et al. 1998). For example, Aber et al. (1998) found declining tree growth and increases in tree mortality in experimentally manipulated evergreen stands as evidence of a decrease in productivity. Two acids primarily responsible for the accelerated rate of base cation export from soils are sulfuric acid and nitric acid (Currie et al. 1999). The hydrogen ions (H^+) from these acids exchange with base cations in the soil complex, thereby releasing base cations into the soil solution that contains the anions nitrate (NO_3^-) and sulfate (SO_4^{2-}). As these mobile anions move through the solum, in order to maintain electroneutrality in solution, cations are leached out as well (Adams 1999).

Several researchers have found evidence of acid rain leaching of base cations in forested ecosystems. While nearly all watersheds exhibit base cation export, large exports over several years can lead to severe nutrient deficiencies. Friedland and Miller (1999) found a net loss of calcium and magnesium from above and below the canopy in precipitation, throughfall, and soil solution, over ten years at a site in the northeastern Adirondack Mountains. In western Maryland, the Herrington Creek watershed had a net export of calcium, magnesium, and sodium in 1996-1997 (precipitation input-streamwater output budget), with export rates 2-5 times above throughfall inputs (Castro and Morgan 2000). At Hubbard Brook Experimental Forest in New Hampshire, Likens et al. (1996) found evidence that forest recovery from acidic deposition will be delayed due to the large quantities of calcium and magnesium lost from the soil complex and declines in base cation deposition. Lawrence et al. (1999) demonstrated that decreasing trends in acid-neutralizing capacity in Neversink Basin (Catskill Mountains, NY) result from lower soil base saturation caused by acidic deposition.

In addition to acid deposition, excess nitrogen deposition can impact soil chemistry, particularly cations. Nitrogen saturation, defined by a series of symptoms including absence of vegetative growth despite adequate nutrients, initiation of nitrate leaching from watersheds, and lack of N retention, has several negative environmental impacts (Aber 1992). Cation removal from soils by nitrate leaching is one such detrimental impact (Aber 1992, Adams et al. 1997, Likens et al. 1996). At Fernow Experimental Forest in the Central Appalachians, a reference watershed is exhibiting the symptoms of nitrogen saturation, which include long term increases in the export of nitrate and base cations to streams (Adams 1999). Johnson et al. (1985) found that base cation leaching rates increased two- to three-fold as a result of acidic deposition at Walker Branch Watershed in eastern Tennessee. In this study, conducted in a yellow poplar stand and a chestnut oak stand, a net loss of sodium, potassium, and magnesium was observed over a two-year study (Johnson et al. 1985). In a study by Sverdrup et al. (1992), the area of Maryland where TMat1 and TNef1 are located was shown to be acid-sensitive, thus the area will likely export base cations in response to acid precipitation including nitrate and sulfate ions. Conversely, in a broader study of the northeastern US, Yanai et al. (1999) found that most forest floors were not currently experiencing substantial base cation losses, but the authors thought that losses may have occurred prior to the 21-year study. Based on the aforementioned studies, I expected to observe net base cation losses from the two small, paired watersheds in Western Maryland that are quantitatively consistent with a response to acidic deposition.

Base saturation, another way of expressing the base cation nutrient status of a soil, is defined as "the degree to which cation exchange capacities in a particular soil are filled with cations" (Perry 1994) or "the percent of the total cation exchange capacity occupied by base cations" (Schlesinger 1997). The proportion of the CEC occupied by a particular cation is the percentage saturation for that cation. With high percentage saturation for a particular base, we can assume that nutrient is readily available to plants. The converse is also true (Brady and Weil 1999). Base saturation is calculated by the following equation (Brady and Weil 1999):

$$\%BS = \frac{B}{CEC} * 100 \qquad \text{(eq. 1)}$$

where,

B = exchangeable base forming cations ($cmol_c/kg$)

CEC = cation exchange capacity ($cmol_c/kg$)

Over the long term, primary mineral weathering is the most important source of base cations to sustain vegetation and neutralize acidity in forested catchments, making weathering rates essential to the understanding of base cation pools and cycling in watersheds (Furman et al. 1998, Taylor and Velbel 1991). Type of mineral, vegetation, cation exchange, and atmospheric deposition can also play an important role in the determination of weathering rates and cation cycling (Miller et al. 1993, Bormann et al. 1998, Furman et al. 1998). A study by Bormann et al. (1998), in which mesocosms were created to determine the importance of vegetation cation accumulation to weathering rates, demonstrated that potential weathering rates could be approximately ten times faster than when rates are calculated without attention to vegetative uptake and storage. This is especially true in disturbed conditions with abundant primary minerals and during an early successional stage (Bormann et al. 1998).

In the present study, TMat1 (pre-mining) was underlain by the Conemaugh and Allegheny Groups, while parent material at TNef1 is composed completely of the Conemaugh Group (Maryland Geological Survey 1998). These two groups are comprised mostly of sedimentary rocks like shales and siltstones, coal seams, and sandstones units above the coal beds (Maryland Geological Survey 1998). The 1968 (most recent) surficial geology map indicates that the Dunkard and Monongahela Groups may also be present at TNef1 and TMat1, and those groups contain limestones in addition to the rocks in the Conemaugh and Allegheny Groups (Maryland Geological Survey 1998). The shale, siltstone, claystone, and limestone are less weathering-resistant rocks while the sandstones tend to be more resistant to weathering (Schmidt

1993). The weathering of these rocks will produce high levels of cations as well as silica, depending upon the mineralogy of these rocks. Silicate and aluminosilicate rocks will weather more silica than limestones, siltstones, and shales. Since these bedrock layers were removed, crushed, and homogenized during strip mining at TMat1, I can expect chemical weathering to yield even greater amounts of base cations due to the increase in exposed surface area (physical weathering).

To determine if base cations are sourced from silicate mineral weathering, a few studies have found correlations between base cations and silica concentrations. In a study by Hedin et al. in an old-growth temperate forest in Chile (1995), the authors found a significant ($p< 0.002$) correlation between calcium, magnesium, and sodium concentrations in stream water and dissolved silica concentrations. Net base cation and silica fluxes were highly correlated with discharge at Cone Pond watershed in New Hampshire, suggesting that weathering in that watershed is impacted by runoff rather than acidic deposition (Hyman et al. 1998).

Weathering rates and watershed cation flux can also be impacted by disturbance by insects, acid deposition, logging, or mining. In a study in western Scotland, soils with both low and high acid sensitivity were subjected to sulfate inputs approximately 10 times field levels in a laboratory soil column leaching experiment, in order to isolate the effects of ion exchange and weathering from other factors like horizon thickness, water flow paths, and residence time (Grieve 1999). Soil solution, after sulfate treatment, had calcium concentrations ranging from 0.13-0.34 meq L^{-1}, magnesium concentrations ranging from 0.03-0.25 meq L^{-1}, and potassium concentrations ranging from 0.13-0.25 meq L^{-1} (Grieve 1999). Despite the differences in parent material, there was no evidence of differences in ability to neutralize acid inputs, and no detectable differences due to weathering (Grieve 1999). Unfortunately, silica was not measured in this study. Conversely, in a mass balance weathering study conducted in Shenandoah National Park, VA, a gypsy moth defoliation disturbance had no impact on weathering rates in all but the most base-poor watershed (Furman et al. 1998). The present study sought a soil disturbance weathering indicator, as demonstrated in the study by Grieve (1999). I expected to observe elevated base cation concentrations and efflux, as well as elevated silica concentrations and efflux at TMat1.

Cation exchange capacity (CEC) and exchangeable base cation concentrations in soils are generally related to soil texture. The texture of a soil, which is determined by particle-size analysis, is just one important indicator of soil nutrient status. Soil texture influences soil chemistry, soil moisture, pore space, and root development (Spurr and Barnes 1992). The USDA separates soil particles (<2 mm fraction) into three size classes: sand (0.05 mm-2 mm), silt (0.002 mm-0.05 mm), and clay (<0.002 mm) (Brady and Weil 1999). Three factors are generally responsible for CEC of a soil: clay content, the types of clay minerals or amorphous colloids present, and the humus content (Barbour et al. 1987). Humus and clay colloids are the functional units responsible for storing nutrient cations in soils.

Nutrient content of soil is highly dependent on soil texture and organic matter content. Humic colloids, composed of decomposing organic matter, have a greater capacity for adsorbing cations per unit weight than clay colloids (Spurr and Barnes 1992). Clay soils (>40% clay particles) have a heavy texture and are capable of holding more water and nutrients but less air than sandy soils (Spurr and Barnes 1992, Barbour et al. 1987). Therefore, sandy soils have generally low CEC's while clays and clay loams have very high CEC's (Spurr and Barnes 1992). Loam refers to an approximately equal mixture of sand, silt, and clay-sized particles in a soil. The nutrient status of a soil is also dependent upon the types of minerals a soil contains. Forest soils with 2:1 clay minerals have a much higher CEC than those soils dominated by 1:1 clay minerals such as kaolinite (Schlesinger 1997). Cation exchange capacity and soil fertility are both highly dependent on soil texture and organic matter content.

Base cations are key nutrients for plant growth and development. One way to measure the health of an ecosystem is to assess the status of the vegetation living in that ecosystem. Although base cations in vegetation were not measured in the present study, soil fertility and ecological integrity of a site directly impacts vegetative health and vigor. Both TNef1 and TMat1 are vegetated, but their nutrient status may be very different.

Base cations are classified as plant macronutrients, making them essential to plant life in significant amounts. Most trees require calcium and potassium in the largest amounts (Perry 1994). Growing plants get the nutrients they need from soil water that contains available anions and cations (Barbour et al. 1987). Ions in soil solution maintain equilibrium with adsorbed ions on soil colloids, which in turn maintain equilibrium with adsorbed ions in primary mineral structures. Therefore, when ions are removed from one of these pools, other ions diffuse to maintain equilibrium in the system (Barbour et al. 1987). Plants take up cations as they become available to the roots, not necessarily as the nutrients are needed. For example, trees do not require large amounts of sodium, but often take up substantial amounts of this base cation (Spurr and Barnes 1992). At Hubbard Brook, one forest took up 34.9 kg/ha/yr sodium, but returned 98% of it back to the soil in the form of root exudates. Conversely, only 1% of nitrogen and 6% of calcium taken up by trees was returned to the soil as root exudates (Spurr and Barnes 1992).

B. OBJECTIVES

The present study sought to determine the differences in base cation nutrient status between a previously mined and reclaimed watershed and a forested watershed. To that end, annual base cation input-output budgets were constructed and the magnitude of base cation export was compared between sites. Second, I wanted to determine if base cations exported in stream water derived from the soil exchange complex or were sourced from mineral weathering. I tried to determine the source of base cation export by correlating silica output per unit area to base cation output per unit area. A correlation would indicate silicate mineral weathering, whereas no relationship would indicate that base cations in streamwater are coming from the soil exchange complex.

This thesis also sought to compare the soil solution base cation concentrations at two depths between watersheds. The concentrations of exchangeable base cations in soil solution (i.e., lysimeters) were compared between the two watersheds. Soil solution composition is a particularly useful parameter, because it provides a measure of the mobile and available plant nutrients in the rooting zone, which can be drastically impacted by soil compaction and forest floor removal (Arocena 2000). I also wanted to assess and compare soil base cation fertility of the two watersheds. To that end, the CEC and exchangeable base status of the soil were compared between the two sites.

These objectives were met by soil sampling, lysimeter sampling, and two types of stream sampling. Streams were sampled bi-weekly in water year 2000 (October 1, 1999-September 30, 2000), and event sampling was employed in water year 2001 (October 1, 2000-September 30, 2001). Bi-weekly sampling did not appear to be an adequate method of sampling to construct a budget because the streams are ephemeral and dry much of the year. Also, there were concerns about the chemistry of the water during base flow as compared to storm flow.

Some researchers have found that most of the nutrients from watersheds will discharge during large storm or snowmelt events, not during low flow periods (Nagorski et al. 2003, Creed and Band 1998, Murdoch and Stoddard 1992, Hyman et al. 1998, McDowell and Asbury 1994). For example, at both mined and unmined sites in western Montana, calcium and magnesium were significantly inversely correlated with streamflow, most likely due to a snowmelt dilution effect (Nagorski et al. 2003).

Potassium, however, displayed a concentration increase along the rising limb of the hydrograph, believed to be related to an acidic flush of H^+ ions accumulated in snowpack, followed by a concentration decrease in the recession limb due to dilution (Nagorski et al. 2003). Hyman et al. (1998) found that net base cation and silica fluxes were highly correlated with annual stream discharge, while Murdoch and Stoddard (1992) found a consistent seasonal pattern of increased nitrate concentrations with increased flow during spring snowmelt in a small forested watershed in the Catskill Mountains. However, the nitrate concentration was not found to be an entirely consistent function of discharge, which indicates there is a biological component determining in-stream nitrate concentrations (Murdoch and Stoddard 1992). Also, sulfate concentrations at this same watershed decreased with increased discharge, indicating a dilution effect (Murdoch and Stoddard 1992). Nitrogen flux from the Turkey Lakes watershed was strongly correlated with discharge (r^2=0.69 and 0.71), but monthly discharge was not a strong predictor of monthly discharge-weighted average nitrogen (dissolved organic or inorganic nitrogen) concentration in that same catchment (Creed and Band 1998). In light of these studies, it is important to sample storm events when trying to establish an input-output budget, as these events could account for a high proportion of the nutrient efflux and base cation concentrations could be correlated with stream discharge.

This research contributes to the broader field of biogeochemistry by combining chemical analyses on soil, stream, precipitation, and soil solution samples from a reclaimed mine. This combination of sample types in such a system has not previously been studied, to my knowledge. The extensive data set created by this project should prove to be a valuable resource in comparing mined sites with other areas.

C. HYPOTHESES

The following is a comprehensive list of the hypotheses, predictions, and expected results that drove my research.

- I hypothesized that both of these sites were experiencing net base cation (BC) export, and I predicted that the net export ratio of TMat1: TNef1 would be greater than 1:1, indicating greater cation export from TMat1 due to the mining disturbance.

H_o: Volume-weighted cation concentration by paired rain event at TMat1 is not significantly different from volume-weighted cation concentration at TNef1.

H_a: Volume-weighted cation concentration by paired rain event at TMat1 is significantly greater than volume-weighted cation concentration at TNef1.

Most ecosystems are continually exporting base cations, with few exceptions. One notable exception, detailed by Hemond (1980) is Thoreau's Bog in Massachusetts. Potassium and magnesium exports are less than inputs, thus these cations are accumulated in the bog (Hemond 1980). Coastal systems where there are high amounts of sodium deposition from seawater may also have inputs greater than exports. The idea that both of these watersheds are exporting base cations is not novel; the magnitude and ratio of export between the sites is more compelling.

The paired analysis of the volume-weighted stream cation concentrations was the only statistically appropriate way to determine if the cation concentrations were significantly different by site. A paired analysis was most appropriate in this case to effectively remove the effect of time on the results. Otherwise, had the data been merely analyzed using a standard t-test, the samples would not have been statistically independent, thus violating a key assumption of the test (Hurlbert 1984). Multiple samples taken from each experimental unit, when taken sequentially over several dates (as in event sampling), are temporal pseudoreplicates unless analyzed using a paired or repeated measures design (Hurlbert 1984).

- Silicate mineral weathering, signified by silica export to streams, is occurring more intensely at TMat1 than TNef1. I further predicted that silica output would be strongly correlated to BC output at TMat1 due to mineral weathering, as the recent mining disturbance likely increased chemical and mechanical weathering of parent materials.

H_o: [Si] is not correlated to [Ca], [Mg], [K], and [Na] at TMat1

H_a: [Si] is correlated to [Ca], [Mg], [K], and [Na] at TMat1

According to a study by Sverdrup et al. (1992), western MD experiences very low catchment weathering rates (<1.0 keq/ha/yr), which is the base cation release to streams due to weathering as calculated from mineralogy, texture, temperature, and water chemistry. In the early stages of soil development after soil replacement and reclamation, weathering is prevalent and rapid, slowing as the soil develops and horizonization begins (Thomas and Jansen 1985).

- The exchangeable base status of the soil, in the mineral and organic horizons, is lower at TMat1 than TNef1 due to soil compaction, lack of organic matter, and rapid nutrient runoff.

H_o: [exchangeable base] $_{TMat1}$ is not significantly different from [exchangeable base] $_{TNef1}$

H_a: [exchangeable base] $_{TMat1}$ is significantly less than [exchangeable base] $_{TNef1}$

While I expected this difference to be significant for both mineral and organic horizons, I thought it would be more pronounced in the mineral horizon because the mediating effect of the organic matter would not be as evident in the mineral soils. Organic matter in both horizons and at both sites was analyzed and compared to strengthen this hypothesis.

- The CEC of the TMat1 mineral soil is significantly higher than the CEC of the TNef1 mineral soil, due to the high clay content observed at TMat1. A related hypothesis is that the TMat1 clay content is significantly greater than the TNef1 clay content in the mineral soil.

H_o: $CEC_{TMat1} = CEC_{TNef1}$, in mineral soil

H_a: CEC_{TMat1} is significantly greater than CEC_{TNef1}, in mineral soil

H_o: % $clay_{TMat1}$ = % $clay_{TNef1}$, in mineral soil

H_a: % $clay_{TMat1}$ is significantly greater than % $clay_{TNef1}$, in mineral soil

Cation exchange capacity and base saturation increase during initial soil development on exposed parent material, conditions which might occur after a severe disturbance such as mining (Schlesinger 1997). I anticipate a higher mineral soil CEC at TMat1 than TNef1 due to the high clay content I observed in situ at TMat1. Textural analysis will determine with greater certainty the amount of sand, silt, and clay in soil samples at each site. In the sites used for the present study, one watershed is forested and the other watershed is partially forested and partially a reclaimed mineland with grassland and wetland vegetation. The base cation status of the reclaimed mine was compared with the forested watershed and other forests to determine if a base cation deficit is preventing the mine from converting to forest, as a significant seed source is present. I expected that the per mass exchangeable base status of the mineral soil would be significantly lower at TMat1 than TNef1, due to soil compaction, lack of organic matter and rapid nutrient runoff. I expected to see the same pattern in the organic horizon, but less pronounced differences due to the high organic matter (OM) content of the soils.

- The concentrations of base cations in soil solution will be significantly higher at TNef1 than TMat1, and should be a good predictor of the relative fluxes of base cations in stream discharge.

H_o: [base cations in soil solution] $_{TNef1}$ are not significantly different from [base cations in soil solution] $_{TMat1}$

H_a: [base cations in soil solution] $_{TNef1}$ are significantly greater than [base cations in soil solution] $_{TMat1}$

Soil solution base cations are nutrients present in the plant-rooting zone derived from precipitation inputs and from the soil exchange complex. These concentrations might be lower at TMat1 due to surface compaction creating overland flow. At this site, there is little infiltration capacity and little surface organic matter accumulation to absorb nutrients from precipitation.

CHAPTER II. METHODS

A. SITE DESCRIPTION

A paired watershed study was conducted on Dan's Mountain in Allegany County, Maryland. Two small watersheds, TMat1 and TNef1, are less than two kilometers apart, thus presumably receiving similar atmospheric inputs of base cations and experiencing similar climatic regimes (Figures 1, 2, 4). The forested watershed (TNef1 watershed) is 3.0 ha in contributing area (Negley 2002), was selectively cut ca. 1983 (Dale Allan, landowner, personal communication), and discharges into an ephemeral stream that will be referred to throughout as Neff Tributary. A vegetation analysis of TNef1 was performed in 2001, and confirms the landowner's estimate of the selective cut around 1983 (K. Kuers unpublished data). In 1974, the forest soil was classified as a Cookport very stony silt loam with 10-30% slopes (USDA Soil Conservation Service 1974). The forest present at TNef1 is a deciduous stand consisting primarily of black cherry (*Prunus serotina*), black birch (*Betula lenta*), and sugar maple (*Acer saccharum*) (K. Kuers unpublished data). This forested watershed serves as a reference site for this study.

The reclaimed mine site (TMat1) is 27.1 ha in contributing area, of which 12.4 ha (46%) was mined in 1982, and reclaimed in 1984 (Tower Resources, Inc. 1981). Runoff from the watershed discharges into an ephemeral, constructed drainage ditch (Figure 1). The remainder of the watershed (the unmined portion) is predominantly forested, consisting of a mixed-sized hardwood forest with several rock outcroppings. The TMat1 watershed was classified as predominantly oak with a growth rate of 0.6 cm (0.25 in.) diameter per year in the mining permit application (Tower Resources, Inc. 1981). Prior to mining, the

TMat1 soils were mapped as a Cookport silt loam with 0-10% slopes and a Cookport very stony silt loam with 10-30% slopes (USDA Soil Conservation Service 1974). Following mining, TMat1 slopes were restored to < 5% grade, with swales and dips created by reclamation and further settling. As part of the ROCA study described above, three plots (20x20 m) and three transects (100 m) were installed on both watersheds, with transect 1 and plot 1 located at a low elevation near the stream outlet, transect 2 and plot 2 located at mid-elevation, and transect 3 and plot 3 at the top of the watershed (Figure 2).

A reference watershed was chosen for this study to be analogous to a control, but since TNef1 was selectively harvested, it is inappropriate to call it an experimental control. The harvesting and mining occurred at approximately the same time at each watershed, so their time since disturbance are roughly the same, as well as their underlying geology, parent material, and soils before disturbance. If TMat1 had not been mined, we believe it would have similar vegetation, stream and soil chemistry, species diversity, and other environmental parameters to TNef1. Only the stand age and selective cut would be different between the two sites.

B. UNDERLYING GEOLOGY

Surficial geology maps (Maryland Geological Survey 1998) of the region show that bedrock under these watersheds belongs to the Conemaugh and Allegheny Groups. The Conemaugh Group consists of interbedded gray-green and medium gray shale, gray micaceous sandstone and siltstone, coal beds, locally occurring reddish claystones, and two thin fossilferous shales in the lower half of the group (Maryland Geological Survey 1998). The Allegheny Group consists of interbedded medium to dark gray shale and siltstone, tan to light gray sandstone, and coal with claystone intervals near the base of the group (Maryland Geological Survey 1998). The geologic columnar section from a 69.2 m (227 foot) deep hole drilled prior to mining at the TMat1 site can be seen in Figure 3 (Tower Resources, Inc. 1981), and appears most similar to the Conemaugh Group as described in the 1998 geologic map (Maryland Geological Survey 1998). According to the mining application (Tower Resources 1981), all four of the coal seams shown in the columnar section (Figure 3) were mined, so all of the layers in between the coal seams consisting of sandstone and shale were removed, pulverized, and homogenized as overburden.

Mineralogical analysis from the Maryland Critical Loads Study (Rabenhorst et al. 1991) was available for the Dekalb soil series, a soil series very similar to the Cookport series. In the sand fraction of the Dekalb series, potassium feldspar accounted for 0.78%, 1.03% consisted of albite, and 1.32% was muscovite (Rabenhorst et al. 1991). Muscovite accounted for 7.84% of the silt fraction, and both potassium feldspar and albite accounted for less than 5% of the silt fraction (Rabenhorst et al. 1991). Kaolin and chlorite accounted for almost 20% of the clay fraction, smectite accounted for 15%, illite accounted for 11% and vermiculite and potassium feldspar each accounted for less than 5% of the clay mineralogy of the Dekalb series (Rabenhorst et al. 1991). These estimates are for weatherable minerals only (Rabenhorst et al. 1991). The Cookport soil series was formed from similar lithology as the Dekalb series, so their mineralogical compositions can be assumed to be similar.

C. STREAM SAMPLING AND STREAM WATER CHEMICAL ANALYSIS

Biweekly collection of streamwater samples was attempted beginning in October 1999 and concluded in October 2000 (Figures 5 and 6). One-liter samples were "grabbed" from the two streams at locations near the outlet of each watershed (Figure 4). It was not always possible to obtain stream samples during water year 2000, because the streams located on each watershed are ephemeral (zero-order). Samples taken from TNef1 and TMat1 were taken ~10 m above the stream gage, to avoid any effects of the gage on stream chemistry. As part of the broader collaborative study, EBNR, TNef1, and TMat1 streams were all gaged, continuously recording flow on an hourly basis. Stream gage locations on each of these watersheds are shown in Figure 4. The present study only discusses the results of the sampling at TNef1 and TMat1. TMat1 and TNef1 streams were gaged with "Montana" flumes anchored to timber or fiberglass wingwalls buried in the stream bank (Negley 2002). Each gage was equipped with stilling wells and stage recorders with copper floats to record stage height fluctuations (Negley 2002). Instantaneous stage heights were digitized and converted to hourly discharge and average daily discharge (Negley 2002). These data were used in subsequent cation budget calculations and in developing concentration-discharge relationships.

Once brought back to the laboratory, samples were immediately (within 4 hours of collection) analyzed for pH with an Orion Model 250A pH meter and conductivity (specific conductance) with a YSI Model 32 conductance meter. The pH meter was calibrated with buffer solutions of pH 4.0, 7.0, and 11.0, and a quality control buffer solution of pH 4.6. The conductance meter was checked against potassium chloride solutions of 14.7, 74.0, and 147.0 $\mu S\ cm^{-1}$. The remainder of each sample was then vacuum filtered through a tared 47mm glass fiber filter (Whatman GF/F, nominal pore size 0.7µm) that had been ashed at 425°C for 1 hour to remove any organic matter. Filters were dried in a 105°C drying oven for 48 hours, cooled in a dessicator, and weighed. Total suspended matter (TSM) was calculated using the following equation:

$$TSM = \frac{(dry\ weight - tare\ weight)}{volume\ \ filtered\ (mL)} * 10^6 \qquad \text{(eq. 2)}$$

Where the units of TSM are mg L^{-1}. Filtered samples were stored in high-density polyethylene (HDPE) bottles at 4°C for up to 6 months and then were analyzed for base cations on a Perkin-Elmer atomic absorption spectrophotometer (AAS).

After one full year of bi-weekly stream sampling, it became apparent that the ephemeral streams were not flowing enough to base an input-output budget on those sample collections. It was therefore decided that an event-based sampling scheme should be adopted, in order to more accurately quantify the fluxes of base cations from each watershed.

To improve the stream sampling scheme, ISCO samplers were installed at the gaging stations for both TNef1 and TMat1 watersheds (Figure 2), and programmed to take 500 mL samples every two hours for 48 hours during an event. Under ideal conditions, 24 samples were taken from each stream at the end of each event, capturing the rising limb, peak, and recession limb of each storm hydrograph. An actual example of sampling along the storm hydrograph is shown in Figure 7. Liquid level actuator (LLA) conductivity probes were secured in each streambed and were set at an appropriate height to sample the largest events. These heights were determined by looking at the historic stream stage as reported from each gaging station, and setting the LLA high enough to only sample major events. However, the LLA probes proved to be unreliable, so I set out to program and start the sampler when a large event was forecast, setting the sampler to sample every 1 to 4 hours, depending on the forecast duration of the event. Often, if the hydrograph had not reached the recession limb by the time 24 samples had been taken, the sampler was set to take another 24 samples in order to adequately sample the storm hydrograph.

These samplers were used for one water year (October 1, 2000 to September 31, 2001) in which I sampled 10 large events at TMat1 and 9 large events at TNef1 (Figures 8 and 9). The first event where samples were collected was used as a test event for flow-proportional sampling. I measured the cation concentration in each of the 48 discrete samples, then composited every four consecutive samples proportional to the flow, based on the hydrographs generated at the gaging stations. Compositing was based on the percentage of flow that occurred over the composited time period. Cation concentrations were measured on discrete samples and on composited samples. Flow-weighted concentrations were calculated for the individually analyzed samples and plotted against the concentrations measured on the composited samples (Figures 10-15). A paired t-test was conducted to determine if the measured and composited sample concentrations were significantly different from one another. A best-fit line was drawn through the points and a 1:1 line was plotted against it. The equation of the best-fit line is shown on Figures 10-15 to show the departure of the slope from 1 and the departure of the y-intercept from zero. This experiment was performed to determine whether the flow-proportional composited samples accurately represent the cation concentrations of the individual samples. Subsets of the flow-composited event samples taken throughout the water year were analyzed for silica.

D. SOIL SAMPLING AND ANALYSIS

As part of the broader collaborative ROCA study, an intensive soil sampling was conducted at each site. Subsamples from this collaborative effort were used to conduct my analyses. Soils were collected from the forest floor (O_e and O_a horizons combined) and upper mineral horizon at TNef1, and from the "organic crust" and upper mineral horizon at TMat1. The organic crust is the layer of dead and decomposing vegetation on the surface of the soil at TMat1, and is considered to be analogous to the forest organic horizon for the purposes of the present study. In August 1999, 15x15 cm forest floor "brownies" and mineral soil bulk-density cores were taken approximately every three meters along the three transects on the forested watershed. In July 2000, 15x15 cm organic crust samples and soil bulk-density cores were collected along the three transects on the reclaimed mineland. These samples were taken at random locations, stratified within 3 meter segments, along the transects. An additional sixteen random samples were taken from the adjacent forested portion of the TMat1 watershed and were treated the same as the samples taken from the forested watershed, but these results will not be considered in the present study.

The soils were kept on ice and transported back to the laboratory for sieving. Forest floor and organic crust samples were sieved at 2 mm mesh size, roots were sorted out quantitatively and excluded from further treatment, and woody debris > 0.5 cm and mineral grains > 2 mm were dried, weighed, and discarded. Woody debris < 0.5 cm and organic clumps were recombined with the fraction passing through the sieve. Mineral soil bulk density samples were also sieved at a 2 mm mesh size, roots were quantitatively picked out and excluded from further treatment, and woody debris > 0.5 cm and mineral grains not passing through the sieve were dried and weighed, then discarded. Woody debris < 0.5 cm and the fraction of soil passing through the sieve were combined. Every two adjacent samples were composited after sieving. Samples were refrigerated at 4° C until analyses were performed. I analyzed mineral soil samples in field moist condition for pH (1:1 in 0.01M $CaCl_2$) within 1 week of collection.

For base cation analysis, extractions were performed on both forest floor and organic crust samples < 2 mm with recombined organic clumps and mineral soil < 2 mm. For the determination of exchangeable bases, ~2.5 g of air dried organic soil or ~10 g of air dried mineral soil was extracted with ~100 mL of 1M NH_4Cl by vacuum extraction (Johnson et al. 1991). Prior to vacuum extraction, soil samples were shaken for at least one hour. The extracted solution was analyzed by Perkin-Elmer AAS for Ca^{2+}, Mg^{2+}, K^+, and Na^+ concentration. To convert from concentration units to charge units, the following equations were used:

$$\frac{mg\ element\ (Na, K, Ca, or Mg)}{g\ soil} = \frac{concentration\ (ppm) * volume\ of\ extract}{g\ dry\ soil}$$

(eq. 3)

$$\frac{cmol_c\ element}{kg\ soil} = \frac{(mg\ element / g\ soil) * valence\ of\ ion}{10 * atomic\ mass\ of\ element}$$

(eq. 4)

All units were then converted to equivalents for ease of comparison with other studies. Cation exchange capacity was measured using the method for exchangeable acidity titrimetrically, and then CEC was calculated by summing exchangeable acidity and the exchangeable bases (Johnson et al. 1991, Robertson et al. 1999). For the determination of exchangeable acidity, ~2.5 g of air dried organic soil or ~10 g of air dried mineral soil was shaken with 50 mL of 1M KCl for half an hour and allowed to sit for half an hour before extraction. The slurry was then vacuum extracted and the soil was washed with two additional 50 mL aliquots of 1M KCl, for a total of 150 mL of KCl per sample. Five drops of phenolphthalein were added to the filtrate, which was then titrated with 0.1N NaOH to the pink endpoint and the volume of sodium hydroxide used was recorded. Several blank solutions were also titrated, to establish baseline acidity. Exchangeable acidity and effective cation exchange capacity (ECEC) are calculated with the following equations:

$$EA = \frac{S - B}{g\ dry\ soil} * \frac{0.1\, mmol_c H^+}{volume\ NaOH} * \frac{0.1\, cmol_c H^+}{mmol_c H^+} * \frac{1000\, g}{1 kg}$$
(eq. 5)

$$ECEC = \frac{K^+ cmol_c}{kg\ soil} + \frac{Ca^{2+} cmol_c}{kg\ soil} + \frac{Na^+ cmol_c}{kg\ soil} + \frac{Mg^{2+} cmol_c}{kg\ soil} + EA$$
(eq. 6)

where,
S= volume of NaOH required to titrated sample
B= volume of NaOH required to titrated blank
EA= exchangeable acidity, units $cmol_c$ (kg soil)$^{-1}$
ECEC= effective cation exchange capacity, units $cmol_c$ (kg soil)$^{-1}$

Using equation (1), base saturation was determined from the amount of exchangeable bases and the ECEC. Since no species of aluminum were measured in the present study, calculated base saturation values are greatly overestimated and should not be relied upon for site-to-site comparison.

For soil texture analysis, the hydrometer method detailed by Gee and Bauder (1986) was followed. Only mineral soil samples were analyzed, due to the extensive length and difficulty of analysis and the high organic matter content of organic soils could be problematic. Approximately 20 g of dry mineral soil was treated with 30% hydrogen peroxide at 90º C to remove organic matter, and then combined with 100 mL of hexametaphosphate (HMP) solution (concentration 50 g L^{-1}) and 250 mL of distilled water and allowed to sit overnight (minimum 8 hours). The slurry was transferred to a shaker table and allowed to shake overnight, then transferred to a 1 liter graduated cylinder and filled to 1 liter with distilled water. The contents were mixed thoroughly, hydrometer inserted into the solution, and temperature and hydrometer readings taken at 30 sec, 1 min, 90 min, and 1440 min. Using the equations found in Gee and Bauder (1986) and Robertson et al. (1999), sand, silt, and clay fractions were calculated.

Percent organic matter of mineral soil samples was completed using the loss-on-ignition method. Approximately 10 g of 105ºC dry soil was weighed into a tared crucible of known weight, the sample was ashed at 550ºC for 48 hours, allowed to cool in a dessicator, and then weighed again. Percent organic matter was calculated as:

$$\%\, Organic\ Matter = \frac{OM\ \ weight\ (g)}{Dry\ Soil\ Weight\ (g)} * 100 \qquad \text{(eq. 7)}$$

E. LYSIMETER SAMPLING AND ANALYSIS

Eighteen tension lysimeters were installed in early May 2000, as part of the collaborative project, on each site, 6 in each plot with 3 at 15 cm depth (shallow) and 3 at 60 cm depth (deep). Lysimeters were sampled in July, August, September and October 2000 and May, June, July, and August 2001, approximately once each month. Twenty-four to 72 hours before sample collection (depending upon wetness conditions prior to the sampling), the lysimeters were pumped to a tension between 60 and 80 centibars of soil suction. Lysimeter samples were kept in coolers on ice in the field, brought back to the laboratory, analyzed for pH and conductivity (specific conductance) within 24 hours, and then filtered with glass fiber filters (Whatman GF/F, nominal pore size 0.7µm) previously ashed at 425º C for 1 hour to remove any organic matter. Samples were stored in HDPE bottles at 4º C for up to six months until base cation analysis. Samples were not acidified as is customary for this analysis, because they were not archived or saved for analysis past their six-month holding time.

F. PRECIPITATION SAMPLING AND ANALYSIS

Weekly precipitation sample partitioning for the present study began on the TMat1 site (Figure 2) in October 2000 and concluded in October 2001 (courtesy M. Castro). Only one precipitation collection station served both watersheds, which is acceptable because they are so close. However, throughfall inputs were not considered in this study and could have measurable impact on the rainfall chemistry at TNef1. Throughfall inputs tend to concentrate and increase the amount of nutrient input onto a forested site, thus impacting nutrient cycling and export. Samples were stored frozen in HDPE bottles until analyzed for exchangeable base cations.

G. LABORATORY QUALITY CONTROL

The extensive amount of laboratory work performed for this project required quality control check standards (QCCS), duplicates, and blanks to verify the quality of the data collected. For pH of soil and water samples and conductivity, QCCS were run every 5-10 samples. Conductivity standards were made to bracket the sample range and made fresh every seven days.

For all natural water samples analyzed on the Perkin-Elmer AAS and the flow injection silica analysis, lab duplicates were run every 10 samples with relative percent difference (RPD) <10%. QCCS, made from different stock solutions than the instrument calibration standards, were run every 10 samples and were always observed to be within 10% of the known value.

AAS instrument replicates, where each sample, standard, and QCCS cup was analyzed at least twice, always had a relative standard deviation (RSD) <15%. Only calibrations with an r^2 = 0.999 or higher were accepted and the instruments were recalibrated when running at least every 30 samples. Baseline blank solutions were analyzed at the beginning of every calibration of natural water samples so the instruments could autozero. However, for samples in an NH_4Cl matrix analyzed by AAS, 9 blanks were run as samples and had the following mean values: [Na]=0.1420 ppm, [K]=0.00 ppm, [Ca]=0.0163 ppm, and [Mg]=0.0200 ppm.

Exchangeable acidity titration blanks had a mean of 0.0756 mL 0.1N NaOH and duplicate samples had a mean RPD of 22.5%. ECEC duplicate samples had a mean of 7.3% RPD, and exchangeable cation duplicate samples had mean RPD's of 3.5% for Na, 17% for K (due to a large number of samples with concentrations below instrument detection), 9.6% for Ca, and 15.9% for Mg. These higher RPD values in the soil samples are not surprising, as it would have been very difficult to obtain a perfectly homogenous subsample for each analysis that was performed. A complete listing of soil exchangeable bases quality control data can be found in Appendix A.

H. INPUT-OUTPUT BUDGETS

The budgets were calculated by subtracting the fluxes of cations exported from each watershed (eq $ha^{-1}yr^{-1}$) from the fluxes entering the system through precipitation. Any differences between the inputs and outputs can only be attributed to vegetative uptake, mineral weathering, and release from the labile soil pool or from the cation exchange complex (Currie et al. 1996), or from another source such as limestone gravel or fertilizer. A mass balance approach was taken, similar to those previously used by Currie et al. (1996), Velbel (1985), and McDowell and Asbury (1994). Cation and silica output from the two watersheds were calculated three ways. First, the mean annual cation and silica concentrations were used to calculate a rough annual export, following the equation below.

$$eq\,ha^{-1}yr^{-1} = \overline{C} * R * \frac{1m}{10^3 mm} * \frac{10^3 L}{m^3} * \frac{1g}{10^3 mg} * \frac{1mol}{Xg} * \frac{Xeq}{1mol} * \frac{10^4 m^2}{1ha}$$

(eq. 8)

where,
$\overline{C}$ = unweighted mean annual concentration in mg L^{-1}
R = runoff in mm yr^{-1}
X = number of grams per mole or equivalents per mole, depending on element

This is the mean concentration budget, and will be referred to as Method 1 throughout. Silica is presented in units of mol ha^{-1} yr^{-1}, and uses the same calculations as are shown in equation 8, with the elimination of the conversion from molar units to equivalent units. Since the only error I can quantify for this budget calculation is in the cation concentration, the standard error (SE) of the mean concentration was calculated and perpetuated through the calculations to give a SE for this budget. Error in the water budget will also contribute to error in the cation budgets. Flume and bedrock water leakage would cause underestimation of cation export in the budgets at each site.

A second budget (Method 2) was calculated using the composited event sample cation and silica concentrations along with the mean discharge over the sampling period. Stream chemistry concentrations are in units of mg L^{-1} and discharge is in units of cubic feet per second (cfs). This was calculated in a series of several steps, described by the equations below.

$$eq\ ha^{-1} events^{-1} = \sum_{i=1}^{N} \frac{(\overline{D}_i * \frac{28.3L}{1cf} * C_i * \frac{1g}{1000mg} * \frac{1mol}{Xg} * \frac{Xeq}{1mol} * T_{stp})}{A}$$

(eq. 9)

where,
$\overline{D}_i$ = mean discharge over sampling period in cfs, for the ith event
C_i = concentration in mg L^{-1}, for the ith event
T_{stp} = time, over entire sampling time period, in seconds
A = watershed area, in hectares
N = number of events sampled

Next I calculated the proportion of discharge sampled for that water year (WY00: Mat1 = 8.4% and Nef1 = 8.9%; WY01: Mat1 = 33.3% and Nef1 = 26.4%) (Figures 5 and 6, 8 and 9). Finally, I annualized the total cation export, based on the proportion of yearly discharge sampled and the event sampling cation export. For example, if event export = 8 eq $ha^{-1}yr^{-1}$, and discharge sampled is 25% of total yearly discharge:

$$\frac{8\ eq\ ha^{-1}yr^{-1}}{total} = \frac{25.0}{100.0}$$

(eq. 10)

$$\text{total export} = 32 \text{ eq ha}^{-1}\text{yr}^{-1}$$

A third budget (Method 3) was created using concentration-discharge relationships created for each cation and silica at each site (Figures 16-25). Linear best-fit lines were drawn through scatter plots of concentration versus the discharge function. The reciprocal discharge function follows Johnson et al. (1969):

$$\frac{1}{1+bD} \qquad \text{(eq. 11)}$$

where,

b = constant of either 10^2 (TNef1) or 10^1 (TMat1)

D = mean discharge over sampling period (cfs)

Beta (b) was selected by trial and error to determine which constant produced the widest range (from zero to 1) of discharge function values when input into equation 11 and the highest r-squared values when plotted against concentration. Previous research has shown that there can be curvilinear and hyperbolic decay relationships between concentration and discharge, as well as linear relationships (Nagorski et al. 2003, Creed and Band 1998, Murdoch and Stoddard 1992, Hyman et al. 1998, McDowell and Asbury 1994, Hill 1993). The equations of these best-fit lines (Figures 16-25) were used to calculate cation concentrations using daily discharge data for WY2001. I used the same equation (Equation 9) as was used in the event sampling budget to determine an annual cation export from each watershed.

For precipitation input, the calculations are similar. For each week that precipitation was adequate enough so that I could obtain a sample, the following equation was used.

$$eq\ ha^{-1}\ yr^{-1} = \sum_{i=1}^{52} \frac{C_i * R_i * A_m * \frac{1000L}{1m^3} * \frac{1g}{1000mg} * \frac{1mol}{Xg} * \frac{Xeq}{1mol}}{A_h}$$

(eq. 11)

where,
C_i = concentration of cation in rainwater, in mg L^{-1}, for the ith week
R_i = amount of rainfall, in meters, for the ith week
A_m = watershed area, in square meters
A_h = watershed area, in hectares

If the cation export was greater than cation input, I can conclude that either the system is leaching bases from soils (depletion) or that cations are coming from weathering of primary minerals. High silica concentrations in streamwater indicate that weathering is at least partially responsible for cation efflux. If the amount of cations coming in through precipitation inputs is greater than that coming out, then I can conclude the system is aggrading.

Since an input-output budget only results in one value for each site, there is no statistical way to determine if the two watersheds are behaving significantly differently with respect to cation export. So, I separated out each individual storm event from the water year and graphed the cation concentrations against the storm hydrographs (Figures 26-45). Each event was assigned a letter, with only the paired events (those events occurring simultaneously at both sites) sharing a letter designation. Six such events were captured at both TNef1 and TMat1 during WY2001. Volume-weighted mean cation concentrations for each event were calculated using the following equations.

$$F = \sum_i C_i Q_i \qquad \text{(eq. 12)}$$

where,
F = loading or flux
C_i = concentration of the ith sample in mg L^{-1}
Q_i = runoff over the ith sampling period in mm hr^{-1}

$$\overline{C}_{vw} = \frac{F}{\sum_i Q_i}$$

(eq. 13)

where,
$\overline{C}_{vw}$ = volume-weighted mean cation concentration
F = loading or flux
Q_i = runoff over the i^{th} event in mm hr^{-1}

I was able to perform a paired t-test on this data to determine if the volume-weighted mean cation concentrations differed significantly by site. Using a paired t-test here recognizes that the sequential event samplings are not time-independent, and adjusts for statistical non-independence (Hurlbert 1984).

I. STATISTICAL DESIGN

Tests for descriptive statistics and data distributions were performed before any further statistical analysis, to check for parametric assumptions. For all data that were analyzed using ANOVA or regression techniques, the residuals were checked for normality. In the event that a data set violated an assumption, a data transform (i.e. log_{10}, natural log, or square root) was performed or the equivalent nonparametric test was used.

An implicit first hypothesis is that concentration varies as a function of discharge during runoff events. Concentration versus a discharge function (eq. 11) was plotted for each cation and silica at each site and a best-fit line was drawn through the points. Linear regression was used to determine if these relationships were statistically significant. Even though all relationships were not significant, the equations of the best-fit lines were used for Method 3 input-output budget calculations.

To determine if sample compositing was valid, an analysis of covariance (ANCOVA) for heterogeneity of slopes was conducted for each cation individually. This analysis was performed on data shown in Figures 10-15. If the slope of measured samples versus composited sample (x-y scatterplot best-fit line) concentrations is different from one (i.e. $y = x$), then the compositing method is not valid. Large departures of the slope or y-intercept from one and zero, respectively, indicate a lack of similarity between the best-fit and 1:1 lines. Both of these tests were used to determine if sample compositing is valid for this study.

A paired t-test was used to compare base cation stream concentrations between the two sites. The null hypothesis for this test is the volume-weighted mean cation concentrations across each of six paired event samplings (events B, F, G, H, I, and J) conducted in water year 2001 are not significantly different for TMat1 and TNef1.

Silica concentrations were plotted against calcium, magnesium, sodium, and potassium concentrations. Positive linear relationships between cations and silica indicate that nutrient export increases with increased silicate weathering. No relationship between silica and cation concentrations indicates that other mechanisms such as cation exchange are at work in the export of base cations from these watersheds.

A one-way analysis of variance (ANOVA) was performed to compare silica concentration and TSM in stream samples, exchangeable bases and ECEC in the organic and mineral horizons, percent organic matter and soil texture in mineral soil, and base cations in soil solution by depth at TMat1 and TNef1. A regression analysis was also employed to determine if any individual base cation or the sum of the base cations (SBC) had a significant relationship with TSM. Multiple regression with a stepwise selection technique (entry probability = 0.5; exit probability = 0.05) was used to determine if any or all the base cations combined have a significant relationship with TSM.

In the organic horizon, soil exchangeable magnesium and calcium concentrations (+1 to avoid undefined values) were $\log_{10}$ transformed so that parametric statistics could be used. No data transformations were required for exchangeable bases in the mineral soil horizon.

Texture and percent organic matter are the two most important factors in the ECEC of a soil. Thus, these analyses will allow me to determine which factor is most strongly controlling ECEC at these two sites. The ECEC of the mineral soil was compared using a one-way ANOVA, and the organic soil ECEC was $\log_{10}$ (y+1) transformed (to avoid undefined values) and then compared using a one-way ANOVA.

A large number of lysimeters were dry each month, leading to a problem with missing data throughout the growing season. Water year 2000 was a drought year, so very few samples were taken that year. Samples from water year 2001 were partitioned for eight separate analyses, so rarely was there enough sample volume to partition for cation analysis. To remedy this problem, data from the month with the highest number of adequate samples (June 2001) were the only data analyzed for this thesis. A complete collection of lysimeter data throughout the study can be found in Appendix B. For both the shallow (15 cm length) and deep (60 cm length) lysimeters, magnesium concentration was log (y+1) transformed to normalize the residuals so a one-way ANOVA could be employed. Also, a two-way ANOVA was used to determine if there was a difference between shallow and deep lysimeters for each cation at each site. No other lysimeter cation data had to be transformed in order to use parametric statistics.

Data manipulations were performed using Microsoft Excel spreadsheet software and Statistical Analysis System (SAS) software, and statistical analysis was completed using SAS. All raw data collected for this project with calculations and manipulations can be found in Appendices C-F.

CHAPTER III. RESULTS

A. RELATIONSHIPS BETWEEN CONCENTRATION AND DISCHARGE

Relationships between concentration and the discharge function (1/(1+ßD)) that would normally be hyperbolic or follow a decay function are reduced to a simple linear function. At TNef1, concentrations generally increase with increasing discharge (Figures 16-20), indicating that water infiltrates and moves through the solum after a rain event, picking up nutrient cations along the way. Calcium ($p = 0.022$) and magnesium ($p = 0.004$) are significantly related to the discharge function, but potassium, sodium, and silica are not. These r-squared values are fairly low, ranging from 0.03-0.13, in part due to compositing. Compositing averages out the sample – to – sample variability but allows for a larger sample size, important in establishing annual budgets. Equations of these best fit-lines were later used to calculate cation budgets (Table 4) but the silica equation was not used due to the small sample size ($n = 25$).

The TMat1 concentration-discharge function relationships were more positive with r-squared values ranging from 0.04-0.26 (Figures 21-25). This range is misleading because the four cations all had r-squared values greater than 0.11, demonstrating that the discharge function explains more than 10% of the variation in concentration for calcium, magnesium, potassium, and sodium. All four cations were also significantly linearly related to the discharge function, with p-values less than 0.002. Silica had the lowest r-squared and a very small sample size ($n = 18$), thus the line equation was not used to calculate an annual export value. The relationship between silica and the discharge function was not statistically significant ($p = 0.45$). The linear equations for

Ca, Mg, K, and Na were all used to calculate annual cation exports for budget Method 3 (Table 4).

In contrast to TNef1, TMat1 had higher base cation concentrations at low flow and concentrations decreased as flow increased. An inverse relationship indicates that nutrient flushing occurs at the start of rain events followed by a dilution effect as flow increases. This flowpath is compatible with a low infiltration capacity where nutrients accumulate at the surface and runoff as soon as an event begins, followed by runoff consisting of less nutrient cations and more diluent.

B. FLOW-COMPOSITING COMPARISON

Linear regression for measured versus composited concentrations for all four cations is statistically significant ($p<0.0001$ for all; see Figures 10-15 for r-squared values), but ANCOVA shows that only the best-fit line slope of potassium has a slope statistically equivalent to one ($p = 0.7764$) (Figure 13). Calcium, magnesium, and sodium have best-fit lines slopes significantly different from one ($p<0.0001$ for Ca, Mg, and Na) (Figures 10, 12, 15).

Despite that for 3 out of 4 cations compositing was not valid, I still used this method for the remainder of the water year. This research was mainly focused on an annual budget, so individual sample concentrations were not vital in this study. Also, I believe that compositing averaged out the small peaks and valleys of concentration, but that little information was lost when annualized. If anything, flow compositing made the annual budgets more conservative by averaging out extreme values. The loss in resolution was worth the increase in numbers of samples and rain events that I was able to process.

The magnesium graph (without outlier) illustrates perfectly that high concentrations decreased and lower concentrations increased when composited, thus greatly decreasing the slope of the line but not greatly impacting the actual concentrations (Figure 12). Calcium data (Figure 10) exhibit two populations of data, which could cause the best-fit line slope to depart from one. Sodium concentrations bracket a very small concentration range (from > 0.4 mg L^{-1} to < 0.6 mg L^{-1}), which could have been problematic in the ANCOVA heterogeneity of slopes analysis. Also, instrument quality control was the most difficult with sodium, due to its low detection limit (0.002 mg L^{-1}) and its tendency to lose precision throughout instrument runs. I believe the measured and composited sample concentration differences for sodium are due to instrument error, not an actual difference due to the compositing method. Compositing enabled me to sample many more events throughout the water year with slightly less precision, which I think is more appropriate to this study than sampling very few events in great detail.

C. BASE CATION INPUT-OUTPUT BUDGETS

Base cation exports for water year 2000 ranged from 125-932 eq $ha^{-1}yr^{-1}$ at TMat1 and 24-237 eq $ha^{-1}yr^{-1}$ at TNef1 (Table 1). The highest output is calcium at both sites, and the lowest is sodium at TMat1 and potassium at TNef1. TMat1 exports between 3.7 and

6 times the amount of cations TNef1 exports (Table 1). Potassium has the highest output ratio, and the other three ratios all vary around 4:1. For all four cations, TMat1 exports much more than TNef1.

Water year 2001 annual mass balances of base cations, based on three different computational methods, at the two watersheds and the ratio of net export are shown in Tables 2, 3, and 4. For three of the four base cations, regardless of computation method, precipitation input was grossly exceeded by stream water output. Potassium and sodium output at TNef1 are the only instances where input and output were nearly equivalent. Input values are the same for both watersheds, when normalized by watershed area, as one precipitation collector serves both sites (Figure 2). The three budgets I constructed indicate that base cations in these two watersheds are being depleted from these watershed systems. Contrary to my hypothesis, weathering of aluminosilicate minerals appears to be responsible for a greater proportion of base cation export at TNef1 than at TMat1 ($SiO_{2TNEF1} > SiO_{2TMAT1}$). At TMat1, removal of base cations from the soil exchange complex by cation exchange and leaching is the more prevalent process at work in cation export. TMat1 exhibits a consistently greater net export of all base cations than does TNef1 ($BC_{TMAT1} > BC_{TNEF1}$), but the net export ratios Mat1: Nef1 varied greatly by cation.

The Mat1: Nef1 ratio of potassium export is slightly confounded, because it compares a site experiencing net export (TMat1) to one experiencing almost no loss or gain (TNef1) (Tables 2-4). TNef1 appears to also not be losing or gaining much sodium, but TMat1 is exporting 6-10 times more sodium than TNef1. Calcium has 3.8:1 to 5.5:1 ratios of net TMat1: TNef1 export, while the magnesium ratios are much lower, ranging from 1.3:1 to 1.8:1.

The three different export calculation methods produced strikingly similar results for the four base cations. The similarity in these results gives me great confidence that all three methods are accurate and reasonable, especially since different datasets (discharge versus runoff, annual mean concentration versus individual sample concentrations) were used to calculate the cation export each way. Silica, however, produced slightly different results dependent upon the calculation method I used. The mean concentration method appears to produce more reasonable results, but since the sample size (n = 25) for the mean concentration is low, there is a high degree of uncertainty surrounding that mean (Mat1 SE = 7.8 mol ha^{-1} yr^{-1}; Nef1 SE = 5.3 mol ha^{-1} yr^{-1}). I chose not to present the results of the silica budget calculations from the concentration-discharge relationships due to the small sample size and temporal similarity amongst the samples (Table 4).

Water years 2000 and 2001 have similar cation outputs, despite the vastly different sampling scheme employed during the two study years (Tables 1-4). There was much greater runoff in water year 2001 than in water year 2000, which also could account for year-to-year differences. The increased runoff in WY2001 could cause a dilution effect thereby effectively decreasing the cation export for that water year. Calcium at TMat1 is slightly lower than in WY2001, but magnesium and sodium are higher. Cation export at

TNef1 is lower across the board, most substantially for calcium and magnesium. The ratio presented in Table 1 is an output ratio not a net export ratio, and since precipitation cation chemistry was not measured during WY2000, the ratios of WY2000 and WY2001 are not comparable. It is important to note that, even in the absence of inputs, TMat1 is cycling and releasing many more cations than TNef1.

To better understand the differences between the water years, I used a one-way ANOVA to compare the cation concentrations at each site and each water year. I found that sodium ($p = 0.0039$, df = 75, WY00>WY01) and calcium ($p = 0.0452$, df = 75, WY01>WY00) were significantly different between water years at TNef1, and that sodium ($p<0.0001$, df = 67, WY00>WY01), magnesium ($p<0.0001$, df = 67, WY00>WY01), and calcium ($p<0.0001$, df = 67, WY00>WY01) were significantly different between water years at TMat1. In general, stream samples from water year 2000 had higher mean concentrations, with the exception of calcium at TNef1. This result is the opposite of what I expected, given the cation outputs discussed above (Tables 1-4).

D. CATION CONCENTRATIONS COMPARED BY EVENT

When the entire year of event sampling was partitioned into individual storm events, each event was assigned a letter and cation concentrations, and discharge were graphed against time (Figures 26-45). Concentration symbols were located in time at the midpoint of the composited event samples. Paired events (occurring and sampled at both sites simultaneously) were assigned the same letter, but events where the timing was off or the two watersheds responded differently were assigned a unique letter. Nine events were sampled at TNef1 and 11 events were sampled at TMat1.

Event A (TMat1) was a snowmelt event so the hydrograph only shows a recession (Figure 26). Event I (TMat1 and TNEf1) (Figures 36 and 37) and event N (TMat1) (Figure 42) also only show the recession limb of the hydrograph, as I missed the rising limb and peak due to error or time constraints. Events I and N will therefore not be included in the discussion of cation chemistry throughout a storm.

Some patterns of flushing and dilution emerged when each event was inspected individually. For example, event E shows a clear increase in potassium concentration through the rising limb, a high concentration near the hydrograph peak, and a decline in the recession limb of the storm (Figure 29). Similar patterns are seen in events L (TMat1; Ca and K) (Figure 40), B (TNef1, Ca, Mg, and K) (Figure 44), C (TNef1, Ca and K) (Figure 43), D (TNef1, Ca) (Figure 44), and K (TNef1, Ca and K) (Figure 45). Nutrient flushing in the storm rise and subsequent dilution after the peak and throughout the recession highlights the importance of an event-based sampling scheme.

Individual storm characteristics were too small to be picked up in the concentration-discharge relationships (Figures 16-25) because they do not occur in each and every storm event, but are obviously important when shown in several events in one year. Also, I think it is remarkable that any within-event patterns emerged given that samples were composited. Compositing averages out the resolution of within-event changes in chemistry, and is not ideal when looking for nutrient flushing or dilution effects.

Volume-weighted mean cation concentrations were also calculated for each cation and event at each site (Table 5). These volume-weighted concentrations normalize by amount of runoff, so that concentration between sites can be effectively compared. Table 6 shows the concentrations that were run through the paired t-test and the t-test results. All cations except magnesium ($p = 0.4401$, $df = 5$) were found to have significantly higher volume-weighted mean concentrations at TMat1 than TNef1. This is exactly what one would expect after looking at the WY2001 budgets (Tables 2-4), as magnesium consistently had net export ratios closest to 1:1 between the two sites.

E. BASE CATION AND SILICA CONCENTRATIONS IN STREAMS

Calcium ($p<0.0001$, $df=6$), potassium ($p = 0.0043$, $df=6$), and sodium ($p = 0.0011$, $df=6$) had higher mean concentrations in streamwater, on an event basis, sampled at TMat1 than TNef1 ($a=0.05$ throughout). Export from TMat1 is significantly greater (at least in mean concentration in large storm events) than export from TNef1, for Ca, K, and Na. I sampled events that comprised >25% of the discharge from water year 2001 from each site (Figures 8 and 9) and since ephemeral streams are most active during storm events, it follows that higher concentrations during stream events will lead to greater annualized rates of export. This is supported by the large differences in cation export fluxes between the two sites (especially shown in Ca and K) as calculated in the budgets (Tables 2-4).

Figures 46 and 47 show annual hydrographs and plots of cation concentration over time for both sites and water years sampled, and it appears that when streams were sampled at base flow conditions, concentrations were not markedly different from concentrations at storm flow conditions. Therefore, examining each event individually is useful to determine nutrient flushing behavior and dilution effects. The increase in concentration at both the first WY00 sampling and first WY01 sampling at the TNef1 site is likely due to extended periods without precipitation prior to these two events. A flushing effect can also be observed at the first WY00 sampling at the TMat1 site. However, since concentrations level off after these initial nutrient flushings, I do not expect that these extreme values have compromised the budget at either site.

Silica concentration was significantly higher ($p<0.0001$, $df=29$) in stream event samples taken from TNef1 than in event samples taken from TMat1 (Figure 48). Also, silica output at TMat1 is only 60-70% of the output at TNef1 (Tables 2 and 3). These results indicate that primary silicate or aluminosilicate mineral weathering is not the greatest source of cation export at the TMat1 site, but may be a significant source of cation export from the TNef1 site. However, since TMat1 exports many more base cations than TNef1 exports (see Tables 2-4), mineral weathering is likely still an important source of base cation export at TMat1. Mineralogy of the soils and the stoichiometry of weathering reactions at these sites would greatly aid in discerning the source of the base cations being exported from these watersheds. Limestone may also play an important role in the cation budget at TMat1, and is likely responsible for a large amount of calcium and magnesium export there. However, since limestone is not a silica-based mineral, this thesis cannot determine if limestone weathering is contributing calcium and magnesium to the stream at TMat1.

Dissolved silica concentrations at both sites are plotted against cation concentrations in Figures 49-52. Calcium (Figure 49) and magnesium (Figure 50) export appear to be linked to silicate mineral weathering at TMat1. A weak negative relationship between silica and magnesium exists at TNef1, suggesting cation exchange is the more important process for Mg at TNef1 (Figure 50). No relationships exist between potassium and silica (Figure 51) or sodium and silica (Figure 52), also indicating that cation exchange or mechanisms other than silicate mineral weathering are responsible for Na and K export from these two watersheds. TNef1 has greater silica output but lower net export of Ca and Mg than TMat1 (Tables 2 and 3), indicating that weathering and cation exchange are both important in the export of base cations from TMat1.

Determining the difference between silicate mineral weathering and soil cation export quantitatively is beyond the scope of this study, but would be useful in determining the full environmental impacts of the mining and reclamation disturbance.

F. TOTAL SUSPENDED MATTER

Mean total suspended matter (TSM) is significantly higher at TMat1 than TNef1 by a factor of ~6.5 (Figure 53) ($p = 0.0450$, $df = 269$). One high outlier was removed from the dataset of each site; TSM = 444 mg L^{-1} at TNef1 and TSM = 3576 mg L^{-1} at TMat1.

Dissolved potassium concentration ($p = 0.0012$, $df = 135$) (Figure 56) and sodium concentration ($p < 0.0001$, $df = 135$) (Figure 57) both are significantly linearly related to TSM at TNef1, and only calcium concentration ($p = 0.0429$, $df = 130$) (Figure 59) has a significant relationship with TSM at TMat1 (Figures 54-63). The multiple regression model of TNef1 combined dissolved magnesium and sodium to explain 31.59% of the variation in TSM ($p = 0.0010$, $df = 136$), indicating that greater suspended solids in stream samples is indicative of higher magnesium and sodium concentrations at TNef1. The TMat1 multiple regression model entered calcium and sodium to explain merely 7.26% of the variability in TSM ($p = 0.0414$, $df = 131$). Stream sediments exert greater control over base cation stream chemistry at TNef1 than TMat1, despite much greater cation export at TMat1 (Tables 2-4).

G. EXCHANGEABLE BASE CATIONS IN SOIL AND CATION EXCHANGE CAPACITY

For mineral soil exchangeable bases, Na ($p<0.0001$, $df=88$), $\log_{10}$ Ca+1 ($p<0.0001$, $df=89$), and Mg ($p<0.0001$, $df=88$) were all significantly greater at TMat1. However, K ($p = 0.0870$) is not significantly different between the two sites (Figures 64a and 64b). The mineral soil at TMat1 is more base cation rich, and thus less likely to subject plant life to macro- or micronutrient deficiencies. One of the most biologically important base cations, potassium, was not shown to be different between the sites. Vegetative cation levels are required to determine vegetation stress or deficiency, but were not analyzed for this project.

For organic soil exchangeable bases, Na ($p = 0.4203$) and Mg ($p = 0.9939$) are not significantly different between sites, whereas K ($p<0.0001$, Mat1>Nef1) and Ca ($p = 0.0398$, Nef1>Mat1) are significantly different by site (Figures 65a and 65b). This result indicates that two biologically important cations are more abundant at different sites. Potassium is present in higher amounts at TMat1, while calcium is more abundant at TNef1. Since these sites are subjected to nearly identical atmospheric conditions, and net export of both Ca and K occurs in greater amounts at TMat1, the significantly higher calcium in the organic soil of the forested site may just indicate that base cations are held more tightly at that site due to high organic matter content (Figure 66) or less overland flow (i.e. greater infiltration capacity) (Negley 2002).

More rigorous study of this topic would require detailed measurements of base cations in both live and dead vegetation, as well as measurements of base cation cycling through time in these systems. Also, it is surprising that the mineral soil exchangeable base amounts do not correspond well with the organic soil base levels. The most striking result is that in mineral soil calcium is actually more abundant at TMat1 but in organic soil it is present at higher levels at TNef1. Mining and reclamation, as a result of overburden removal and mixing, actually causes a reversal of podzolization and brings base cations up to the surface soils. Vegetative base cation fluxes could actually be greater at TNef1, despite the generally lower amounts of exchangeable bases in soils there, if the CEC is continually being replenished with base cations. This indicates that fundamentally different physical soil characteristics control exchangeable base levels in mineral and organic soils, and that the two sites exhibit substantially different cation cycling.

Organic soil ECEC's were significantly different ($p < 0.0001$, Nef1>Mat1) between sites (Figure 67a), whereas mineral soil ECEC's were not significantly different ($p = 0.4318$) between the two sites (Figure 67b). Cation exchange capacity is highly dependent upon soil texture, particularly clay content, so texture was analyzed by site using one-way ANOVA for square root transformed percent sand and percent silt, and Kruskal-Wallis nonparametric one-way ANOVA for percent clay. Sand content is significantly higher at TNef1 than TMat1 ($p<0.0001$, df=83), but the silt and clay fractions are significantly higher at TMat1 than TNef1 ($p<0.0001$ and $p = 0.0053$ respectively, df = 83). Figure 68 shows the clay content in mineral soil at the two sites. The mineral soils at TNef1, based on mean soil texture, are sandy clays, whereas the soils at TMat1 are simply clay soils (Figures 69 and 70). It is surprising that mineral soil ECEC's are not significantly different between the two sites, despite the well-established greater number of exchange sites for clay. In trying to establish a relationship between CEC and percent clay for these soils, I used a simple linear regression between CEC and $\log_{10}$ clay content. While the relationship was not very strong ($r^2 = 0.071$), only explaining 7% of the variability in cation exchange capacity, it was statistically significant ($p = 0.0146$, df = 83), likely due to the large sample size (Figure 71).

Base saturation, as calculated using equation 1, is 96% at TMat1 in the organic crust and 85% in the mineral soil horizon. These are extraordinarily high base saturations, due in part to the omission of soil aluminum analysis. At TNef1 values are more reasonable, at 78% in the organic horizon and only 34% in the mineral soil, but again are skewed because aluminum analysis was not completed for these soils. If aluminum analysis had been completed for these soils, base saturations would still be very high, indicating extremely base cation-rich soils in both of these watersheds.

H. BASE CATIONS IN SOIL SOLUTION

For shallow lysimeters (15 cm depth), Na ($p = 0.0031$, $df = 11$), Ca ($p = 0.0037$, $df = 11$), and $\log_{10}$ Mg+1 ($p = 0.0002$, $df = 11$) concentrations are all significantly higher at theTMat1 site than the TNef1 watershed (Figure 72a). For lysimeters at the 60cm depth, K ($p = 0.0418$, $df = 16$), Ca ($p = 0.0096$, $df = 16$), and $\log_{10}$ Mg+1 ($p<0.0001$, $df = 16$) concentrations are also significantly greater at the TMat1 site (Figure 72b). These results indicate that micronutrients are available in greater quantities at the reclaimed mine watershed at the depths indicated above. Magnesium concentrations are higher than calcium in the deep lysimeters, which contrasts the observed stream (Figures 46 and 47) and soil cation levels (Figure 64a). There may be a cation depth gradient present in the soils at TMat1, not addressed or testable by the analyses completed by the present study.

Additionally, a two-way ANOVA was used to determine if there were differences between sites and depths, and if there were any site*depth interactions. With this analysis, sodium concentrations were only significantly different between depths ($p = 0.0142$), calcium was only significantly different between sites ($p = 0.0043$), and log 10 transformed magnesium was significantly different by both site ($p < 0.0001$) and depth ($p = 0.0469$). Potassium concentration was significantly different between depths ($p = 0.0207$) and had a significant site*depth interaction, indicating that a site effect was not consistent across both depths.

CHAPTER IV. DISCUSSION

This study has demonstrated that stream base cation output is much greater than precipitation inputs, as was shown by the three input-output budgets I calculated (Tables 2-4). All Mat1: Nef1 net export ratios are greater than 1:1, suggesting that the mining disturbance has changed cation cycling and retention in this watershed. De-vegetation, topsoil removal, and homogenization and compaction over more than 60 meters of soil depth, despite attempts at reclamation, has increased cation export from the TMat1 watershed.

Other examples of massive environmental disturbance have found similar results. As indicated previously, clear-cutting and other types of logging disturbance can serve as a surrogate for a mining disturbance for purposes of literature comparison, because the ecosystem impacts (compaction and loss of organic matter) are strikingly similar. The main difference is that in the absence of surface mining, the soil column is not disturbed by homogenization, fragmentation of parent material, and physically enhanced bedrock weathering. A clear-cutting experiment performed at Hubbard Brook found a 15-30% increase in stream calcium export and a 135-218% increase in potassium export post clear-cut (Hornbeck et al. 1986). Magnesium and sodium exports following the clear-cut showed relatively small increases that were in direct proportion to the increase in stream discharge (Hornbeck et al. 1986).

More recently at Hubbard Brook, Dahlgren and Driscoll (1994) found that clear-cutting increased average calcium, magnesium, and potassium concentrations in streamwater for

2-4 years following the disturbance. Sodium concentration, however, only increased slightly and the increase persisted less than a year post-disturbance (Dahlgren and Driscoll 1994). At Shenandoah National Park in Virginia, gypsy moth defoliation, another type of disturbance, also caused a streamwater calcium, magnesium, and potassium concentration increase, while sodium concentration did not change (Webb et al. 1995).

To validate the input-output budgets, I compared the Herrington Creek watershed (HCWS) cation export (Castro and Morgan 2000) with the WY2001 export at both TNef1 and TMat1. At HCWS, calcium export is 1055 eq ha^{-1} yr^{-1}, 599 eq ha^{-1} yr^{-1} for Mg, and approximately 100 eq ha^{-1} yr^{-1} for both Na and K (Castro and Morgan 2000). These values are well within the range of values found at TMat1and TNef1 for all four cations (Tables 2-4).

The potassium budgets at TMat1 and TNef1 support an assertion from collaborators on the larger project that TNef1 is nitrogen saturated and TMat1 is nitrogen limited (Tables 2-4). In the saturated system (TNef1), there is almost no potassium net export (less than 3.0 eq ha^{-1} yr^{-1}) and the watershed is exporting large amounts of nitrogen (Castro et al. in preparation). Conversely, in the N-limited watershed (TMat1), vegetation cannot use all of the available potassium without available nitrogen, so the potassium export is greater than 100 eq ha^{-1} yr^{-1}.

Cation export from watersheds can come from mineral weathering, cation exchange and cycling, or from soil cation loss precipitated by acid inputs. The positive linear relationship between dissolved silica and both calcium and magnesium in stream water at TMat1 indicates that at least some of the Ca and Mg output from TMat1 comes from weathered silicate minerals (Figures 49 - 52). The remainder of the export could come from cation exchange or the replacement of cations with hydrogen ions on soil exchange sites (Castro and Morgan 2000). Non-silicate mineral (i.e. limestone) weathering could be a significant source of Ca and Mg at TMat1 as well. Silica output is greater at TNef1, but has no positive relationships with base cations at that site (Tables 2 and 3; Figures 49-52). Silicate mineral weathering may actually be greater at TNef1, but nutrient uptake may be preventing the cations from being discharged from the watershed in stream water.

The Conemaugh Group, which makes up the parent material at TNef1, includes a micaceous sandstone and siltstone. Two common micas are muscovite and biotite (Nagy 1995). The chemical formula of muscovite is $K_{1.84}Na_{0.16}(Al_{3.75}Fe_{0.22}Mg_{0.12}Ti_{0.2})[Si_{6.06}Al_{1.92}O_{20}](OH)_4$ and biotite is $K_2(Mg_3Fe_3)Al_2Si_6O_{20}(OH)_4$ (Nagy 1995). Micas are 2:1 layer sheet silicates and weather fairly readily in the presence of water and acids, which can be attributed to their sheet structure and di- or trioctahedral composition (Nagy 1995). Silica, potassium, sodium, and aluminum preferentially weather from micas in the presence of acids (Nagy 1995). If this sandstone is in the infiltration and groundwater pathway of the TNef1 watershed, it would follow that silica would weather from this layer preferentially. This same mechanism may not be occurring at the TMat1 site because of the presence of a clay fragipan and lack of infiltration capacity to the deeper soil. Also, this layer could have been pulverized by the mining disturbance and dispersed throughout the homogenized solum, limiting its impact on stream chemistry. While greater surface area has been shown to increase dissolution rates (Nagy 1995), homogenization would tend to lessen the impact of a thin layer spread throughout the ~69 m of replaced soil (Figure 3). Micaceous sandstone could be absent from the TMat1 site entirely, and thus would not likely contribute much dissolved silica to stream water.

Without knowing the mineralogy of these soils, a finer-scale geologic map, weathering rates for rocks and minerals at these sites, and a very good idea what elements make up the siltstone, sandstone, shale, and limestone thought to be the underlying parent material, it is impossible to make any firm conclusions about differences in mineral weathering between the two sites.

Exchangeable bases in the soil do not follow the pattern I expected. In the mineral soil, TMat1 has significantly greater Ca, Mg, and Na than TNef1 (Figure 64a). In the organic soil, TMat1 has significantly greater K but TNef1 has significantly greater Ca (Figure 64b). The mining disturbance therefore did not deplete the soil exchangeable bases to such a low level that the site would not be able to sustain forested vegetation. In fact, the soil at TMat1 is base-rich, leading to another reason that forested vegetation has not established at this site, despite a significant seed source. Perhaps compaction or lack of infiltration capacity is a controlling factor in the establishment of trees at TMat1 (Negley

2002). Nitrogen could also be limiting the establishment of forest vegetation at this site, in light of the evidence provided by the potassium budgets. The excess soil cations at TMat1 may be available because the grassland vegetation cannot take up or does not need the nutrients, unlike the forest vegetation at TNef1.

Mineral soil cation exchange capacities are not significantly different between the two sites (Figure 67b), but the organic soil CEC at TNef1 is greater than the TMat1 CEC. This is likely caused by the significantly higher percent organic matter at TNef1 (Figure 66). Organic matter content and % clay both impact cation exchange capacity of a soil. There is a significantly higher percent clay in the soil at TMat1 than TNef1, but perhaps the difference in % clay between the two sites (<10%) is not enough to perpetuate a significant difference in CEC.

For reference, I have compared the soil base status of TMat1 and TNef1 with other published values. Following a clear-cut of watershed 5 at HBEF, Johnson et al. (1991) studied the cation soil effects (i.e. exchangeable bases and CEC) of this severe disturbance at the time of disturbance (1983) and 3 years afterward (1986). The exchangeable bases present in the upper horizons post-disturbance (1986) range from 15.5-39.2 meq kg^{-1} soil for Ca, 2.2-7.1 meq kg^{-1} for Mg, and 1.9-4.9 meq kg^{-1} for K, which are all well below the levels found at the TMat1 and TNef1 sites for organic soil, but not out of range for either site's mineral soil exchangeable bases (Johnson et al. 1991). Also, the disturbed site in the present study had much more than 3 years to recover, so direct comparison may be misleading. Regardless, the TNef1 and TMat1 sites are more cation rich in the organic soil horizon at both sites than W5 at HBEF was 3 years after disturbance.

It would be useful to see data on WS5 fifteen or 20 years post-disturbance to evaluate ecosystem recovery and to have a better direct site comparison. Cation exchange capacity at WS5 in the upper horizons 3 years post disturbance ranges from 77-134 meq kg^{-1} (Johnson et al. 1991), which is again more in the range of the mineral soil CEC rather than the organic soil CEC (which is ~3-4 times that of WS5 in 1986) at TNef1 and TMat1 (Figures 67a and 67b).

There have been a few studies performed on the mining and reclamation disturbance and its effects on soil cations. One study, performed very close to the Dan's Mountain Site was in Mineral and Monongalia Counties in West Virginia and sought to determine if there were differences between nonamended and amended (fly ash and/or lime) reclaimed minesoils. Twenty years post-mining, amended sites had up to 50 times more available soil calcium, up to 10 times more potassium, and up to four times more magnesium than nonamended sites (Shirey and Sexstone 1989). The TMat1 mine was limed for reclamation 15-20 years ago at a rate of ~12,000 kg ha^{-1} (10,000-11,000 pounds per acre) (Tower Resources, Inc. 1983, Eagle Mining, Inc. 1986), and the stream channel/drainage ditch does have some limestone lining it, both of which could be influencing current soil and stream cation levels (especially calcium and magnesium). Assuming dolomitic limestone ($CaMg(CO_3)_2$) was used at this site, a rate of 12,000 kg ha^{-1} would add roughly 26000 eq ha^{-1} of calcium and 16000 eq ha^{-1} of magnesium to this site. Levels of calcium and magnesium this high are likely contributing to the calcium and magnesium export as the lime dissolves over time.

Soil water concentrations are exactly opposite of what I predicted they would be at these sites. Shallow lysimeter base cation concentrations are higher at TMat1 (calcium, magnesium, and sodium) (Figure 72a) and deep lysimeter concentrations (potassium, calcium, and magnesium) are also higher at TMat1 than TNef1. Vegetative uptake may again be contributing to this difference, but this is just one more piece of evidence showing that TMat1 is not base cation limited.

Lysimeter concentrations did not prove to be a good predictor of the pattern of base cation export at these sites. Whereas potassium and sodium are quite comparable in soil solution concentration at the two sites, potassium export at TMat1 is four times greater than potassium export at TNef1. Potassium in soil water and streamwater exports, along with the significant interaction of lysimeter K concentrations are undoubtedly linked to the nitrogen limitation or saturation of these watersheds. Sodium and magnesium exports at TMat1 are less than double that of TNef1; magnesium soil solution concentrations are much greater at TMat1. Calcium is the only cation that is both very high in soil solution concentration and stream export at TMat1. Although high relative to other sites, the stream calcium and magnesium concentrations are much lower than the soil solution concentrations at both depths and both sites. Soil water may not contribute greatly to storm flow due to the lack of infiltration at TMat1. Conversely, TNef1 is highly infiltrated with precipitation that equilibrates with soil compounds.

When a rain event occurs, this equilibrated soil water is pushed out by new precipitation and becomes an important component of stream storm flow. Additionally, Lawrence et al. (1999) found that leachate collected under pressure tends to have higher calcium concentrations than freely flowing soil water. Lysimeter concentrations therefore are not reliable indicators of stream concentrations or export at these sites.

In the eastern US, CEC values at Walker Branch Watershed in Tennessee are close to values from both TMat1 and TNef1 in the mineral soil. However, organic soil CEC's are approximately 5 to 7 times higher at the Dan's Mountain sites than at Walker Branch (Johnson et al. 1985). Exchangeable cations at Walker Branch are all lower than the Dan's Mountain sites, with the exception of exchangeable potassium in the mineral soil (Johnson et al. 1985). Soil solution concentrations in Tennessee are generally lower than those measured in the present study, and tend to follow a different pattern. Johnson et al. (1985) found lower concentrations in the deeper horizons with the exception of sodium, whereas the present study found consistently higher concentrations in the deeper lysimeters especially at TMat1 in calcium and magnesium. The shallow lysimeters were higher in calcium and magnesium concentration at TMat1 than Walker Branch, and only higher in calcium at TNef1.

Less than 60 km to the west of the Dan's Mountain sites, a study at Herrington Creek watershed (HCWS) found CEC's in the lower organic/upper mineral soil of 140 meq kg^{-1} soil, close to the cation exchange capacities found in the mineral horizon of the present study. However, exchangeable soil calcium at Herrington Creek was measured at 6.7

and 3.7 meq kg^{-1} soil (organic and mineral horizons, respectively), at least an order of magnitude lower than exchangeable calcium levels at TMat1 and TNef1 (Castro and Morgan 2000).

A study by Bussler et al. (1984) shows exchangeable calcium in soils at a mined and reclaimed site in Illinois to be much greater than the reference site, sodium to be slightly greater, potassium about the same, and magnesium to be slightly less. In comparison to TNef1 and TMat1, amounts are in the range of the mineral soil at both sites, but much lower than the organic soil exchangeable cations. Cation exchange capacity is slightly higher than the control at the reclaimed site in Illinois, and is in the range of the organic soil CEC at our two sites. Similar to TMat1, percent clay was higher at the mined site than at the reference site, but the means were not quite as high as I found at TMat1 (27-40% compared to >50%) (Bussler et al. 1984). These conditions, favorable for plant growth in terms of nutrient availability, are quite similar to what I found at the Dan's Mountain mined and reclaimed site.

However, some aspects of minesoils, even those that have been reclaimed, are not favorable for plant growth. For example, lower porosity, lower permeability, lower water-holding capacity and lower infiltration capacity coupled with higher clay content and bulk densities can make plant establishment and growth difficult (Leopold and Wali 1992, Bussler et al. 1984, Negley 2002). Despite high nutrient levels, even in soil solution, if plants cannot establish roots to get to the nutrients due to compaction, or if plants cannot get water because it is not infiltrating the soil but running off as if the surface were impermeable, then plant establishment, especially trees, will be problematic.

The soils data I collected does not indicate conditions at the TMat1 site that would be considered infertile or unfavorable for vegetation growth and development. Stream cation export, while extraordinarily large, does not always have negative implications. Sustained cation export at high levels could deplete the TMat1 watershed and lead to nutrient limitation and soil acidification. But if the source is unknown (i.e. either soil leaching loss or mineral weathering loss), then no conclusions can be drawn about watershed cation export without further study. It is unlikely though, based on the availability of cations in soil and soil pore water in this watershed, that cation depletion will be a real problem at this site for many years. Instead, it is possible that the cation export is serving to abate acid mine drainage, increase stream water pH levels for biota, and increase acid neutralizing capacity.

While the budgets I calculated are reasonable and repeatable, a few improvements could be made. Lack of strong relationships between concentration and discharge may be attributed to an inappropriate analysis time scale (Creed and Band 1998), lack of variation in discharge in these two ephemeral streams, or statistical impact of the initial nutrient flushings (Hill 1993) seen at the start of each water year (Figures 46 and 47). Creed and Band (1998) had difficulty establishing concentration-discharge relationships when compositing event data monthly, and propose that within each event, concentration-discharge relationships may exist that are particular to the characteristics of that storm event. The compositing of samples, while useful in allowing me to sample more storm events, decreased the within-event sample size too much to adequately analyze the concentration-discharge relationships for each event. At TNef1, it is possible that few significant concentration-discharge relationships emerged because event water infiltrated soils, thus pushing out previously equilibrated soil water; storm flow (due to an absence of any "true" base flow) consists primarily of equilibrated soil water from previous storm events (Velbel 1985, Johnson and Swank 1973).

An improved budget would entail both event and baseflow stream sampling and analysis for the same water year and the ability to construct concentration-discharge relationships that bracket a wide range of discharge, such that baseflow and storm events concentrations are not over- or underestimated. Also, possible dilution effects need to be considered for the particularly large storm events, or export overestimation could be problematic.

In addition, the cation input-output budget could be improved to include more cation pools and generally greater specificity. First I would include both live and dead vegetation cation pools, such that biomass accretion could be factored into the mass-balance equation (Currie et al. 1996). I also think I would implement a tracer study, as Blum et al. (2002) used strontium isotopes to trace apatite weathering to available calcium in a base-poor watershed at Hubbard Brook (WS1). Through this tracer study, a mechanism of mycorrhizal weathering was uncovered, demonstrating that products of weathering do not necessarily have to go through the labile soil pool to be taken up by trees and plants (Blum et al. 2002). Also, isotopes are helpful when attempting to determine the source of elements such as base cations, such that a labile soil pool source can be distinguished from a mineral weathering source, which would have been invaluable in my study. Dry and cloudwater deposition could be important input factors that were not accounted for in this study that I would like to quantify.

The results of this study indicate, over the time period studied here, that these two watersheds exhibited very different cation pools, transport, and export, despite their similarities in underlying geology and atmospheric inputs. However, the watersheds have similarities in pattern and process, but mostly differences in magnitude. The watersheds are both exporting all four base cations at a fairly high rate, they are weathering silicate and other types of minerals at an undetermined rate, they have soils high in clay, and they both have very high quantities of bases in the soil exchange complex and soil solution for vegetative growth and development. While it is clear that these two watersheds are different, it is unclear as to whether or not the mining disturbance has impacted the TMat1 watershed such that it is functioning fundamentally differently from TNef1, or if TMat1 is an inherently less healthy ecosystem because of disturbance.

Table 1. Cation export from TMat1 and TNef1 watersheds for water year 2000.

Cation input data were not available for water year 2000.

Watershed	Calcium	Magnesium	Potassium	Sodium	Annual Runoff
	(eq/ha/yr)	(eq/ha/yr)	(eq/ha/yr)	(eq/ha/yr)	(mm/yr)
Trib Mat1	931.6	824.6	139.7	125.1	259.6
Trib Nef1	237.1	223.0	23.8	28.8	208.9
Mat1:Nef1	4.0:1	3.7:1	6.0:1	4.3:1	1.2:1

Table 2. WY 2001 annualized input-output budget calculated using Method 1.

Output values are +/- 1 standard error (SE). Mat1:Nef1 ratios were calculated using net export values from each watershed.

Watershed	In; out; net	Calcium	Magnesium	Potassium	Sodium	Silica	Annual Runoff
		(eq/ha/yr)	(eq/ha/yr)	(eq/ha/yr)	(eq/ha/yr)	(mol/ha/yr)	(mm/yr)
Trib Mat1	In	129.7	34.6	30.2	33.5	*	
	out	1442.5 +/- 7.4	589.6 +/- 4.4	166.9 +/- 0.9	63.2 +/- 0.6	220.6 +/- 5.3	271.3
	net	1312.8	555.0	136.7	29.7		
Trib Nef1	In	129.7	34.6	30.2	33.5	*	
	out	389.2 +/- 32.3	351.4 +/- 21.0	29.3 +/- 8.8	36.5 +/- 1.8	327.9 +/- 7.8	188.9
	net	259.5	316.8	-0.9	3.0		
Mat1:Nef1	ratio	5.1:1	1.8:1	156.8:1	9.9:1	0.7:1	1.4:1

* not measured

Table 3. WY2001 annualized input-output budget calculated using Method 2.

Mat1:Nef1 ratios were calculated using net export values from each watershed.

Watershed	In; out; net	Calcium (eq/ha/yr)	Magnesium (eq/ha/yr)	Potassium (eq/ha/yr)	Sodium (eq/ha/yr)	Silica (mol/ha/yr)
Trib Mat1	In	129.7	34.6	30.2	33.5	*
	out	1129.1	452.3	131.0	56.8	184.6
	net	999.4	417.7	100.8	23.3	
Trib Nef1	In	129.7	34.6	30.2	33.5	*
	out	392.5	352.3	30.8	37.1	326.9
	net	262.8	317.7	0.6	3.6	
Mat1:Nef1	ratio	3.8:1	1.3:1	174.2:1	6.5:1	0.6:1

* not measured

Table 4. WY2001 annualized input-output budget calculated using Method 3.

Mat1:Nef1 ratios were calculated using net export values from each watershed.

Watershed	In; out; net	Calcium (eq/ha/yr)	Magnesium (eq/ha/yr)	Potassium (eq/ha/yr)	Sodium (eq/ha/yr)
Trib Mat1	In	129.7	34.6	30.2	33.5
	out	1295.2	518.3	146.0	62.7
	net	1165.5	483.7	115.8	29.2
Trib Nef1	In	129.7	34.6	30.2	33.5
	out	395.1	354.4	31.5	37.0
	net	265.4	319.8	1.3	3.5
Mat1:Nef1	ratio	4.4:1	1.5:1	89.1:1	8.3:1

* not measured

Table 5. Volume-weighted mean cation concentrations (mg L^{-1}) for all events sampled at TMat1 and TNef1, WY2001.

		Volume-weighted Mean Cation Concentration							
		Calcium		Magnesium		Potassium		Sodium	
Event	Dates	TMat1	TNef1	TMat1	TNef1	TMat1	TNef1	TMat1	TNef1
A	1/31-2/2	10.9		2.4		3.3		0.6	
B	2/7-2/11	9.8	5.1	2.2	2.6	2.8	0.7	0.5	0.5
C	2/11-2/15		4.5		2.5		0.6		0.5
D	2/15-2/18		5.0		2.5		0.6		0.5
E	2/13-2/17	10.9		2.5		3.7		0.6	
F	3/12-3/15	8.7	4.0	2.3	2.3	2.2	0.6	0.6	0.5
G	3/15-3/17	8.5	3.9	2.2	2.4	2.0	0.6	0.5	0.4
H	3/29-4/2	10.4	3.9	2.4	2.0	1.7	0.5	0.5	0.4
I	4/11-4/13	10.8	3.8	2.8	2.2	1.7	0.6	0.5	0.4
J	4/15-4/18	9.8	3.6	2.5	2.2	1.3	0.5	0.6	0.4
K	5/22-5/27		4.3		2.3		0.9		0.5
L	5/21-5/25	8.4		1.9		1.1		0.6	
M	6/22-6/24	10.0		3.2		1.1		0.4	
N	7/5-7/6	16.6		5.5		5.1		0.7	

Note: A blank cell indicates a particular event was only sampled at one site.

Table 6. Volume-weighted mean cation concentrations analyzed with a paired t-test.

Volume-weighted mean cation concentrations analyzed with a paired t-test. Results of paired t-test are shown in the lower three rows, indicating whether one site has a significantly larger or smaller cation concentration, the p-value, and the degrees of freedom (df).

		Volume-weighted Mean Cation Concentration							
		Calcium		Magnesium		Potassium		Sodium	
Event	Dates	TMat1	TNef1	TMat1	TNef1	TMat1	TNef1	TMat1	TNef1
B	2/7-2/11	9.83	5.12	2.16	2.65	2.80	0.67	0.51	0.48
F	3/12-3/15	8.75	4.04	2.26	2.32	2.19	0.56	0.61	0.50
G	3/15-3/17	8.46	3.94	2.24	2.40	1.97	0.64	0.45	0.40
H	3/29-4/2	10.40	3.89	2.36	1.99	1.67	0.45	0.47	0.41
I	4/11-4/13	10.80	3.77	2.77	2.16	1.72	0.58	0.52	0.44
J	4/15-4/18	9.81	3.63	2.51	2.15	1.32	0.49	0.56	0.43
Result		Mat1 [Ca] > Nef1 [Ca]		Mat1 [Mg] = Nef1 [Mg]		Mat1 [K] > Nef1 [K]		Mat1 [Na] > Nef1 [Na]	
p-value		$p<0.0001$		$p = 0.4401$		$p = 0.0011$		$p = 0.0197$	
df		5		5		5		5	

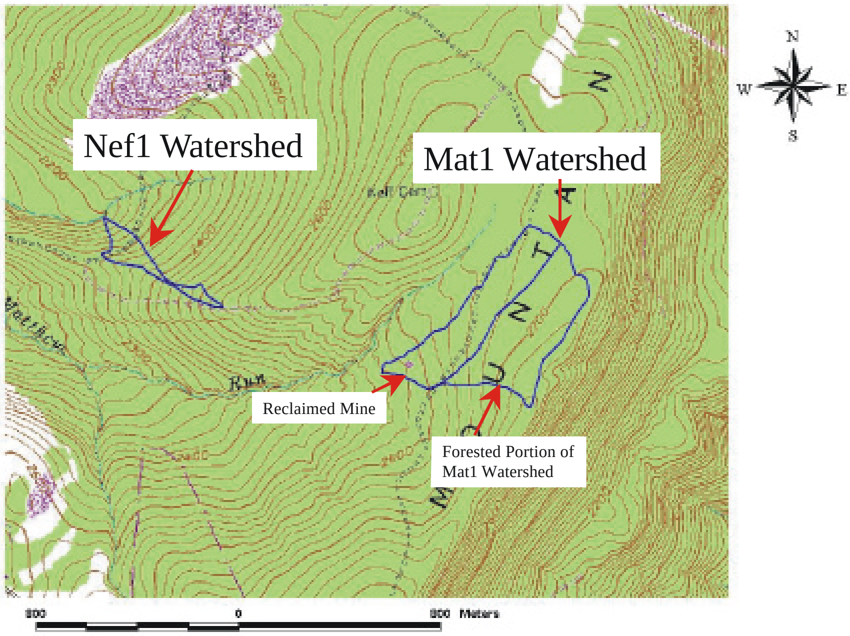


Figure 1. Topographic map overlain with watershed outlines.

Watersheds will be referred to throughout these figures as TNef1 and TMat1. Figure courtesy of T. Negley.

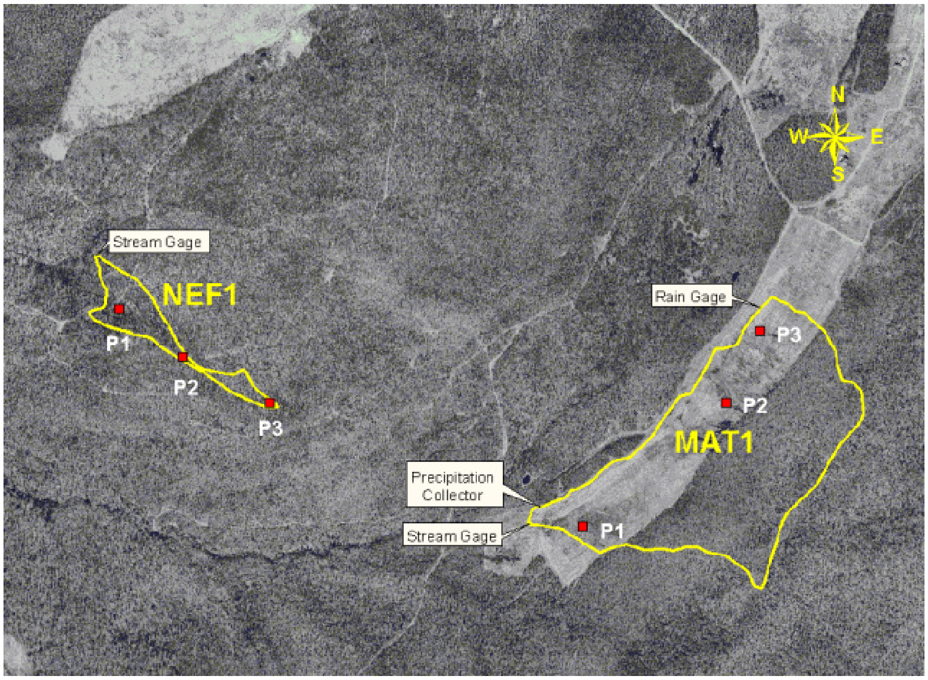


Figure 2. Aerial photograph showing watershed boundaries and plot locations (P1, P2, and P3).

Transects are located approximately adjacent to plots and numbered similarly. The precipitation collector shown near the stream gage at the Mat1 watershed was used to collect precipitation samples analyzed for the input-output budget. Stream event samplers were located immediately upstream of the stream gages at both watersheds. The rain gage shown at the top of the Mat1 watershed was used to record rainfall amounts, which were used in the calculations of the budget. Figure courtesy of T. Negley.

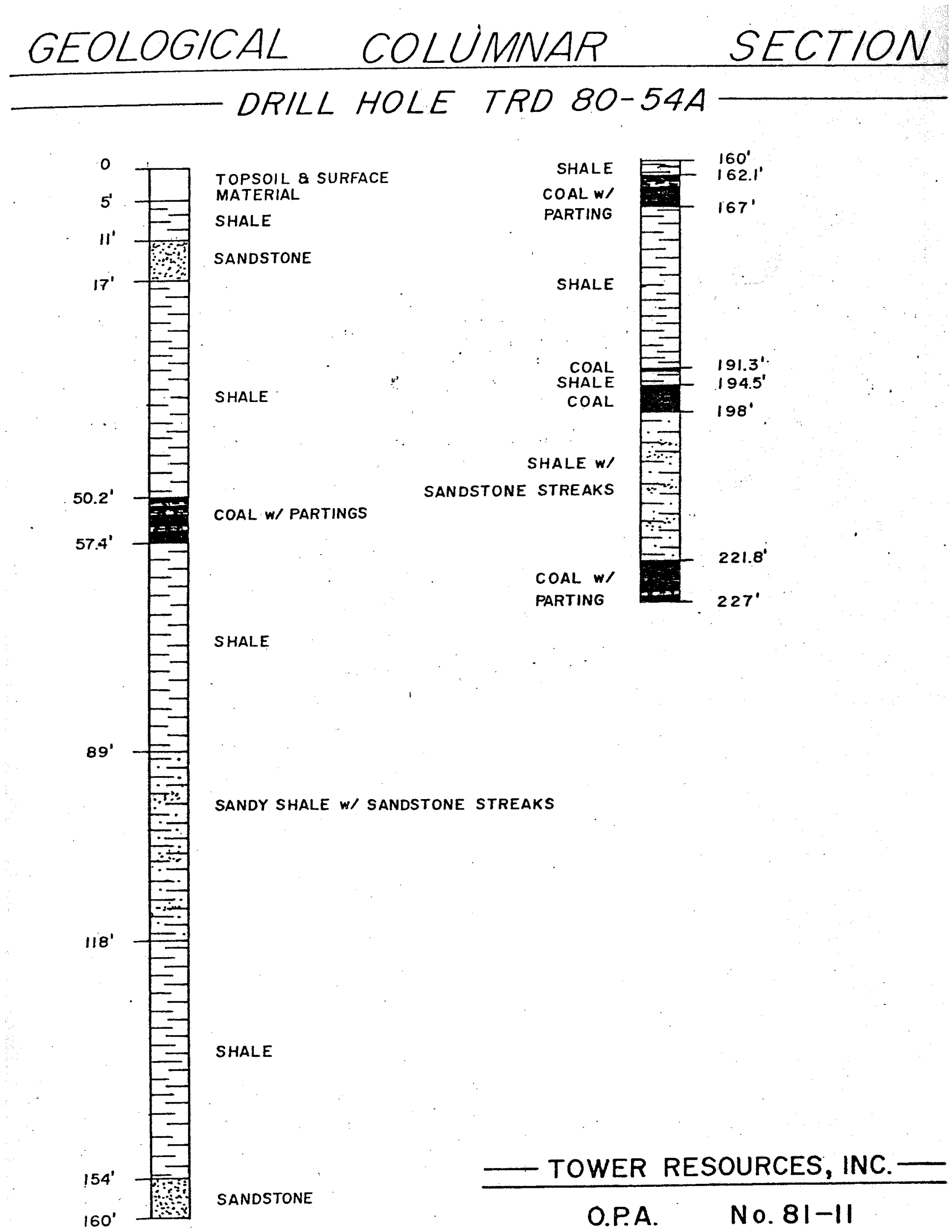


Figure 3. Geologic columnar section of a core taken pre-mining disturbance at the TMat1 watershed (Tower Resources, Inc. 1981).

The ‘ indicates units of feet below surface and 1 foot = 0.305 m.

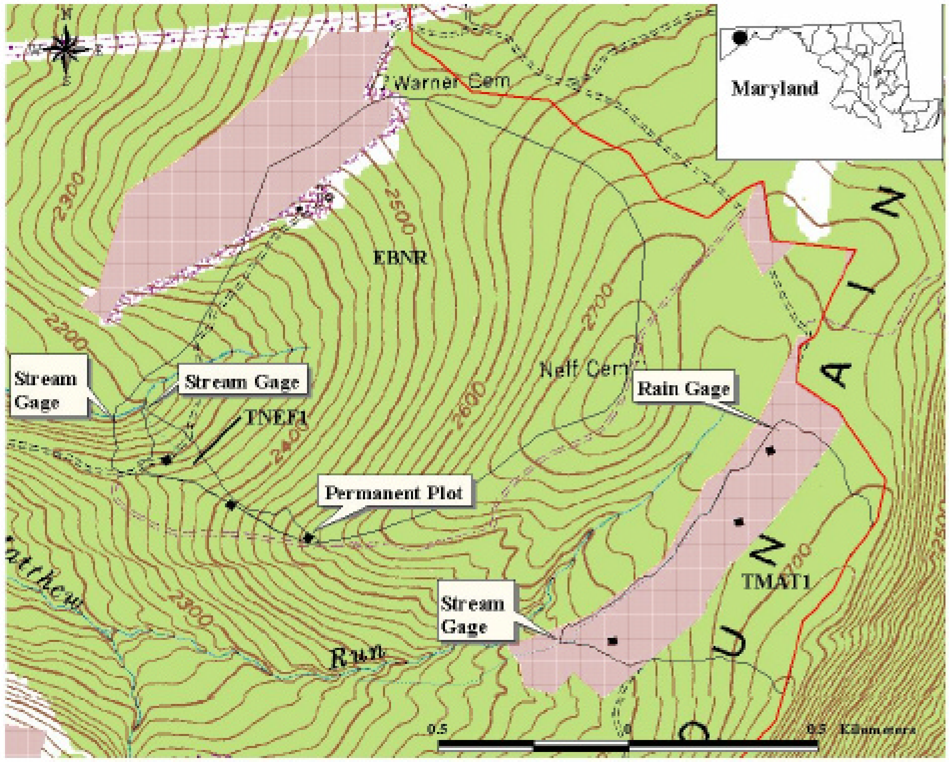


Figure 4. Map of 3 gaged watersheds with stream gage locations.

Figure courtesy of T. Negley.

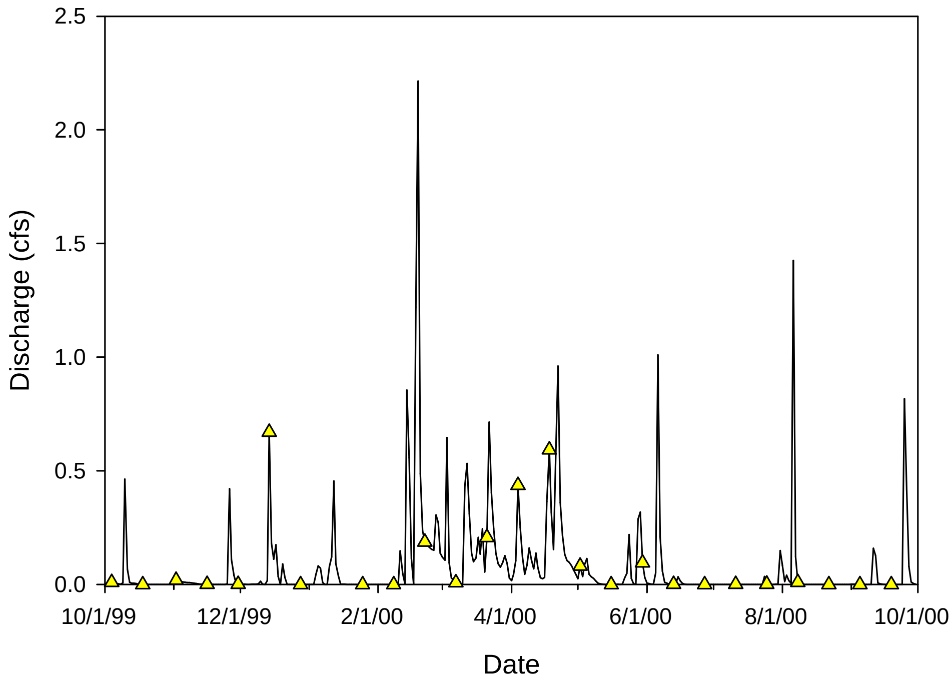


Figure 5. TMat1 water year 2000 (WY00) annual hydrograph marked with sampling dates (yellow triangles).

Note that the bi-weekly sampling misses most of the discharge over the water year (8.4%).

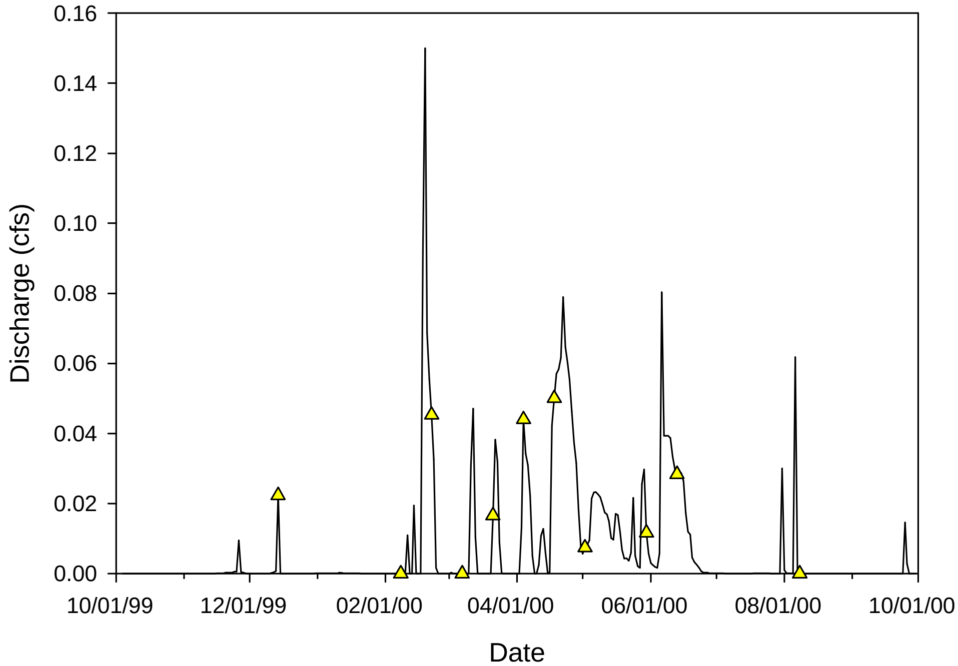


Figure 6. TNef1 WY00 annual hydrograph marked with sampling dates (yellow triangles).

Note that the bi-weekly sampling misses most of the discharge over the water year (8.9%).

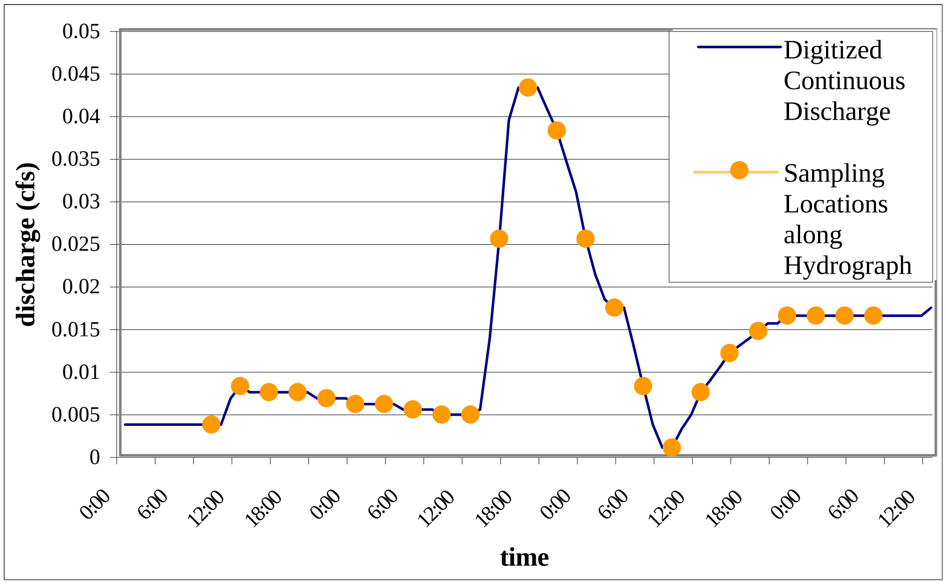


Figure 7. Storm hydrograph for a storm sampled at TNef1 beginning 2/8/01 0:00 and ending 2/11/01 12:00.

Continuous discharge is shown in blue on an hourly basis. Sampling locations along the hydrograph are marked in orange, and for this particular storm, samples were taken every 3 hours.

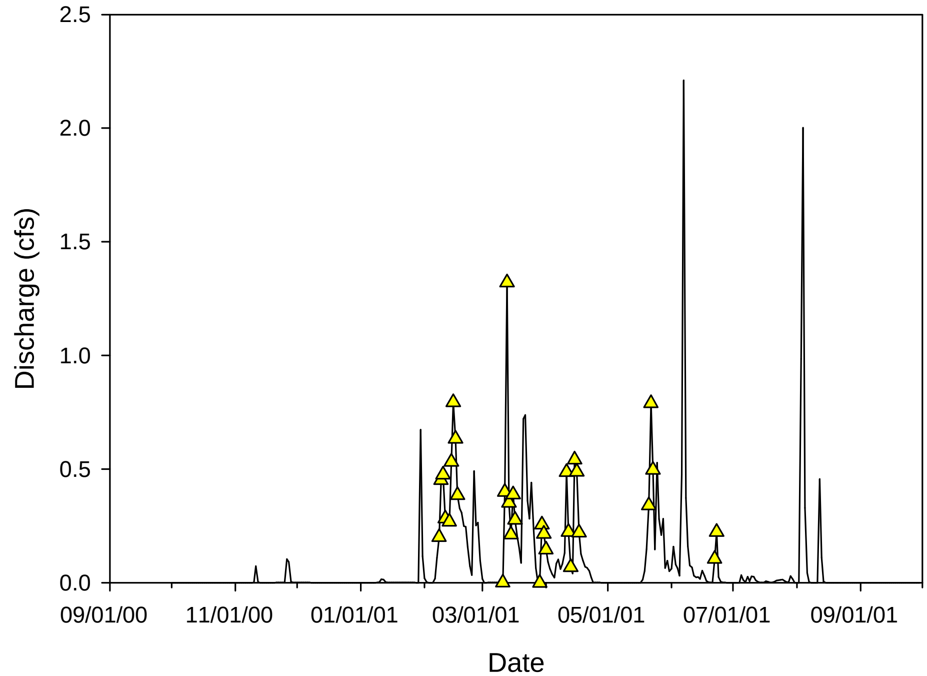


Figure 8. TMat1 water year 2001 (WY01) annual hydrograph marked with sampling dates (yellow triangles).

Note that the event sampling scheme captured much of the discharge over the water year (33.3%). Unfortunately, the largest two events were not sampled.

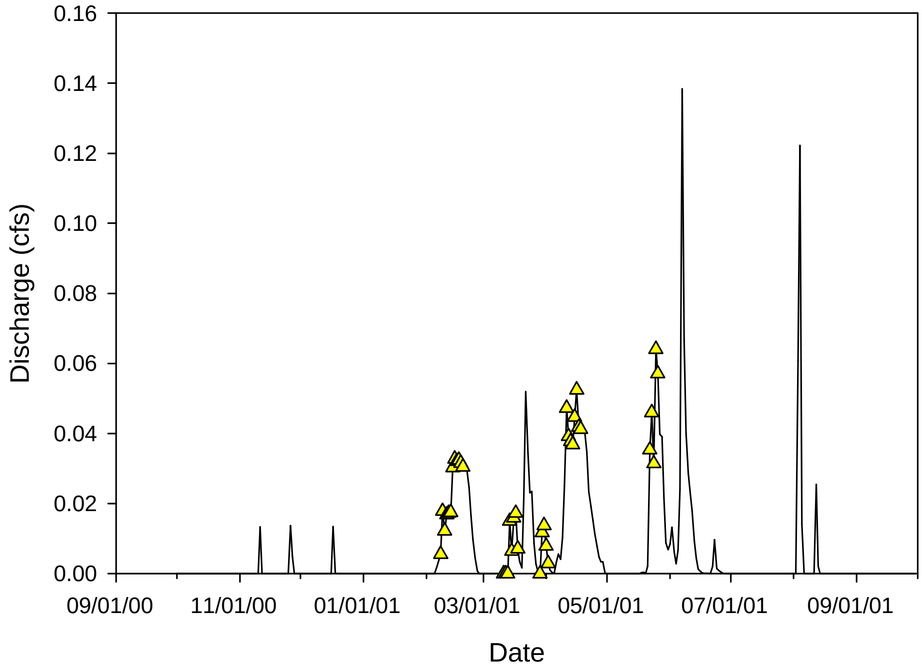


Figure 9. TNef1 WY01 annual hydrograph marked with sampling dates (yellow triangles).

Note that the event sampling scheme captured much of the discharge over the water year (26.4%). Unfortunately, the largest two events were not sampled.

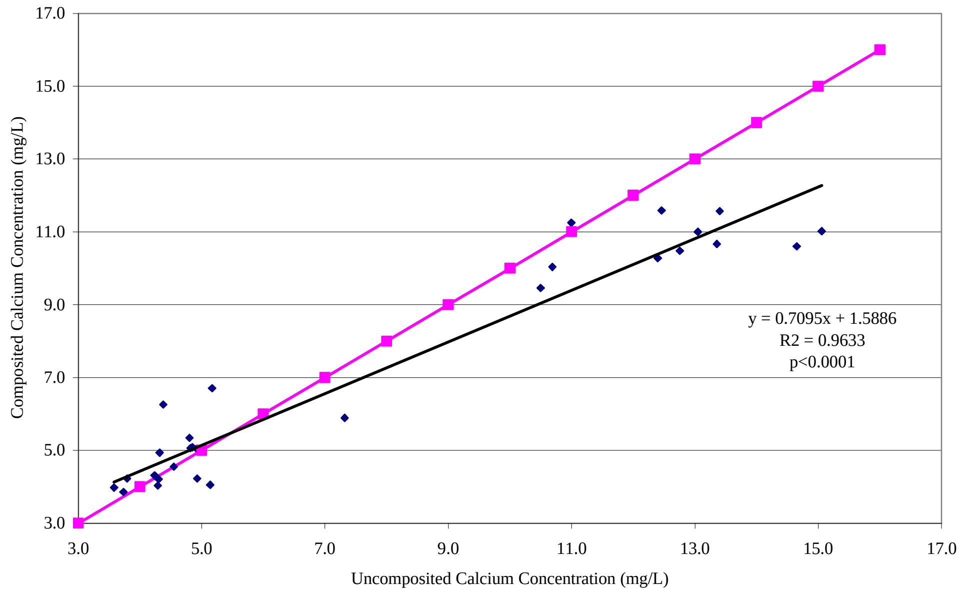


Figure 10. Uncomposited versus composited samples analyzed for calcium.

Pink line is 1:1 line and black line is best-fit through x and y coordinates. Data are significantly linearly related ($p<0.0001$) but the slope of the best-fit line is significantly different from the 1:1 line ($p<0.0001$).

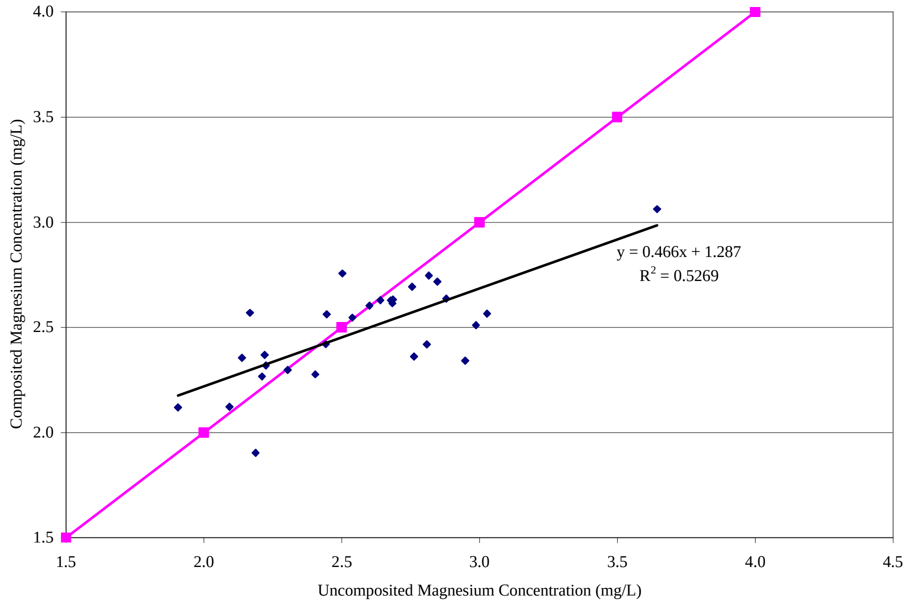


Figure 11. Uncomposited versus composited samples analyzed for magnesium.

Pink line is 1:1 line, while black line is trendline through data points. No statistical analysis was completed with these data, due to the high outlier.

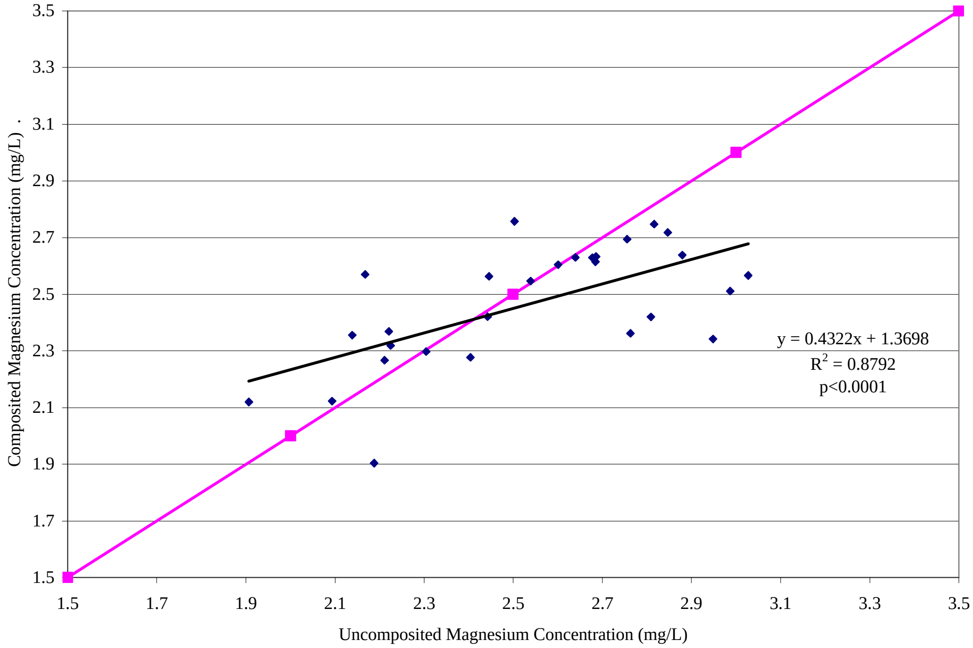


Figure 12. Uncomposited versus composited samples analyzed for magnesium with high outlier removed.

Slope decreases slightly and y-intercept slightly increases. Data are significantly linearly related ($p<0.0001$) but the slope of the best-fit line is significantly different from the 1:1 line ($p<0.0001$).

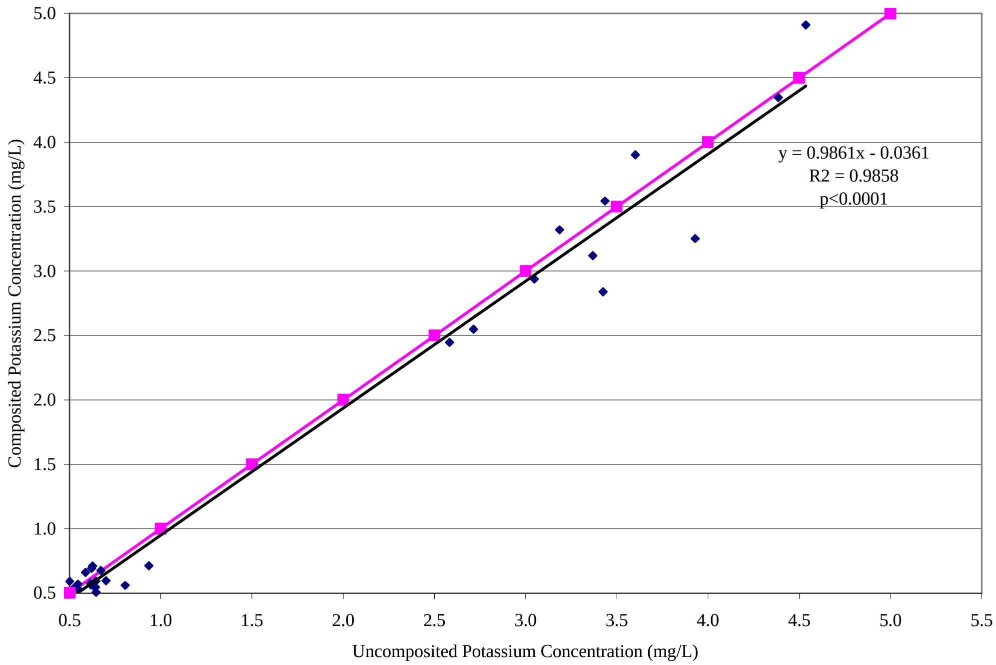


Figure 13. Uncomposited versus composited event samples analyzed for potassium.

Pink line is 1:1 line, while black line is best-fit line through data. Both slope and y-intercept are nearly identical to y = x line. Slopes of the two lines are statistically equivalent (p = 0.7764).

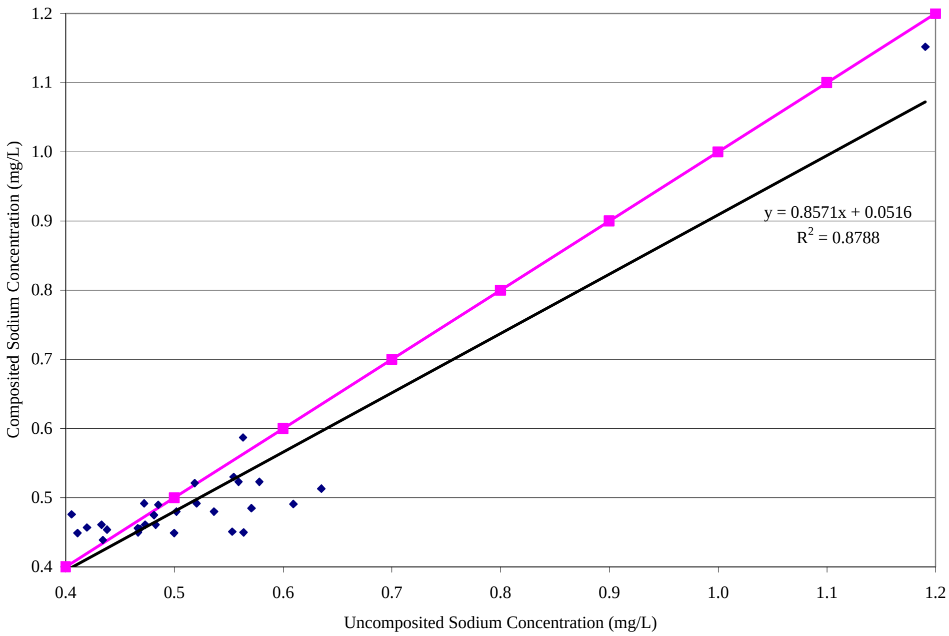


Figure 14. Uncomposited versus composited event samples analyzed for sodium.

Pink line is y = x, and black line is best-fit through x and y coordinates. Notice the high outlier at y = 1.15 and x = 1.9. No statistical analysis was completed with these data, due to this outlier.

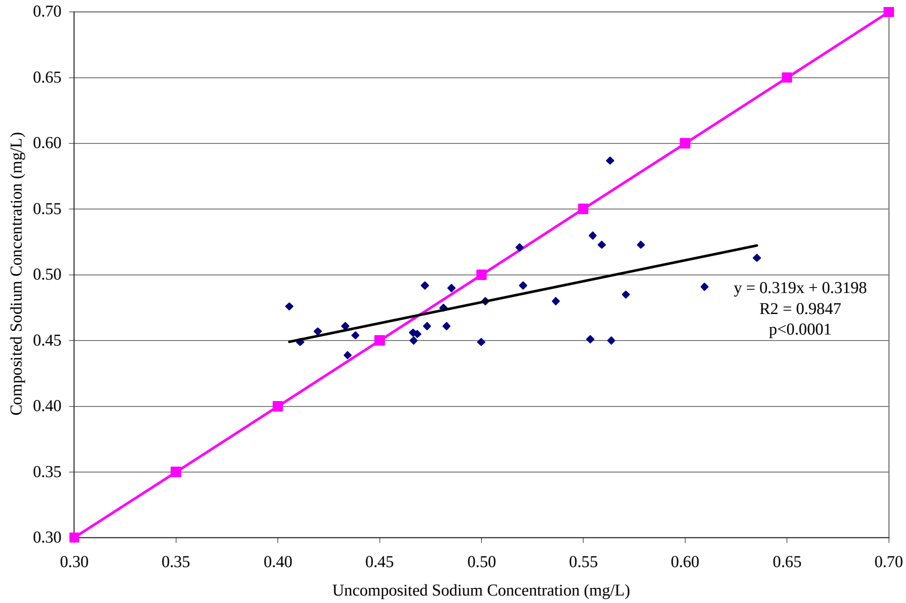


Figure 15. Uncomposited versus composited event samples analyzed for sodium excluding outlier.

The slope of best-fit line sharply decreased and the y-intercept increased as a result of outlier exclusion. Data are significantly linearly related ($p<0.0001$) but the slope of the best-fit line is significantly different from the 1:1 line ($p<0.0001$).

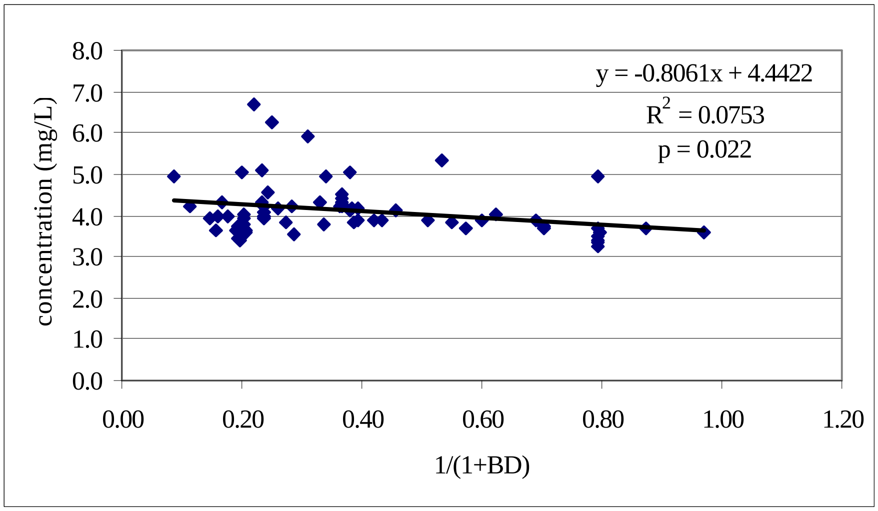


Figure 16. Composited calcium concentration versus discharge function at TNef1. Trendline is linear. Beta = 10^2. Discharge is in units of cubic feet per second.

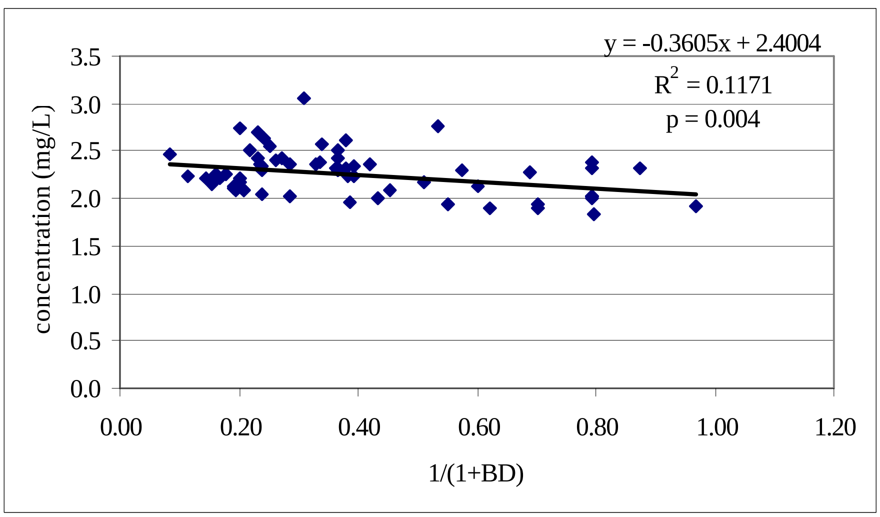


Figure 17. Composited magnesium concentration versus discharge function at TNef1. Trendline is linear. Beta = 10^2. Discharge is in units of cubic feet per second.

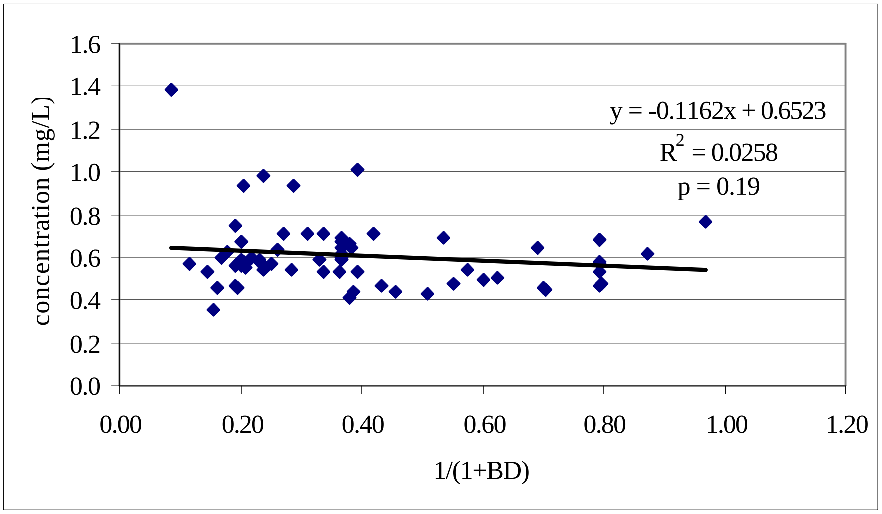


Figure 18. Composited potassium concentration versus discharge function at TNef1.

Trendline is linear. Beta = 10^2. Discharge is in units of cubic feet per second.

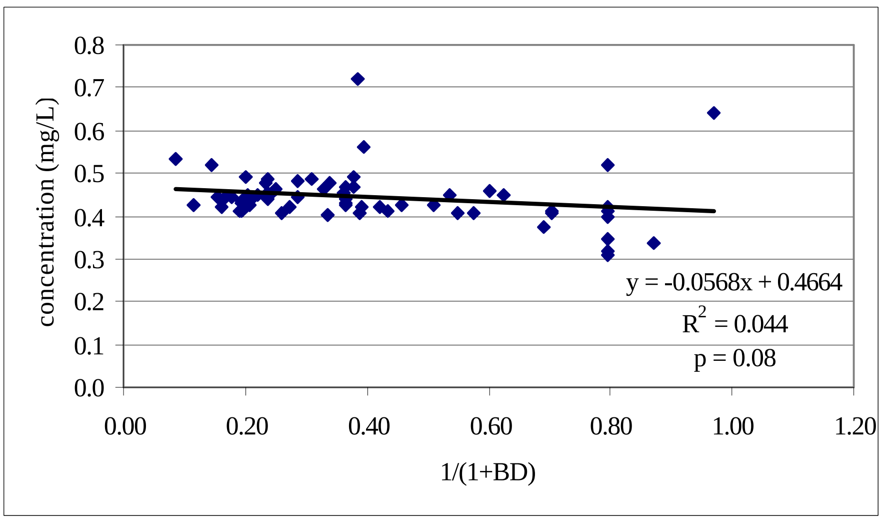


Figure 19. Composited sodium concentration versus discharge function at TNef1.

Trendline is linear. Beta = 10^2. Discharge is in units of cubic feet per second.

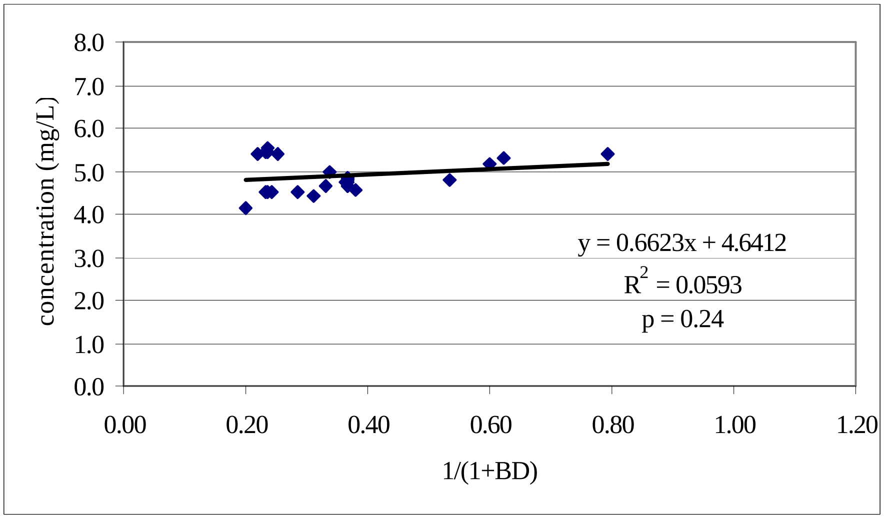


Figure 20. Composited silica concentration versus discharge function at TNef1.

Trendline is linear. Beta = 10^2. Discharge is in units of cubic feet per second.

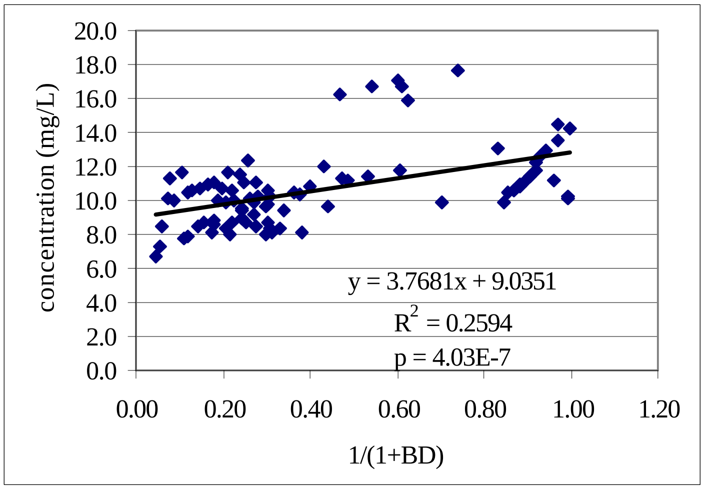


Figure 21. Composited calcium concentration versus discharge function at TMat1.

Beta = 10. Discharge is in units of cubic feet per second.

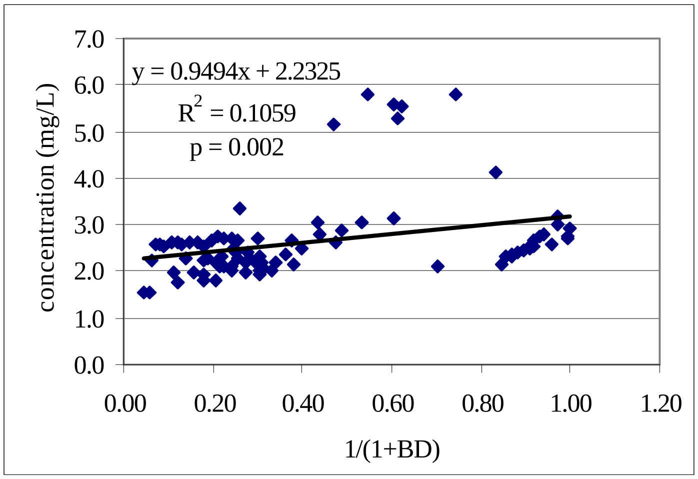


Figure 22. Composited magnesium concentration versus discharge function at TMat1.

Beta = 10. Discharge is in units of cubic feet per second.

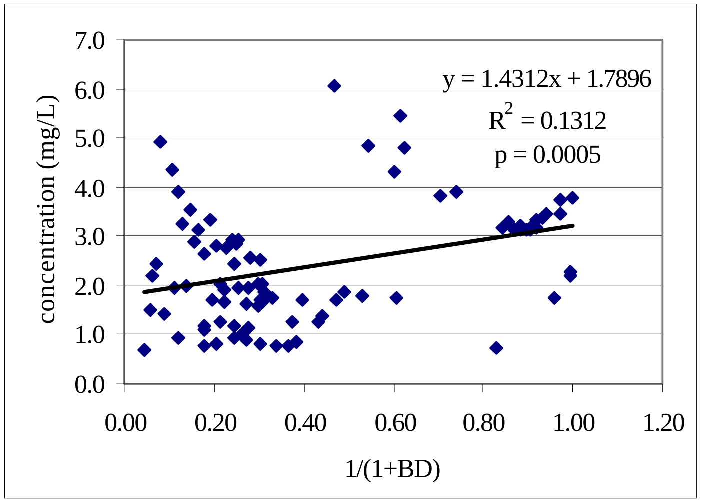


Figure 23. Composited potassium concentration versus discharge function at TMat1.

The fit of any function to this set of points is poor due to the disparate groups of data points. Beta = 10. Discharge is in units of cubic feet per second.

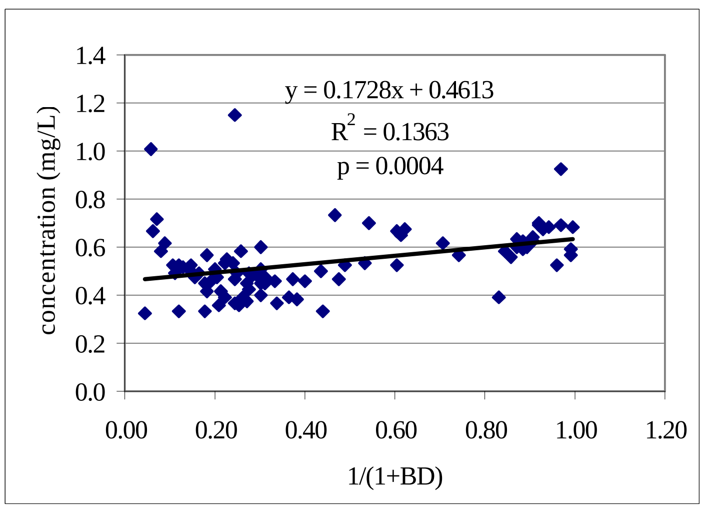


Figure 24. Composited sodium concentration versus discharge function at TMat1.

Trendline is linear. Beta = 10. Discharge is in units of cubic feet per second.

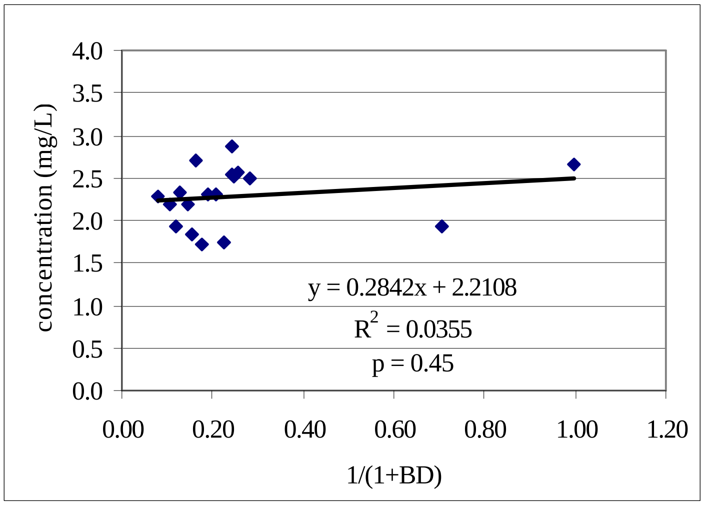
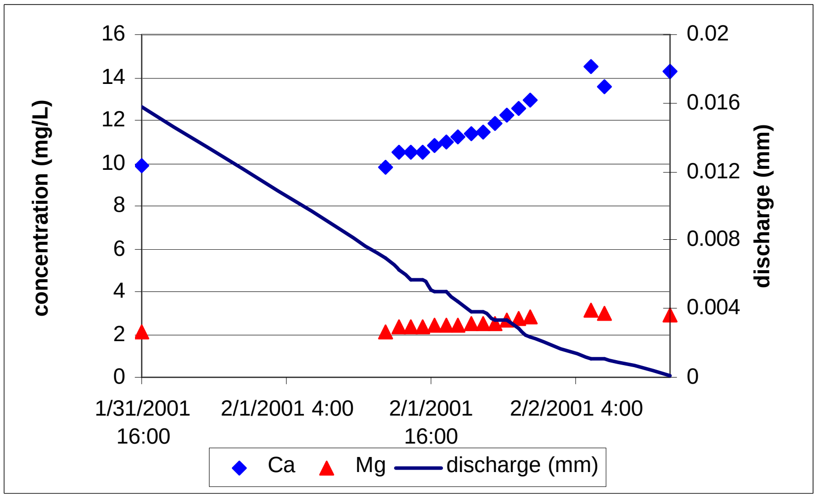


Figure 25. Composited silica concentration versus discharge function at TMat1.

Trendline is linear. Beta = 10. Discharge is in units of cubic feet per second.

26a.



26b.

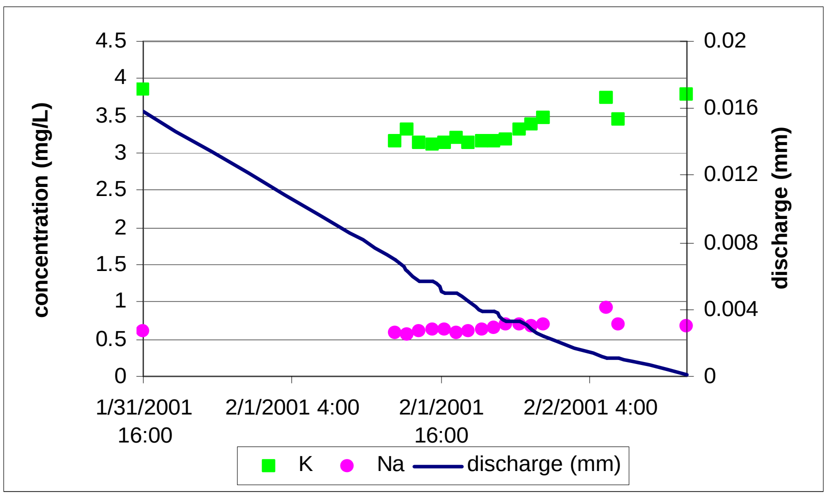
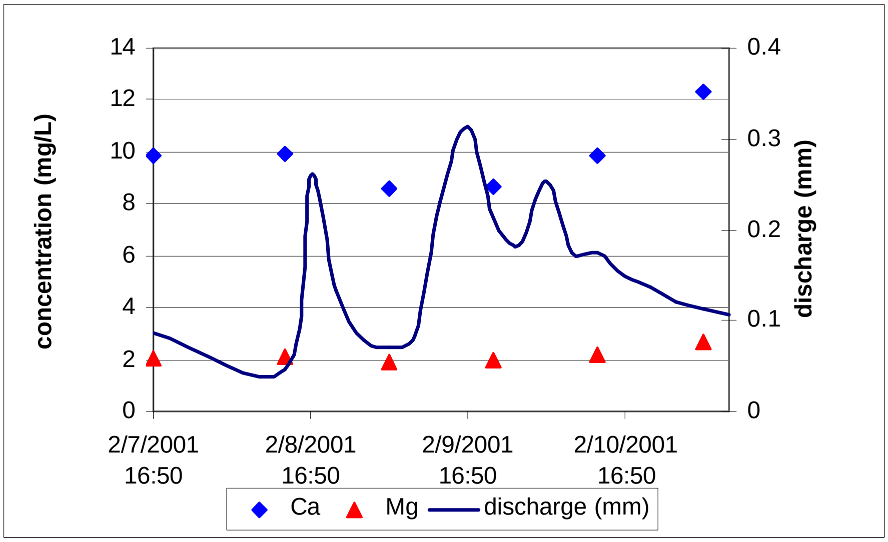


Figure 26. Cation concentrations during snowmelt event A at TMat1.

a. Calcium and magnesium. b. Potassium and sodium.

27a.



27b.

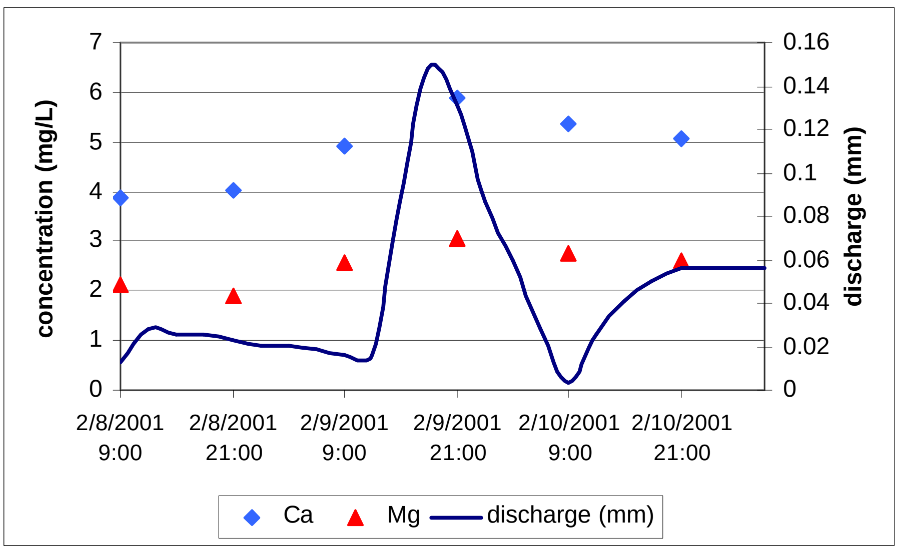
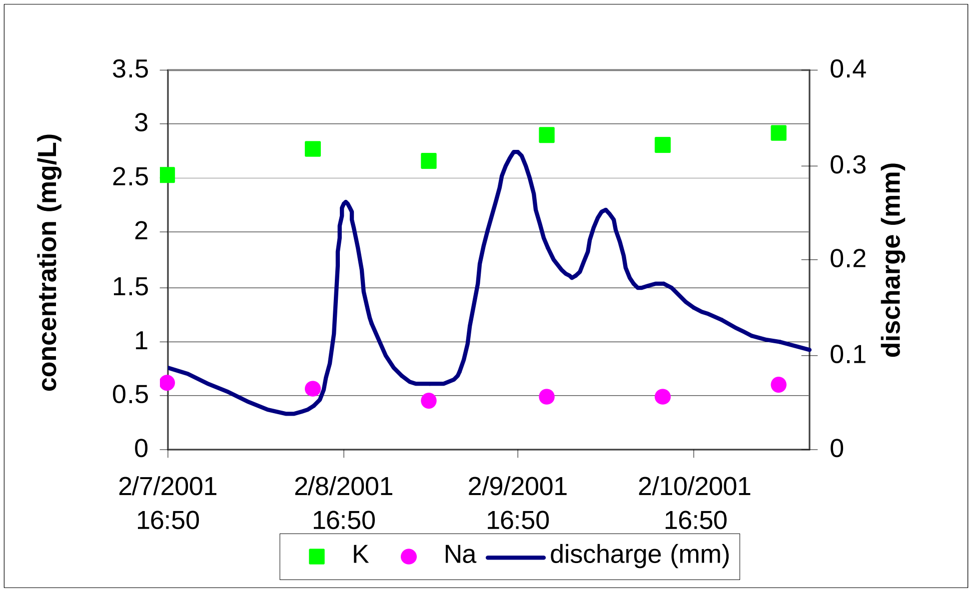


Figure 27. Calcium and magnesium concentrations during event B at TNef1 and TMat1.

a. Calcium and magnesium concentration at TMat1. b. Calcium and magnesium concentration at TNef1.

28a.



28b.

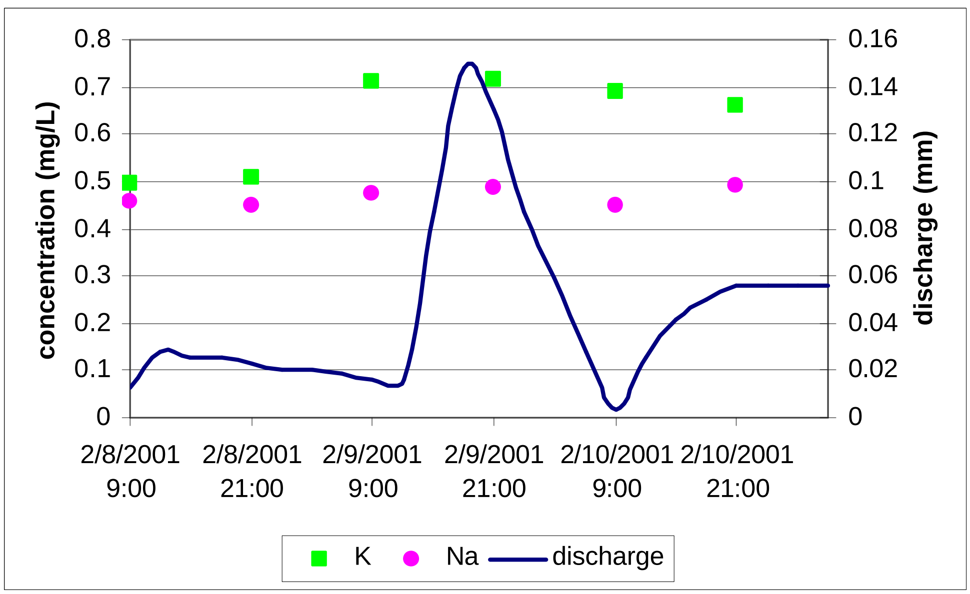
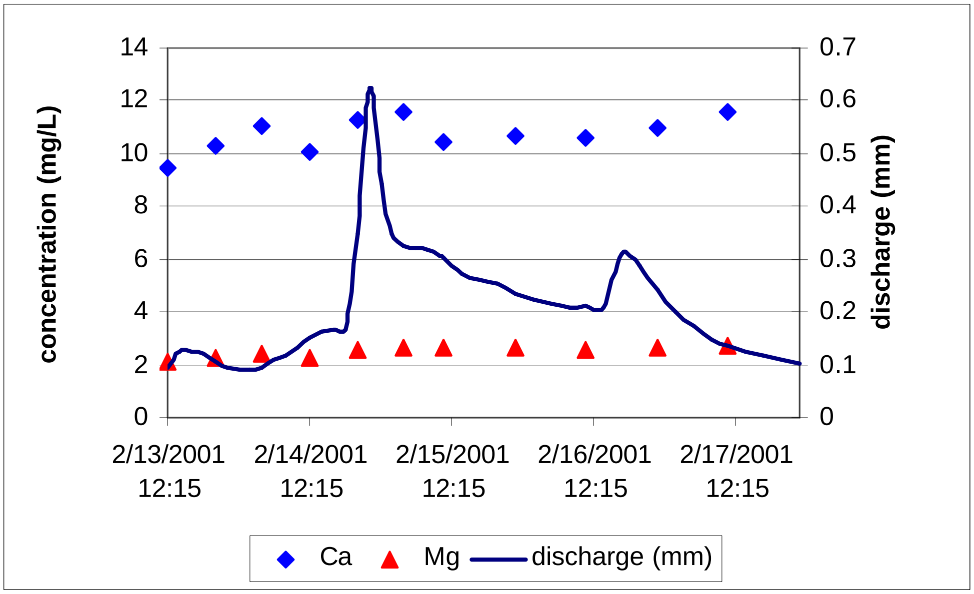


Figure 28. Potassium and sodium concentrations during event B at TNef1 and TMat1.

a. Potassium and sodium concentration and discharge TMat1. b. Potassium and sodium concentration and discharge at TNef1.

29a.



29b.

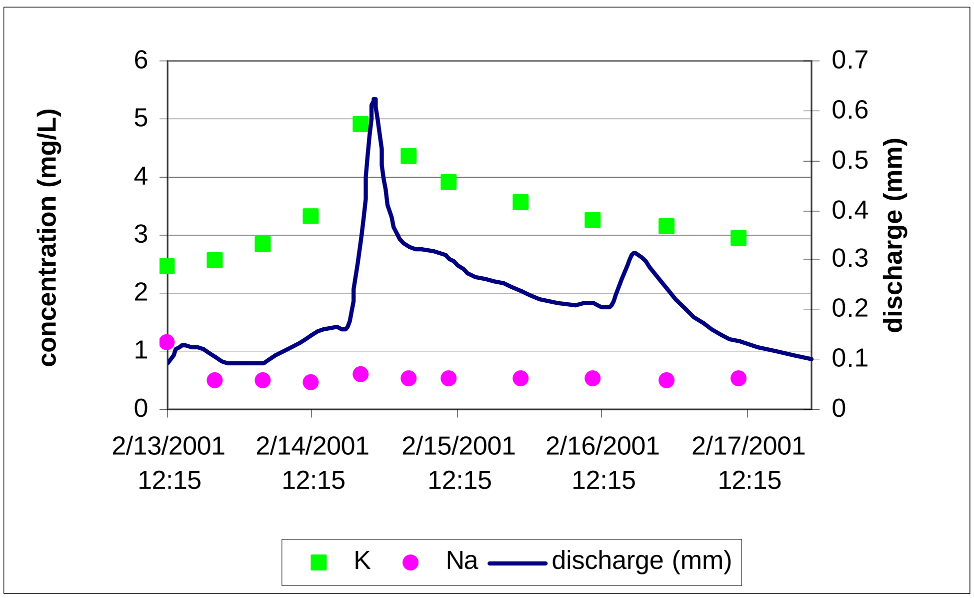
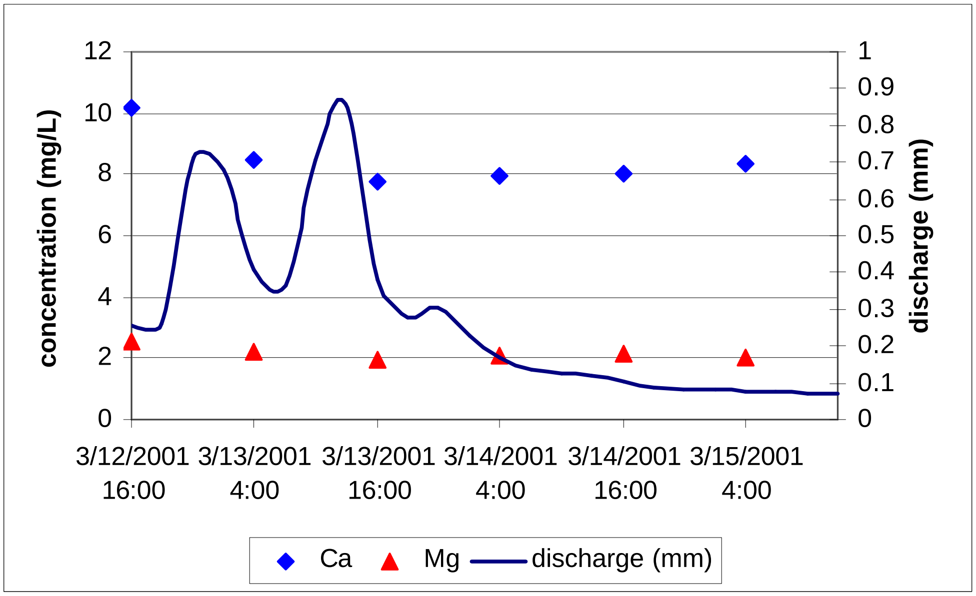


Figure 29. Cation concentrations during event E at TMat1.

a. Calcium and magnesium concentration at TMat1. b. Potassium and sodium concentration and discharge at TMat1.

30a.



30b.

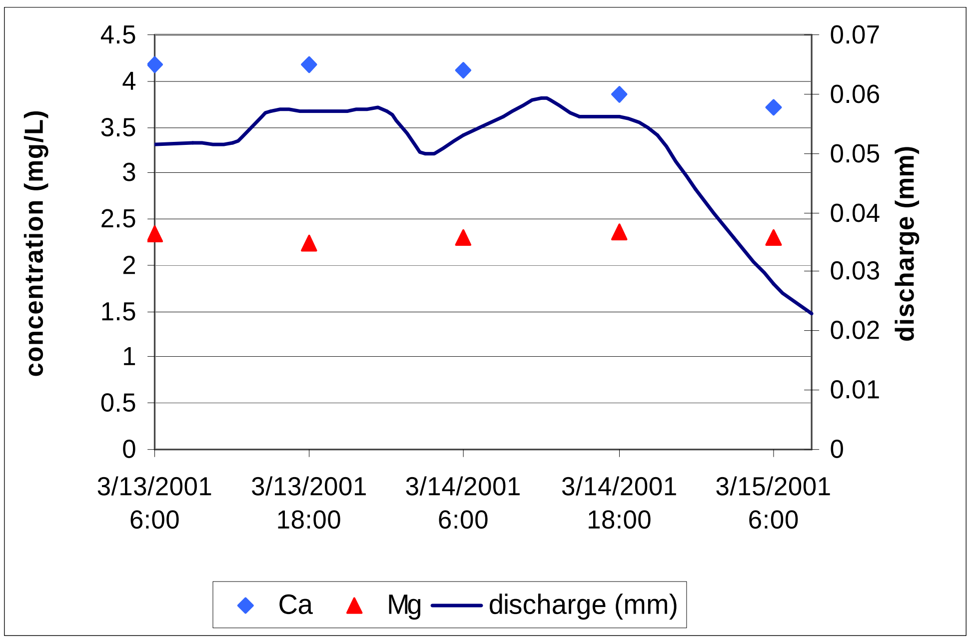
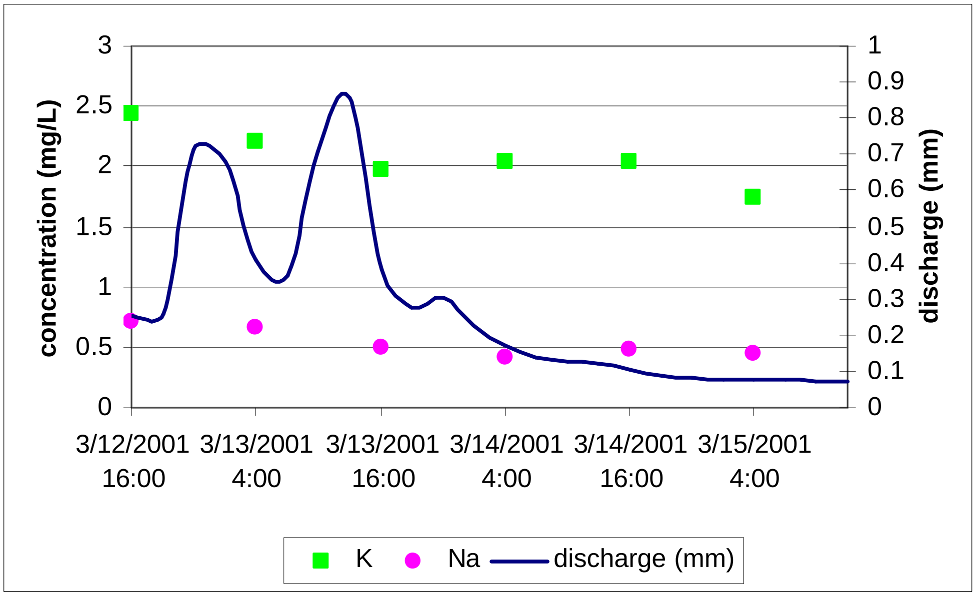


Figure 30. Calcium and magnesium concentrations during event F at TMat1 and TNef1.

a. Calcium and magnesium concentration and discharge at TMat1. b. Calcium and magnesium concentration and discharge at TNef1.

31a.



31b.

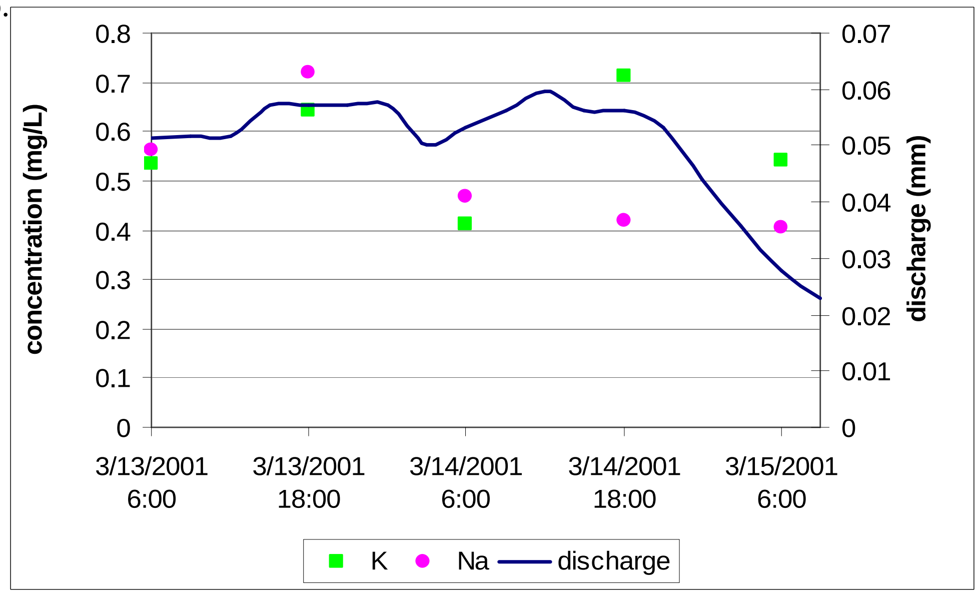
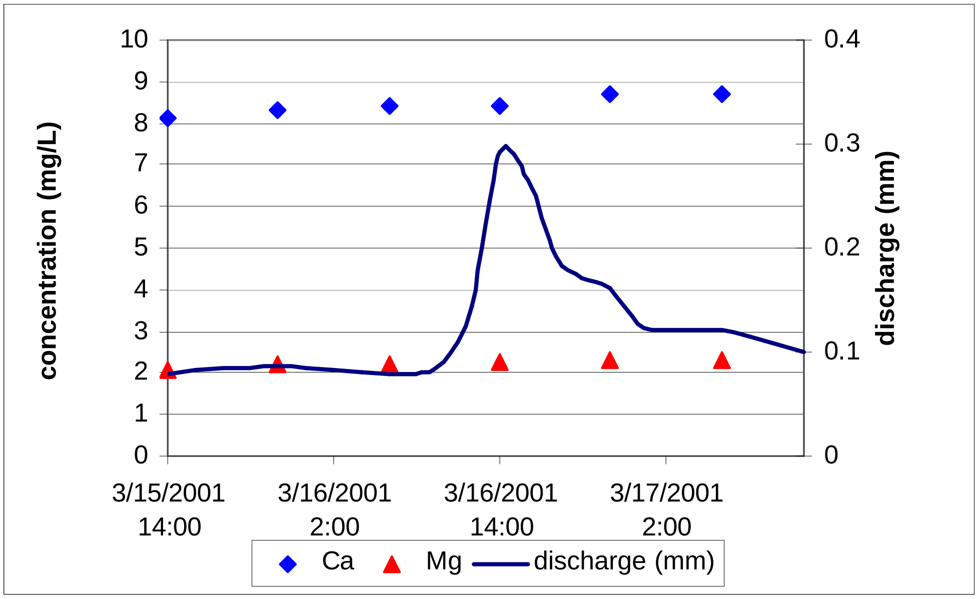


Figure 31. Potassium and sodium concentrations during event F at TMat1 and TNef1.

a. Potassium and sodium concentration and discharge at TMat1. b. Potassium and sodium concentration and discharge at TNef1.

32a.



32b.

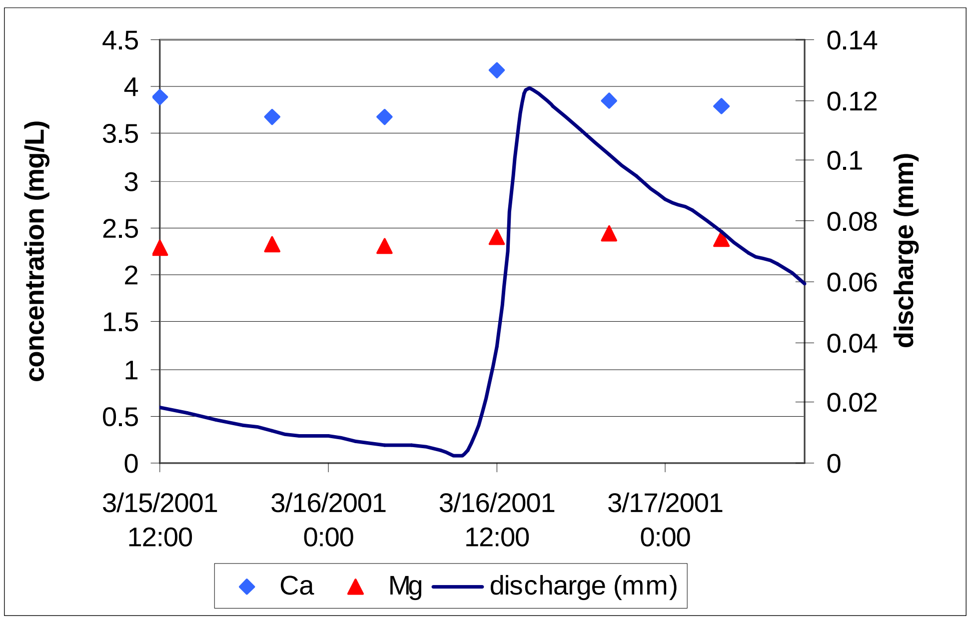
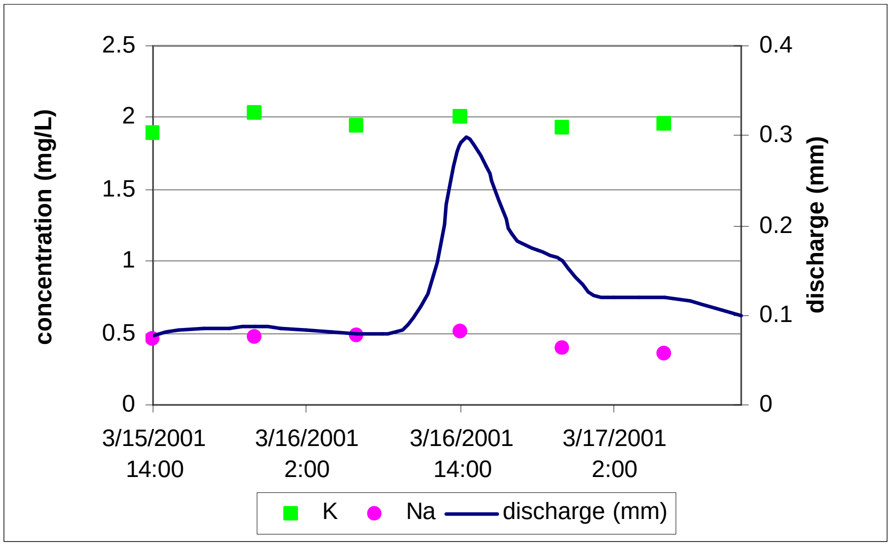


Figure 32. Calcium and magnesium concentration and discharge during event G at TMat1 and TNef1.

a. Calcium and magnesium concentration and discharge at TMat1. b. Calcium and magnesium concentration and discharge at TNef1.

33a.



33b.

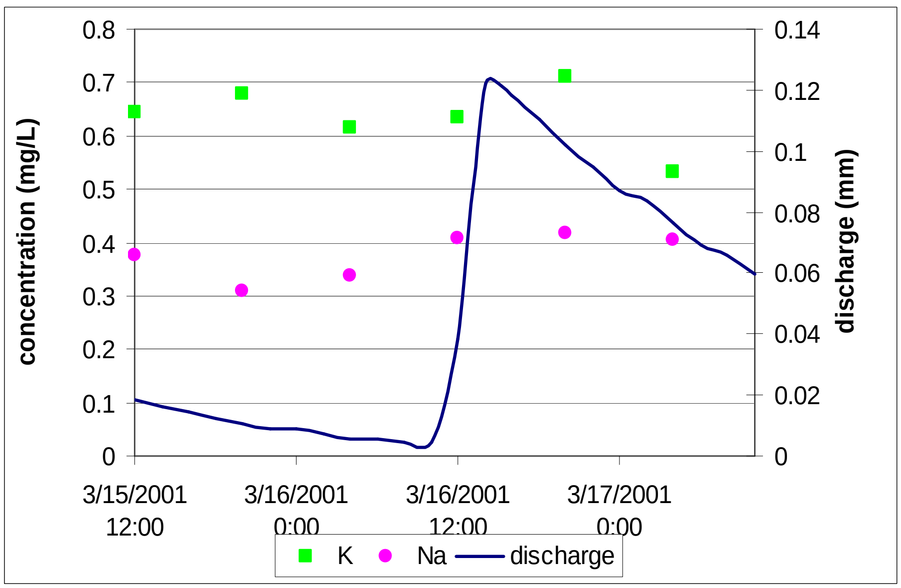
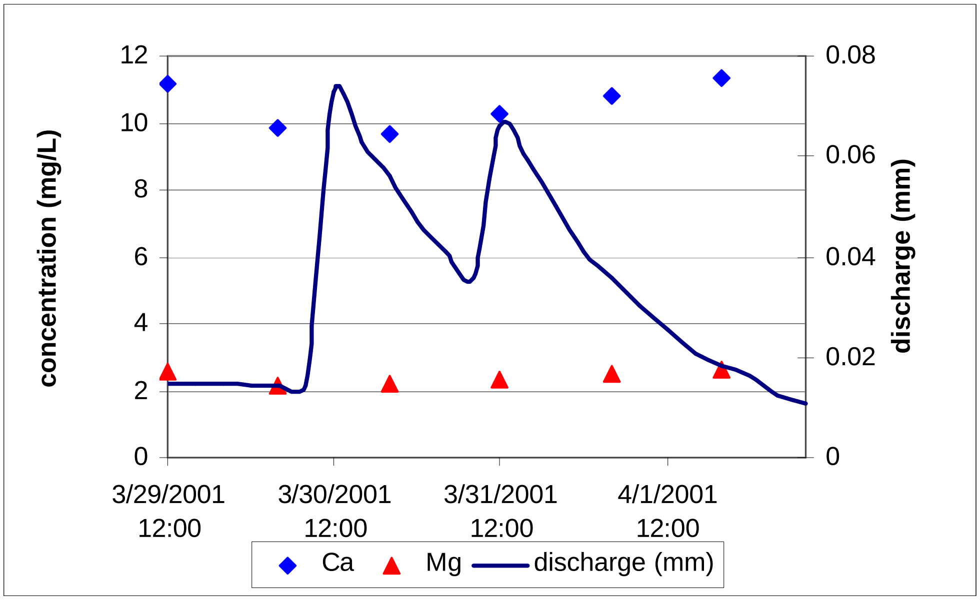


Figure 33. Potassium and sodium concentrations during event G at TMat1 and TNef1.

a. Potassium and sodium concentrations and discharge at TMat1. b. Potassium and sodium concentrations and discharge at TNef1.

34a.



34b.

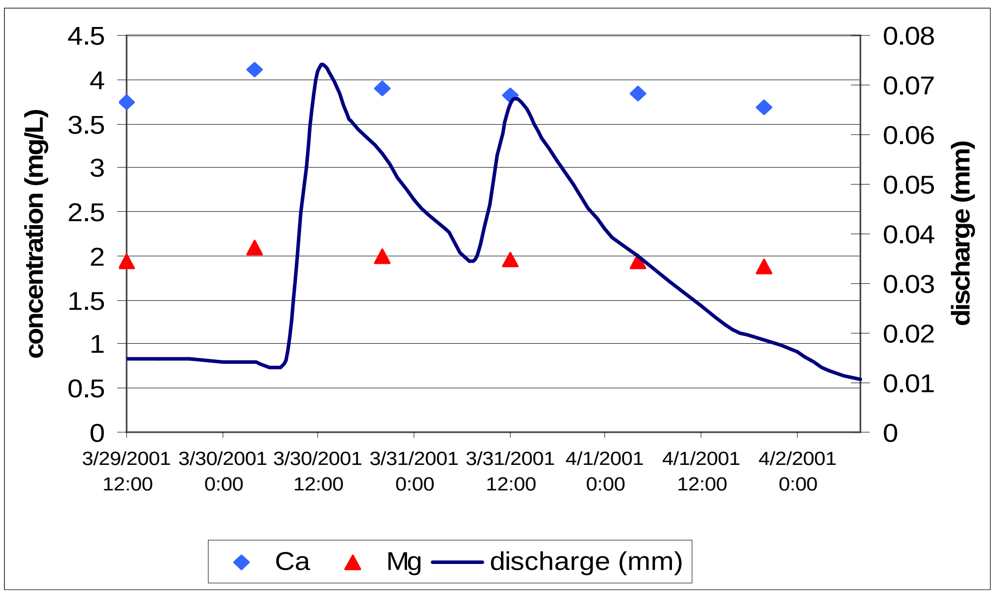
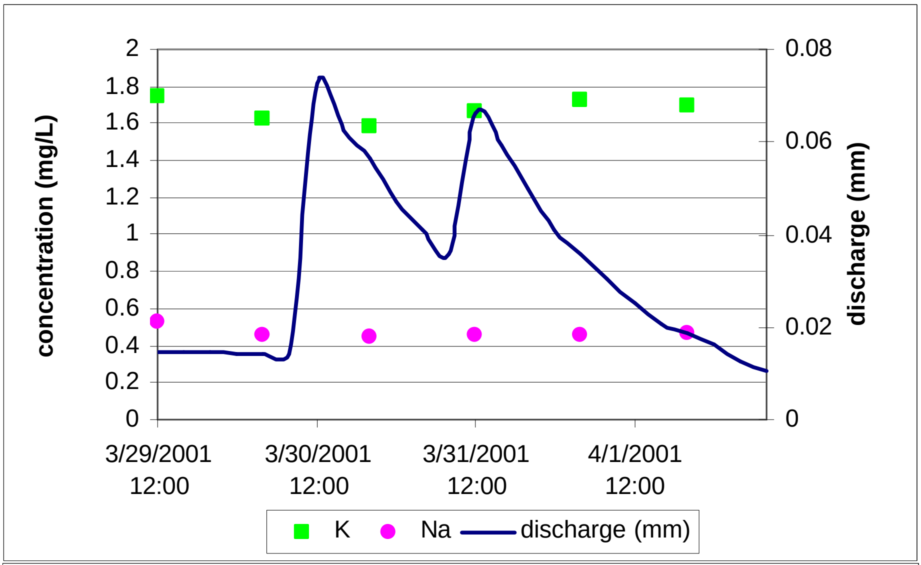


Figure 34. Calcium and magnesium concentration and discharge during event H at TMat1 and TNef1.

a. Calcium and magnesium concentration and discharge at TMat1. b. Calcium and magnesium concentration and discharge at TNef1.

35a.



35b.

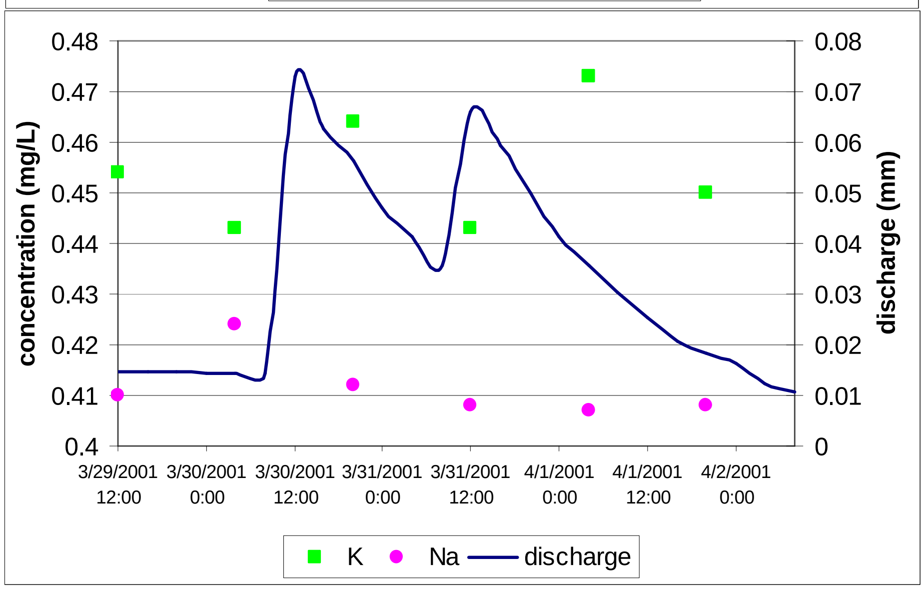
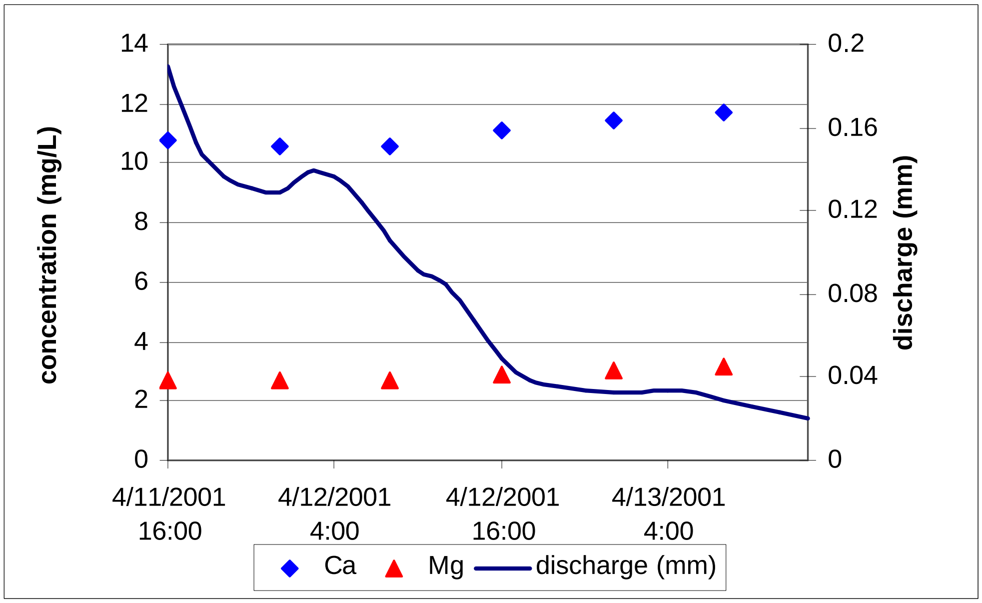


Figure 35. Potassium and sodium concentration and discharge during event H at TMat1 and TNef1.

a. Potassium and sodium concentration and discharge at TMat1. b. Potassium and sodium concentration and discharge at TNef1.

36a.



36b.

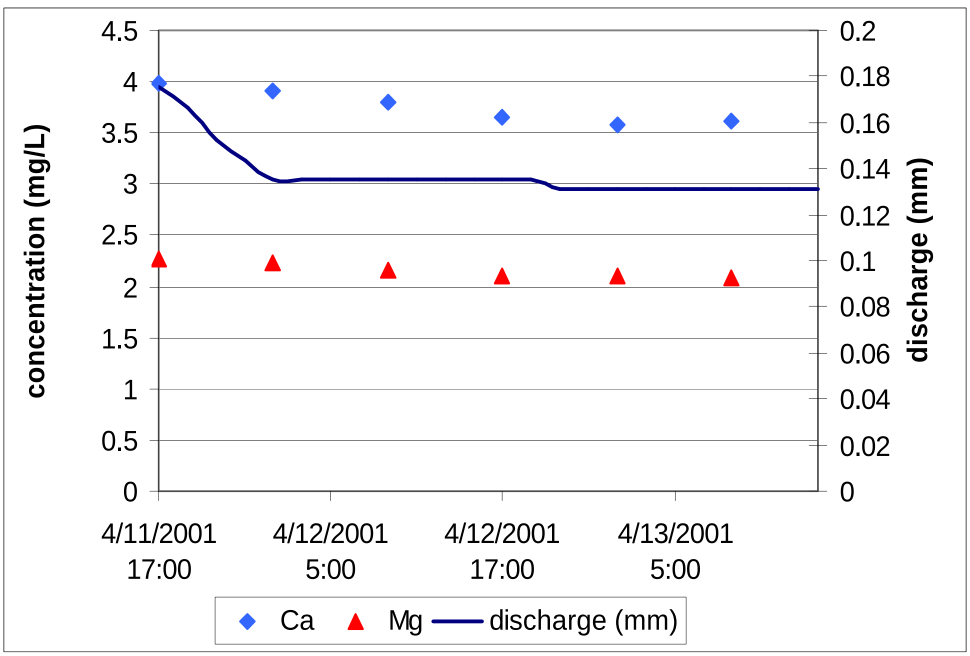
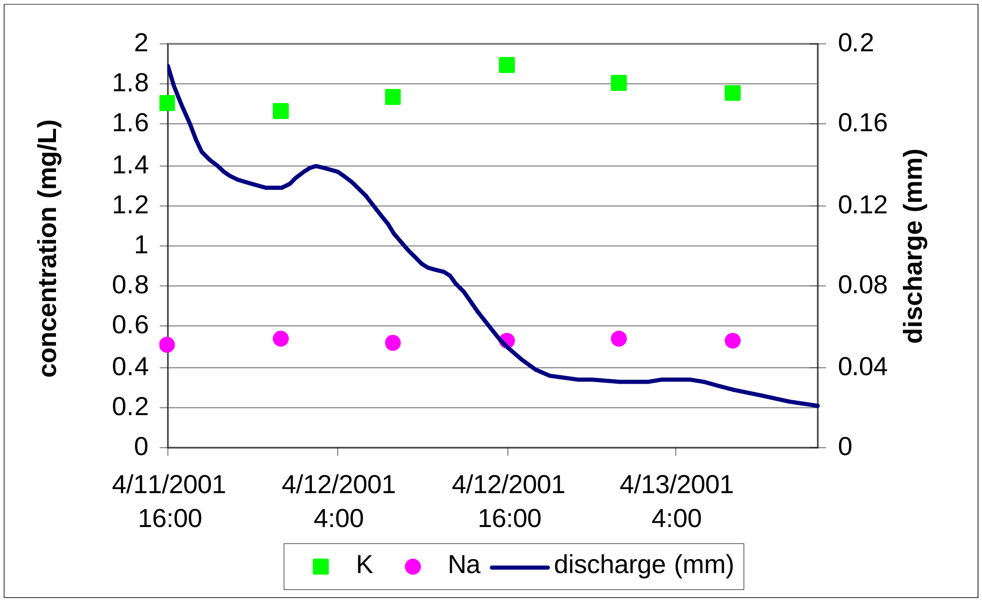


Figure 36. Calcium and magnesium concentration and discharge during event I at TMat1 and TNef1.

a. Calcium and magnesium concentration and discharge at TMat1. b. Calcium and magnesium concentration and discharge at TNef1.

37a.



37b.

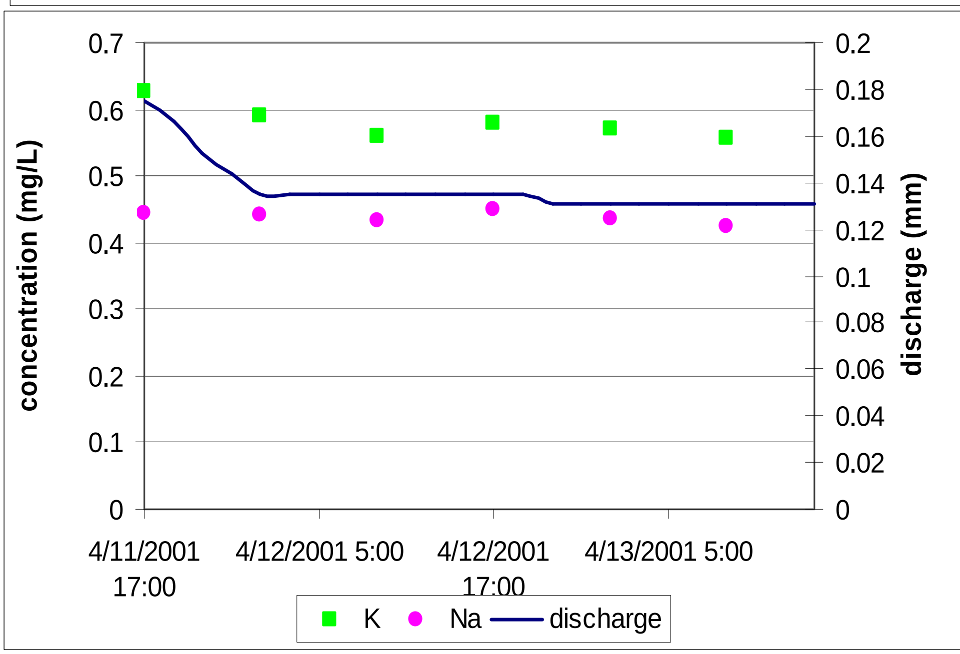
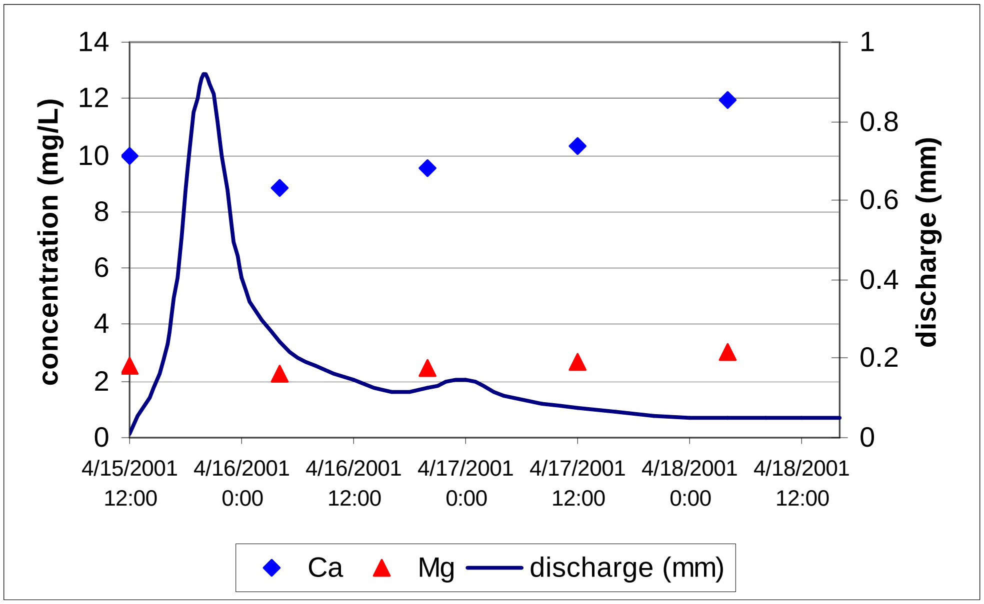


Figure 37. Potassium and sodium concentration and discharge during event I at TMat1 and TNef1.

a. Potassium and sodium concentration and discharge at TMat1. b. Potassium and sodium concentration and discharge at TNef1.

38a.



38b.

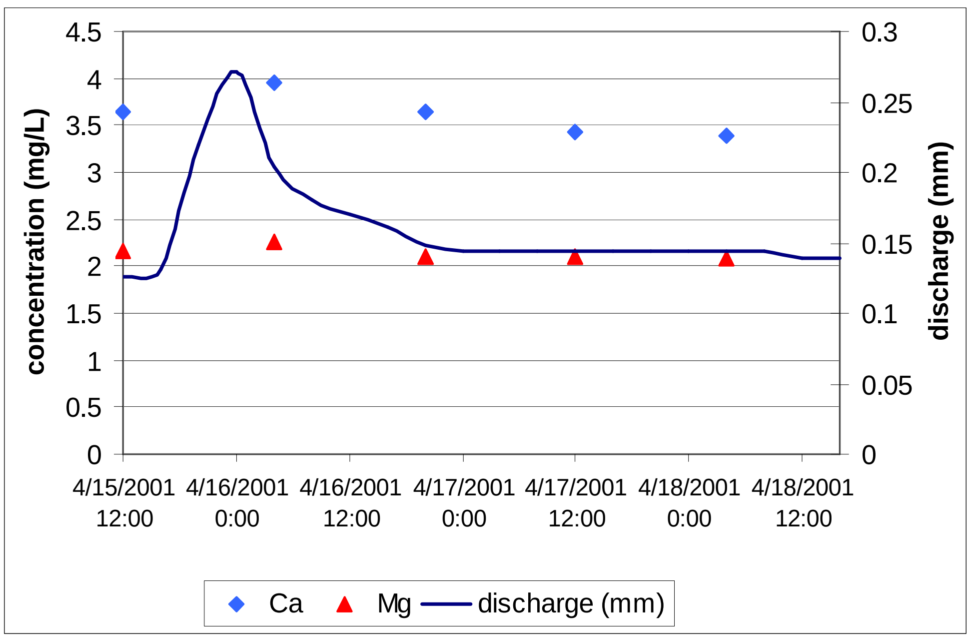
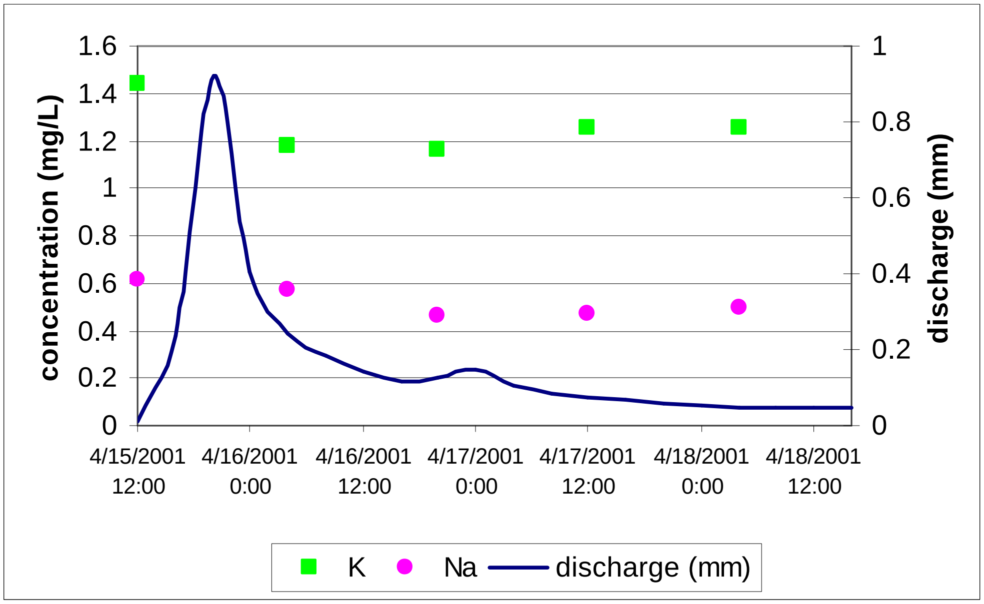


Figure 38. Calcium and magnesium concentration and discharge during event J at TMat1 and TNef1.

a. Calcium and magnesium concentration and discharge at TMat1. b. Calcium and magnesium concentration and discharge at TNef1.

39a.



39b.

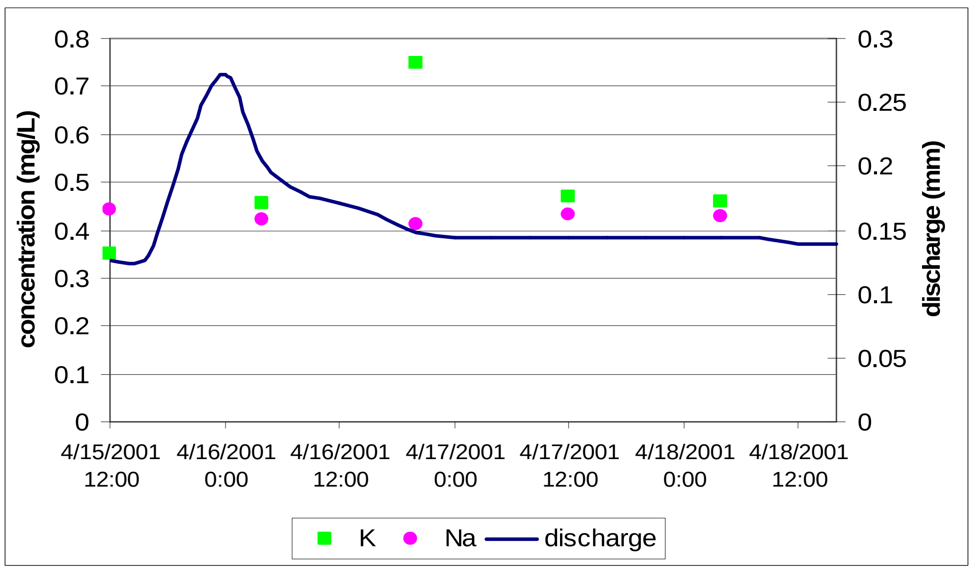


Figure 39. Potassium and sodium concentration and discharge during event J at TMat1 and TNef1.

a. Potassium and sodium concentration and discharge at TMat1. b. Potassium and sodium concentration and discharge at TNef1.

40a.

40b.

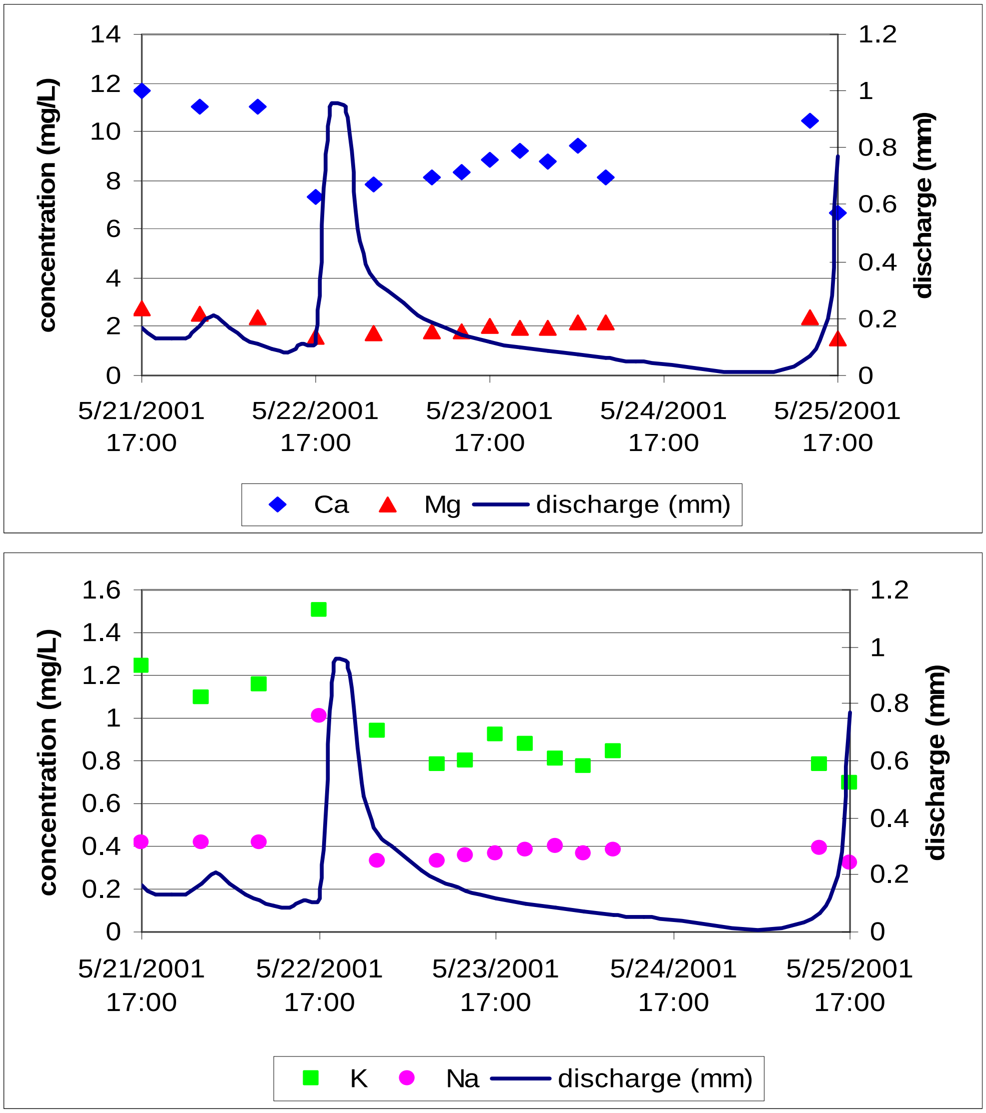
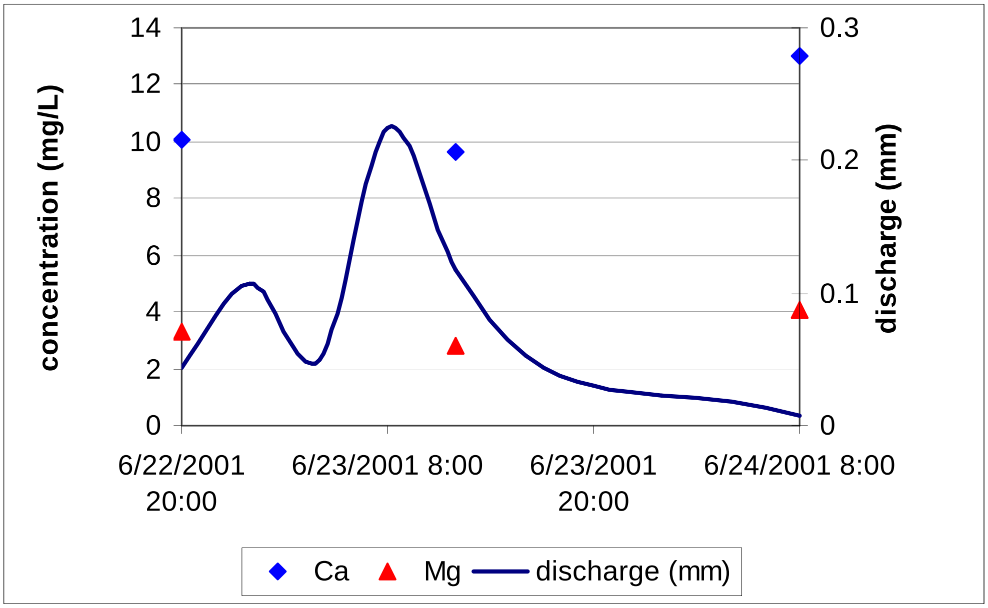


Figure 40. Cation concentrations and discharge during event L at TMat1.

The last nine samples (5/23/01 13:00 – 5/25/01 17:00) were not composited. a. Calcium and magnesium concentration and discharge. b. Potassium and sodium concentration and discharge.

41a.



41b.

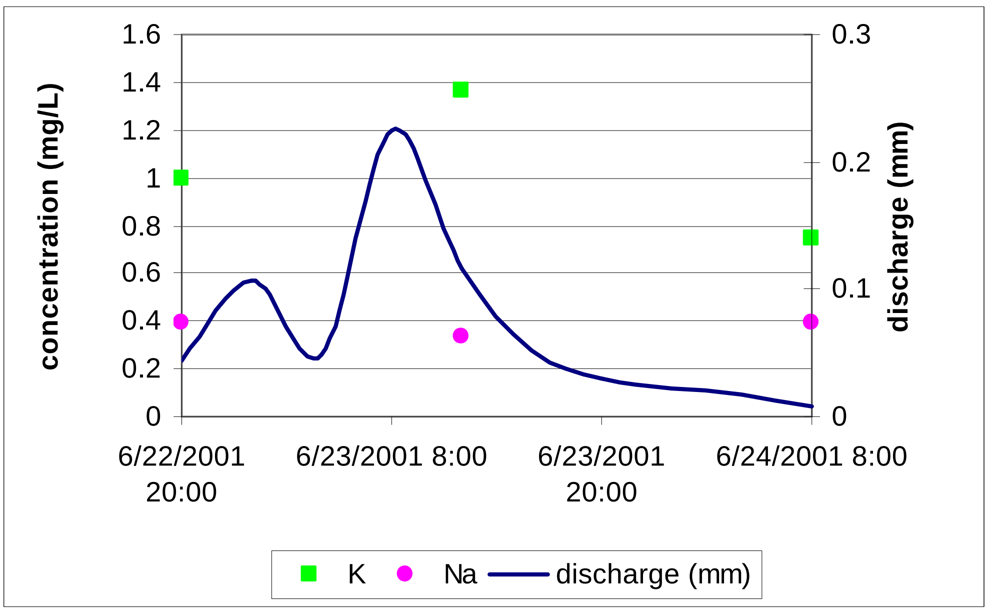
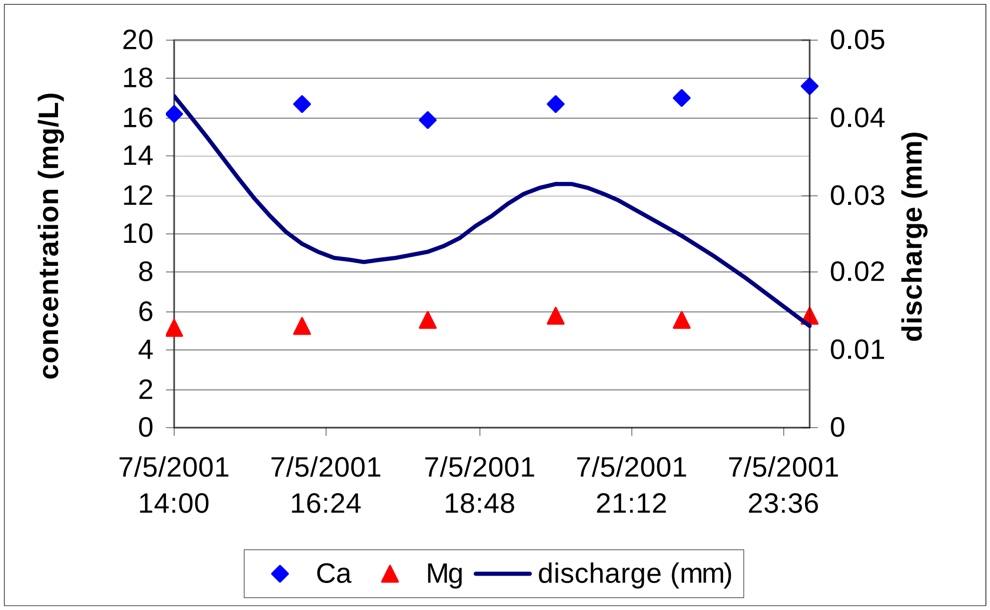


Figure 41. Cation concentration and discharge during event M at TMat1.

a. Calcium and magnesium concentration and discharge. b. Potassium and sodium concentration and discharge.

42a.



42b.

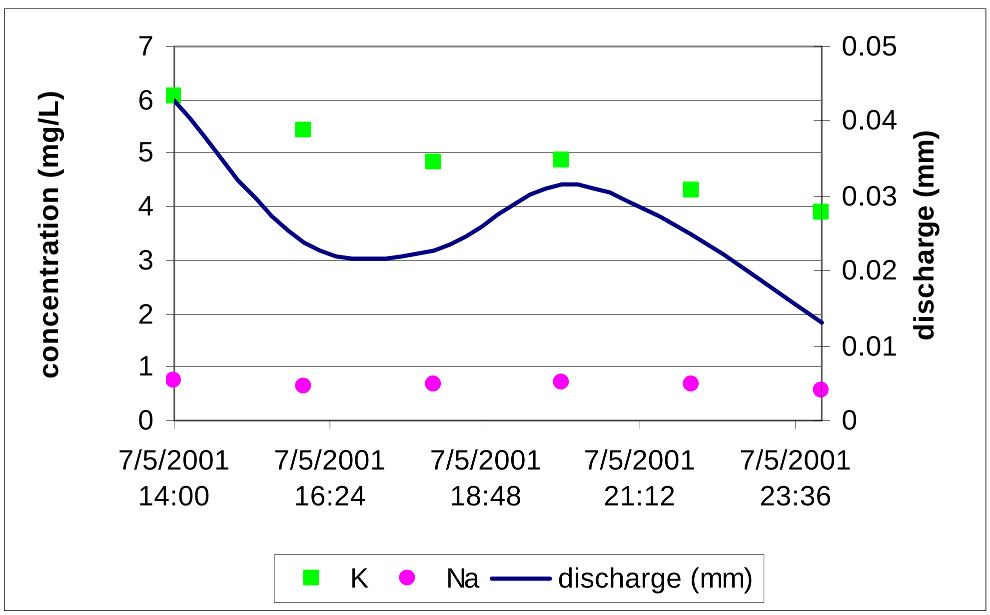
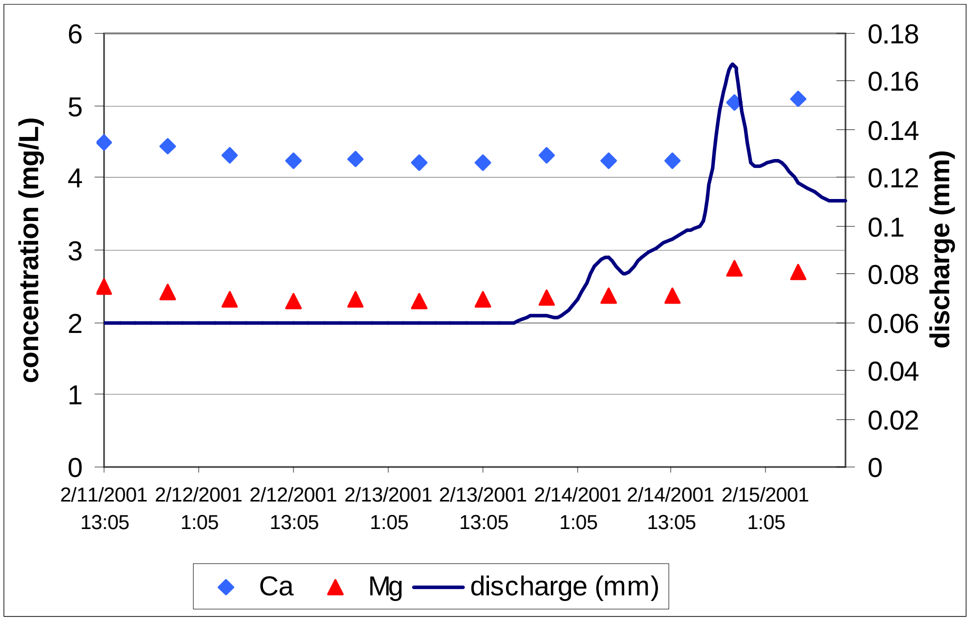


Figure 42. Cation concentration and discharge during event N at TMat1.

Samples were not composited during event N. a. Calcium and magnesium concentration and discharge. b. Potassium and sodium concentration and discharge.

43a.



43b.

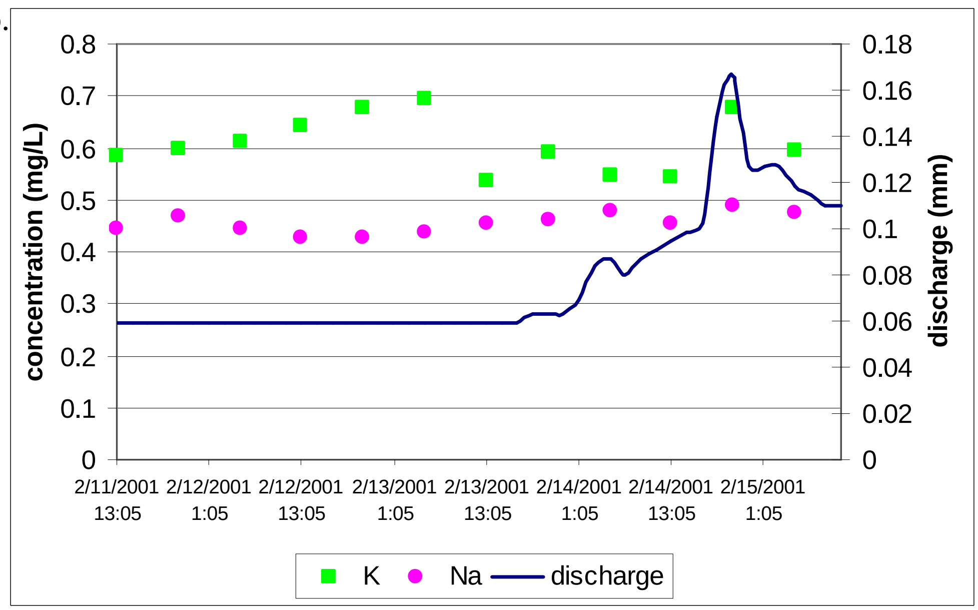
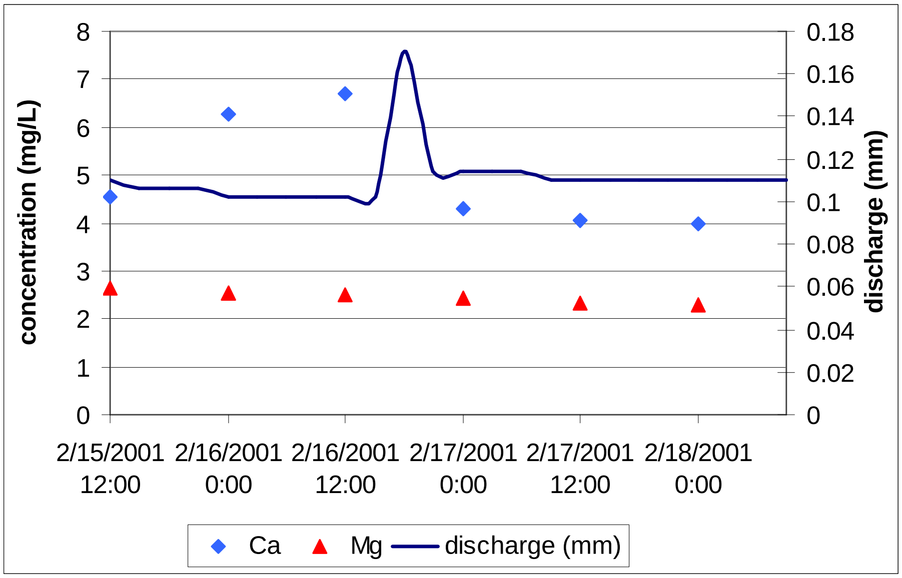


Figure 43. Cation concentrations and discharge during event C at TNef1.

a. Calcium and magnesium concentration and discharge. b. Potassium and sodium concentration and discharge.

44a.



44b.

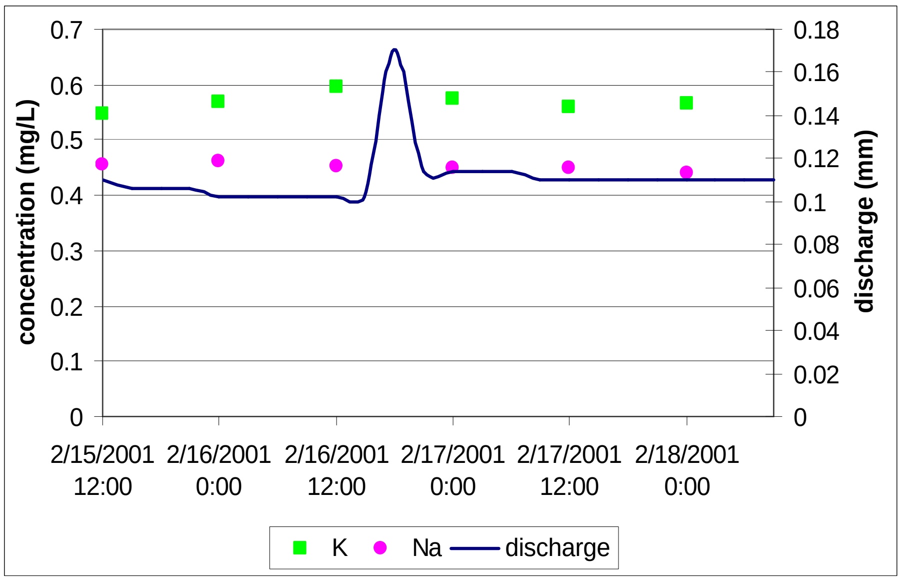
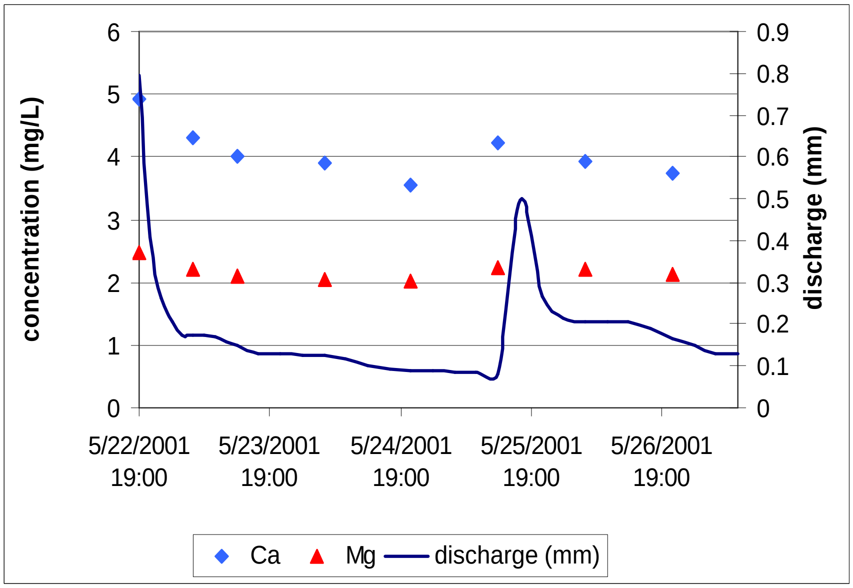


Figure 44. Cation concentrations and discharge during event D at TNef1.

a. Calcium and magnesium concentration and discharge. b. Potassium and sodium concentration and discharge.

45a.



45b.

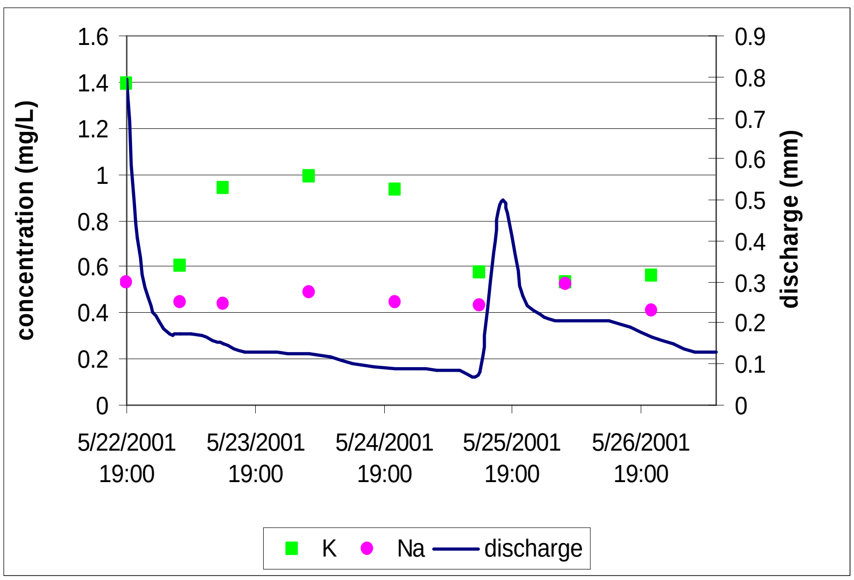


Figure 45. Cation concentration and discharge during event K at TNef1.

a. Calcium and magnesium concentrations and discharge. b. Potassium and sodium concentrations and discharge.

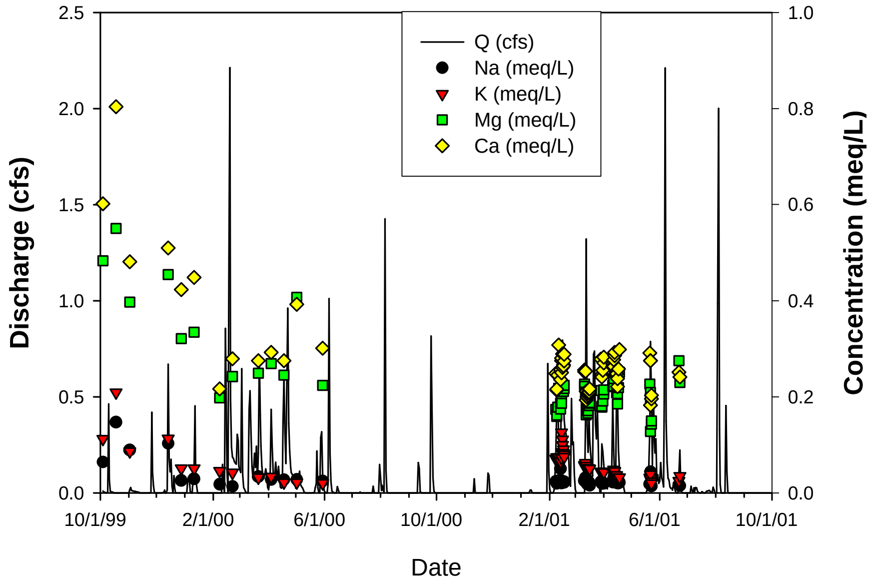


Figure 46. Base cation concentrations at TNef1 for 2000 and 2001 water years plotted with discharge.

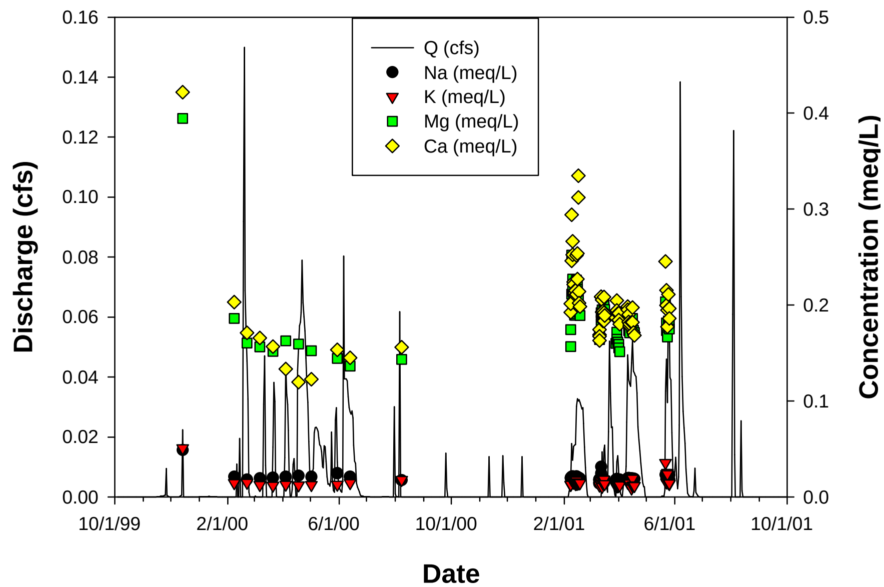


Figure 47. Base cation concentrations at Mat1 for 2000 and 2001 water years.

Note different left and right y-axis scales in Figure 46.

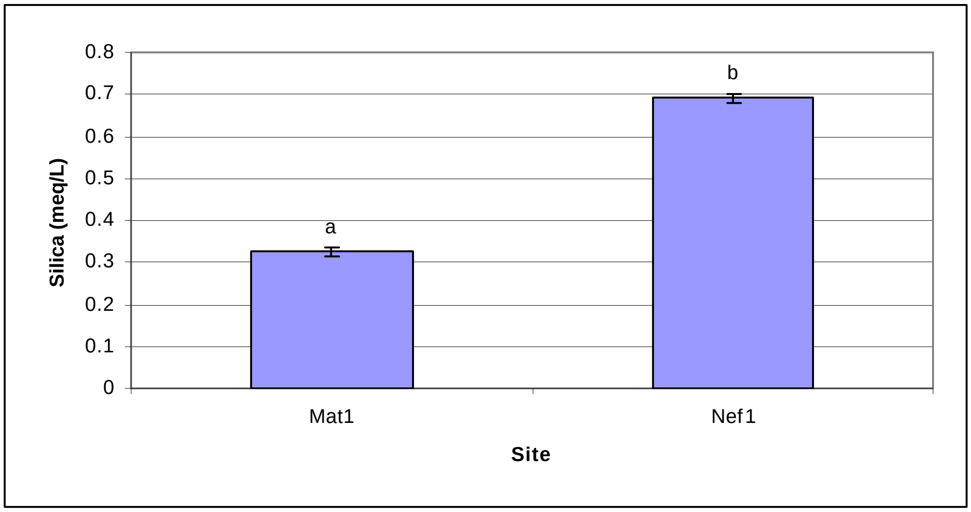


Figure 48. Mean concentration of silica in event-sampled streamwater by site for WY2001.

Means with the same letter are not significantly different (a = 0.05). Error bars are ± 1 standard error.

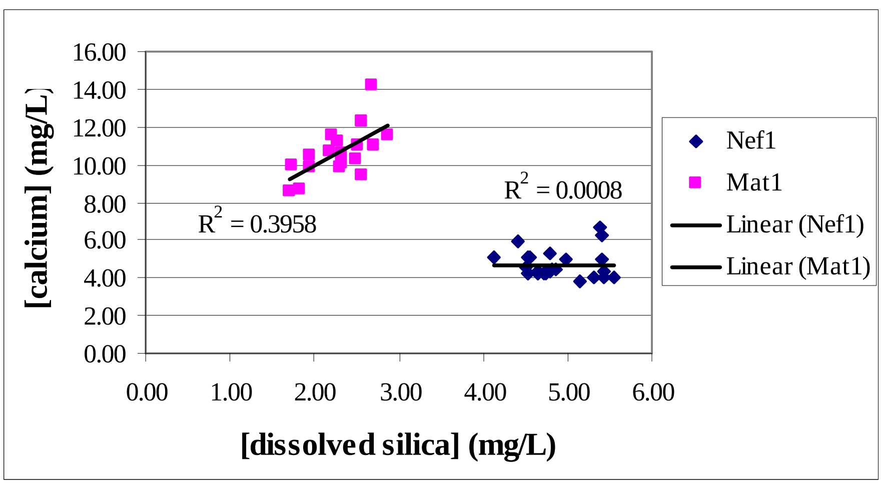


Figure 49. Dissolved silica versus calcium concentration at Nef1 and Mat1, WY2001.

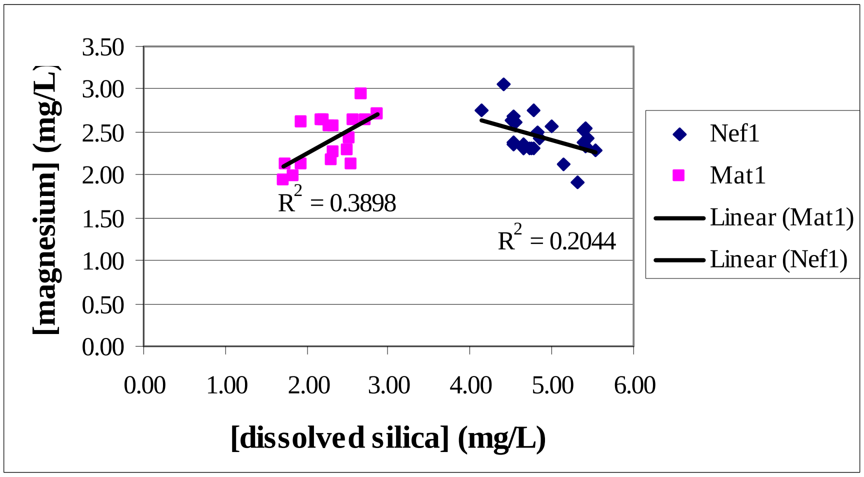


Figure 50. Dissolved silica versus magnesium concentration at Nef1 and Mat1, WY 2001.

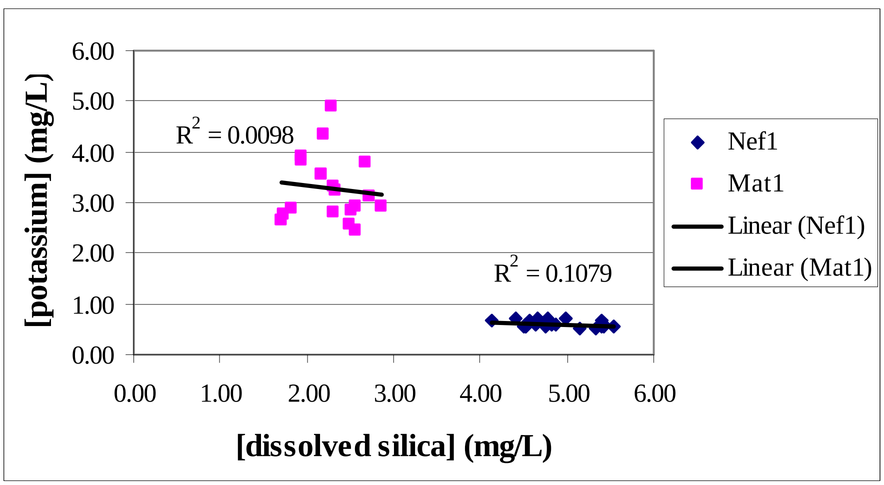


Figure 51. Silica versus potassium concentration at both sites, WY 2001.

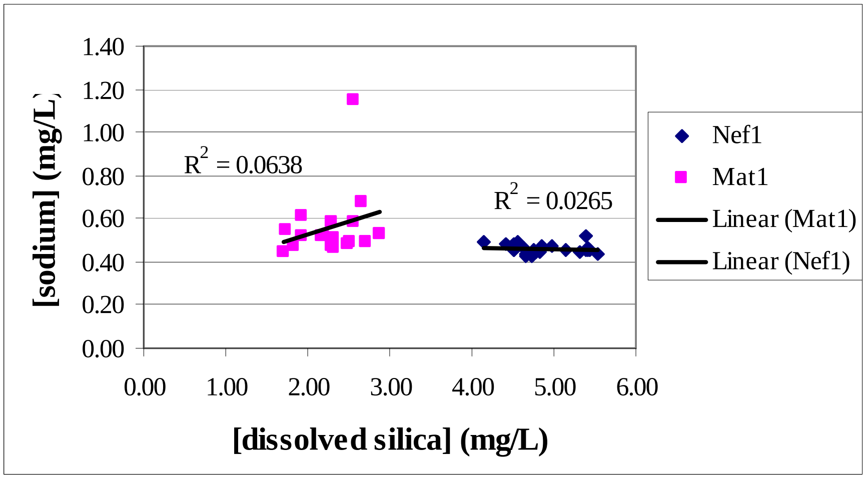


Figure 52. Dissolved silica versus sodium concentrations in WY 2001, Mat1 and Nef1 watersheds.

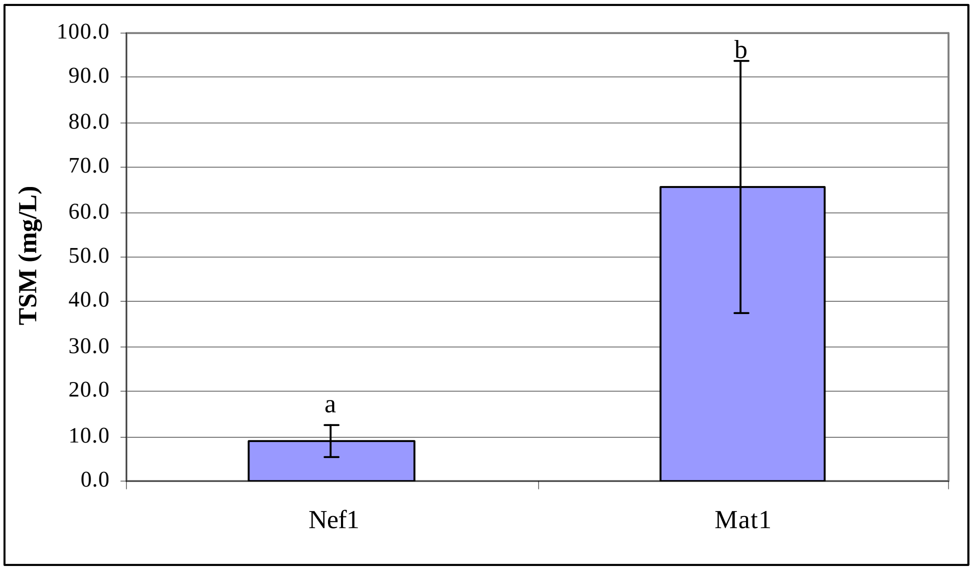


Figure 53. Total suspended matter (TSM) by site for stream event samples for water year 2000.

Means with the same letter are not significantly different. Error bars are ± 1 standard error.

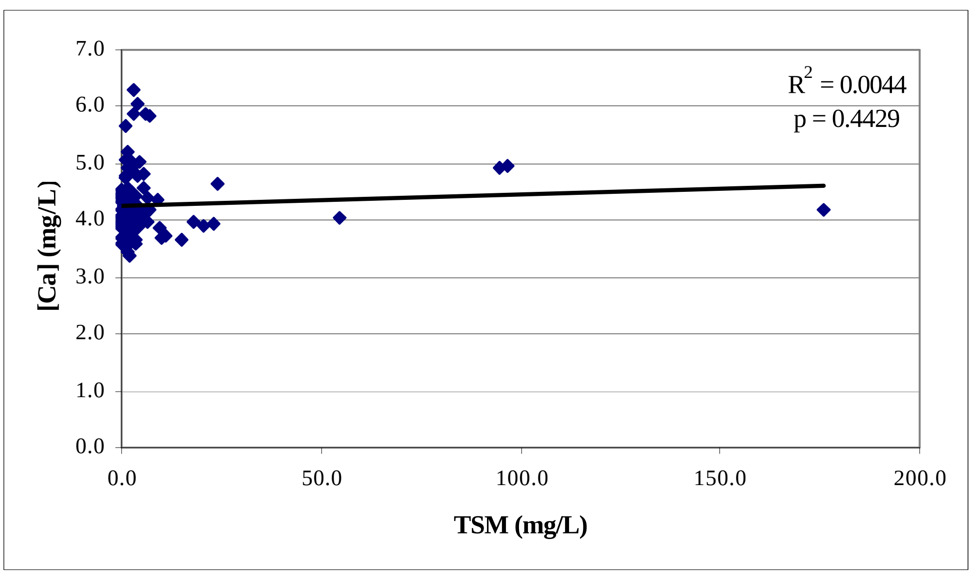


Figure 54. Calcium concentration versus TSM at Nef1, water year 2001.

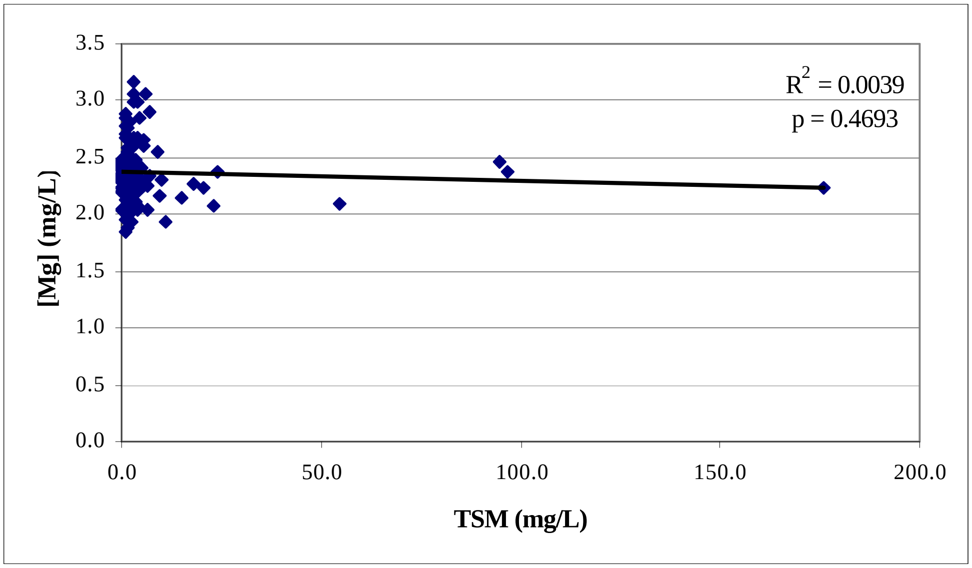


Figure 55. Magnesium concentration versus TSM at Nef1, water year 2001.

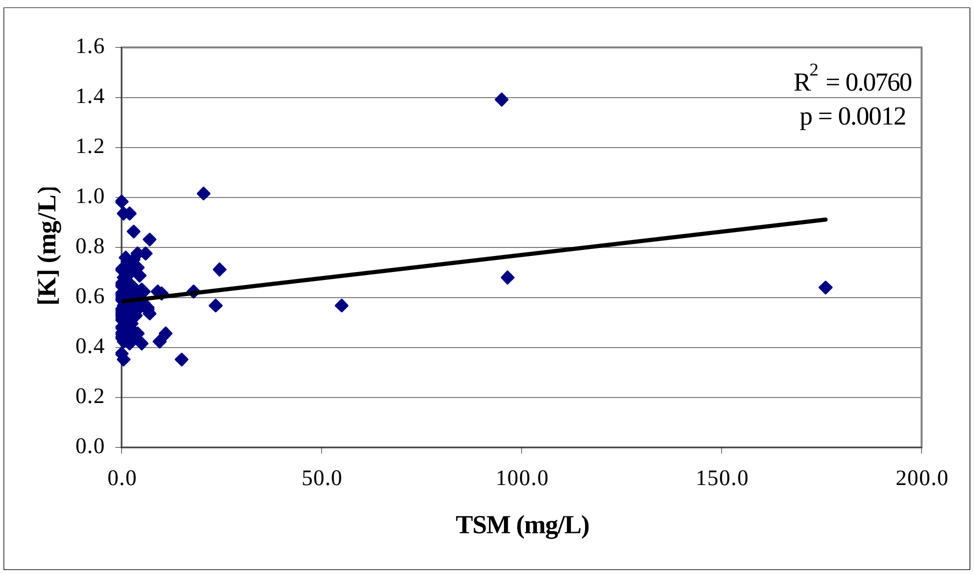


Figure 56. Potassium concentration versus TSM at Nef1, water year 2001.

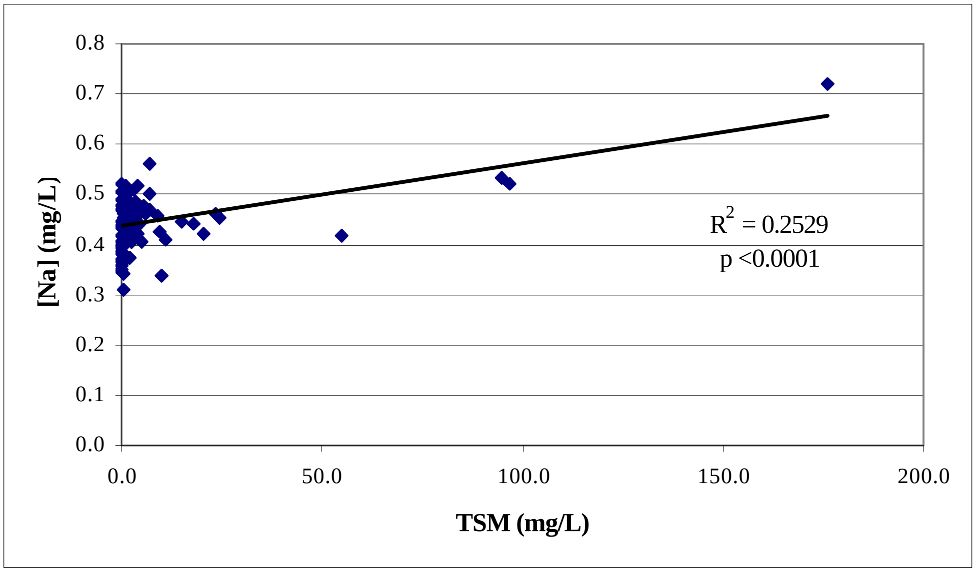


Figure 57. Sodium concentration versus TSM at Nef1, water year 2001.

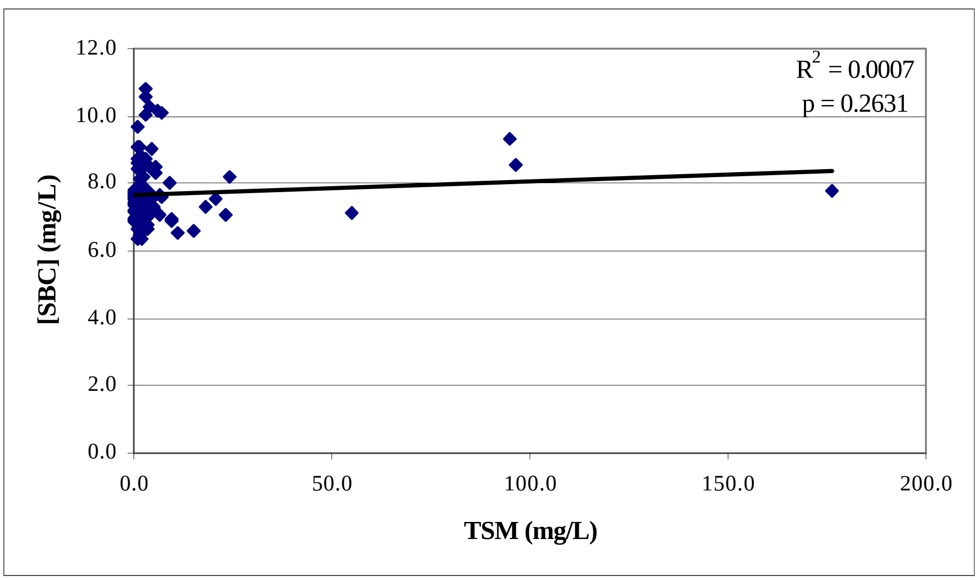


Figure 58. Sum of base cations (SBC) versus TSM at Nef1, water year 2001.

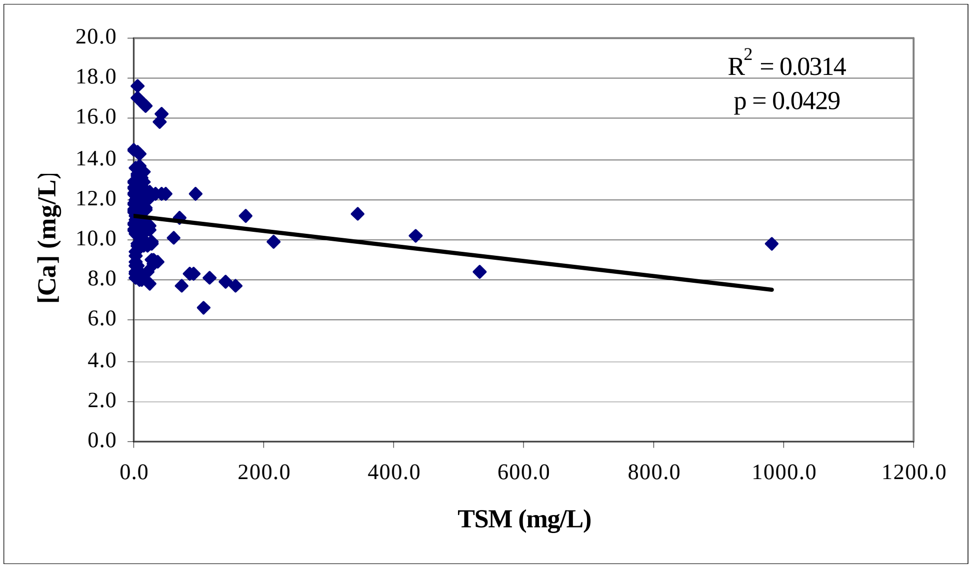


Figure 59. Calcium concentration versus TSM at Mat1, water year 2001.

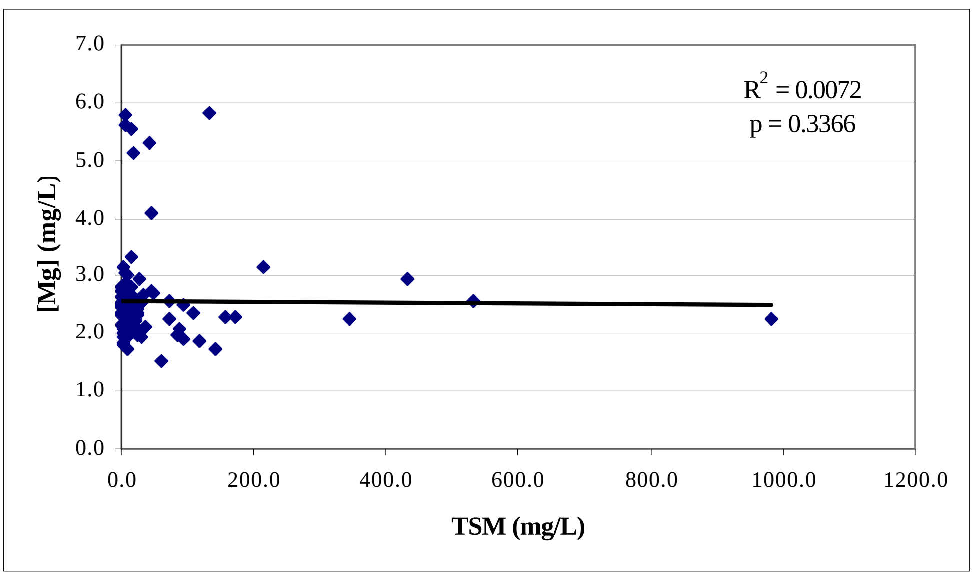


Figure 60. Magnesium concentration versus TSM at Mat1, water year 2001.

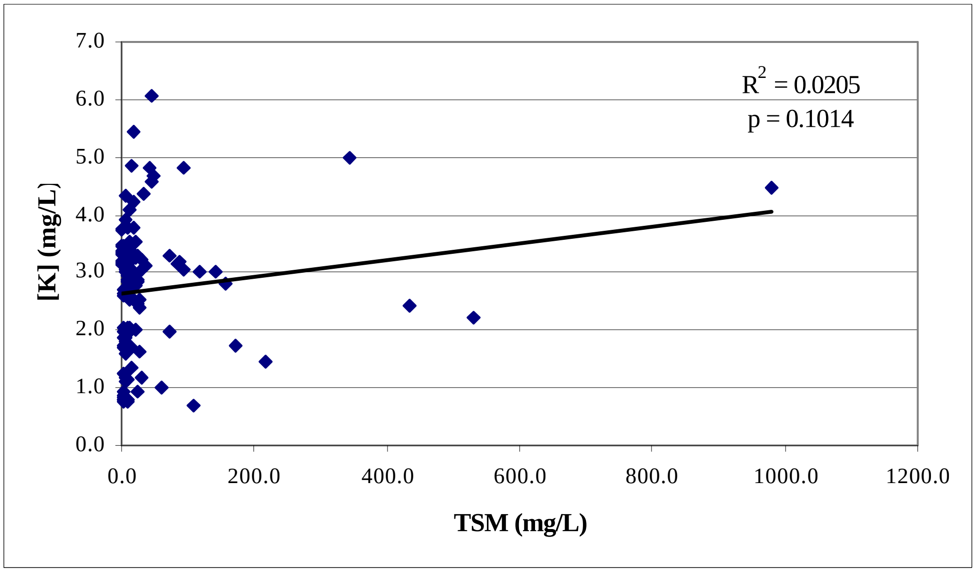


Figure 61. Potassium concentration versus TSM at Mat1, water year 2001.

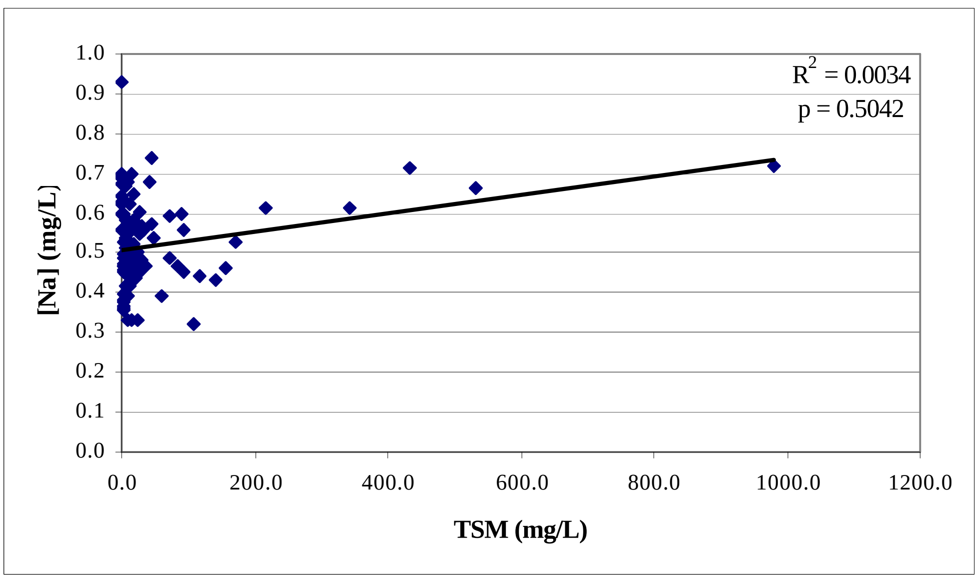


Figure 62. Sodium concentration versus TSM at Mat1, water year 2001.

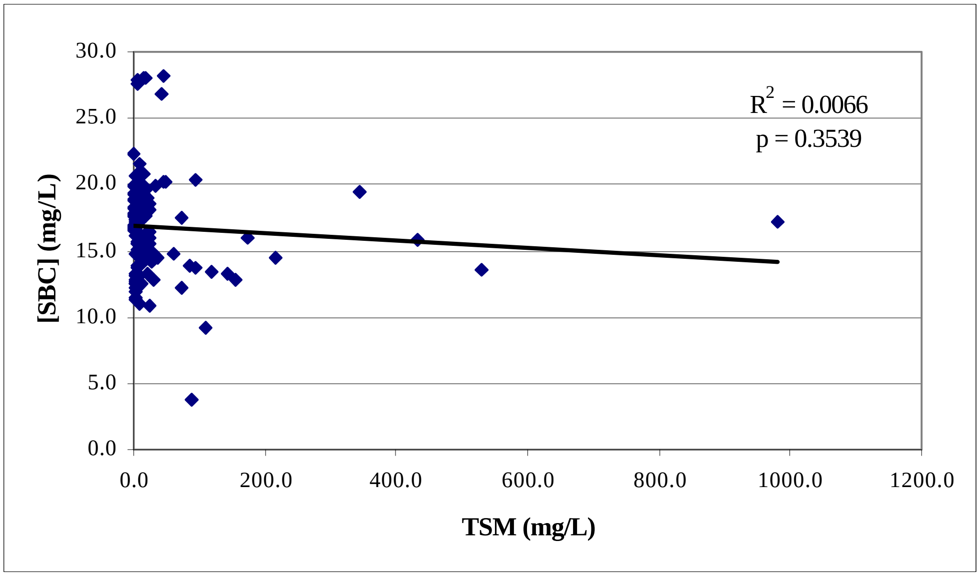
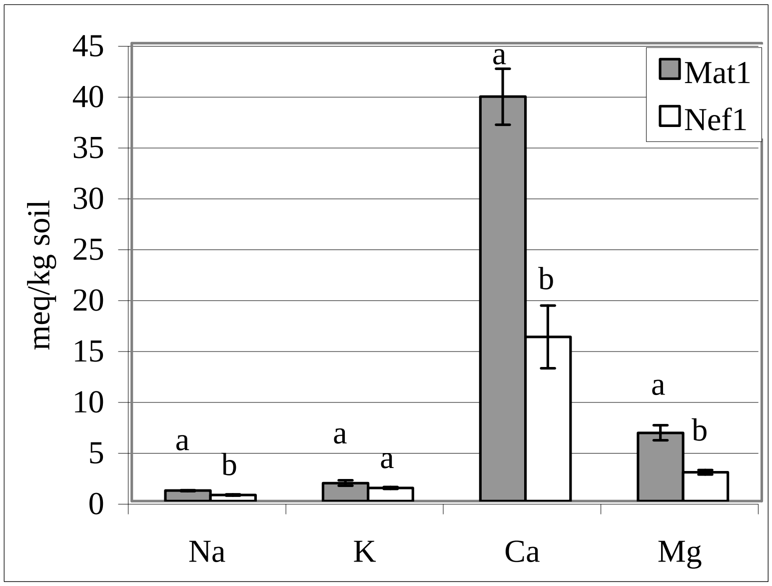


Figure 63. Sum of base cations (SBC) versus TSM at Mat1, water year 2001.

64a.



64b.

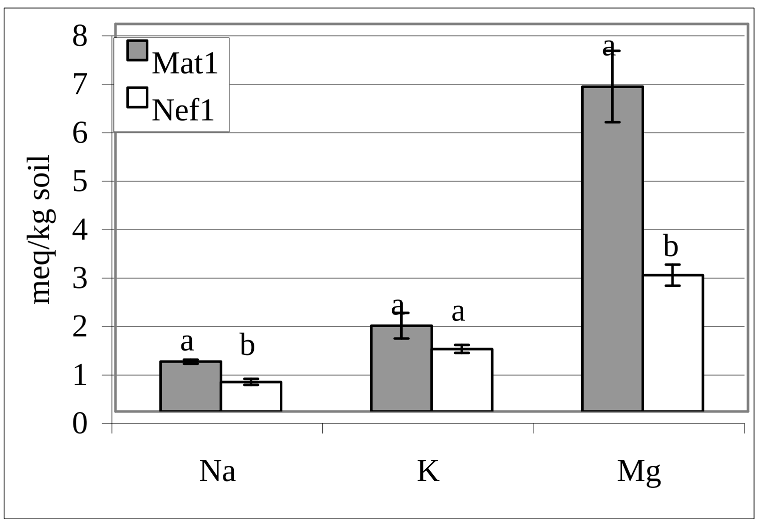
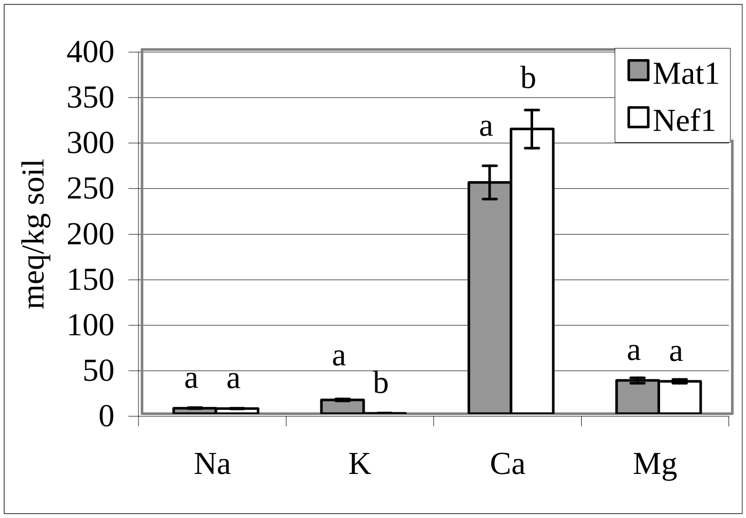


Figure 64. Mineral soil exchangeable base cations.

a. A comparison of mean mineral soil exchangeable base cations between a forested (Nef1) and a reclaimed mine (Mat1) watershed. Units are meq of charge per kg dry (105 C) soil throughout. Error bars are standard error. Means with the same letter are not significantly different. b. Calcium is excluded so differences between sites can be observed at the appropriate scale.

65a.



65b.

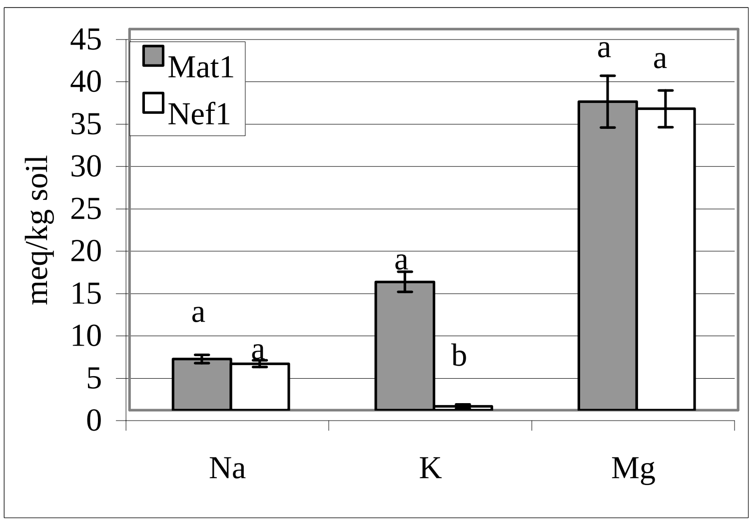


Figure 65. Organic horizon exchangeable bases.

a. A comparison of mean organic horizon exchangeable base cations between a forested (Nef1) and a reclaimed mine (Mat1) watershed. Error bars are standard error. Means with the same letter are not significantly different. b. Calcium is excluded so differences between sites can be observed at the appropriate scale.

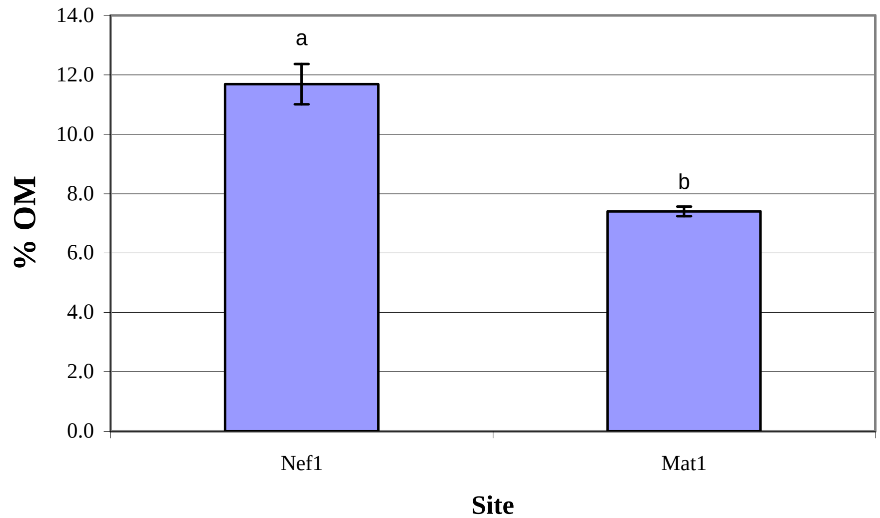
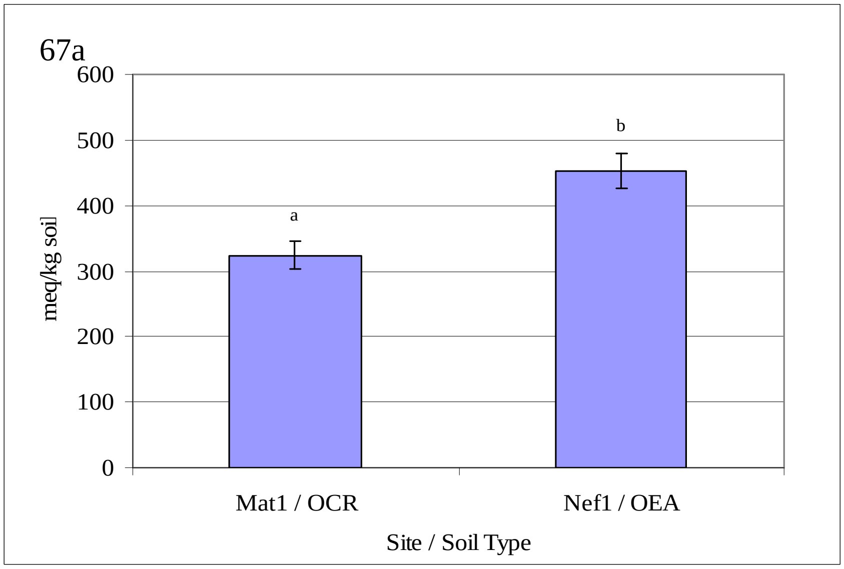


Figure 66. Mean gravimetric percent organic matter in mineral soil at a forested (Nef1) and reclaimed mine (Mat1) watershed.

Means with the same letter are not significantly different (a = 0.05). Error bars are ± 1 standard error.



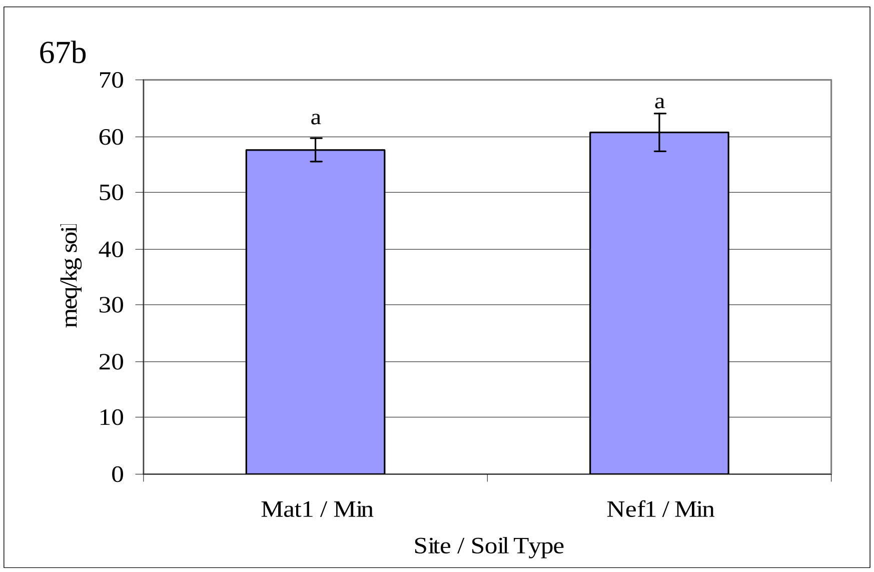


Figure 67. Cation exchange capacity.

a. Mean effective cation exchange capacity (ECEC) at a TMat1 and TNef1. Error bars are standard error. Cation exchange capacity was analyzed separately by soil type; organic soils are indicated by the abbreviations OCR (organic crust layer of decomposing vegetation at reclaimed mine) and OEA (the O_e and O_a horizons at the forested site). b. Mineral soils consist of the top 15cm of mineral soil directly beneath the organic horizon and are abbreviated 'Min'. Means with the same letter are not statistically significant.

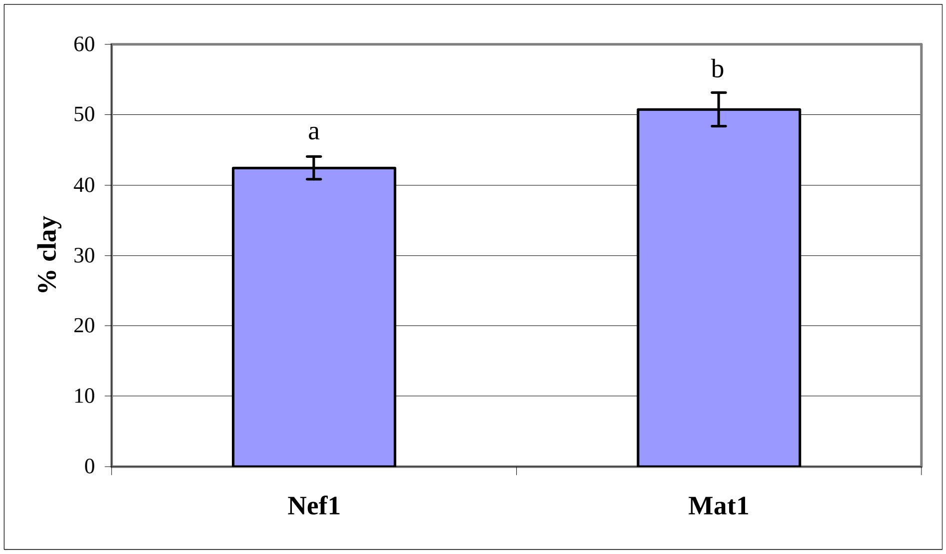


Figure 68. Mean percent clay in mineral soil samples at each watershed.
Means with the same letter are not statistically significant. Error bars are standard error.

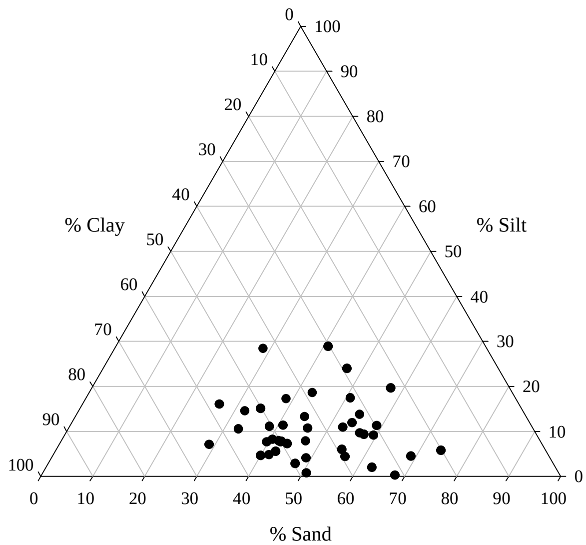


Figure 69. Soil texture triangle, showing the percent sand, silt, and clay in mineral soil samples at Nef1.

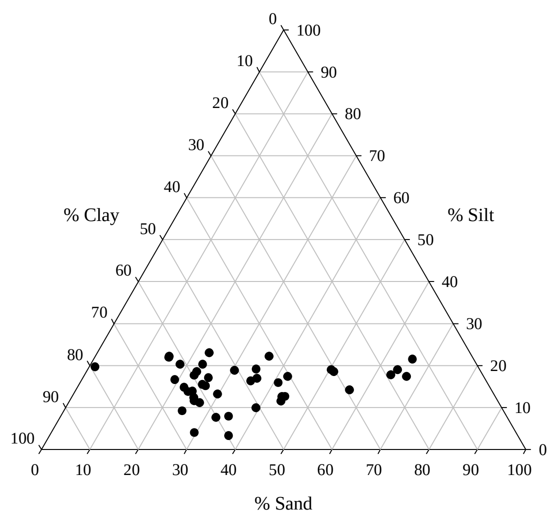


Figure 70. Soil texture triangle, showing the percent sand, silt, and clay in mineral soil samples at Mat1.

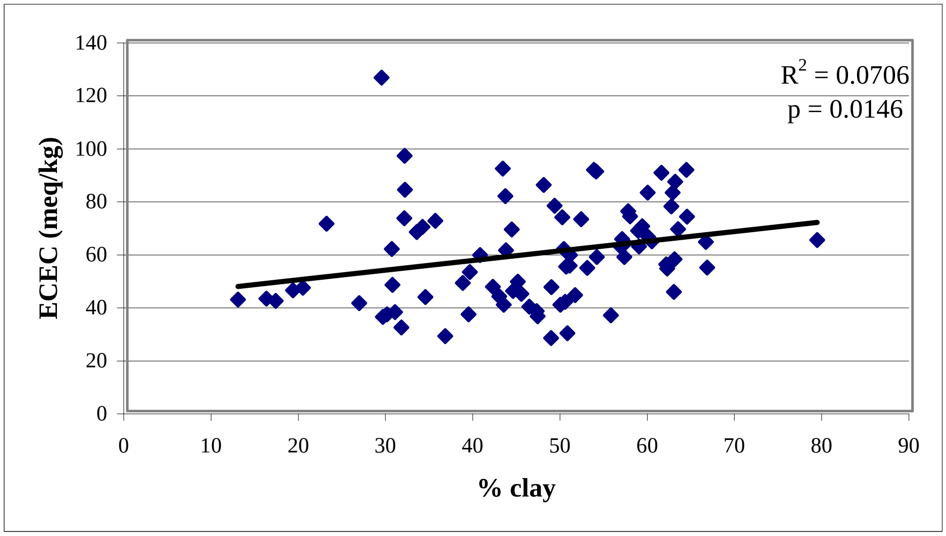
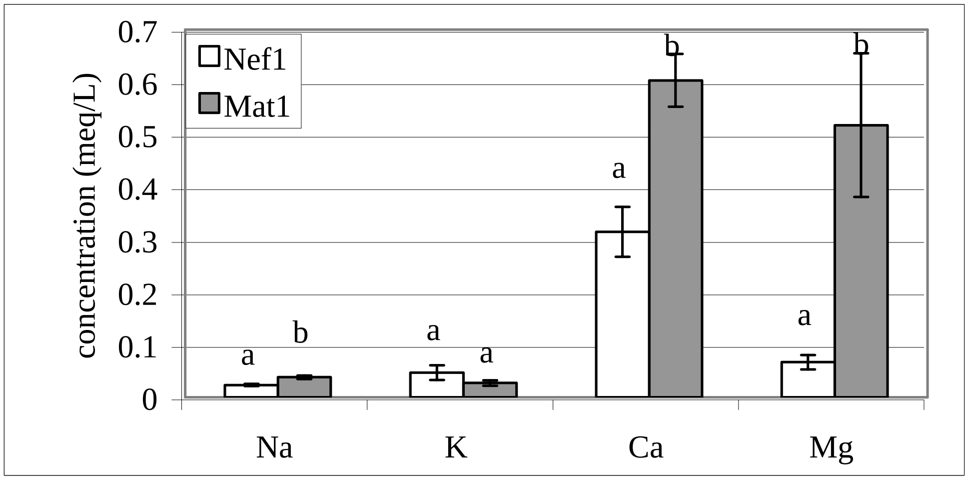


Figure 71. Regression plot of effective cation exchange capacity (ECEC) and percent clay.

This plot shows values at both the forested watershed (Nef1) and the reclaimed mine watershed (Mat1), but only for the mineral soil horizon.

72a.



72b.

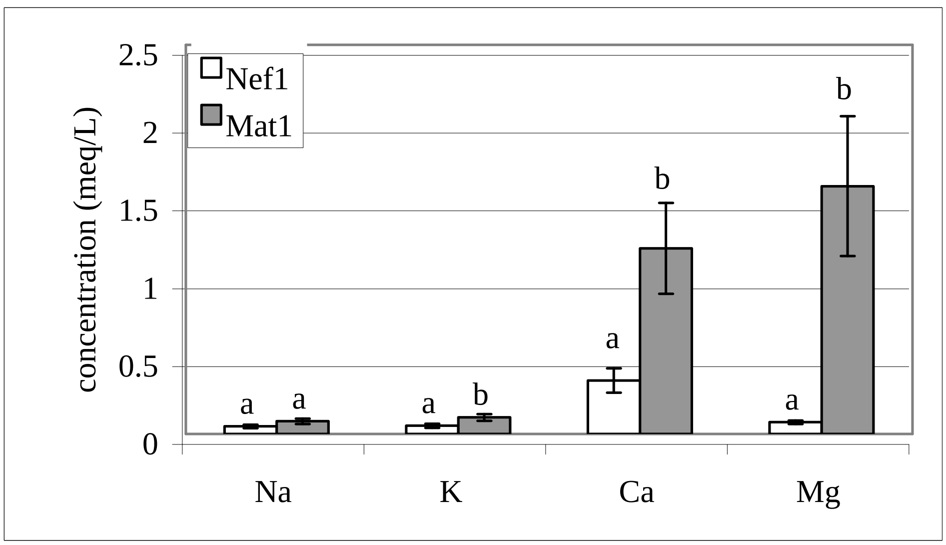


Figure 72. Cation concentrations in lysimeters sampled June 2001.

a. Mean soil solution cation concentrations in shallow lysimeters. b. Mean soil solution concentration in deep lysimeters. Error bars are standard error. Means with the same letter are not significantly different.

APPENDICES

Appendix A. Data for soil exchangeable bases, including quality control results. Soil types include: OCR (Organic crust), Oea (Oe and Oa horizons combined), and <2mm (less than 2mm fraction of A horizon mineral soil). R%D is relative percent difference between sample and lab duplicate (LD). Each exchangeable base cation concentration is presented in 4 different units (mg/L, µg/g soil, $cmol_c$/kg soil, and meq/kg soil) for easy comparison with other published data.

Sample ID	date	site	soil type	Na (mg/L)	µg Na/g soil	$cmol_c$ Na/kg	Na meq/kg	R%D
1c	7/5/00	TMat1	OCR	1.02	58.37	0.25	2.54	
3c	7/5/00	TMat1	OCR	1.98	218.47	0.95	9.50	
5c	7/5/00	TMat1	OCR	2.90	179.26	0.78	7.80	
7c	7/5/00	TMat1	OCR	2.96	142.41	0.62	6.19	
9c	7/5/00	TMat1	OCR	2.11	167.36	0.73	7.28	
11c	7/5/00	TMat1	OCR	1.55	157.74	0.69	6.86	
13c	7/5/00	TMat1	OCR	1.48	130.57	0.57	5.68	
15c	7/5/00	TMat1	OCR	1.48	146.74	0.64	6.38	
17c	7/5/00	TMat1	OCR	1.56	148.28	0.64	6.45	
19c	7/5/00	TMat1	OCR	1.86	104.33	0.45	4.54	
21c	7/5/00	TMat1	OCR	2.14	126.90	0.55	5.52	
23c	7/5/00	TMat1	OCR	2.87	215.06	0.94	9.35	
25c	7/5/00	TMat1	OCR	1.61	73.82	0.32	3.21	15.89
25c LD	7/5/00	TMat1	OCR	1.20	62.96	0.27	2.74	
27c	7/5/00	TMat1	OCR	2.61	88.23	0.38	3.84	
29c	7/5/00	TMat1	OCR	1.80	83.60	0.36	3.64	
31c	7/5/00	TMat1	OCR	2.06	163.21	0.71	7.10	
33c	7/5/00	TMat1	OCR				0.00	
35c	7/5/00	TMat1	OCR	1.35	79.42	0.35	3.45	
37c	7/5/00	TMat1	OCR	1.26	106.54	0.46	4.63	
39c	7/5/00	TMat1	OCR	2.48	370.29	1.61	16.11	
41c	7/5/00	TMat1	OCR				0.00	
43c	7/5/00	TMat1	OCR				0.00	
45c	7/5/00	TMat1	OCR	2.79	225.00	0.98	9.79	
47c	7/5/00	TMat1	OCR	1.23	51.08	0.22	2.22	
49c	7/5/00	TMat1	OCR	1.63	97.82	0.43	4.26	
51c	7/5/00	TMat1	OCR	2.24	116.33	0.51	5.06	
53c	7/5/00	TMat1	OCR	1.66	192.34	0.84	8.37	
55c	7/5/00	TMat1	OCR	1.92	119.49	0.52	5.20	
57c	7/5/00	TMat1	OCR	1.63	157.45	0.68	6.85	
59c	7/5/00	TMat1	OCR				0.00	
61c	7/5/00	TMat1	OCR	2.26	234.97	1.02	10.22	
63c	7/5/00	TMat1	OCR	2.14	293.69	1.28	12.77	
65c	7/5/00	TMat1	OCR	1.21	40.02	0.17	1.74	

67c	7/5/00	TMat1	OCR	1.12	52.16	0.23	2.27	
69c	7/5/00	TMat1	OCR	2.09	223.24	0.97	9.71	
71c	7/5/00	TMat1	OCR	1.53	208.61	0.91	9.07	
73c	7/5/00	TMat1	OCR	1.31	66.90	0.29	2.91	
75c	7/5/00	TMat1	OCR	1.35	53.22	0.23	2.31	-45.26
75c LD	7/5/00	TMat1	OCR	2.15	84.35	0.37	3.67	
77c	7/5/00	TMat1	OCR	1.31	81.56	0.35	3.55	
79c	7/5/00	TMat1	OCR				0.00	
81c	7/5/00	TMat1	OCR	1.27	49.30	0.21	2.14	
83c	7/5/00	TMat1	OCR	1.25	95.43	0.42	4.15	
85c	7/5/00	TMat1	OCR	1.20	199.19	0.87	8.66	
87c	7/5/00	TMat1	OCR	1.08	138.60	0.60	6.03	
89c	7/5/00	TMat1	OCR	1.14	62.93	0.27	2.74	
91c	7/5/00	TMat1	OCR	1.88	99.26	0.43	4.32	
93c	7/5/00	TMat1	OCR	2.10	72.67	0.32	3.16	
95c	7/5/00	TMat1	OCR	1.44	503.62	2.19	21.91	
97c	7/5/00	TMat1	OCR	1.52	72.83	0.32	3.17	
99c	7/5/00	TMat1	OCR	1.63	146.32	0.64	6.36	
101c	7/5/00	TMat1	OCR	1.94	84.30	0.37	3.67	-41.64
101c LD	7/5/00	TMat1	OCR	2.59	128.63	0.56	5.60	
103c	7/5/00	TMat1	OCR	1.48	87.71	0.38	3.82	
105c	7/5/00	TMat1	OCR	1.56	63.09	0.27	2.74	3.69
105c LD	7/5/00	TMat1	OCR	1.23	60.80	0.26	2.64	
1c	7/5/00	TMat1	<2mm	1.62	15.95	0.07	0.69	
3c	7/5/00	TMat1	<2mm	1.83	18.49	0.08	0.80	
5c	7/5/00	TMat1	<2mm	1.89	18.64	0.08	0.81	
7c	7/5/00	TMat1	<2mm	2.15	32.08	0.14	1.40	27.03
7c LD	7/5/00	TMat1	<2mm	1.63	24.44	0.11	1.06	
9c	7/5/00	TMat1	<2mm	1.60	23.83	0.10	1.04	
11c	7/5/00	TMat1	<2mm	2.19	32.46	0.14	1.41	
13c	7/5/00	TMat1	<2mm	2.27	29.26	0.13	1.27	-18.67
13c LD	7/5/00	TMat1	<2mm	2.51	35.29	0.15	1.54	
15c	7/5/00	TMat1	<2mm	2.16	30.25	0.13	1.32	
17c	7/5/00	TMat1	<2mm	2.13	31.23	0.14	1.36	
19c	7/5/00	TMat1	<2mm	2.14	21.26	0.09	0.92	
21c	7/5/00	TMat1	<2mm	1.56	15.67	0.07	0.68	
23c	7/5/00	TMat1	<2mm	2.13	19.34	0.08	0.84	
25c	7/5/00	TMat1	<2mm	1.84	18.93	0.08	0.82	
27c	7/5/00	TMat1	<2mm	1.87	18.24	0.08	0.79	
29c	7/5/00	TMat1	<2mm	2.07	20.29	0.09	0.88	
31c	7/5/00	TMat1	<2mm	1.67	16.91	0.07	0.74	
33c	7/5/00	TMat1	<2mm	1.74	16.72	0.07	0.73	
35c	7/5/00	TMat1	<2mm	2.47	24.40	0.11	1.06	
37c	7/5/00	TMat1	<2mm	2.01	18.85	0.08	0.82	

39c	7/5/00	TMat1	<2mm	2.10	20.86	0.09	0.91	
41c	7/5/00	TMat1	<2mm	1.80	17.52	0.08	0.76	
43c	7/5/00	TMat1	<2mm	2.15	31.60	0.14	1.37	8.87
43c LD	7/5/00	TMat1	<2mm	1.94	28.91	0.13	1.26	
45c	7/5/00	TMat1	<2mm	2.21	30.59	0.13	1.33	
47c	7/5/00	TMat1	<2mm	2.00	26.41	0.11	1.15	
49c	7/5/00	TMat1	<2mm	1.74	17.65	0.08	0.77	
51c	7/5/00	TMat1	<2mm	1.78	17.77	0.08	0.77	
53c	7/5/00	TMat1	<2mm	1.79	17.21	0.07	0.75	
55c	7/5/00	TMat1	<2mm	1.82	17.82	0.08	0.78	
57c	7/5/00	TMat1	<2mm	1.73	16.66	0.07	0.72	
59c	7/5/00	TMat1	<2mm	1.66	16.27	0.07	0.71	
61c	7/5/00	TMat1	<2mm	2.05	30.38	0.13	1.32	
63c	7/5/00	TMat1	<2mm	2.19	32.91	0.14	1.43	-4.72
63c LD	7/5/00	TMat1	<2mm	2.35	34.50	0.15	1.50	
65c	7/5/00	TMat1	<2mm	2.31	33.76	0.15	1.47	-6.74
65c LD	7/5/00	TMat1	<2mm	2.28	36.11	0.16	1.57	
67c	7/5/00	TMat1	<2mm	2.26	32.80	0.14	1.43	
69c	7/5/00	TMat1	<2mm	2.18	30.00	0.13	1.30	
71c	7/5/00	TMat1	<2mm	2.04	19.93	0.09	0.87	
73c	7/5/00	TMat1	<2mm	2.36	23.76	0.10	1.03	
75c	7/5/00	TMat1	<2mm	1.92	26.20	0.11	1.14	
77c	7/5/00	TMat1	<2mm	2.43	35.52	0.15	1.54	
79c	7/5/00	TMat1	<2mm	1.85	25.57	0.11	1.11	-25.64
79c LD	7/5/00	TMat1	<2mm	2.23	33.09	0.14	1.44	
81c	7/5/00	TMat1	<2mm	2.54	35.44	0.15	1.54	
83c	7/5/00	TMat1	<2mm	2.25	21.85	0.10	0.95	
85c	7/5/00	TMat1	<2mm	2.23	21.60	0.09	0.94	
87c	7/5/00	TMat1	<2mm	2.42	19.88	0.09	0.86	
89c	7/5/00	TMat1	<2mm	2.23	21.25	0.09	0.92	
91c	7/5/00	TMat1	<2mm	2.69	82.63	0.36	3.59	
93c	7/5/00	TMat1	<2mm	1.46	268.01	1.17	11.66	
95c	7/5/00	TMat1	<2mm	2.13	38.14	0.17	1.66	
97c	7/5/00	TMat1	<2mm	2.30	111.23	0.48	4.84	
99c	7/5/00	TMat1	<2mm	2.07	27.27	0.12	1.19	
101c	7/5/00	TMat1	<2mm	2.01	20.16	0.09	0.88	
103c	7/5/00	TMat1	<2mm	2.31	22.51	0.10	0.98	
105c	7/5/00	TMat1	<2mm	2.13	20.03	0.09	0.87	
1c	8/25/99	TNef1	<2mm	1.17	17.96	0.08	0.78	
3c	8/25/99	TNef1	<2mm	1.25	17.51	0.08	0.76	
5c	8/25/99	TNef1	<2mm	1.11	45.86	0.20	1.99	
7c	8/25/99	TNef1	<2mm	1.19	17.53	0.08	0.76	
9c	8/25/99	TNef1	<2mm	1.28	17.71	0.08	0.77	
11c	8/25/99	TNef1	<2mm	1.11	24.11	0.10	1.05	

13c	8/25/99	TNef1	<2mm	1.18	31.64	0.14	1.38
15c	8/25/99	TNef1	<2mm	1.27	28.56	0.12	1.24
17c	8/25/99	TNef1	<2mm	1.09	27.59	0.12	1.20
19c	8/25/99	TNef1	<2mm	1.14	27.37	0.12	1.19
21c	8/25/99	TNef1	<2mm	1.17	25.79	0.11	1.12
23c	8/25/99	TNef1	<2mm	1.11	24.76	0.11	1.08
25c	8/25/99	TNef1	<2mm	1.17	28.27	0.12	1.23
27c	8/25/99	TNef1	<2mm	1.26	19.24	0.08	0.84
29c	8/25/99	TNef1	<2mm	1.12	25.91	0.11	1.13
31c	8/25/99	TNef1	<2mm	0.45	6.67	0.03	0.29
33c	8/25/99	TNef1	<2mm	0.48	7.45	0.03	0.32
35c	8/25/99	TNef1	<2mm	0.52	7.42	0.03	0.32
37c	8/25/99	TNef1	<2mm	0.59	6.43	0.03	0.28
39c	8/25/99	TNef1	<2mm	0.33	4.56	0.02	0.20
41c	8/25/99	TNef1	<2mm	0.24	10.87	0.05	0.47
43c	8/25/99	TNef1	<2mm	0.42	5.90	0.03	0.26
45c	8/25/99	TNef1	<2mm	0.36	9.30	0.04	0.40
47c	8/25/99	TNef1	<2mm	0.20	19.59	0.09	0.85
49c	8/25/99	TNef1	<2mm	0.18	22.50	0.10	0.98
51c	8/25/99	TNef1	<2mm	0.28	8.21	0.04	0.36
53c	8/25/99	TNef1	<2mm	0.19	13.74	0.06	0.60
55c	8/25/99	TNef1	<2mm	0.44	9.38	0.04	0.41
57c	8/25/99	TNef1	<2mm	0.25	17.57	0.08	0.76
59c	8/25/99	TNef1	<2mm	0.65	11.48	0.05	0.50
61c	8/25/99	TNef1	<2mm	0.30	7.29	0.03	0.32
63c	8/25/99	TNef1	<2mm	0.25	5.53	0.02	0.24
65c	8/25/99	TNef1	<2mm	0.30	6.14	0.03	0.27
67c	8/25/99	TNef1	<2mm	0.23	5.40	0.02	0.23
69c	8/25/99	TNef1	<2mm	0.23	4.88	0.02	0.21
71c	8/25/99	TNef1	<2mm	0.21	3.86	0.02	0.17
73c	8/25/99	TNef1	<2mm	0.19	4.04	0.02	0.18
75c	8/25/99	TNef1	<2mm	0.16	3.85	0.02	0.17
77c	8/25/99	TNef1	<2mm	0.24	6.89	0.03	0.30
79c	8/25/99	TNef1	<2mm	0.24	10.17	0.04	0.44
81c	8/25/99	TNef1	<2mm	0.22	6.60	0.03	0.29
83c	8/25/99	TNef1	<2mm	0.26	6.66	0.03	0.29
85c	8/25/99	TNef1	<2mm	0.27	6.01	0.03	0.26
87c	8/25/99	TNef1	<2mm	0.20	5.55	0.02	0.24
89c	8/25/99	TNef1	<2mm	0.18	7.70	0.03	0.33
1c	8/25/99	TNef1	Oea	0.09	85.71	0.37	3.73
3c	8/25/99	TNef1	Oea	0.06	289.22	1.26	12.58
5c	8/25/99	TNef1	Oea	0.14	80.06	0.35	3.48
7c	8/25/99	TNef1	Oea	0.09	56.90	0.25	2.47
9c	8/25/99	TNef1	Oea	0.12	131.91	0.57	5.74

11c	8/25/99	TNef1	Oea	0.10	30.65	0.13	1.33	
13c	8/25/99	TNef1	Oea	0.05	144.91	0.63	6.30	
15c	8/25/99	TNef1	Oea	0.11	84.05	0.37	3.66	
17c	8/25/99	TNef1	Oea	0.10	164.18	0.71	7.14	
19c	8/25/99	TNef1	Oea	0.08	56.43	0.25	2.45	
21c	8/25/99	TNef1	Oea	0.07	123.50	0.54	5.37	
23c	8/25/99	TNef1	Oea	0.13	89.10	0.39	3.88	
25c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	-200.00
25c LD	8/25/99	TNef1	Oea	0.32	46.37	0.20	2.02	
27c	8/25/99	TNef1	Oea	0.06	76.18	0.33	3.31	
29c	8/25/99	TNef1	Oea	0.07	101.46	0.44	4.41	
31c	8/25/99	TNef1	Oea	0.16	112.82	0.49	4.91	
33c	8/25/99	TNef1	Oea	0.12	116.47	0.51	5.07	
35c	8/25/99	TNef1	Oea	0.13	114.51	0.50	4.98	
37c	8/25/99	TNef1	Oea	0.13	118.99	0.52	5.18	
39c	8/25/99	TNef1	Oea	0.09	101.90	0.44	4.43	
41c	8/25/99	TNef1	Oea	0.13	234.88	1.02	10.22	
43c	8/25/99	TNef1	Oea	0.21	70.23	0.31	3.05	
45c	8/25/99	TNef1	Oea	0.17	161.25	0.70	7.01	
47c	8/25/99	TNef1	Oea	0.22	167.69	0.73	7.29	161.09
47c LD	8/25/99	TNef1	Oea	0.29	18.07	0.08	0.79	
49c	8/25/99	TNef1	Oea	0.14	87.14	0.38	3.79	
51c	8/25/99	TNef1	Oea	0.22	130.23	0.57	5.66	
53c	8/25/99	TNef1	Oea	0.25	92.10	0.40	4.01	
55c	8/25/99	TNef1	Oea	0.14	94.49	0.41	4.11	
57c	8/25/99	TNef1	Oea	0.09	147.61	0.64	6.42	
59c	8/25/99	TNef1	Oea	0.11	111.37	0.48	4.84	
61c	8/25/99	TNef1	Oea	0.46	142.55	0.62	6.20	
63c	8/25/99	TNef1	Oea	0.09	67.19	0.29	2.92	55.47
63c LD	8/25/99	TNef1	Oea	0.28	38.01	0.17	1.65	
65c	8/25/99	TNef1	Oea	0.29	182.01	0.79	7.92	
67c	8/25/99	TNef1	Oea	0.15	138.75	0.60	6.04	
69c	8/25/99	TNef1	Oea	0.39	113.93	0.50	4.96	93.98
69c LD	8/25/99	TNef1	Oea	0.31	41.09	0.18	1.79	
71c	8/25/99	TNef1	Oea	0.35	169.54	0.74	7.37	
73c	8/25/99	TNef1	Oea	0.20	124.69	0.54	5.42	
75c	8/25/99	TNef1	Oea	0.24	124.14	0.54	5.40	
77c	8/25/99	TNef1	Oea	0.38	280.12	1.22	12.18	
79c	8/25/99	TNef1	Oea	0.12	68.82	0.30	2.99	59.50
79c LD	8/25/99	TNef1	Oea	0.34	37.26	0.16	1.62	
81c	8/25/99	TNef1	Oea	0.29	246.55	1.07	10.72	
83c	8/25/99	TNef1	Oea	0.34	191.79	0.83	8.34	
85c	8/25/99	TNef1	Oea	0.40	196.91	0.86	8.56	
87c	8/25/99	TNef1	Oea	0.22	162.32	0.71	7.06	

89c	8/25/99	TNef1	Oea	0.23	96.86	0.42	4.21
blank1				0.18			0.00
blank2				0.11			0.00
blank3				0.14			0.00

Sample ID	date	site	soil type	K (mg/L)	ug K/g soil	cmolc K/kg	K meq/kg	R%D
1c	7/5/00	TMat1	OCR	6.35	364.69	0.93	9.33	
3c	7/5/00	TMat1	OCR	6.02	665.60	1.70	17.02	
5c	7/5/00	TMat1	OCR	7.49	463.24	1.18	11.85	
7c	7/5/00	TMat1	OCR	15.39	739.67	1.89	18.92	
9c	7/5/00	TMat1	OCR	6.67	528.65	1.35	13.52	
11c	7/5/00	TMat1	OCR	4.00	407.33	1.04	10.42	
13c	7/5/00	TMat1	OCR	10.81	954.95	2.44	24.42	
15c	7/5/00	TMat1	OCR	7.06	697.99	1.79	17.85	
17c	7/5/00	TMat1	OCR	12.44	1186.27	3.03	30.34	
19c	7/5/00	TMat1	OCR	9.79	549.78	1.41	14.06	
21c	7/5/00	TMat1	OCR	11.85	701.74	1.79	17.95	
23c	7/5/00	TMat1	OCR	17.50	1312.86	3.36	33.58	
25c	7/5/00	TMat1	OCR	13.56	623.15	1.59	15.94	107.52
25c LD	7/5/00	TMat1	OCR	3.56	187.39	0.48	4.79	
27c	7/5/00	TMat1	OCR	16.69	563.21	1.44	14.40	
29c	7/5/00	TMat1	OCR	12.51	581.32	1.49	14.87	
31c	7/5/00	TMat1	OCR	2.39	189.40	0.48	4.84	
33c	7/5/00	TMat1	OCR				0.00	
35c	7/5/00	TMat1	OCR	10.59	623.43	1.59	15.95	
37c	7/5/00	TMat1	OCR	5.95	505.35	1.29	12.93	
39c	7/5/00	TMat1	OCR	2.46	368.49	0.94	9.42	
41c	7/5/00	TMat1	OCR				0.00	
43c	7/5/00	TMat1	OCR				0.00	
45c	7/5/00	TMat1	OCR	4.66	375.65	0.96	9.61	
47c	7/5/00	TMat1	OCR	6.53	270.63	0.69	6.92	
49c	7/5/00	TMat1	OCR	13.32	801.12	2.05	20.49	
51c	7/5/00	TMat1	OCR	14.51	753.90	1.93	19.28	
53c	7/5/00	TMat1	OCR	2.92	339.10	0.87	8.67	
55c	7/5/00	TMat1	OCR	5.30	330.57	0.85	8.45	
57c	7/5/00	TMat1	OCR	12.88	1245.65	3.19	31.86	
59c	7/5/00	TMat1	OCR				0.00	
61c	7/5/00	TMat1	OCR	11.03	1145.78	2.93	29.30	
63c	7/5/00	TMat1	OCR	4.59	629.92	1.61	16.11	
65c	7/5/00	TMat1	OCR	10.79	357.21	0.91	9.14	
67c	7/5/00	TMat1	OCR	11.81	549.98	1.41	14.07	
69c	7/5/00	TMat1	OCR	3.56	380.93	0.97	9.74	
71c	7/5/00	TMat1	OCR	3.16	431.56	1.10	11.04	
73c	7/5/00	TMat1	OCR	9.75	498.25	1.27	12.74	

75c	7/5/00	TMat1	OCR	5.39	212.47	0.54	5.43	-17.53
75c LD	7/5/00	TMat1	OCR	6.45	253.29	0.65	6.48	
77c	7/5/00	TMat1	OCR	7.53	468.42	1.20	11.98	
79c	7/5/00	TMat1	OCR				0.00	
81c	7/5/00	TMat1	OCR	11.47	445.61	1.14	11.40	
83c	7/5/00	TMat1	OCR	4.58	350.28	0.90	8.96	
85c	7/5/00	TMat1	OCR	7.47	1242.90	3.18	31.79	
87c	7/5/00	TMat1	OCR	4.39	561.70	1.44	14.37	
89c	7/5/00	TMat1	OCR	4.09	225.50	0.58	5.77	
91c	7/5/00	TMat1	OCR	14.37	756.90	1.94	19.36	
93c	7/5/00	TMat1	OCR	30.99	1070.84	2.74	27.39	
95c	7/5/00	TMat1	OCR	0.96	336.10	0.86	8.60	
97c	7/5/00	TMat1	OCR	16.79	802.13	2.05	20.52	
99c	7/5/00	TMat1	OCR	4.22	379.17	0.97	9.70	
101c	7/5/00	TMat1	OCR	11.12	484.18	1.24	12.38	134.79
101c LD	7/5/00	TMat1	OCR	1.90	94.31	0.24	2.41	
103c	7/5/00	TMat1	OCR	13.96	827.34	2.12	21.16	
105c	7/5/00	TMat1	OCR	18.73	757.40	1.94	19.37	30.67
105c LD	7/5/00	TMat1	OCR	11.22	556.00	1.42	14.22	
1c	7/5/00	TMat1	<2mm	20.76	204.31	0.52	5.23	
3c	7/5/00	TMat1	<2mm	7.81	79.08	0.20	2.02	
5c	7/5/00	TMat1	<2mm	8.81	86.91	0.22	2.22	
7c	7/5/00	TMat1	<2mm	4.62	68.88	0.18	1.76	16.52
7c LD	7/5/00	TMat1	<2mm	3.89	58.37	0.15	1.49	
9c	7/5/00	TMat1	<2mm	5.28	78.66	0.20	2.01	
11c	7/5/00	TMat1	<2mm	4.31	63.85	0.16	1.63	
13c	7/5/00	TMat1	<2mm	5.05	65.15	0.17	1.67	0.80
13c LD	7/5/00	TMat1	<2mm	4.60	64.63	0.17	1.65	
15c	7/5/00	TMat1	<2mm	4.27	59.92	0.15	1.53	
17c	7/5/00	TMat1	<2mm	4.31	63.34	0.16	1.62	
19c	7/5/00	TMat1	<2mm	5.60	55.62	0.14	1.42	
21c	7/5/00	TMat1	<2mm	8.14	81.87	0.21	2.09	
23c	7/5/00	TMat1	<2mm	7.16	65.06	0.17	1.66	
25c	7/5/00	TMat1	<2mm	6.59	67.94	0.17	1.74	
27c	7/5/00	TMat1	<2mm	5.48	53.62	0.14	1.37	
29c	7/5/00	TMat1	<2mm	5.95	58.26	0.15	1.49	
31c	7/5/00	TMat1	<2mm	3.83	38.74	0.10	0.99	
33c	7/5/00	TMat1	<2mm	4.45	42.64	0.11	1.09	
35c	7/5/00	TMat1	<2mm	49.56	490.50	1.25	12.55	
37c	7/5/00	TMat1	<2mm	3.44	32.32	0.08	0.83	
39c	7/5/00	TMat1	<2mm	5.01	49.78	0.13	1.27	
41c	7/5/00	TMat1	<2mm	4.34	42.40	0.11	1.08	
43c	7/5/00	TMat1	<2mm	3.08	45.15	0.12	1.15	9.51
43c LD	7/5/00	TMat1	<2mm	2.75	41.05	0.10	1.05	

45c	7/5/00	TMat1	<2mm	3.33	46.14	0.12	1.18	
47c	7/5/00	TMat1	<2mm	3.29	43.55	0.11	1.11	
49c	7/5/00	TMat1	<2mm	4.57	46.35	0.12	1.19	
51c	7/5/00	TMat1	<2mm	3.63	36.19	0.09	0.93	
53c	7/5/00	TMat1	<2mm	4.48	43.15	0.11	1.10	
55c	7/5/00	TMat1	<2mm	3.73	36.56	0.09	0.94	
57c	7/5/00	TMat1	<2mm	2.33	22.50	0.06	0.58	
59c	7/5/00	TMat1	<2mm	3.45	33.86	0.09	0.87	
61c	7/5/00	TMat1	<2mm	5.07	75.03	0.19	1.92	
63c	7/5/00	TMat1	<2mm	5.68	85.18	0.22	2.18	12.16
63c LD	7/5/00	TMat1	<2mm	5.13	75.42	0.19	1.93	
65c	7/5/00	TMat1	<2mm	3.27	47.74	0.12	1.22	-0.16
65c LD	7/5/00	TMat1	<2mm	3.02	47.82	0.12	1.22	
67c	7/5/00	TMat1	<2mm	4.11	59.70	0.15	1.53	
69c	7/5/00	TMat1	<2mm	3.29	45.37	0.12	1.16	
71c	7/5/00	TMat1	<2mm	9.17	89.67	0.23	2.29	
73c	7/5/00	TMat1	<2mm	8.84	88.93	0.23	2.27	
75c	7/5/00	TMat1	<2mm	3.58	48.81	0.12	1.25	
77c	7/5/00	TMat1	<2mm	3.76	54.95	0.14	1.41	
79c	7/5/00	TMat1	<2mm	2.55	35.22	0.09	0.90	200.00
79c LD	7/5/00	TMat1	<2mm		0.00	0.00	0.00	
81c	7/5/00	TMat1	<2mm	4.62	64.44	0.16	1.65	
83c	7/5/00	TMat1	<2mm	4.79	46.41	0.12	1.19	
85c	7/5/00	TMat1	<2mm	5.32	51.43	0.13	1.32	
87c	7/5/00	TMat1	<2mm	7.93	65.21	0.17	1.67	
89c	7/5/00	TMat1	<2mm	5.90	56.23	0.14	1.44	
91c	7/5/00	TMat1	<2mm	8.46	259.71	0.66	6.64	
93c	7/5/00	TMat1	<2mm	0.85	156.25	0.40	4.00	
95c	7/5/00	TMat1	<2mm	2.70	48.29	0.12	1.24	
97c	7/5/00	TMat1	<2mm	2.17	105.36	0.27	2.69	
99c	7/5/00	TMat1	<2mm	3.72	49.06	0.13	1.25	
101c	7/5/00	TMat1	<2mm	4.67	46.79	0.12	1.20	
103c	7/5/00	TMat1	<2mm	8.00	77.97	0.20	1.99	
105c	7/5/00	TMat1	<2mm	9.17	86.20	0.22	2.20	
1c	8/25/99	TNef1	<2mm	4.36	66.80	0.17	1.71	
3c	8/25/99	TNef1	<2mm	5.66	79.53	0.20	2.03	
5c	8/25/99	TNef1	<2mm	2.23	92.30	0.24	2.36	
7c	8/25/99	TNef1	<2mm	4.68	68.77	0.18	1.76	
9c	8/25/99	TNef1	<2mm	3.88	53.51	0.14	1.37	
11c	8/25/99	TNef1	<2mm	1.96	42.49	0.11	1.09	
13c	8/25/99	TNef1	<2mm	1.99	53.12	0.14	1.36	
15c	8/25/99	TNef1	<2mm	2.26	50.70	0.13	1.30	
17c	8/25/99	TNef1	<2mm	1.95	49.19	0.13	1.26	
19c	8/25/99	TNef1	<2mm	1.83	43.98	0.11	1.12	

21c	8/25/99	TNef1	<2mm	2.12	46.68	0.12	1.19
23c	8/25/99	TNef1	<2mm	2.33	51.74	0.13	1.32
25c	8/25/99	TNef1	<2mm	1.72	41.57	0.11	1.06
27c	8/25/99	TNef1	<2mm	4.04	61.54	0.16	1.57
29c	8/25/99	TNef1	<2mm	2.08	48.05	0.12	1.23
31c	8/25/99	TNef1	<2mm	4.45	66.25	0.17	1.69
33c	8/25/99	TNef1	<2mm	5.75	89.60	0.23	2.29
35c	8/25/99	TNef1	<2mm	4.84	69.13	0.18	1.77
37c	8/25/99	TNef1	<2mm	6.05	66.12	0.17	1.69
39c	8/25/99	TNef1	<2mm	3.72	51.73	0.13	1.32
41c	8/25/99	TNef1	<2mm	0.69	31.92	0.08	0.82
43c	8/25/99	TNef1	<2mm	4.00	56.10	0.14	1.43
45c	8/25/99	TNef1	<2mm	1.72	45.15	0.12	1.15
47c	8/25/99	TNef1	<2mm	0.37	36.21	0.09	0.93
49c	8/25/99	TNef1	<2mm	0.00	0.00	0.00	0.00
51c	8/25/99	TNef1	<2mm	1.03	30.37	0.08	0.78
53c	8/25/99	TNef1	<2mm	0.00	0.00	0.00	0.00
55c	8/25/99	TNef1	<2mm	3.00	64.04	0.16	1.64
57c	8/25/99	TNef1	<2mm	0.32	22.65	0.06	0.58
59c	8/25/99	TNef1	<2mm	3.95	69.38	0.18	1.77
61c	8/25/99	TNef1	<2mm	2.76	66.27	0.17	1.69
63c	8/25/99	TNef1	<2mm	4.29	93.43	0.24	2.39
65c	8/25/99	TNef1	<2mm	3.96	81.95	0.21	2.10
67c	8/25/99	TNef1	<2mm	2.55	61.00	0.16	1.56
69c	8/25/99	TNef1	<2mm	2.04	42.70	0.11	1.09
71c	8/25/99	TNef1	<2mm	2.58	46.88	0.12	1.20
73c	8/25/99	TNef1	<2mm	1.76	38.19	0.10	0.98
75c	8/25/99	TNef1	<2mm	1.08	25.61	0.07	0.65
77c	8/25/99	TNef1	<2mm	0.68	19.72	0.05	0.50
79c	8/25/99	TNef1	<2mm	0.23	9.74	0.02	0.25
81c	8/25/99	TNef1	<2mm	1.22	36.05	0.09	0.92
83c	8/25/99	TNef1	<2mm	1.94	50.45	0.13	1.29
85c	8/25/99	TNef1	<2mm	2.74	60.59	0.15	1.55
87c	8/25/99	TNef1	<2mm	1.44	39.53	0.10	1.01
89c	8/25/99	TNef1	<2mm	1.11	47.10	0.12	1.20
1c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
3c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
5c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
7c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
9c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
11c	8/25/99	TNef1	Oea	0.39	126.45	0.32	3.23
13c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
15c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00
17c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00

19c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
21c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
23c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
25c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	-200.00
25c LD	8/25/99	TNef1	Oea	3.72	547.74	1.40	14.01	
27c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
29c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
31c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
33c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
35c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
37c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
39c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
41c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
43c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
45c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
47c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	-200.00
47c LD	8/25/99	TNef1	Oea	5.91	370.82	0.95	9.48	
49c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
51c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
53c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
55c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
57c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
59c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
61c	8/25/99	TNef1	Oea	1.18	367.70	0.94	9.40	
63c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	-200.00
63c LD	8/25/99	TNef1	Oea	2.74	373.43	0.96	9.55	
65c	8/25/99	TNef1	Oea	0.07	45.19	0.12	1.16	
67c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
69c	8/25/99	TNef1	Oea	0.58	168.21	0.43	4.30	-105.39
69c LD	8/25/99	TNef1	Oea	4.12	542.98	1.39	13.89	
71c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
73c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
75c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
77c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
79c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	-200.00
79c LD	8/25/99	TNef1	Oea	6.44	699.67	1.79	17.90	
81c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
83c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
85c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
87c	8/25/99	TNef1	Oea	0.00	0.00	0.00	0.00	
89c	8/25/99	TNef1	Oea	0.18	75.86	0.19	1.94	
blank1				0.00			0.00	
blank2				0.00			0.00	
blank3				0.00			0.00	

Sample ID	date	site	soil type	Ca (mg/L)	ug Ca/g soil	cmolc Ca/kg	Ca meq/kg	R%D
1c	7/5/00	TMat1	OCR	116.30	6681.35	33.34	333.42	
3c	7/5/00	TMat1	OCR	79.40	8783.19	43.83	438.30	
5c	7/5/00	TMat1	OCR	108.50	6711.34	33.49	334.91	
7c	7/5/00	TMat1	OCR	149.86	7202.50	35.94	359.42	
9c	7/5/00	TMat1	OCR	80.19	6357.56	31.73	317.26	
11c	7/5/00	TMat1	OCR	62.36	6350.31	31.69	316.90	
13c	7/5/00	TMat1	OCR	101.50	8966.43	44.74	447.45	
15c	7/5/00	TMat1	OCR	85.51	8455.17	42.19	421.94	
17c	7/5/00	TMat1	OCR	98.58	9400.51	46.91	469.11	
19c	7/5/00	TMat1	OCR	132.54	7446.07	37.16	371.58	
21c	7/5/00	TMat1	OCR	123.00	7283.85	36.35	363.48	
23c	7/5/00	TMat1	OCR	107.30	8051.53	40.18	401.79	
25c	7/5/00	TMat1	OCR	145.32	6676.26	33.32	333.16	-45.91
25c LD	7/5/00	TMat1	OCR	202.57	10654.36	53.17	531.68	
27c	7/5/00	TMat1	OCR	205.80	6946.44	34.66	346.65	
29c	7/5/00	TMat1	OCR	204.60	9507.43	47.44	474.45	
31c	7/5/00	TMat1	OCR	30.05	2377.37	11.86	118.64	
33c	7/5/00	TMat1	OCR				0.00	
35c	7/5/00	TMat1	OCR	91.36	5378.34	26.84	268.39	
37c	7/5/00	TMat1	OCR	45.34	3848.90	19.21	192.07	
39c	7/5/00	TMat1	OCR	24.05	3596.71	17.95	179.49	
41c	7/5/00	TMat1	OCR				0.00	
43c	7/5/00	TMat1	OCR				0.00	
45c	7/5/00	TMat1	OCR	42.90	3459.68	17.26	172.65	
47c	7/5/00	TMat1	OCR	83.13	3443.66	17.18	171.85	
49c	7/5/00	TMat1	OCR	57.96	3485.97	17.40	173.96	
51c	7/5/00	TMat1	OCR	81.98	4259.44	21.26	212.56	
53c	7/5/00	TMat1	OCR	26.44	3067.29	15.31	153.07	
55c	7/5/00	TMat1	OCR	42.53	2653.70	13.24	132.43	
57c	7/5/00	TMat1	OCR	28.96	2800.77	13.98	139.77	
59c	7/5/00	TMat1	OCR				0.00	
61c	7/5/00	TMat1	OCR	50.59	5255.19	26.22	262.25	
63c	7/5/00	TMat1	OCR	40.53	5562.21	27.76	277.57	
65c	7/5/00	TMat1	OCR	98.71	3267.82	16.31	163.07	
67c	7/5/00	TMat1	OCR	100.00	4656.94	23.24	232.39	
69c	7/5/00	TMat1	OCR	11.12	1188.88	5.93	59.33	
71c	7/5/00	TMat1	OCR	23.03	3146.17	15.70	157.00	
73c	7/5/00	TMat1	OCR	79.46	4060.99	20.27	202.65	
75c	7/5/00	TMat1	OCR	8.01	315.68	1.58	15.75	-22.16
75c LD	7/5/00	TMat1	OCR	10.04	394.33	1.97	19.68	
77c	7/5/00	TMat1	OCR	63.90	3975.53	19.84	198.39	
79c	7/5/00	TMat1	OCR				0.00	

81c	7/5/00	TMat1	OCR	86.27	3351.59	16.73	167.25	
83c	7/5/00	TMat1	OCR	65.94	5046.43	25.18	251.83	
85c	7/5/00	TMat1	OCR	18.40	3059.87	15.27	152.70	
87c	7/5/00	TMat1	OCR	35.15	4502.56	22.47	224.69	
89c	7/5/00	TMat1	OCR	52.67	2902.46	14.48	144.84	
91c	7/5/00	TMat1	OCR	10.84	571.13	2.85	28.50	
93c	7/5/00	TMat1	OCR	27.35	945.06	4.72	47.16	
95c	7/5/00	TMat1	OCR	3.11	1088.20	5.43	54.30	
97c	7/5/00	TMat1	OCR	7.35	351.18	1.75	17.52	
99c	7/5/00	TMat1	OCR	14.12	1267.50	6.33	63.25	
101c	7/5/00	TMat1	OCR	53.85	2344.70	11.70	117.01	-53.40
101c LD	7/5/00	TMat1	OCR	81.74	4053.05	20.23	202.26	
103c	7/5/00	TMat1	OCR	49.27	2919.99	14.57	145.72	
105c	7/5/00	TMat1	OCR	17.78	719.06	3.59	35.88	-70.62
105c LD	7/5/00	TMat1	OCR	30.35	1503.96	7.51	75.05	
1c	7/5/00	TMat1	<2mm	142.50	1402.42	7.00	69.98	
3c	7/5/00	TMat1	<2mm	161.80	1637.49	8.17	81.71	
5c	7/5/00	TMat1	<2mm	148.14	1461.23	7.29	72.92	
7c	7/5/00	TMat1	<2mm	81.51	1215.24	6.06	60.64	-1.44
7c LD	7/5/00	TMat1	<2mm	82.06	1232.87	6.15	61.52	
9c	7/5/00	TMat1	<2mm	86.42	1286.52	6.42	64.20	
11c	7/5/00	TMat1	<2mm	67.29	996.00	4.97	49.70	
13c	7/5/00	TMat1	<2mm	87.80	1132.90	5.65	56.53	-1.44
13c LD	7/5/00	TMat1	<2mm	81.84	1149.33	5.74	57.35	
15c	7/5/00	TMat1	<2mm	60.36	847.28	4.23	42.28	
17c	7/5/00	TMat1	<2mm	76.10	1117.36	5.58	55.76	
19c	7/5/00	TMat1	<2mm	76.39	758.59	3.79	37.86	
21c	7/5/00	TMat1	<2mm	88.41	889.71	4.44	44.40	
23c	7/5/00	TMat1	<2mm	147.50	1339.57	6.68	66.85	
25c	7/5/00	TMat1	<2mm	90.60	933.64	4.66	46.59	
27c	7/5/00	TMat1	<2mm	109.70	1073.07	5.35	53.55	
29c	7/5/00	TMat1	<2mm	74.48	729.48	3.64	36.40	
31c	7/5/00	TMat1	<2mm	57.01	577.32	2.88	28.81	
33c	7/5/00	TMat1	<2mm	51.66	495.25	2.47	24.71	
35c	7/5/00	TMat1	<2mm	70.40	696.75	3.48	34.77	
37c	7/5/00	TMat1	<2mm	42.56	399.85	2.00	19.95	
39c	7/5/00	TMat1	<2mm	67.19	667.03	3.33	33.29	
41c	7/5/00	TMat1	<2mm	57.61	562.27	2.81	28.06	
43c	7/5/00	TMat1	<2mm	45.91	673.50	3.36	33.61	-7.08
43c LD	7/5/00	TMat1	<2mm	48.48	722.93	3.61	36.08	
45c	7/5/00	TMat1	<2mm	42.09	582.80	2.91	29.08	
47c	7/5/00	TMat1	<2mm	56.45	747.29	3.73	37.29	
49c	7/5/00	TMat1	<2mm	62.30	632.23	3.16	31.55	
51c	7/5/00	TMat1	<2mm	78.33	781.66	3.90	39.01	

53c	7/5/00	TMat1	<2mm	75.24	725.00	3.62	36.18	
55c	7/5/00	TMat1	<2mm	66.02	647.76	3.23	32.33	
57c	7/5/00	TMat1	<2mm	35.86	345.67	1.72	17.25	
59c	7/5/00	TMat1	<2mm	1.42	14.00	0.07	0.70	
61c	7/5/00	TMat1	<2mm	77.90	1153.73	5.76	57.57	
63c	7/5/00	TMat1	<2mm	91.60	1374.69	6.86	68.60	-3.22
63c LD	7/5/00	TMat1	<2mm	96.49	1419.67	7.08	70.85	
65c	7/5/00	TMat1	<2mm	63.05	920.17	4.59	45.92	-5.28
65c LD	7/5/00	TMat1	<2mm	61.19	970.04	4.84	48.41	
67c	7/5/00	TMat1	<2mm	69.50	1010.47	5.04	50.43	
69c	7/5/00	TMat1	<2mm	15.26	210.27	1.05	10.49	
71c	7/5/00	TMat1	<2mm	56.89	556.27	2.78	27.76	
73c	7/5/00	TMat1	<2mm	69.97	703.57	3.51	35.11	
75c	7/5/00	TMat1	<2mm	4.67	63.59	0.32	3.17	
77c	7/5/00	TMat1	<2mm	28.97	423.62	2.11	21.14	
79c	7/5/00	TMat1	<2mm	22.82	314.93	1.57	15.72	-3.56
79c LD	7/5/00	TMat1	<2mm	22.01	326.33	1.63	16.28	
81c	7/5/00	TMat1	<2mm	47.13	657.32	3.28	32.80	
83c	7/5/00	TMat1	<2mm	114.30	1107.88	5.53	55.29	
85c	7/5/00	TMat1	<2mm	97.33	940.93	4.70	46.96	
87c	7/5/00	TMat1	<2mm	67.51	555.09	2.77	27.70	
89c	7/5/00	TMat1	<2mm	49.28	469.47	2.34	23.43	
91c	7/5/00	TMat1	<2mm	0.58	17.66	0.09	0.88	
93c	7/5/00	TMat1	<2mm	0.48	88.05	0.44	4.39	
95c	7/5/00	TMat1	<2mm	0.29	5.24	0.03	0.26	
97c	7/5/00	TMat1	<2mm	0.25	12.07	0.06	0.60	
99c	7/5/00	TMat1	<2mm	0.30	3.93	0.02	0.20	
101c	7/5/00	TMat1	<2mm	0.71	7.06	0.04	0.35	
103c	7/5/00	TMat1	<2mm	0.44	4.27	0.02	0.21	
105c	7/5/00	TMat1	<2mm	0.38	3.58	0.02	0.18	
1c	8/25/99	TNef1	<2mm	2.06	31.62	0.16	1.58	
3c	8/25/99	TNef1	<2mm	6.52	91.58	0.46	4.57	
5c	8/25/99	TNef1	<2mm	2.14	88.70	0.44	4.43	
7c	8/25/99	TNef1	<2mm	2.61	38.39	0.19	1.92	
9c	8/25/99	TNef1	<2mm	2.49	34.31	0.17	1.71	
11c	8/25/99	TNef1	<2mm	0.96	20.78	0.10	1.04	
13c	8/25/99	TNef1	<2mm	2.22	59.26	0.30	2.96	
15c	8/25/99	TNef1	<2mm	1.92	43.11	0.22	2.15	
17c	8/25/99	TNef1	<2mm	1.85	46.74	0.23	2.33	
19c	8/25/99	TNef1	<2mm	2.83	68.07	0.34	3.40	
21c	8/25/99	TNef1	<2mm	4.53	100.03	0.50	4.99	
23c	8/25/99	TNef1	<2mm	12.12	269.37	1.34	13.44	
25c	8/25/99	TNef1	<2mm	20.40	492.99	2.46	24.60	
27c	8/25/99	TNef1	<2mm	30.54	464.89	2.32	23.20	

29c	8/25/99	TNef1	<2mm	27.56	638.26	3.19	31.85	
31c	8/25/99	TNef1	<2mm	1.17	17.46	0.09	0.87	
33c	8/25/99	TNef1	<2mm	6.03	94.00	0.47	4.69	
35c	8/25/99	TNef1	<2mm	1.63	23.33	0.12	1.16	
37c	8/25/99	TNef1	<2mm	24.29	265.29	1.32	13.24	
39c	8/25/99	TNef1	<2mm	11.23	156.16	0.78	7.79	
41c	8/25/99	TNef1	<2mm	13.01	599.17	2.99	29.90	
43c	8/25/99	TNef1	<2mm	5.44	76.40	0.38	3.81	
45c	8/25/99	TNef1	<2mm	13.38	350.38	1.75	17.49	
47c	8/25/99	TNef1	<2mm	11.64	1151.72	5.75	57.47	
49c	8/25/99	TNef1	<2mm	8.05	990.00	4.94	49.40	
51c	8/25/99	TNef1	<2mm	15.83	467.24	2.33	23.32	
53c	8/25/99	TNef1	<2mm	9.45	702.15	3.50	35.04	
55c	8/25/99	TNef1	<2mm	27.10	579.22	2.89	28.90	
57c	8/25/99	TNef1	<2mm	15.34	1082.31	5.40	54.01	
59c	8/25/99	TNef1	<2mm	39.61	696.46	3.48	34.76	
61c	8/25/99	TNef1	<2mm	6.09	146.07	0.73	7.29	
63c	8/25/99	TNef1	<2mm	5.57	121.18	0.60	6.05	
65c	8/25/99	TNef1	<2mm	8.23	170.03	0.85	8.49	
67c	8/25/99	TNef1	<2mm	3.06	73.10	0.36	3.65	
69c	8/25/99	TNef1	<2mm	3.55	74.07	0.37	3.70	
71c	8/25/99	TNef1	<2mm	7.37	134.15	0.67	6.69	
73c	8/25/99	TNef1	<2mm	3.08	66.82	0.33	3.33	
75c	8/25/99	TNef1	<2mm	3.55	84.22	0.42	4.20	
77c	8/25/99	TNef1	<2mm	2.88	83.88	0.42	4.19	
79c	8/25/99	TNef1	<2mm	4.63	199.57	1.00	9.96	
81c	8/25/99	TNef1	<2mm	6.29	185.17	0.92	9.24	
83c	8/25/99	TNef1	<2mm	10.09	262.94	1.31	13.12	
85c	8/25/99	TNef1	<2mm	26.94	596.81	2.98	29.78	
87c	8/25/99	TNef1	<2mm	13.73	376.16	1.88	18.77	
89c	8/25/99	TNef1	<2mm	52.48	2230.66	11.13	111.32	
1c	8/25/99	TNef1	Oea	3.38	3289.29	16.41	164.14	
3c	8/25/99	TNef1	Oea	1.31	6117.19	30.53	305.26	
5c	8/25/99	TNef1	Oea	10.24	5953.49	29.71	297.10	
7c	8/25/99	TNef1	Oea	5.88	3721.52	18.57	185.71	
9c	8/25/99	TNef1	Oea	3.20	3404.26	16.99	169.88	
11c	8/25/99	TNef1	Oea	13.12	4232.26	21.12	211.20	
13c	8/25/99	TNef1	Oea	1.70	4540.18	22.66	226.57	
15c	8/25/99	TNef1	Oea	7.86	6080.41	30.34	303.43	
17c	8/25/99	TNef1	Oea	2.95	4814.67	24.03	240.27	
19c	8/25/99	TNef1	Oea	4.69	3287.38	16.40	164.05	
21c	8/25/99	TNef1	Oea	2.67	4453.33	22.22	222.23	
23c	8/25/99	TNef1	Oea	9.89	6868.75	34.28	342.77	
25c	8/25/99	TNef1	Oea	7.40	7762.24	38.74	387.36	-13.39

25c LD	8/25/99	TNef1	Oea	60.30	8876.35	44.30	442.95	
27c	8/25/99	TNef1	Oea	6.39	7542.52	37.64	376.39	
29c	8/25/99	TNef1	Oea	7.25	10256.60	51.18	511.83	
31c	8/25/99	TNef1	Oea	4.12	2926.78	14.61	146.05	
33c	8/25/99	TNef1	Oea	5.51	5405.88	26.98	269.77	
35c	8/25/99	TNef1	Oea	6.18	5656.10	28.23	282.25	
37c	8/25/99	TNef1	Oea	10.11	9303.68	46.43	464.28	
39c	8/25/99	TNef1	Oea	10.05	11964.29	59.71	597.05	
41c	8/25/99	TNef1	Oea	7.09	12508.24	62.42	624.19	
43c	8/25/99	TNef1	Oea	13.54	4615.91	23.03	230.35	
45c	8/25/99	TNef1	Oea	6.35	5953.13	29.71	297.08	
47c	8/25/99	TNef1	Oea	5.89	4533.08	22.62	226.21	-12.14
47c LD	8/25/99	TNef1	Oea	81.53	5119.09	25.55	255.46	
49c	8/25/99	TNef1	Oea	9.70	6037.97	30.13	301.31	
51c	8/25/99	TNef1	Oea	10.56	6139.53	30.64	306.38	
53c	8/25/99	TNef1	Oea	18.88	6958.23	34.72	347.23	
55c	8/25/99	TNef1	Oea	7.44	5142.86	25.66	256.64	
57c	8/25/99	TNef1	Oea	7.35	11720.74	58.49	584.90	
59c	8/25/99	TNef1	Oea	5.57	5461.76	27.26	272.56	
61c	8/25/99	TNef1	Oea	12.06	3745.34	18.69	186.90	
63c	8/25/99	TNef1	Oea	5.39	4170.62	20.81	208.13	11.48
63c LD	8/25/99	TNef1	Oea	27.29	3717.98	18.55	185.54	
65c	8/25/99	TNef1	Oea	9.39	5891.42	29.40	294.00	
67c	8/25/99	TNef1	Oea	4.88	4570.31	22.81	228.07	
69c	8/25/99	TNef1	Oea	19.94	5763.01	28.76	287.59	-4.34
69c LD	8/25/99	TNef1	Oea	45.70	6018.44	30.03	300.34	
71c	8/25/99	TNef1	Oea	11.47	5604.23	27.97	279.67	
73c	8/25/99	TNef1	Oea	10.15	6265.43	31.27	312.66	
75c	8/25/99	TNef1	Oea	5.44	2815.86	14.05	140.52	
77c	8/25/99	TNef1	Oea	8.07	5960.10	29.74	297.42	
79c	8/25/99	TNef1	Oea	11.42	6717.65	33.52	335.23	-1.60
79c LD	8/25/99	TNef1	Oea	62.80	6826.09	34.06	340.64	
81c	8/25/99	TNef1	Oea	6.57	5659.48	28.24	282.42	
83c	8/25/99	TNef1	Oea	11.20	6412.21	32.00	319.99	
85c	8/25/99	TNef1	Oea	8.75	4272.80	21.32	213.22	
87c	8/25/99	TNef1	Oea	15.89	11514.49	57.46	574.60	
89c	8/25/99	TNef1	Oea	37.01	15861.43	79.15	791.53	
blank1				0.02			0.00	
blank2				0.00			0.00	
blank3				0.03			0.00	

Sample ID	date	site	soil type	Mg (mg/L)	ug Mg/g soil	cmolc Mg/kg	Mg meq/kg	R%D
1c	7/5/00	TMat1	OCR	4.84	277.88	2.29	22.87	
3c	7/5/00	TMat1	OCR	3.36	371.57	3.06	30.58	

5c	7/5/00	TMat1	OCR	4.23	261.90	2.16	21.55	
7c	7/5/00	TMat1	OCR	6.17	296.30	2.44	24.38	
9c	7/5/00	TMat1	OCR	3.90	309.51	2.55	25.47	
11c	7/5/00	TMat1	OCR	2.88	293.69	2.42	24.17	
13c	7/5/00	TMat1	OCR	7.54	665.81	5.48	54.79	
15c	7/5/00	TMat1	OCR	7.25	716.78	5.90	58.98	
17c	7/5/00	TMat1	OCR	6.88	655.88	5.40	53.97	
19c	7/5/00	TMat1	OCR	11.10	623.48	5.13	51.30	
21c	7/5/00	TMat1	OCR	10.70	633.64	5.21	52.14	
23c	7/5/00	TMat1	OCR	10.75	806.80	6.64	66.39	
25c	7/5/00	TMat1	OCR	17.96	824.93	6.79	67.88	-97.08
25c LD	7/5/00	TMat1	OCR	45.27	2381.06	19.59	195.93	
27c	7/5/00	TMat1	OCR	15.62	527.30	4.34	43.39	
29c	7/5/00	TMat1	OCR	9.92	460.78	3.79	37.92	
31c	7/5/00	TMat1	OCR	2.33	184.57	1.52	15.19	
33c	7/5/00	TMat1	OCR				0.00	
35c	7/5/00	TMat1	OCR	7.23	425.80	3.50	35.04	
37c	7/5/00	TMat1	OCR	4.02	341.00	2.81	28.06	
39c	7/5/00	TMat1	OCR	2.15	321.68	2.65	26.47	
41c	7/5/00	TMat1	OCR				0.00	
43c	7/5/00	TMat1	OCR				0.00	
45c	7/5/00	TMat1	OCR	2.66	214.11	1.76	17.62	
47c	7/5/00	TMat1	OCR	4.78	198.05	1.63	16.30	
49c	7/5/00	TMat1	OCR	2.95	177.43	1.46	14.60	
51c	7/5/00	TMat1	OCR	3.41	177.38	1.46	14.60	
53c	7/5/00	TMat1	OCR	1.12	129.35	1.06	10.64	
55c	7/5/00	TMat1	OCR	1.63	101.58	0.84	8.36	
57c	7/5/00	TMat1	OCR	1.79	172.63	1.42	14.21	
59c	7/5/00	TMat1	OCR				0.00	
61c	7/5/00	TMat1	OCR	7.54	783.66	6.45	64.49	
63c	7/5/00	TMat1	OCR	4.44	609.19	5.01	50.13	
65c	7/5/00	TMat1	OCR	10.45	345.95	2.85	28.47	
67c	7/5/00	TMat1	OCR	10.94	509.47	4.19	41.92	
69c	7/5/00	TMat1	OCR	3.37	360.51	2.97	29.67	
71c	7/5/00	TMat1	OCR	6.83	933.61	7.68	76.82	
73c	7/5/00	TMat1	OCR	20.59	1052.30	8.66	86.59	
75c	7/5/00	TMat1	OCR	6.00	236.42	1.95	19.45	-91.32
75c LD	7/5/00	TMat1	OCR	16.13	633.78	5.22	52.15	
77c	7/5/00	TMat1	OCR	7.76	482.54	3.97	39.71	
79c	7/5/00	TMat1	OCR				0.00	
81c	7/5/00	TMat1	OCR	9.66	375.10	3.09	30.87	
83c	7/5/00	TMat1	OCR	5.71	437.14	3.60	35.97	
85c	7/5/00	TMat1	OCR	1.57	260.75	2.15	21.46	
87c	7/5/00	TMat1	OCR	3.80	487.28	4.01	40.10	

89c	7/5/00	TMat1	OCR	4.85	267.10	2.20	21.98	
91c	7/5/00	TMat1	OCR	4.09	215.44	1.77	17.73	
93c	7/5/00	TMat1	OCR	8.28	286.07	2.35	23.54	
95c	7/5/00	TMat1	OCR	0.64	225.00	1.85	18.51	
97c	7/5/00	TMat1	OCR	3.67	175.23	1.44	14.42	
99c	7/5/00	TMat1	OCR	2.10	188.51	1.55	15.51	
101c	7/5/00	TMat1	OCR	5.62	244.70	2.01	20.14	-105.07
101c LD	7/5/00	TMat1	OCR	15.86	786.41	6.47	64.71	
103c	7/5/00	TMat1	OCR	5.47	324.18	2.67	26.68	
105c	7/5/00	TMat1	OCR	5.25	212.32	1.75	17.47	-112.61
105c LD	7/5/00	TMat1	OCR	15.33	759.49	6.25	62.50	
1c	7/5/00	TMat1	<2mm	6.65	65.49	0.54	5.39	
3c	7/5/00	TMat1	<2mm	5.77	58.41	0.48	4.81	
5c	7/5/00	TMat1	<2mm	6.14	60.59	0.50	4.99	
7c	7/5/00	TMat1	<2mm	3.54	52.78	0.43	4.34	5.38
7c LD	7/5/00	TMat1	<2mm	3.33	50.02	0.41	4.12	
9c	7/5/00	TMat1	<2mm	3.85	57.25	0.47	4.71	
11c	7/5/00	TMat1	<2mm	5.16	76.35	0.63	6.28	
13c	7/5/00	TMat1	<2mm	4.98	64.25	0.53	5.29	4.92
13c LD	7/5/00	TMat1	<2mm	4.36	61.16	0.50	5.03	
15c	7/5/00	TMat1	<2mm	3.93	55.18	0.45	4.54	
17c	7/5/00	TMat1	<2mm	3.60	52.92	0.44	4.35	
19c	7/5/00	TMat1	<2mm	7.40	73.48	0.60	6.05	
21c	7/5/00	TMat1	<2mm	6.79	68.37	0.56	5.63	
23c	7/5/00	TMat1	<2mm	6.88	62.45	0.51	5.14	
25c	7/5/00	TMat1	<2mm	7.53	77.57	0.64	6.38	
27c	7/5/00	TMat1	<2mm	5.59	54.72	0.45	4.50	
29c	7/5/00	TMat1	<2mm	4.21	41.22	0.34	3.39	
31c	7/5/00	TMat1	<2mm	5.72	57.89	0.48	4.76	
33c	7/5/00	TMat1	<2mm	5.99	57.40	0.47	4.72	
35c	7/5/00	TMat1	<2mm	6.53	64.58	0.53	5.31	
37c	7/5/00	TMat1	<2mm	5.27	49.50	0.41	4.07	
39c	7/5/00	TMat1	<2mm	7.20	71.45	0.59	5.88	
41c	7/5/00	TMat1	<2mm	5.49	53.62	0.44	4.41	
43c	7/5/00	TMat1	<2mm	3.04	44.58	0.37	3.67	1.91
43c LD	7/5/00	TMat1	<2mm	2.93	43.74	0.36	3.60	
45c	7/5/00	TMat1	<2mm	2.69	37.19	0.31	3.06	
47c	7/5/00	TMat1	<2mm	3.39	44.82	0.37	3.69	
49c	7/5/00	TMat1	<2mm	2.66	26.98	0.22	2.22	
51c	7/5/00	TMat1	<2mm	2.60	25.98	0.21	2.14	
53c	7/5/00	TMat1	<2mm	2.91	28.04	0.23	2.31	
55c	7/5/00	TMat1	<2mm	2.04	20.04	0.16	1.65	
57c	7/5/00	TMat1	<2mm	1.76	16.98	0.14	1.40	
59c	7/5/00	TMat1	<2mm	0.80	7.81	0.06	0.64	

61c	7/5/00	TMat1	<2mm	10.57	156.55	1.29	12.88	
63c	7/5/00	TMat1	<2mm	10.82	162.44	1.34	13.37	0.82
63c LD	7/5/00	TMat1	<2mm	10.95	161.11	1.33	13.26	
65c	7/5/00	TMat1	<2mm	9.08	132.50	1.09	10.90	3.29
65c LD	7/5/00	TMat1	<2mm	8.09	128.22	1.06	10.55	
67c	7/5/00	TMat1	<2mm	10.44	151.85	1.25	12.50	
69c	7/5/00	TMat1	<2mm	10.22	140.80	1.16	11.59	
71c	7/5/00	TMat1	<2mm	27.91	272.91	2.25	22.46	
73c	7/5/00	TMat1	<2mm	31.54	317.14	2.61	26.10	
75c	7/5/00	TMat1	<2mm	9.85	134.17	1.10	11.04	
77c	7/5/00	TMat1	<2mm	7.82	114.29	0.94	9.40	
79c	7/5/00	TMat1	<2mm	5.86	80.91	0.67	6.66	0.37
79c LD	7/5/00	TMat1	<2mm	5.44	80.61	0.66	6.63	
81c	7/5/00	TMat1	<2mm	7.91	110.36	0.91	9.08	
83c	7/5/00	TMat1	<2mm	11.00	106.62	0.88	8.77	
85c	7/5/00	TMat1	<2mm	10.47	101.22	0.83	8.33	
87c	7/5/00	TMat1	<2mm	10.04	82.55	0.68	6.79	
89c	7/5/00	TMat1	<2mm	7.96	75.84	0.62	6.24	
91c	7/5/00	TMat1	<2mm	1.65	50.79	0.42	4.18	
93c	7/5/00	TMat1	<2mm	0.38	69.85	0.57	5.75	
95c	7/5/00	TMat1	<2mm	0.80	14.28	0.12	1.18	
97c	7/5/00	TMat1	<2mm	0.57	27.58	0.23	2.27	
99c	7/5/00	TMat1	<2mm	0.52	6.84	0.06	0.56	
101c	7/5/00	TMat1	<2mm	0.85	8.53	0.07	0.70	
103c	7/5/00	TMat1	<2mm	1.01	9.81	0.08	0.81	
105c	7/5/00	TMat1	<2mm	0.96	9.01	0.07	0.74	
1c	8/25/99	TNef1	<2mm	1.45	22.19	0.18	1.83	
3c	8/25/99	TNef1	<2mm	2.20	30.89	0.25	2.54	
5c	8/25/99	TNef1	<2mm	0.82	33.77	0.28	2.78	
7c	8/25/99	TNef1	<2mm	1.61	23.66	0.19	1.95	
9c	8/25/99	TNef1	<2mm	1.56	21.59	0.18	1.78	
11c	8/25/99	TNef1	<2mm	0.81	17.45	0.14	1.44	
13c	8/25/99	TNef1	<2mm	0.98	26.05	0.21	2.14	
15c	8/25/99	TNef1	<2mm	0.84	18.75	0.15	1.54	
17c	8/25/99	TNef1	<2mm	0.67	16.96	0.14	1.40	
19c	8/25/99	TNef1	<2mm	0.78	18.84	0.16	1.55	
21c	8/25/99	TNef1	<2mm	0.85	18.77	0.15	1.54	
23c	8/25/99	TNef1	<2mm	1.38	30.74	0.25	2.53	
25c	8/25/99	TNef1	<2mm	1.40	33.83	0.28	2.78	
27c	8/25/99	TNef1	<2mm	3.03	46.06	0.38	3.79	
29c	8/25/99	TNef1	<2mm	1.81	41.82	0.34	3.44	
31c	8/25/99	TNef1	<2mm	1.59	23.70	0.20	1.95	
33c	8/25/99	TNef1	<2mm	2.97	46.35	0.38	3.81	
35c	8/25/99	TNef1	<2mm	1.95	27.83	0.23	2.29	

37c	8/25/99	TNef1	<2mm	4.29	46.88	0.39	3.86	
39c	8/25/99	TNef1	<2mm	1.91	26.59	0.22	2.19	
41c	8/25/99	TNef1	<2mm	1.14	52.55	0.43	4.32	
43c	8/25/99	TNef1	<2mm	1.19	16.65	0.14	1.37	
45c	8/25/99	TNef1	<2mm	1.29	33.78	0.28	2.78	
47c	8/25/99	TNef1	<2mm	0.60	58.97	0.49	4.85	
49c	8/25/99	TNef1	<2mm	0.52	64.18	0.53	5.28	
51c	8/25/99	TNef1	<2mm	1.12	32.97	0.27	2.71	
53c	8/25/99	TNef1	<2mm	0.65	47.92	0.39	3.94	
55c	8/25/99	TNef1	<2mm	2.14	45.83	0.38	3.77	
57c	8/25/99	TNef1	<2mm	1.04	73.02	0.60	6.01	
59c	8/25/99	TNef1	<2mm	4.84	85.05	0.70	7.00	
61c	8/25/99	TNef1	<2mm	1.26	30.27	0.25	2.49	
63c	8/25/99	TNef1	<2mm	1.34	29.21	0.24	2.40	
65c	8/25/99	TNef1	<2mm	1.49	30.80	0.25	2.53	
67c	8/25/99	TNef1	<2mm	1.03	24.67	0.20	2.03	
69c	8/25/99	TNef1	<2mm	0.97	20.32	0.17	1.67	
71c	8/25/99	TNef1	<2mm	1.01	18.41	0.15	1.52	
73c	8/25/99	TNef1	<2mm	0.90	19.42	0.16	1.60	
75c	8/25/99	TNef1	<2mm	0.71	16.81	0.14	1.38	
77c	8/25/99	TNef1	<2mm	0.67	19.49	0.16	1.60	
79c	8/25/99	TNef1	<2mm	0.52	22.46	0.18	1.85	
81c	8/25/99	TNef1	<2mm	0.93	27.39	0.23	2.25	
83c	8/25/99	TNef1	<2mm	1.15	29.99	0.25	2.47	
85c	8/25/99	TNef1	<2mm	1.92	42.42	0.35	3.49	
87c	8/25/99	TNef1	<2mm	1.18	32.44	0.27	2.67	
89c	8/25/99	TNef1	<2mm	2.17	92.15	0.76	7.58	
1c	8/25/99	TNef1	Oea	0.41	394.48	3.25	32.46	
3c	8/25/99	TNef1	Oea	0.11	529.69	4.36	43.59	
5c	8/25/99	TNef1	Oea	0.76	444.19	3.66	36.55	
7c	8/25/99	TNef1	Oea	0.66	418.99	3.45	34.48	
9c	8/25/99	TNef1	Oea	0.29	312.77	2.57	25.74	
11c	8/25/99	TNef1	Oea	1.06	341.29	2.81	28.08	
13c	8/25/99	TNef1	Oea	0.19	500.89	4.12	41.22	
15c	8/25/99	TNef1	Oea	0.81	626.29	5.15	51.54	
17c	8/25/99	TNef1	Oea	0.21	344.02	2.83	28.31	
19c	8/25/99	TNef1	Oea	0.29	200.47	1.65	16.50	
21c	8/25/99	TNef1	Oea	0.18	293.33	2.41	24.14	
23c	8/25/99	TNef1	Oea	0.57	397.92	3.27	32.74	
25c	8/25/99	TNef1	Oea	0.43	447.90	3.69	36.86	-6.65
25c LD	8/25/99	TNef1	Oea	3.25	478.70	3.94	39.39	
27c	8/25/99	TNef1	Oea	0.38	446.46	3.67	36.74	
29c	8/25/99	TNef1	Oea	0.37	520.75	4.29	42.85	
31c	8/25/99	TNef1	Oea	0.43	303.55	2.50	24.98	

33c	8/25/99 TNef1	Oea	0.55	536.27	4.41	44.13	
35c	8/25/99 TNef1	Oea	0.51	467.38	3.85	38.46	
37c	8/25/99 TNef1	Oea	0.85	784.97	6.46	64.59	
39c	8/25/99 TNef1	Oea	0.72	854.76	7.03	70.34	
41c	8/25/99 TNef1	Oea	0.64	1125.88	9.26	92.65	
43c	8/25/99 TNef1	Oea	0.83	281.93	2.32	23.20	
45c	8/25/99 TNef1	Oea	0.39	363.75	2.99	29.93	
47c	8/25/99 TNef1	Oea	0.37	280.77	2.31	23.10	-7.19
47c LD	8/25/99 TNef1	Oea	4.81	301.70	2.48	24.83	
49c	8/25/99 TNef1	Oea	0.69	427.59	3.52	35.19	
51c	8/25/99 TNef1	Oea	0.65	376.16	3.10	30.95	
53c	8/25/99 TNef1	Oea	0.70	256.51	2.11	21.11	
55c	8/25/99 TNef1	Oea	0.56	389.86	3.21	32.08	
57c	8/25/99 TNef1	Oea	0.41	659.04	5.42	54.23	
59c	8/25/99 TNef1	Oea	0.45	441.18	3.63	36.30	
61c	8/25/99 TNef1	Oea	1.03	320.50	2.64	26.37	
63c	8/25/99 TNef1	Oea	0.45	344.07	2.83	28.31	16.29
63c LD	8/25/99 TNef1	Oea	2.15	292.23	2.40	24.05	
65c	8/25/99 TNef1	Oea	0.76	476.99	3.93	39.25	
67c	8/25/99 TNef1	Oea	0.43	400.31	3.29	32.94	
69c	8/25/99 TNef1	Oea	1.30	374.86	3.08	30.85	4.21
69c LD	8/25/99 TNef1	Oea	2.73	359.39	2.96	29.57	
71c	8/25/99 TNef1	Oea	0.51	248.21	2.04	20.42	
73c	8/25/99 TNef1	Oea	0.68	420.99	3.46	34.64	
75c	8/25/99 TNef1	Oea	0.40	205.86	1.69	16.94	
77c	8/25/99 TNef1	Oea	0.43	320.69	2.64	26.39	
79c	8/25/99 TNef1	Oea	0.53	312.94	2.58	25.75	-1.21
79c LD	8/25/99 TNef1	Oea	2.91	316.74	2.61	26.06	
81c	8/25/99 TNef1	Oea	0.45	389.66	3.21	32.06	
83c	8/25/99 TNef1	Oea	0.64	365.84	3.01	30.10	
85c	8/25/99 TNef1	Oea	0.47	231.60	1.91	19.06	
87c	8/25/99 TNef1	Oea	0.88	634.78	5.22	52.23	
89c	8/25/99 TNef1	Oea	1.50	642.86	5.29	52.90	
blank1			0.03			0.00	
blank2			0.03			0.00	
blank3			0.01			0.00	

Appendix B. Soilwater base cations for 2000 and 2001. Date is the date lysimeters were sampled. SampleID is the lysimeter number and s = shallow, d=deep. Sample? is whether or not any liquid sample was present in the lysimeter (yes or no). Base cation values are in units of mg/L.

Date	Sample ID	Sample?	Na	K	Ca	Mg
7/31/2000	1s	n				
7/31/2000	2d	n				
7/31/2000	3s	n				
7/31/2000	4d	n				
7/31/2000	5s	n				
7/31/2000	6d	n				
7/31/2000	7s	n				
7/31/2000	8d	n				
7/31/2000	9s	n				
7/31/2000	10d	n				
7/31/2000	11s	n				
7/31/2000	12d	n				
7/31/2000	13s	n				
7/31/2000	14d	n				
7/31/2000	15s	n				
7/31/2000	16d	n				
7/31/2000	17s	n				
7/31/2000	18d	n				
7/31/2000	19s	n				
7/31/2000	20d	y	1.354	14.229	30.640	23.930
7/31/2000	21s	y	1.663	14.241	12.830	
7/31/2000	22d	y	1.443	8.913	27.860	16.880
7/31/2000	23s	y	2.178	1.883	18.350	9.771
7/31/2000	24d	y	3.490	1.880	11.010	11.110
7/31/2000	25s	y				
7/31/2000	26d	y	1.821	4.807	26.280	10.470
7/31/2000	27s	n				
7/31/2000	28d	n				
7/31/2000	29s	y	3.676	2.329	15.740	3.447
7/31/2000	30d	n				
7/31/2000	31s	y	1.701	0.315	95.950	5.827
7/31/2000	32d	y	8.602	4.793	34.120	21.380
7/31/2000	33s	y	3.687	2.135	48.580	5.737
7/31/2000	34d	y	5.754	2.048	38.870	18.220

7/31/2000	35s	y	0.020	1.942	24.740	3.150
7/31/2000	36d	y	0.018	10.242		
7/31/2000	37s	y	4.556	1.251	24.300	3.764
7/31/2000	38d	y	4.570	3.060	28.220	6.862
7/31/2000	39s	y	1.923	1.723	15.100	8.323
7/31/2000	40d	y	2.027	2.879	20.370	19.160
7/31/2000	41s	y	2.027	2.888	21.970	12.440
7/31/2000	42d	y	2.348	1.719	31.700	28.110
7/31/2000	43s	y	1.185	1.611	23.120	19.510
7/31/2000	44d	y	3.238	2.962	19.880	26.500
7/31/2000	45s	n				
7/31/2000	46d	n				
7/31/2000	47s	y	6.148	7.936	20.900	18.820
7/31/2000	48d	n				
8/31/2000	1s	y	0.714	2.600	8.609	0.793
8/31/2000	2d	n				
8/31/2000	3s	n				
8/31/2000	4d	y	3.719	4.308	20.120	2.297
8/31/2000	5s	y	1.281	2.792	8.454	0.942
8/31/2000	6d	n				
8/31/2000	7s	y	1.283	1.724	4.466	0.847
8/31/2000	8d	n				
8/31/2000	9s	n				
8/31/2000	10d	n				
8/31/2000	11s	y	NS	2.556	6.690	0.749
8/31/2000	12d	n				
8/31/2000	13s	n				
8/31/2000	14d	n				
8/31/2000	15s	n				
8/31/2000	16d	n				
8/31/2000	17s	n				
8/31/2000	18d	n				
8/31/2000	19s	n				
8/31/2000	20d	y	0.995	4.067	21.800	20.010
8/31/2000	21s	n				
8/31/2000	22d	y	1.142	1.832	20.290	18.660
8/31/2000	23s	n				
8/31/2000	24d	y	2.509	2.873	9.982	10.900
8/31/2000	25s	n				

8/31/2000	26d	y	1.539	4.393	16.360	9.552
8/31/2000	27s	n				
8/31/2000	28d	n				
8/31/2000	29s	n				
8/31/2000	30d	n				
8/31/2000	31s	y	1.409	0.265	73.130	5.992
8/31/2000	32d	y	4.248	3.189	23.280	19.160
8/31/2000	33s	y	2.729	1.822	32.630	5.137
8/31/2000	34d	y	4.539	11.486	31.940	12.040
8/31/2000	35s	y	3.031	1.866	22.070	3.366
8/31/2000	36d	y	7.096	9.402	40.920	26.980
8/31/2000	37s	y	2.103	0.933	24.760	3.852
8/31/2000	38d	y	2.843	3.053	22.930	6.649
8/31/2000	39s	y	1.215	1.479	16.440	7.652
8/31/2000	40d	y	2.425	3.790	20.050	19.990
8/31/2000	41s	y	1.485	1.456	24.510	7.833
8/31/2000	42d	y	1.399	1.748	24.800	29.480
8/31/2000	43s	n				
8/31/2000	44d	y	5.101	8.020	18.440	35.640
8/31/2000	45s	n				
8/31/2000	46d	n				
8/31/2000	47s	y	1.907	1.001	11.830	3.358
8/31/2000	48d	y	4.640	11.180	46.400	79.420
10/3/2000	1s	y	0.924	2.882	9.877	0.895
10/3/2000	2d	y	0.855	3.759	12.860	1.257
10/3/2000	3s	y	0.991	2.289	17.870	1.627
10/3/2000	4d	y	1.812	3.504	12.040	1.435
10/3/2000	5s	y	0.551	2.068	8.344	0.997
10/3/2000	6d	y	1.805	1.520	7.643	0.947
10/3/2000	7s	y	0.898	1.062	3.430	0.563
10/3/2000	8d	y	1.679	1.309	2.317	1.270
10/3/2000	9s	n				
10/3/2000	10d	y	2.827	1.418	5.288	0.899
10/3/2000	11s	y	0.656	2.396	3.940	0.488
10/3/2000	12d	y	0.773	2.007	6.124	0.936
10/3/2000	13s	n				
10/3/2000	14d	y	0.803	1.274	6.278	1.230
10/3/2000	15s	y	0.500	5.374	8.759	1.325
10/3/2000	16d	y	1.431	4.812	18.370	2.205

10/3/2000	17s	y	1.000	4.247	14.420	2.208
10/3/2000	18d	y	1.004	0.600	10.510	1.721
10/3/2000	19s	y	1.167	0.860	12.870	8.009
10/3/2000	20d	y	0.703	3.483	16.580	15.656
10/3/2000	21s	y	1.181	0.590	11.130	6.568
10/3/2000	22d	y	0.784	1.399	13.450	11.510
10/3/2000	23s	y	1.310	1.449	14.030	8.525
10/3/2000	24d	y	1.859	2.579	8.740	9.833
10/3/2000	25s	y	1.254	0.937	28.720	10.020
10/3/2000	26d	y	0.471	2.767	12.300	5.366
10/3/2000	27s	y	2.651	1.491	43.070	11.350
10/3/2000	28d	y	2.762	2.144	34.720	12.360
10/3/2000	29s	n				
10/3/2000	30d	y	3.091	3.417	11.120	4.987
10/3/2000	31s	y	0.632	0.335	93.670	6.494
10/3/2000	32d	y	3.078	2.838	19.180	15.824
10/3/2000	33s	y	2.059	1.390	41.330	5.131
10/3/2000	34d	y	3.524	9.580	33.070	12.120
10/3/2000	35s	y	2.079	1.670	25.450	3.214
10/3/2000	36d	y	4.015	7.855	40.880	22.720
10/3/2000	37s	y	1.323	0.707	26.740	4.221
10/3/2000	38d	y	2.506	3.108	30.100	7.145
10/3/2000	39s	n				
10/3/2000	40d	y	1.673	2.846	19.040	20.140
10/3/2000	41s	y	0.955	1.156	29.750	7.754
10/3/2000	42d	y	0.593	1.574	17.300	11.890
10/3/2000	43s	y	2.141	2.924	17.960	16.510
10/3/2000	44d	y	3.508	6.385	26.080	28.580
10/3/2000	45s	y	1.647	3.063	26.770	14.430
10/3/2000	46d	y	2.414	6.825	57.970	39.520
10/3/2000	47s	y	1.019	0.722	11.870	3.195
10/3/2000	48d	y	2.531	9.446	57.120	49.840
11/7/2000	1s	y	1.256	5.374	13.880	1.179
11/7/2000	2d	n				
11/7/2000	3s	y	0.983	1.620	25.240	1.894
11/7/2000	4d	y	1.586	2.741	11.910	1.255
11/7/2000	5s	y	2.064	2.566	12.320	1.327
11/7/2000	6d	y	1.654	1.435	9.117	0.992
11/7/2000	7s	n				

11/7/2000	8d	y	2.140	1.209	2.590	1.714
11/7/2000	9s	y	0.513	5.655	5.207	0.588
11/7/2000	10d	y	3.400	1.289	5.825	0.881
11/7/2000	11s	y	1.323	2.899	7.391	0.784
11/7/2000	12d	y	0.753	1.292	5.934	0.749
11/7/2000	13s	n				
11/7/2000	14d	n				
11/7/2000	15s	n				
11/7/2000	16d	y	1.714	4.153	21.350	2.379
11/7/2000	17s	y	1.493	3.113	15.700	2.267
11/7/2000	18d	y	1.030	0.481	12.100	1.778
11/7/2000	19s	n				
11/7/2000	20d	y	1.665	3.390	24.360	20.100
11/7/2000	21s	n				
11/7/2000	22d	y	1.115	1.264	25.720	17.350
11/7/2000	23s	y	1.364	1.114	19.980	10.440
11/7/2000	24d	y	2.722	2.578	11.870	11.750
11/7/2000	25s	n				
11/7/2000	26d	y	1.080	2.725	19.510	7.453
11/7/2000	27s	n				
11/7/2000	28d	n				
11/7/2000	29s	n				
11/7/2000	30d	n				
11/7/2000	31s	y	0.025	0.036	108.800	7.102
11/7/2000	32d	y	3.378	2.531	31.240	20.020
11/7/2000	33s	y				
11/7/2000	34d	n				
11/7/2000	35s	y	1.772	1.453	24.860	3.135
11/7/2000	36d	y	4.321	7.741	41.810	24.880
11/7/2000	37s	y	1.049	0.366	23.940	4.011
11/7/2000	38d	y	2.208	2.636	29.840	7.391
11/7/2000	39s	y	1.393	1.375	20.780	9.549
11/7/2000	40d	y	1.903	3.483	20.300	20.460
11/7/2000	41s	y	1.013	0.878	27.550	7.743
11/7/2000	42d	y	0.424	1.406	26.190	34.670
11/7/2000	43s	y				
11/7/2000	44d	y	4.121	6.815	24.500	37.780
11/7/2000	45s	n				
11/7/2000	46d	y				

11/7/2000	47s	y	2.623	1.073	13.770	3.331
11/7/2000	48d	y	3.775	9.710	49.740	68.020
5/4/2001	1s	y	0.958	2.789	4.886	0.643
5/4/2001	2d	y	0.776	2.045	15.12	1.184
5/4/2001	3s	y	1.007	1.372	15.18	0.873
5/4/2001	4d	y	1.335	2.74	14.71	1.525
5/4/2001	5s	y				
5/4/2001	6d	y	1.123	1.414	8.82	0.91
5/4/2001	7s	y	0.749	0.635	2.88	0.519
5/4/2001	8d	y	2.123	3.482	1.377	0.623
5/4/2001	9s	y	0.829	1.96	1.903	0.438
5/4/2001	10d	y	2.04	0.884	2.576	0.486
5/4/2001	11s	n				
5/4/2001	12d	y	0.494	0.869	2.774	0.354
5/4/2001	13s	y				
5/4/2001	14d	y	0.618	0.897	4.367	0.791
5/4/2001	15s	y	0.778	4.512	5.256	1.127
5/4/2001	16d	y	0.851	3.196	18.34	1.935
5/4/2001	17s	y	1.557	3.085	8.128	1.847
5/4/2001	18d	y	0.903	1.182	9.846	1.885
5/4/2001	19s	n				
5/4/2001	20d	y	0.75	2.067	14.97	11.5
5/4/2001	21s	y	1.932	1.277	10.9	9.19
5/4/2001	22d	y	0.833	1.675	13.68	8.835
5/4/2001	23s	y	1.008	1.37	6.793	5.276
5/4/2001	24d	y	1.193	1.751	9.079	9.094
5/4/2001	25s	y	1.981	2.033	11.31	3.648
5/4/2001	26d	y	0.766	2.763	14.68	7.355
5/4/2001	27s	y				
5/4/2001	28d	y	1.064	2.818	18.1	3.686
5/4/2001	29s	n				
5/4/2001	30d	y	3.697	3.174	55.98	27.32
5/4/2001	31s	y	0.953	0.148		6.94
5/4/2001	32d	y	4.308	2.337	33.16	18.01
5/4/2001	33s	y	2.116	1.289		5.34
5/4/2001	34d	y	3.274	7.007	33.89	13.25
5/4/2001	35s	n				
5/4/2001	36d	y				
5/4/2001	37s	n				

5/4/2001	38d	n				
5/4/2001	39s	y	1.877	1.42	21.85	10.81
5/4/2001	40d	y	1.648	2.569	18.12	20.72
5/4/2001	41s	y	1.17	1.085	17.99	6.829
5/4/2001	42d	y	0.932	1.352	30.56	28.47
5/4/2001	43s	n				
5/4/2001	44d	y	3.649	4.827	24.83	36.2
5/4/2001	45s	y				
5/4/2001	46d	y				
5/4/2001	47s	y				
5/4/2001	48d	y	0.662	3.287	12.86	3.172
6/13/2001	1s	y	0.541	0.963	5.258	0.471
6/13/2001	2d	y	0.581	1.294	10.58	0.844
6/13/2001	3s	y	0.483	0.425	7.573	0.347
6/13/2001	4d	y	1.029	2.683	13.59	1.406
6/13/2001	5s	y	0.385	1.326	8.769	0.792
6/13/2001	6d	y	0.774	1.491	6.146	0.665
6/13/2001	7s	y	0.715	0.44	2.482	0.43
6/13/2001	8d	y	2.895	5.238	2.058	1.076
6/13/2001	9s	y	0.577	1.374	2.39	0.403
6/13/2001	10d	y	1.886	0.823	2.312	0.47
6/13/2001	11s	n				
6/13/2001	12d	y	0.399	0.838	2.505	0.318
6/13/2001	13s	y	0.45	3.058	6.82	1.324
6/13/2001	14d	y	0.605	0.838	4.044	0.75
6/13/2001	15s	y	0.419	4.955	7.941	1.242
6/13/2001	16d	y	0.757	3.194	13.56	1.462
6/13/2001	17s	y	0.745	2.107	9.317	1.488
6/13/2001	18d	y	1.078	2.071	7.134	1.269
6/13/2001	19s	y	0.763	0.87	15.1	10.69
6/13/2001	20d	y	0.667	2.653	15.47	12.34
6/13/2001	21s	y				
6/13/2001	22d	y	0.84	1.91	13.03	9.538
6/13/2001	23s	y	0.716	0.698	10.86	6.875
6/13/2001	24d	y	1.004	1.861	11.83	9.963
6/13/2001	25s	y				
6/13/2001	26d	y	0.8	3.43	14.39	7.372
6/13/2001	27s	y				
6/13/2001	28d	y	2.755	3.272	16.99	3.548

6/13/2001	29s	n				
6/13/2001	30d	n				
6/13/2001	31s	y	1.045	0.154	104.1	7.271
6/13/2001	32d	n	4.87	2.915	35.57	23.8
6/13/2001	33s	y	1.684	1.124	50.7	6.872
6/13/2001	34d	y	2.675	6.906	32.11	12.49
6/13/2001	35s	n				
6/13/2001	36d	y				
6/13/2001	37s	y				
6/13/2001	38d	y				
6/13/2001	39s	y	1.666	1.287	18.61	8.894
6/13/2001	40d	y	1.805	2.823	16.51	15.94
6/13/2001	41s	n				
6/13/2001	42d	y	0.915	1.361	22.13	16.24
6/13/2001	43s	y				
6/13/2001	44d	y	3.374	4.97	22.21	32.16
6/13/2001	45s	y	1.055	1.622	11	4.577
6/13/2001	46d	y	2.969	6.683	59.03	43.73
6/13/2001	47s	y	0.977	1.057	11.42	3.035
6/13/2001	48d	y	2.537	8.48	38.26	36.09
7/11/2001	1s	y				
7/11/2001	2d	n				
7/11/2001	3s	y				
7/11/2001	4d	n				
7/11/2001	5s	y				
7/11/2001	6d	n				
7/11/2001	7s	y				
7/11/2001	8d	n				
7/11/2001	9s	y				
7/11/2001	10d	n				
7/11/2001	11s	n				
7/11/2001	12d	y				
7/11/2001	13s	y				
7/11/2001	14d	n				
7/11/2001	15s	y				
7/11/2001	16d	n				
7/11/2001	17s	y				
7/11/2001	18d	y	1.008	1.61	6.359	1.104
7/11/2001	19s	y	1.825	1.236	13.46	8.933

7/11/2001	20d	y	1.023	3.049	16.4	12.99
7/11/2001	21s	y				
7/11/2001	22d	y				
7/11/2001	23s	y				
7/11/2001	24d	y	1.487	1.902	11.22	9.205
7/11/2001	25s	y				
7/11/2001	26d	y				
7/11/2001	27s	y	1.344	0.624	12.69	2.515
7/11/2001	28d	y	2.629	2.718	12.63	3.098
7/11/2001	29s	n				
7/11/2001	30d	y				
7/11/2001	31s	y	1.373	0.131	112.2	8.136
7/11/2001	32d	y		2.722	35.06	25.06
7/11/2001	33s	y	1.717	1.7	68.34	9.122
7/11/2001	34d	y		6.668	32.62	12.32
7/11/2001	35s	n				
7/11/2001	36d	n				
7/11/2001	37s	y	1.225	0.253	20.39	3.526
7/11/2001	38d	n				
7/11/2001	39s	y	1.314	1.202	20.32	10.01
7/11/2001	40d	y	1.668	2.832	17.56	19.3
7/11/2001	41s	y	1.205	1.352	23.86	7.676
7/11/2001	42d	y	0.837	2.209	29.26	25.36
7/11/2001	43s	n				
7/11/2001	44d	y	3.35	5.84	23.08	35
7/11/2001	45s	y	1.26	1.373	8.909	3.431
7/11/2001	46d	y				
7/11/2001	47s	y	0.81	1.081	7.556	1.915
7/11/2001	48d	y	2.615	8.834	43.48	45.26
8/10/2001	1s	y	0.919	1.236	4.508	0.419
8/10/2001	2d	y	0.532	0.838	7.027	0.403
8/10/2001	3s	y	0.98	1.854	4.617	0.251
8/10/2001	4d	n				
8/10/2001	5s	y	0.963	5.347	9.214	0.387
8/10/2001	6d	y	0.812	1.858	4.406	0.412
8/10/2001	7s	n				
8/10/2001	8d	n				
8/10/2001	9s	y				
8/10/2001	10d	y	2.472	1.269	3.02	0.51

8/10/2001	11s	n				
8/10/2001	12d	y	0.908	1.439	3.032	0.328
8/10/2001	13s	n				
8/10/2001	14d	y	0.807	1.035	3.173	0.523
8/10/2001	15s	y	0.817	3.94	3.655	0.57
8/10/2001	16d	n				
8/10/2001	17s	n				
8/10/2001	18d	y	1.495	3.614	4.383	0.905
8/10/2001	19s	y				
8/10/2001	20d	y	0.928	3.147	15.25	11.48
8/10/2001	21s	n				
8/10/2001	22d	y	1.355	3.968	10.76	7.8
8/10/2001	23s	y	0.997	1.426	6.069	3.158
8/10/2001	24d	y				
8/10/2001	25s	y				
8/10/2001	26d	y	0.923	3.986	13.17	6.343
8/10/2001	27s	n				
8/10/2001	28d	y	2.51	2.675	11.62	3.957
8/10/2001	29s	n				
8/10/2001	30d	y	2.816	2.348	31.89	17.59
8/10/2001	31s	y	1.334	0.298	124.3	8.949
8/10/2001	32d	y	3.791	2.516	31.38	22.3
8/10/2001	33s	y	1.524	1.752	51.41	6.742
8/10/2001	34d	y	3.098	7.046	29.27	11.27
8/10/2001	35s	n				
8/10/2001	36d	y	3.548	7.27	39.29	19.83
8/10/2001	37s	y				
8/10/2001	38d	n				
8/10/2001	39s	y	3.287	1.703	21.02	10.64
8/10/2001	40d	y	1.671	2.765	18.08	18.76
8/10/2001	41s	y	1.205	1.469	25.82	8.082
8/10/2001	42d	y	0.835	1.539	27.6	25.39
8/10/2001	43s	n				
8/10/2001	44d	y	4.321	7.665	28.72	40.65
8/10/2001	45s	y	1.829	1.51	12.2	5.351
8/10/2001	46d	y	3.228	6.948	49.56	36.95
8/10/2001	47s	y	1.39	1.438	9.429	2.355
8/10/2001	48d	y	3.282	9.96	40.98	43.54

Appendix C. Streamwater base cation concentrations for water year 2000. TSM is total suspended matter. Locations consist of: NRAC (Neff Run above confluence), MRAC (Mathews Run above confluence), TMat1 (strip-mined and reclaimed watershed stream), TNef1 (Tributary to Neff Run, stream in forested watershed). Base cation concentrations are in units of mg/L.

SampleID	TSM (mg/L)	Date	Time	Location	Na	K	Mg	Ca
991004NRAC	1.71	10/04/99		NRAC	0.97	1.54	2.53	6.49
991004TMat1	126.67	10/04/99		TMat1	1.48	4.4	5.87	24.13
991011NRAC	8.38	10/11/99		NRAC	1.01	1.56	2.59	6.8
991011TMat1	5	10/11/99		TMat1	3.38	8.17	6.69	32.24
991018NRAC	8.8	10/18/99		NRAC				
991018MRAC	1	10/18/99		MRAC	5.54	2.27	3.48	6.55
991025NRAC	4.05	10/25/99		NRAC	1.05	1.49	2.5	6.36
991025MRAC	4	10/25/99		MRAC	5.44	2.36	3.76	7.12
991102TMat1	110.18	11/02/99	4:45 PM	TMat1	2.05	3.38	4.83	19.29
991102NRAC	9.63	11/02/99	5:15 PM	NRAC	1.1	3.64	3.02	7.52
991122NRAC	1.67	11/22/99	9:00 AM	NRAC				
991122MRAC	4.75	11/22/99	9:30 AM	MRAC	5.74	2.09	3.74	7.28
991210NRAC	3.25	12/10/99		NRAC	1.04	1.5	2.62	6.08
991210MRAC	31	12/10/99		MRAC	6.02	1.93	3.41	6.75
991214NRAC	17	12/14/99		NRAC	1.29	2.08	2.84	7.33
991214NFTRB	9.9	12/14/99	10:15 AM	TNef1	1.12	1.99	4.79	8.46
991214MRAC	21.6	12/14/99	9:30 AM	MRAC	6.09	2.33	2.67	5.73
991221NRAC		12/21/99		NRAC	0.493	0.572	1.304	3.043
991221TMat1	4.63	12/21/99		TMat1	0.594	1.993	3.9	16.972
991214TMat1	413	12/14/99	9:30 AM	TMat1	2.36	4.43	5.52	20.45
000110TMat1		01/10/00	1:00 PM	TMat1	0.802	1.388	2.848	13.57
000110MRAC		01/10/00	2:00 PM	MRAC	1.753	0.612	1.451	3.282
000110NRAC		01/10/00	3:00 PM	NRAC	0.494	0.438	1.09	2.909
000111TMat1		01/11/00	11:30 AM	TMat1	0.663	1.996	4.06	17.986
000111MRAC		01/11/00	11:30 AM	MRAC	1.669	0.608	1.469	3.248
000111NRAC		01/11/00	12:00 PM	NRAC	0.489	0.436	1.103	2.92
000125MRAC		01/25/00		MRAC	1.967	0.624	1.565	3.104
000208MRAC	2.67	02/08/00		MRAC	2.086	0.619	1.558	3.063
000208NRAC	5.25	02/08/00		NRAC	0.467	0.353	1.034	2.772
000125NRAC		01/25/00		NRAC	0.444	0.36	1.035	2.706
000222MRAC		02/22/00	1:00 PM	MRAC	0.965	0.822	1.373	3.184

000222NRAC		02/22/00	12:00 PM	NRAC	0.47	0.549	1.044	2.66
000222TMat1		02/22/00	1:00 PM	TMat1	0.306	1.643	2.943	11.21
000222NFTRB		02/22/00	12:00 PM	TNef1	0.415	0.58	1.95	3.426
000211MRAC		02/11/00		MRAC	1.406	0.539	1.457	3.371
000211NRAC		02/11/00		NRAC	0.617	0.491	1.244	3.323
000211NFTRB		02/11/00		TNef1	0.484	0.574	2.26	4.067
000211TMat1		02/11/00		TMat1	0.412	1.783	2.402	8.687
000307MRAC	5.33	03/07/00		MRAC	1.37	0.687	1.227	3.018
000307NRAC	0.75	03/07/00		NRAC	0.482	0.436	0.927	2.521
000307NFTRB	0.25	03/07/00		TNef1	0.445	0.489	1.898	3.321
000321MRAC	0.5	03/21/00		MRAC	1.519	0.635	1.17	2.861
000321NRAC	1.25	03/21/00		NRAC	0.483	0.446	0.915	2.465
000321NFTRB	1.12	03/21/00		TNef1	0.456	0.469	1.844	3.143
000321TMat1	23.87	03/21/00		TMat1	0.78	1.26	3.032	11.02
000404MRAC	0.5	04/04/00	4:00 PM	MRAC	1.497	0.69	1.085	2.084
000404NRAC	1.37	04/04/00	10:15 AM	NRAC	0.498	0.481	0.899	2.039
000404TMat1	15.29	04/04/00	2:37 PM	TMat1	0.637	1.326	3.27	11.73
000404NFTRB	9.5	04/04/00	10:15 AM	TNef1	0.481	0.505	1.978	2.672
000418MRAC		04/18/00		MRAC	1.562	0.645	1.068	1.961
000418NRAC		04/18/00		NRAC	0.541	0.483	0.934	1.798
000418NFTRB		04/18/00		TNef1	0.509	0.483	1.938	2.398
000418TMat1		04/18/00		TMat1	0.628	0.845	2.98	11.03
000502MRAC	0	05/02/00	1:45 PM	MRAC	1.536	0.678	1.048	2.075
000502NRAC	0.875	05/02/00	12:55 PM	NRAC	0.485	0.468	0.857	1.864
000502TMat1	8.167	05/02/00	1:30 PM	TMat1	0.643	0.857	4.95	15.75
000502NFTRB	0.375	05/02/00	12:45 PM	TNef1	0.479	0.496	1.85	2.462
000516MRAC	0.5	05/16/00	1:55 PM	MRAC	1.696	0.642	1.123	2.498
000516NRAC	1.375	05/16/00	1:20 PM	NRAC	0.502	0.464	0.885	2.366
000530MRAC	1.143	05/30/00	3:35 PM	MRAC	1.528	0.401	0.934	2.073
000530NRAC	1.268	05/30/00	2:50 PM	NRAC	0.534	0.425	0.928	2.387
000530TMat1	8.148	05/30/00	3:20 PM	TMat1	0.567	0.797	2.726	12.09
000530NFTRB	5.25	05/30/00	2:45 PM	TNef1	0.563	0.507	1.754	3.072
000613MRAC	1.143	06/13/00	12:50 PM	MRAC	1.615	0.497	0.925	2.233
000613NRAC	1.5	06/13/00	12:15 PM	NRAC	0.487	0.468	0.92	2.496
000613NFTRB	7.5	06/13/00	12:05 PM	TNef1	0.487	0.578	1.658	2.91
000627MRAC	2.857	06/27/00	12:55 PM	MRAC	1.852	0.602	1.024	2.184
000627NRAC	2.333	06/27/00	12:15 PM	NRAC	0.48	0.434	0.929	2.631
000711MRAC	2.353	07/11/00	10:40 AM	MRAC	2.014	0.636	1.137	2.537
000711NRAC	1.333	07/11/00	9:30 AM	NRAC	0.47	0.452	1.039	2.886

000725NRAC	0.25	07/25/00	12:05 PM	NRAC	0.417	0.494	1.052	2.865
000808MRAC	3.2	08/08/00	11:00 AM	MRAC	1.405	0.509	0.99	2.409
000808NRAC	4.533	08/08/00	10:20 AM	NRAC	0.428	0.531	1.055	2.742
000808NFTRB	4.75	08/08/00	10:15 AM	TNef1	0.399	0.703	1.741	3.126
000822NRAC	4.267	08/22/00	11:30 AM	NRAC	0.428	0.743	1.089	2.89
000905NRAC	13.4	09/05/00	10:10 AM	NRAC	0.425	0.511	1.099	2.937
000919NRAC	0.2	09/19/00	10:25 AM	NRAC	0.497	0.584	1.17	3.234
001010NRAC	0.333	10/10/00	10:30 AM	NRAC	0.435	0.857	1.203	3.239
001010MRAC	3.714	10/10/00	11:20 AM	MRAC	2.255	0.694	1.097	2.403

Appendix D. Composited and uncomposited streamwater base cation concentrations for storm events in water year 2001. Bottle number signifies the sequential sample number in the automated sampler. If the sample was taken by hand (i.e. "grabbed") the grab appears in that column. Discharge is in units of cubic feet per second and is recorded at the sampling time. Base cation concentrations, total suspended matter (TSM), and silica are in units of mg/L. Composited samples are labeled with a C after the bottle number.

Event Sampling Data

NS- no sample

Date	Location	bottle number	sampling time	discharge (cfs)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	TSM	Silica
2/2/2001	TNef1	grab	11:00		4.948	2.377	0.681	0.521	96.667	
2/8/2001	TNef1	1	9:00	0.00361460	4.062	2.088	0.572	0.416	54.800	
2/8/2001	TNef1	2	12:00	0.00810594	3.953	2.068	0.565	0.461	23.250	
2/8/2001	TNef1	3	15:00	0.00739147	3.991	2.042	0.564	0.47	6.750	
2/8/2001	TNef1	4	18:00	0.00739147	4.067	2.035	0.551	0.443	3.800	
2/8/2001	TNef1	5	21:00	0.00669994	4.072	2.083	0.720	0.516	4.000	
2/9/2001	TNef1	6	0:00	0.00603208	4.094	2.109	0.557	0.441	3.200	
2/9/2001	TNef1	7	3:00	0.00603208	4.149	2.117	0.648	0.506	1.800	
2/9/2001	TNef1	8	6:00	0.00538867	4.166	2.096	0.535	0.451	2.400	
2/9/2001	TNef1	9	9:00	0.00477061	4.120	2.091	0.607	0.472	2.000	
2/9/2001	TNef1	10	12:00	0.00477061	4.160	2.104	0.568	0.458	2.000	
2/9/2001	TNef1	11	15:00	0.02539524	4.648	2.374	0.710	0.454	24.250	
2/9/2001	TNef1	12	18:00	0.04315010	5.839	2.903	0.829	0.503	7.000	
2/9/2001	TNef1	13	21:00	0.03810596	6.054	2.982	0.780	0.475	3.800	
2/10/2001	TNef1	14	0:00	0.02539524	6.296	3.066	0.751	0.476	3.000	
2/10/2001	TNef1	15	3:00	0.01732346	5.859	3.064	0.777	0.462	6.000	
2/10/2001	TNef1	16	6:00	0.00810594	6.283	3.160	0.864	0.51	3.000	

2/10/2001	TNef1	17	9:00	0.00089618	5.884	2.994	0.732	0.45	3.200
2/10/2001	TNef1	18	12:00	0.00739147	5.655	2.854	0.757	0.441	0.800
2/10/2001	TNef1	19	15:00	0.01200127	5.190	2.758	0.698	0.461	1.750
2/10/2001	TNef1	20	18:00	0.01457890	5.057	2.650	0.633	0.452	1.800
2/10/2001	TNef1	21	21:00	0.01639063	4.969	2.672	0.605	0.478	3.000
2/11/2001	TNef1	22	0:00	0.01639063	4.914	2.655	0.603	0.472	1.569
2/11/2001	TNef1	23	3:00	0.01639063	4.833	2.627	0.595	0.487	3.600
2/11/2001	TNef1	24	6:00	0.01639063	4.832	2.597	0.578	0.478	5.347
2/11/2001	TNef1	1	13:05	0.01732346	4.328	2.510	0.610	0.433	1.250
2/11/2001	TNef1	2	15:05	0.01732346	4.252	2.461	0.599	0.458	2.000
2/11/2001	TNef1	3	17:05	0.01732346	4.211	2.431	0.606	0.404	2.286
2/11/2001	TNef1	4	19:05	0.01732346	4.169	2.430	0.627	0.424	1.143
2/11/2001	TNef1	5	21:05	0.01732346	4.169	2.415	0.647	0.505	0.000
2/11/2001	TNef1	6	23:05	0.01732346	4.040	2.391	0.610	0.404	0.000
2/12/2001	TNef1	7	1:05	0.01732346	4.052	2.399	0.660	0.447	0.000
2/12/2001	TNef1	8	3:05	0.01732346	4.022	2.461	0.645	0.401	0.750
2/12/2001	TNef1	9	5:05	0.01732346	3.962	2.420	0.643	0.343	0.286
2/12/2001	TNef1	10	7:05	0.01732346	3.992	2.418	0.619	0.359	0.000
2/12/2001	TNef1	11	9:05	0.01732346	4.038	2.400	0.352	0.367	0.500
2/12/2001	TNef1	12	11:05	0.01732346	4.074	2.388	0.373	0.367	0.000
2/12/2001	TNef1	13	13:05	0.01732346	4.208	2.377	0.418	0.373	2.000
2/12/2001	TNef1	14	15:05	0.01732346	4.348	2.402	0.468	0.374	1.471
2/12/2001	TNef1	15	17:05	0.01732346	4.443	2.448	0.440	0.394	0.000
2/12/2001	TNef1	16	19:05	0.01732346	4.406	2.458	0.528	0.35	0.000
2/12/2001	TNef1	17	21:05	0.01732346	4.401	2.488	0.444	0.38	0.282

2/12/2001	TNef1	18	23:05	0.01732346	4.380	2.481	0.455	0.387	0.000
2/13/2001	TNef1	19	1:05	0.01732346	4.424	2.487	0.460	0.4	0.000
2/13/2001	TNef1	20	3:05	0.01732346	4.423	2.349	0.483	0.383	0.000
2/13/2001	TNef1	21	5:05	0.01732346	4.464	2.338	0.510	0.432	0.000
2/13/2001	TNef1	22	7:05	0.01732346	4.541	2.321	0.532	0.372	0.000
2/13/2001	TNef1	23	9:05	0.01732346	4.525	2.350	0.535	0.346	0.000
2/13/2001	TNef1	24	11:05	0.01732346	4.502	2.314	0.427	0.384	0.494
2/13/2001	TNef1	1	13:10	0.01732346	4.394	2.250	0.556	0.465	6.571
2/13/2001	TNef1	2	15:10	0.01732346	4.272	2.238	0.541	0.464	0.580
2/13/2001	TNef1	3	17:10	0.01732346	4.331	2.240	0.543	0.477	0.000
2/13/2001	TNef1	4	19:10	0.01827384	4.323	2.232	0.551	0.472	0.800
2/13/2001	TNef1	5	21:10	0.01827384	4.430	2.222	0.536	0.463	0.286
2/13/2001	TNef1	6	23:10	0.01827384	4.412	2.225	0.536	0.470	0.822
2/14/2001	TNef1	7	1:10	0.02022612	4.354	2.231	0.498	0.432	2.500
2/14/2001	TNef1	8	3:10	0.02432941	4.398	2.210	0.511	0.438	1.892
2/14/2001	TNef1	9	5:10	0.02539524	4.438	2.343	0.528	0.434	3.333
2/14/2001	TNef1	10	7:10	0.02327935	4.047	2.344	0.553	0.47	0.000
2/14/2001	TNef1	11	9:10	0.02539524	4.060	2.359	0.547	0.458	1.127
2/14/2001	TNef1	12	11:10	0.02647665	4.022	2.358	0.565	0.479	1.370
2/14/2001	TNef1	13	13:10	0.02757342	4.034	2.361	0.550	0.456	2.286
2/14/2001	TNef1	14	15:10	0.02868536	4.055	2.367	0.560	0.457	0.870
2/14/2001	TNef1	15	17:10	0.02981229	4.002	2.381	0.573	0.467	0.896
2/14/2001	TNef1	16	19:10	0.04315010	4.096	2.383	0.572	0.487	0.571
2/14/2001	TNef1	17	21:10	0.04840520	4.375	2.550	0.625	0.459	9.167
2/14/2001	TNef1	18	23:10	0.03687885	5.034	2.852	0.689	0.473	4.348

2/15/2001	TNef1	19	1:10	0.03687885	5.063	2.876	0.667	0.5	0.833
2/15/2001	TNef1	20	3:10	0.03687885	4.887	2.806	0.652	0.476	2.254
2/15/2001	TNef1	21	5:10	0.03446632	4.778	2.774	0.668	0.517	0.822
2/15/2001	TNef1	22	7:10	0.03328120	4.757	2.705	0.654	0.484	1.176
2/15/2001	TNef1	23	9:10	0.03211038	4.780	2.674	0.596	0.437	4.000
2/15/2001	TNef1	24	11:10	0.03211038	4.734	2.667	0.604	0.448	0.857
2/15/2001	TNef1	1	12:00	0.03211038	4.585	2.649	0.624	0.475	5.542
2/15/2001	TNef1	2	15:00	0.03095402	4.583	2.662	0.652	0.457	1.500
2/15/2001	TNef1	3	18:00	0.03095402	4.504	2.610	0.628	0.46	2.326
2/15/2001	TNef1	4	21:00	0.03095402	4.427	2.588	0.626	0.473	1.750
2/16/2001	TNef1	5	0:00	0.02981229	4.378	2.547	0.519	0.487	1.319
2/16/2001	TNef1	6	3:00	0.02981229	4.374	2.561	0.540	0.482	1.951
2/16/2001	TNef1	7	6:00	0.02981229	4.337	2.507	0.529	0.48	1.149
2/16/2001	TNef1	8	9:00	0.02981229	4.333	2.491	0.585	0.473	1.220
2/16/2001	TNef1	9	12:00	0.02981229	4.328	2.521	0.579	0.467	1.882
2/16/2001	TNef1	10	15:00	0.02981229	4.330	2.483	0.605	0.474	2.093
2/16/2001	TNef1	11	18:00	0.04975104	4.328	2.485	0.590	0.447	3.171
2/16/2001	TNef1	12	21:00	0.03328120	4.291	2.478	0.573	0.462	3.659
2/17/2001	TNef1	13	0:00	0.03328120	4.240	2.469	0.599	0.481	2.529
2/17/2001	TNef1	14	3:00	0.03328120	4.215	2.431	0.616	0.459	2.791
2/17/2001	TNef1	15	6:00	0.03328120	4.230	2.425	0.612	0.463	1.163
2/17/2001	TNef1	16	9:00	0.03211038	4.236	2.402	0.618	0.455	1.000
2/17/2001	TNef1	17	12:00	0.03211038	4.230	2.358	0.643	0.453	0.714
2/17/2001	TNef1	18	15:00	0.03211038	4.174	2.327	0.633	0.45	1.860
2/17/2001	TNef1	19	18:00	0.03211038	4.029	2.355	0.628	0.45	1.395

2/17/2001	TNef1	20	21:00	0.03211038	3.738	2.309	0.648	0.432	0.750
2/18/2001	TNef1	21	0:00	0.03211038	3.626	2.317	0.638	0.429	3.014
2/18/2001	TNef1	22	3:00	0.03211038	3.528	2.304	0.638	0.433	0.789
2/18/2001	TNef1	23	6:00	0.03211038	3.573	2.310	0.597	0.438	0.769
2/18/2001	TNef1	24	9:00	0.03211038	3.589	2.287	0.596	0.437	0.244
6/22/2001	TNef1	2	17:00		3.592	1.915	0.771	0.64	444.041
6/22/2001	TNef1	4	23:00		3.902	2.235	1.015	0.422	20.536
6/23/2001	TNef1	7	8:00		3.856	2.168	0.428	0.426	9.545
1/31/2001	TMat1	grab	16:00		9.899	2.118	3.844	0.614	23.000
2/1/2001	TMat1	1	12:15		9.841	2.152	3.155	0.581	5.333
2/1/2001	TMat1	2	13:15		10.490	2.324	3.311	0.56	1.000
2/1/2001	TMat1	3	14:15		10.540	2.327	3.140	0.596	1.000
2/1/2001	TMat1	4	15:15		10.540	2.361	3.121	0.631	2.333
2/1/2001	TMat1	5	16:15		10.790	2.398	3.143	0.628	1.333
2/1/2001	TMat1	6	17:15		10.990	2.413	3.198	0.592	1.667
2/1/2001	TMat1	7	18:15		11.200	2.460	3.142	0.597	1.667
2/1/2001	TMat1	8	19:15		11.360	2.503	3.154	0.623	0.000
2/1/2001	TMat1	9	20:15		11.450	2.526	3.163	0.641	0.000
2/1/2001	TMat1	10	21:15		11.820	2.543	3.173	0.692	0.000
2/1/2001	TMat1	11	22:15		12.240	2.645	3.324	0.697	1.000
2/1/2001	TMat1	12	23:15		12.540	2.733	3.370	0.675	0.000
2/2/2001	TMat1	13	0:15		12.910	2.809	3.463	0.687	0.667
2/2/2001	TMat1	18	5:15		14.480	3.167	3.730	0.928	0.000
2/2/2001	TMat1	19	6:15		13.570	3.003	3.452	0.688	2.333
2/2/2001	TMat1	grab	11:45		14.240	2.931	3.779	0.68	8.333

2/7/2001	TMat1	1	16:50	0.22977907	9.819	2.034	2.529	0.601	27.250
2/8/2001	TMat1	6	12:50	0.12416040	9.768	2.086	2.400	0.547	25.652
2/8/2001	TMat1	7	16:50	0.68705460	NS	NS	3.192	0.6	88.824
2/8/2001	TMat1	8	20:50	0.35177568	10.710	2.348	2.869	0.469	23.725
2/9/2001	TMat1	9	0:50	0.20768957	10.840	2.408	2.782	0.437	21.200
2/9/2001	TMat1	10	4:50	0.18641862	10.350	2.362	2.721	0.453	14.200
2/9/2001	TMat1	11	8:50	0.21642846	10.730	2.303	2.532	0.464	18.600
2/9/2001	TMat1	12	12:50	0.61497543	7.754	1.747	2.812	0.462	156.829
2/9/2001	TMat1	13	16:50	0.83249004	7.897	1.868	3.017	0.431	142.000
2/9/2001	TMat1	14	20:50	0.56439093	8.094	1.900	3.022	0.44	118.333
2/10/2001	TMat1	15	0:50	0.48559677	8.294	1.969	3.062	0.45	93.000
2/10/2001	TMat1	16	4:50	0.67373527	8.303	1.936	3.155	0.469	85.000
2/10/2001	TMat1	17	8:50	0.46222350	9.028	2.109	3.209	0.48	31.400
2/10/2001	TMat1	18	12:50	0.46222350	8.910	2.037	3.132	0.465	36.078
2/10/2001	TMat1	19	16:50	0.39464572	9.037	2.067	3.064	0.455	28.889
2/10/2001	TMat1	20	20:50	0.36232573	9.864	2.212	3.000	0.487	18.200
2/11/2001	TMat1	21	0:50	0.32080825	11.210	2.450	3.050	0.475	9.600
2/11/2001	TMat1	22	4:50	0.30074207	11.530	2.605	2.968	0.521	19.000
2/11/2001	TMat1	23	8:50	0.28114863	12.400	2.795	3.076	0.554	10.000
2/13/2001	TMat1	1	12:15	0.24802476	11.660	2.361	2.803	4.027	14.722
2/13/2001	TMat1	2	14:15	0.33616305	10.450	2.084	2.460	0.478	25.135
2/13/2001	TMat1	3	16:15	0.33616305	10.460	2.078	2.851	0.564	23.014
2/13/2001	TMat1	4	18:15	0.32080825	10.860	2.147	2.536	0.456	11.507
2/13/2001	TMat1	5	20:15	0.28114863	11.580	2.271	2.622	0.479	5.556
2/13/2001	TMat1	6	22:15	0.24802476	11.970	2.329	2.613	0.489	4.324

2/14/2001	TMat1	7	0:15	0.24341618	12.160	2.351	2.585	0.497	7.297
2/14/2001	TMat1	8	2:15	0.24341618	12.140	2.322	2.636	0.469	3.889
2/14/2001	TMat1	9	4:15	0.24802476	12.520	2.330	2.698	0.529	3.889
2/14/2001	TMat1	10	6:15	0.29088571	12.600	2.372	2.810	0.519	10.617
2/14/2001	TMat1	11	8:15	0.31574785	13.390	2.541	3.124	0.52	7.733
2/14/2001	TMat1	12	10:15	0.35177568	13.230	2.422	3.209	0.515	13.611
2/14/2001	TMat1	13	12:15	0.40012891	12.420	2.310	3.302	0.504	25.352
2/14/2001	TMat1	14	14:15	0.42795228	12.070	2.258	3.279	0.466	23.415
2/14/2001	TMat1	15	16:15	0.43926987	9.727	2.256	3.251	0.475	22.029
2/14/2001	TMat1	16	18:15	0.43926987	9.911	2.258	3.254	0.499	13.708
2/14/2001	TMat1	17	20:15	0.92747978	9.777	2.250	4.474	0.717	981.389
2/14/2001	TMat1	18	22:15	1.66197307	11.290	2.512	4.991	0.612	343.143
2/15/2001	TMat1	19	0:15	1.17666637	12.290	2.695	4.819	0.559	94.722
2/15/2001	TMat1	20	2:15	0.92747978	12.230	2.722	4.689	0.539	48.378
2/15/2001	TMat1	21	4:15	0.86132186	12.310	2.679	4.581	0.572	44.507
2/15/2001	TMat1	22	6:15	0.85408066	12.270	2.648	4.360	0.556	34.286
2/15/2001	TMat1	23	8:15	0.84686160	12.240	2.610	4.230	0.585	17.465
2/15/2001	TMat1	24	10:15	0.81820761	12.220	2.601	4.073	0.563	12.394
2/15/2001	TMat1	1	11:00	0.80401474	12.110	2.612	3.774	0.514	18.462
2/15/2001	TMat1	2	14:00	0.72757457	12.310	2.613	3.523	0.500	21.714
2/15/2001	TMat1	3	17:00	0.69374954	12.720	2.626	3.389	0.502	11.389
2/15/2001	TMat1	4	20:00	0.67373527	12.830	2.654	3.363	0.513	15.733
2/15/2001	TMat1	5	23:00	0.62786531	12.920	2.638	3.376	0.516	9.722
2/16/2001	TMat1	6	2:00	0.58948703	13.000	2.631	3.268	0.517	8.421
2/16/2001	TMat1	7	5:00	0.57062792	13.080	2.612	3.518	0.621	11.233

2/16/2001	TMat1	8	8:00	0.55817875	13.150	2.600	3.247	0.533	5.429
2/16/2001	TMat1	9	11:00	0.56439093	13.240	2.601	3.287	0.526	6.575
2/16/2001	TMat1	10	14:00	0.55817875	13.390	2.563	3.494	0.524	15.000
2/16/2001	TMat1	11	17:00	0.82533766	11.070	2.461	3.293	0.593	71.667
2/16/2001	TMat1	12	20:00	0.76197785	11.610	2.589	3.287	0.515	17.778
2/16/2001	TMat1	13	23:00	0.64085156	11.860	2.635	3.269	0.456	11.268
2/17/2001	TMat1	14	2:00	0.53357973	11.980	2.653	3.058	0.479	6.479
2/17/2001	TMat1	15	5:00	0.46222350	11.920	2.609	2.998	0.471	6.316
2/17/2001	TMat1	16	8:00	0.39464572	12.160	2.669	2.940	0.517	9.577
2/17/2001	TMat1	17	11:00	0.36232573	12.140	2.686	2.851	0.557	12.800
2/17/2001	TMat1	18	14:00	0.33616305	12.160	2.626	2.891	0.49	7.895
2/17/2001	TMat1	19	17:00	0.31071660	12.580	2.655	2.846	0.519	8.333
2/17/2001	TMat1	20	20:00	0.29088571	13.660	2.844	2.986	0.548	8.108
2/17/2001	TMat1	21	23:00	0.27153195	14.380	2.938	3.140	0.558	7.632
5/23/2001	TMat1	1	13:00		8.345	1.823	0.801	0.356	3.704
5/23/2001	TMat1	2	17:00		8.884	2.002	0.921	0.363	3.467
5/23/2001	TMat1	3	21:00		9.211	1.973	0.880	0.379	2.308
5/24/2001	TMat1	4	1:00		8.748	1.939	0.811	0.399	2.250
5/24/2001	TMat1	5	5:00		9.418	2.183	0.776	0.367	2.500
5/24/2001	TMat1	6	9:00		8.129	2.143	0.840	0.381	4.211
5/24/2001	TMat1	7	13:00						6.500
5/25/2001	TMat1	13	13:00		10.470	2.366	0.783	0.392	8.500
5/25/2001	TMat1	14	17:00		6.662	1.528	0.694	0.322	108.333
6/24/2001	TMat1	17	8:00		13.020	4.105	0.747	0.393	10.465
7/5/2001	TMat1	13			16.230	5.134	6.057	0.737	44.500

7/5/2001	TMat1	14	16.650	5.289	5.446	0.646	18.000	
7/5/2001	TMat1	15	15.860	5.531	4.815	0.678	41.200	
7/5/2001	TMat1	16	16.720	5.802	4.860	0.701	14.000	
7/5/2001	TMat1	17	17.040	5.600	4.319	0.669	6.400	
7/6/2001	TMat1	18	17.620	5.816	3.906	0.57	5.773	
2/15/2001		1C-TMat1	10.480	2.615	3.901	0.521		1.9381
2/16/2001		5C- TMat1	10.670	2.633	3.544	0.523		2.1768
2/16/2001		9C- TMat1	10.600	2.566	3.253	0.513		2.32811
2/17/2001		13C- TMat1	11.000	2.638	3.121	0.492		2.7123
2/17/2001		17C- TMat1	11.570	2.718	2.938	0.53		2.86676
2/13/2001		1C- TMat1	9.459	2.123	2.447	1.152		2.55168
2/13/2001		5C- TMat1	10.280	2.277	2.549	0.48		2.48936
2/14/2001		9C- TMat1	11.020	2.420	2.838	0.491		2.52096
2/14/2001		13C- TMat1	10.040	2.267	3.320	0.461		2.31444
2/14/2001		17C- TMat1	11.250	2.563	4.912	0.587		2.28461
2/15/2001		21C- TMat1	11.590	2.629	4.347	0.523		2.19474
2/8/2001		6C- TMat1	9.947	2.114	2.769	0.551		1.73161
2/9/2001		10C- TMat1	8.596	1.934	2.657	0.448		1.71779
2/9/2001		14C- TMat1	8.677	1.972	2.894	0.475		1.82989
2/10/2001		18C- TMat1	9.848	2.169	2.791	0.477		2.30101
2/11/2001		22C- TMat1	12.340	2.648	2.914	0.586		2.56098
2/11/2001		1C-TNef1	4.490	2.504	0.586	0.444		4.82001
2/11/2001		5C- TNef1	4.436	2.422	0.600	0.469		4.85976
2/12/2001		9C- TNef1	4.305	2.319	0.613	0.446		4.77873
2/12/2001		13C- TNef1	4.245	2.299	0.644	0.429		4.72154

2/12/2001	17C- TNef1	4.257	2.321	0.677	0.428	4.65166
2/13/2001	21C- TNef1	4.216	2.302	0.693	0.439	4.65039
2/15/2001	1C- TNef1	4.550	2.630	0.548	0.455	4.50807
2/16/2001	5C- TNef1	6.256	2.547	0.570	0.461	5.40511
2/16/2001	9C- TNef1	6.711	2.511	0.595	0.451	5.39463
2/17/2001	13C- TNef1	4.293	2.421	0.576	0.45	5.43428
2/17/2001	17C- TNef1	4.053	2.342	0.560	0.45	5.41949
2/18/2001	21C- TNef1	3.975	2.298	0.565	0.439	5.54242
2/13/2001	1C- TNef1	4.209	2.319	0.536	0.456	4.75164
2/13/2001	5C- TNef1	4.313	2.356	0.591	0.461	4.64309
2/14/2001	9C- TNef1	4.229	2.362	0.546	0.48	4.52315
2/14/2001	13C- TNef1	4.228	2.369	0.544	0.454	4.51944
2/14/2001	17C- TNef1	5.046	2.747	0.676	0.49	4.13615
2/15/2001	21C- TNef1	5.086	2.694	0.594	0.475	4.52095
2/8/2001	1C- TNef1	3.859	2.120	0.496	0.457	5.13994
2/8/2001	5C- TNef1	4.036	1.904	0.507	0.449	5.32263
2/9/2001	9C- TNef1	4.933	2.570	0.710	0.476	4.98779
2/9/2001	13C- TNef1	5.893	3.063	0.714	0.485	4.41771
2/10/2001	17C- TNef1	5.345	2.757	0.692	0.449	4.78148
2/10/2001	21C- TNef1	5.061	2.604	0.661	0.492	4.56331
3/11/2001	16 TMat1	10.250	2.755	2.190	0.592	
3/11/2001	17 TMat1	10.120	2.698	2.273	0.565	
3/11/2001	15 TNef1	3.387	2.020	0.578	0.344	
3/11/2001	16 TNef1	3.497	1.993	0.529	0.423	
3/11/2001	17 TNef1	3.357	2.024	0.573	0.32	

3/11/2001	18 TNef1	3.268	2.031	0.464	0.396	
3/12/2001	1C- TMat1	10.150	2.556	2.442	0.714	433.489
3/13/2001	5C- TMat1	8.457	2.242	2.205	0.665	531.448
3/13/2001	9C- TMat1	7.736	1.977	1.965	0.489	73.600
3/14/2001	13C- TMat1	7.974	2.094	2.032	0.416	11.400
3/14/2001	17C- TMat1	8.009	2.132	2.031	0.479	9.813
3/15/2001	21C- TMat1	8.374	2.017	1.743	0.455	2.000
3/13/2001	5C- TNef1	4.175	2.333	0.536	0.563	6.863
3/13/2001	9C- TNef1	4.183	2.235	0.644	0.721	176.042
3/14/2001	13C- TNef1	4.118	2.309	0.413	0.467	5.051
3/14/2001	17C- TNef1	3.864	2.369	0.714	0.42	1.400
3/15/2001	21C- TNef1	3.703	2.299	0.542	0.406	0.000
3/15/2001	1C- TNef1	3.883	2.283	0.643	0.375	2.000
3/15/2001	5C- TNef1	3.679	2.327	0.679	0.31	0.600
3/16/2001	9C- TNef1	3.677	2.311	0.616	0.339	9.800
3/16/2001	13C- TNef1	4.181	2.406	0.635	0.407	5.000
3/16/2001	17C- TNef1	3.853	2.435	0.710	0.419	0.000
3/17/2001	21C- TNef1	3.790	2.376	0.532	0.404	2.600
3/15/2001	1C- TMat1	8.149	2.080	1.888	0.451	4.400
3/15/2001	5C- TMat1	8.332	2.207	2.033	0.471	4.2
3/16/2001	9C- TMat1	8.413	2.215	1.939	0.488	8.4
3/16/2001	13C- TMat1	8.412	2.266	2.007	0.508	20.8
3/16/2001	17C- TMat1	8.693	2.314	1.923	0.389	5.200
3/17/2001	21C- TMat1	8.684	2.289	1.958	0.355	4.200
3/29/2001	1C- TMat1	11.150	2.592	1.745	0.526	172.800

3/30/2001	5C- TMat1	9.875	2.170	1.621	0.453	28.200
3/30/2001	9C- TMat1	9.684	2.196	1.586	0.446	5.8
3/31/2001	13C- TMat1	10.240	2.325	1.661	0.46	5
4/1/2001	17C- TMat1	10.830	2.503	1.723	0.457	7.8
4/1/2001	21C- TMat1	11.340	2.606	1.698	0.469	4.000
3/29/2001	1C- TNef1	3.744	1.942	0.454	0.41	11.200
3/30/2001	5C- TNef1	4.105	2.087	0.443	0.424	3.000
3/30/2001	9C- TNef1	3.900	1.998	0.464	0.412	2.000
3/31/2001	13C- TNef1	3.829	1.961	0.443	0.408	1.200
4/1/2001	17C- TNef1	3.839	1.934	0.473	0.407	2.600
4/1/2001	21C- TNef1	3.694	1.890	0.450	0.408	1.600
4/2/2001	TNef1 grab	3.609	1.840	0.479	0.412	1.200
4/11/2001	1C- TMat1	10.750	2.683	1.700	0.507	14.8
4/11/2001	5C- TMat1	10.570	2.718	1.664	0.53	6.6
4/12/2001	9C- TMat1	10.570	2.707	1.729	0.512	5.4
4/12/2001	13C- TMat1	11.120	2.891	1.888	0.527	7.000
4/13/2001	17C- TMat1	11.460	3.050	1.798	0.536	5.098
4/13/2001	21C- TMat1	11.740	3.156	1.754	0.528	4.600
4/11/2001	1C- TNef1	3.980	2.265	0.628	0.443	18.000
4/11/2001	5C- TNef1	3.910	2.224	0.591	0.442	4.600
4/12/2001	9C- TNef1	3.806	2.164	0.560	0.434	2.800
4/12/2001	13C- TNef1	3.658	2.105	0.580	0.449	3.400
4/13/2001	17C- TNef1	3.571	2.095	0.571	0.435	3.400
4/13/2001	21C- TNef1	3.615	2.080	0.556	0.425	3.200
4/15/2001	1C- TNef1	3.649	2.153	0.351	0.444	15.135

4/16/2001	5C- TNef1	3.960	2.262	0.455	0.421	4.200
4/16/2001	9C- TNef1	3.650	2.112	0.748	0.411	1.600
4/17/2001	13C- TNef1	3.438	2.110	0.470	0.434	1.400
4/18/2001	17C- TNef1	3.380	2.084	0.460	0.429	1.800
4/15/2001	1C- TMat1	9.943	2.534	1.443	0.615	215.676
4/16/2001	5C- TMat1	8.859	2.247	1.178	0.569	31.165
4/16/2001	9C- TMat1	9.554	2.509	1.163	0.466	6.400
4/17/2001	13C- TMat1	10.330	2.665	1.258	0.469	3.800
4/18/2001	17C- TMat1	11.950	3.054	1.254	0.498	3.200
5/21/2001	1C- TMat1	11.680	2.755	1.244	0.42	7.525
5/22/2001	5C- TMat1	11.040	2.542	1.092	0.415	6.400
5/22/2001	9C- TMat1	11.030	2.400	1.158	0.421	8.200
5/22/2001	13C- TMat1	7.320	1.560	1.506	1.009	3576.250
5/23/2001	17C- TMat1	7.848	1.742	0.936	0.33	24.752
5/23/2001	21C- TMat1	8.143	1.818	0.781	0.33	7.879
5/22/2001	14C- TNef1	4.922	2.471	1.389	0.532	94.833
5/23/2001	19C- TNef1	4.316	2.205	0.602	0.443	0.800
5/23/2001	1C- TNef1	4.005	2.107	0.937	0.439	1.800
5/24/2001	5C- TNef1	3.905	2.047	0.987	0.488	0.000
5/24/2001	9C- TNef1	3.560	2.025	0.935	0.445	0.588
5/25/2001	13C- TNef1	4.232	2.230	0.573	0.427	3.721
5/26/2001	17C- TNef1	3.936	2.207	0.532	0.521	0.000
5/26/2001	21C- TNef1	3.728	2.127	0.560	0.41	0.792
6/22/2001	8C- TMat1	10.070	3.340	0.999	0.391	61.091
6/23/2001	12C- TMat1	9.671	2.798	1.365	0.333	14.670

Appendix E. Soil cation exchange capacity and exchangeable bases. Exchangeable bases and acidity are in units of $cmol_c$/kg soil. Effective cation exchange capacity (ECEC) is in units of $cmol_c$/kg soil and meq/kg soil, for ease of comparison with published data. Soil types consist of: OCR (organic crust), Oea (combined Oe and Oa organic horizons), and <2mm (less than 2mm fraction of A horizon mineral soil). Rel. % Diff. is the relative percent difference between the sample and lab duplicate (LD).

Sample ID	date	site	soil type	$cmol_c$ Na/kg	$cmol_c$ K/kg	$cmol_c$ Ca/kg	$cmol_c$ Mg/kg
1c	7/5/00	TMat1	OCR	0.25	0.93	33.34	2.29
3c	7/5/00	TMat1	OCR	0.95	1.70	43.83	3.06
5c	7/5/00	TMat1	OCR	0.78	1.18	33.49	2.16
7c	7/5/00	TMat1	OCR	0.62	1.89	35.94	2.44
9c	7/5/00	TMat1	OCR	0.73	1.35	31.73	2.55
11c	7/5/00	TMat1	OCR	0.69	1.04	31.69	2.42
13c	7/5/00	TMat1	OCR	0.57	2.44	44.74	5.48
15c	7/5/00	TMat1	OCR	0.64	1.79	42.19	5.90
17c	7/5/00	TMat1	OCR	0.64	3.03	46.91	5.40
19c	7/5/00	TMat1	OCR	0.45	1.41	37.16	5.13
21c	7/5/00	TMat1	OCR	0.55	1.79	36.35	5.21
23c	7/5/00	TMat1	OCR	0.94	3.36	40.18	6.64
25c	7/5/00	TMat1	OCR	0.32	1.59	33.32	6.79
25c LD	7/5/00	TMat1	OCR	0.27	0.48	53.17	19.59
27c	7/5/00	TMat1	OCR	0.38	1.44	34.66	4.34
29c	7/5/00	TMat1	OCR	0.36	1.49	47.44	3.79
31c	7/5/00	TMat1	OCR	0.71	0.48	11.86	1.52
33c	7/5/00	TMat1	OCR				
35c	7/5/00	TMat1	OCR	0.35	1.59	26.84	3.50
37c	7/5/00	TMat1	OCR	0.46	1.29	19.21	2.81
39c	7/5/00	TMat1	OCR	1.61	0.94	17.95	2.65
41c	7/5/00	TMat1	OCR				
43c	7/5/00	TMat1	OCR				
45c	7/5/00	TMat1	OCR	0.98	0.96	17.26	1.76
47c	7/5/00	TMat1	OCR	0.22	0.69	17.18	1.63
49c	7/5/00	TMat1	OCR	0.43	2.05	17.40	1.46
49c LD	7/5/00	TMat1	OCR				
51c	7/5/00	TMat1	OCR	0.51	1.93	21.26	1.46
53c	7/5/00	TMat1	OCR	0.84	0.87	15.31	1.06
55c	7/5/00	TMat1	OCR	0.52	0.85	13.24	0.84
57c	7/5/00	TMat1	OCR	0.68	3.19	13.98	1.42

59c	7/5/00	TMat1	OCR				
61c	7/5/00	TMat1	OCR	1.02	2.93	26.22	6.45
63c	7/5/00	TMat1	OCR	1.28	1.61	27.76	5.01
65c	7/5/00	TMat1	OCR	0.17	0.91	16.31	2.85
65c LD	7/5/00	TMat1	OCR				
67c	7/5/00	TMat1	OCR	0.23	1.41	23.24	4.19
69c	7/5/00	TMat1	OCR	0.97	0.97	5.93	2.97
71c	7/5/00	TMat1	OCR	0.91	1.10	15.70	7.68
73c	7/5/00	TMat1	OCR	0.29	1.27	20.27	8.66
75c	7/5/00	TMat1	OCR	0.23	0.54	1.58	1.95
75c LD	7/5/00	TMat1	OCR	0.37	0.65	1.97	5.22
77c	7/5/00	TMat1	OCR	0.35	1.20	19.84	3.97
79c	7/5/00	TMat1	OCR				
81c	7/5/00	TMat1	OCR	0.21	1.14	16.73	3.09
83c	7/5/00	TMat1	OCR	0.42	0.90	25.18	3.60
85c	7/5/00	TMat1	OCR	0.87	3.18	15.27	2.15
87c	7/5/00	TMat1	OCR	0.60	1.44	22.47	4.01
89c	7/5/00	TMat1	OCR	0.27	0.58	14.48	2.20
91c	7/5/00	TMat1	OCR	0.43	1.94	2.85	1.77
91c LD	7/5/00	TMat1	OCR				
93c	7/5/00	TMat1	OCR	0.32	2.74	4.72	2.35
95c	7/5/00	TMat1	OCR	2.19	0.86	5.43	1.85
97c	7/5/00	TMat1	OCR	0.32	2.05	1.75	1.44
97c LD	7/5/00	TMat1	OCR				
99c	7/5/00	TMat1	OCR	0.64	0.97	6.33	1.55
101c	7/5/00	TMat1	OCR	0.37	1.24	11.70	2.01
101c LD	7/5/00	TMat1	OCR	0.56	0.24	20.23	6.47
103c	7/5/00	TMat1	OCR	0.38	2.12	14.57	2.67
105c	7/5/00	TMat1	OCR	0.27	1.94	3.59	1.75
105c LD	7/5/00	TMat1	OCR	0.26	1.42	7.51	6.25
1c	7/5/00	TMat1	<2mm	0.07	0.52	7.00	0.54
3c	7/5/00	TMat1	<2mm	0.08	0.20	8.17	0.48
5c	7/5/00	TMat1	<2mm	0.08	0.22	7.29	0.50
5c LD	7/5/00	TMat1	<2mm				
7c	7/5/00	TMat1	<2mm	0.14	0.18	6.06	0.43
7c LD	7/5/00	TMat1	<2mm	0.11	0.15	6.15	0.41
9c	7/5/00	TMat1	<2mm	0.10	0.20	6.42	0.47
9c LD	7/5/00	TMat1	<2mm				
11c	7/5/00	TMat1	<2mm	0.14	0.16	4.97	0.63

13c	7/5/00	TMat1	<2mm	0.13	0.17	5.65	0.53
13c LD	7/5/00	TMat1	<2mm	0.15	0.17	5.74	0.50
15c	7/5/00	TMat1	<2mm	0.13	0.15	4.23	0.45
15c LD	7/5/00	TMat1	<2mm				
17c	7/5/00	TMat1	<2mm	0.14	0.16	5.58	0.44
17c LD	7/5/00	TMat1	<2mm				
19c	7/5/00	TMat1	<2mm	0.09	0.14	3.79	0.60
21c	7/5/00	TMat1	<2mm	0.07	0.21	4.44	0.56
23c	7/5/00	TMat1	<2mm	0.08	0.17	6.68	0.51
25c	7/5/00	TMat1	<2mm	0.08	0.17	4.66	0.64
27c	7/5/00	TMat1	<2mm	0.08	0.14	5.35	0.45
27c LD	7/5/00	TMat1	<2mm				
29c	7/5/00	TMat1	<2mm	0.09	0.15	3.64	0.34
31c	7/5/00	TMat1	<2mm	0.07	0.10	2.88	0.48
33c	7/5/00	TMat1	<2mm	0.07	0.11	2.47	0.47
35c	7/5/00	TMat1	<2mm	0.11	1.25	3.48	0.53
35c LD	7/5/00	TMat1	<2mm				
37c	7/5/00	TMat1	<2mm	0.08	0.08	2.00	0.41
39c	7/5/00	TMat1	<2mm	0.09	0.13	3.33	0.59
41c	7/5/00	TMat1	<2mm	0.08	0.11	2.81	0.44
43c	7/5/00	TMat1	<2mm	0.14	0.12	3.36	0.37
43c LD	7/5/00	TMat1	<2mm	0.13	0.10	3.61	0.36
45c	7/5/00	TMat1	<2mm	0.13	0.12	2.91	0.31
47c	7/5/00	TMat1	<2mm	0.11	0.11	3.73	0.37
49c	7/5/00	TMat1	<2mm	0.08	0.12	3.16	0.22
51c	7/5/00	TMat1	<2mm	0.08	0.09	3.90	0.21
53c	7/5/00	TMat1	<2mm	0.07	0.11	3.62	0.23
55c	7/5/00	TMat1	<2mm	0.08	0.09	3.23	0.16
57c	7/5/00	TMat1	<2mm	0.07	0.06	1.72	0.14
59c	7/5/00	TMat1	<2mm	0.07	0.09	0.07	0.06
59c LD	7/5/00	TMat1	<2mm				
61c	7/5/00	TMat1	<2mm	0.13	0.19	5.76	1.29
63c	7/5/00	TMat1	<2mm	0.14	0.22	6.86	1.34
63c LD	7/5/00	TMat1	<2mm	0.15	0.19	7.08	1.33
65c	7/5/00	TMat1	<2mm	0.15	0.12	4.59	1.09
65c LD	7/5/00	TMat1	<2mm	0.16	0.12	4.84	1.06
67c	7/5/00	TMat1	<2mm	0.14	0.15	5.04	1.25
69c	7/5/00	TMat1	<2mm	0.13	0.12	1.05	1.16
71c	7/5/00	TMat1	<2mm	0.09	0.23	2.78	2.25

73c	7/5/00	TMat1	<2mm	0.10	0.23	3.51	2.61
75c	7/5/00	TMat1	<2mm	0.11	0.12	0.32	1.10
77c	7/5/00	TMat1	<2mm	0.15	0.14	2.11	0.94
79c	7/5/00	TMat1	<2mm	0.11	0.09	1.57	0.67
79c LD	7/5/00	TMat1	<2mm	0.14	0.00	1.63	0.66
81c	7/5/00	TMat1	<2mm	0.15	0.16	3.28	0.91
83c	7/5/00	TMat1	<2mm	0.10	0.12	5.53	0.88
85c	7/5/00	TMat1	<2mm	0.09	0.13	4.70	0.83
87c	7/5/00	TMat1	<2mm	0.09	0.17	2.77	0.68
89c	7/5/00	TMat1	<2mm	0.09	0.14	2.34	0.62
91c	7/5/00	TMat1	<2mm	0.36	0.66	0.09	0.42
93c	7/5/00	TMat1	<2mm	1.17	0.40	0.44	0.57
95c	7/5/00	TMat1	<2mm	0.17	0.12	0.03	0.12
97c	7/5/00	TMat1	<2mm	0.48	0.27	0.06	0.23
99c	7/5/00	TMat1	<2mm	0.12	0.13	0.02	0.06
101c	7/5/00	TMat1	<2mm	0.09	0.12	0.04	0.07
103c	7/5/00	TMat1	<2mm	0.10	0.20	0.02	0.08
105c	7/5/00	TMat1	<2mm	0.09	0.22	0.02	0.07
1c	8/25/99	TNef1	<2mm	0.08	0.17	0.16	0.18
1c LD	8/25/99	TNef1	<2mm				
3c	8/25/99	TNef1	<2mm	0.08	0.20	0.46	0.25
5c	8/25/99	TNef1	<2mm	0.20	0.24	0.44	0.28
7c	8/25/99	TNef1	<2mm	0.08	0.18	0.19	0.19
7c LD	8/25/99	TNef1	<2mm				
9c	8/25/99	TNef1	<2mm	0.08	0.14	0.17	0.18
11c	8/25/99	TNef1	<2mm	0.10	0.11	0.10	0.14
13c	8/25/99	TNef1	<2mm	0.14	0.14	0.30	0.21
15c	8/25/99	TNef1	<2mm	0.12	0.13	0.22	0.15
17c	8/25/99	TNef1	<2mm	0.12	0.13	0.23	0.14
19c	8/25/99	TNef1	<2mm	0.12	0.11	0.34	0.16
21c	8/25/99	TNef1	<2mm	0.11	0.12	0.50	0.15
23c	8/25/99	TNef1	<2mm	0.11	0.13	1.34	0.25
25c	8/25/99	TNef1	<2mm	0.12	0.11	2.46	0.28
27c	8/25/99	TNef1	<2mm	0.08	0.16	2.32	0.38
27c LD	8/25/99	TNef1	<2mm				
29c	8/25/99	TNef1	<2mm	0.11	0.12	3.19	0.34
31c	8/25/99	TNef1	<2mm	0.03	0.17	0.09	0.20
31c LD	8/25/99	TNef1	<2mm				
33c	8/25/99	TNef1	<2mm	0.03	0.23	0.47	0.38

35c	8/25/99	TNef1	<2mm	0.03	0.18	0.12	0.23
35c LD	8/25/99	TNef1	<2mm				
37c	8/25/99	TNef1	<2mm	0.03	0.17	1.32	0.39
37c LD	8/25/99	TNef1	<2mm				
39c	8/25/99	TNef1	<2mm	0.02	0.13	0.78	0.22
41c	8/25/99	TNef1	<2mm	0.05	0.08	2.99	0.43
43c	8/25/99	TNef1	<2mm	0.03	0.14	0.38	0.14
45c	8/25/99	TNef1	<2mm	0.04	0.12	1.75	0.28
47c	8/25/99	TNef1	<2mm	0.09	0.09	5.75	0.49
49c	8/25/99	TNef1	<2mm	0.10	0.00	4.94	0.53
51c	8/25/99	TNef1	<2mm	0.04	0.08	2.33	0.27
53c	8/25/99	TNef1	<2mm	0.06	0.00	3.50	0.39
55c	8/25/99	TNef1	<2mm	0.04	0.16	2.89	0.38
57c	8/25/99	TNef1	<2mm	0.08	0.06	5.40	0.60
59c	8/25/99	TNef1	<2mm	0.05	0.18	3.48	0.70
61c	8/25/99	TNef1	<2mm	0.03	0.17	0.73	0.25
63c	8/25/99	TNef1	<2mm	0.02	0.24	0.60	0.24
65c	8/25/99	TNef1	<2mm	0.03	0.21	0.85	0.25
67c	8/25/99	TNef1	<2mm	0.02	0.16	0.36	0.20
69c	8/25/99	TNef1	<2mm	0.02	0.11	0.37	0.17
71c	8/25/99	TNef1	<2mm	0.02	0.12	0.67	0.15
73c	8/25/99	TNef1	<2mm	0.02	0.10	0.33	0.16
75c	8/25/99	TNef1	<2mm	0.02	0.07	0.42	0.14
77c	8/25/99	TNef1	<2mm	0.03	0.05	0.42	0.16
79c	8/25/99	TNef1	<2mm	0.04	0.02	1.00	0.18
81c	8/25/99	TNef1	<2mm	0.03	0.09	0.92	0.23
83c	8/25/99	TNef1	<2mm	0.03	0.13	1.31	0.25
85c	8/25/99	TNef1	<2mm	0.03	0.15	2.98	0.35
87c	8/25/99	TNef1	<2mm	0.02	0.10	1.88	0.27
89c	8/25/99	TNef1	<2mm	0.03	0.12	11.13	0.76
1c	8/25/99	TNef1	Oea	0.37	0.00	16.41	3.25
3c	8/25/99	TNef1	Oea	1.26	0.00	30.53	4.36
3c LD	8/25/99	TNef1	Oea				
5c	8/25/99	TNef1	Oea	0.35	0.00	29.71	3.66
7c	8/25/99	TNef1	Oea	0.25	0.00	18.57	3.45
9c	8/25/99	TNef1	Oea	0.57	0.00	16.99	2.57
11c	8/25/99	TNef1	Oea	0.13	0.32	21.12	2.81
13c	8/25/99	TNef1	Oea	0.63	0.00	22.66	4.12
15c	8/25/99	TNef1	Oea	0.37	0.00	30.34	5.15

17c	8/25/99	TNef1	Oea	0.71	0.00	24.03	2.83
19c	8/25/99	TNef1	Oea	0.25	0.00	16.40	1.65
21c	8/25/99	TNef1	Oea	0.54	0.00	22.22	2.41
23c	8/25/99	TNef1	Oea	0.39	0.00	34.28	3.27
25c	8/25/99	TNef1	Oea	0.00	0.00	38.74	3.69
25c LD	8/25/99	TNef1	Oea	0.20	1.40	44.30	3.94
27c	8/25/99	TNef1	Oea	0.33	0.00	37.64	3.67
29c	8/25/99	TNef1	Oea	0.44	0.00	51.18	4.29
31c	8/25/99	TNef1	Oea	0.49	0.00	14.61	2.50
33c	8/25/99	TNef1	Oea	0.51	0.00	26.98	4.41
35c	8/25/99	TNef1	Oea	0.50	0.00	28.23	3.85
37c	8/25/99	TNef1	Oea	0.52	0.00	46.43	6.46
39c	8/25/99	TNef1	Oea	0.44	0.00	59.71	7.03
41c	8/25/99	TNef1	Oea	1.02	0.00	62.42	9.26
43c	8/25/99	TNef1	Oea	0.31	0.00	23.03	2.32
45c	8/25/99	TNef1	Oea	0.70	0.00	29.71	2.99
47c	8/25/99	TNef1	Oea	0.73	0.00	22.62	2.31
47c LD	8/25/99	TNef1	Oea	0.08	0.95	25.55	2.48
49c	8/25/99	TNef1	Oea	0.38	0.00	30.13	3.52
51c	8/25/99	TNef1	Oea	0.57	0.00	30.64	3.10
53c	8/25/99	TNef1	Oea	0.40	0.00	34.72	2.11
55c	8/25/99	TNef1	Oea	0.41	0.00	25.66	3.21
57c	8/25/99	TNef1	Oea	0.64	0.00	58.49	5.42
59c	8/25/99	TNef1	Oea	0.48	0.00	27.26	3.63
61c	8/25/99	TNef1	Oea	0.62	0.94	18.69	2.64
63c	8/25/99	TNef1	Oea	0.29	0.00	20.81	2.83
63c LD	8/25/99	TNef1	Oea	0.17	0.96	18.55	2.40
65c	8/25/99	TNef1	Oea	0.79	0.12	29.40	3.93
67c	8/25/99	TNef1	Oea	0.60	0.00	22.81	3.29
69c	8/25/99	TNef1	Oea	0.50	0.43	28.76	3.08
69c LD	8/25/99	TNef1	Oea	0.18	1.39	30.03	2.96
71c	8/25/99	TNef1	Oea	0.74	0.00	27.97	2.04
73c	8/25/99	TNef1	Oea	0.54	0.00	31.27	3.46
75c	8/25/99	TNef1	Oea	0.54	0.00	14.05	1.69
77c	8/25/99	TNef1	Oea	1.22	0.00	29.74	2.64
79c	8/25/99	TNef1	Oea	0.30	0.00	33.52	2.58
79c LD	8/25/99	TNef1	Oea	0.16	1.79	34.06	2.61
81c	8/25/99	TNef1	Oea	1.07	0.00	28.24	3.21
83c	8/25/99	TNef1	Oea	0.83	0.00	32.00	3.01

85c	8/25/99	TNef1	Oea	0.86	0.00	21.32	1.91
87c	8/25/99	TNef1	Oea	0.71	0.00	57.46	5.22
89c	8/25/99	TNef1	Oea	0.42	0.19	79.15	5.29

Sample ID	date	site	soil type	$cmol_c$ ex. Acidity	ECEC ($cmol_c$/kg)	Rel.% Diff.	ECEC (meq/kg)
1c	7/5/00	TMat1	OCR	0.32	7537.14		75371.36
3c	7/5/00	TMat1	OCR	1.40	7550.94		75509.42
5c	7/5/00	TMat1	OCR	0.72	7538.34		75383.35
7c	7/5/00	TMat1	OCR	1.21	7542.10		75421.00
9c	7/5/00	TMat1	OCR	0.60	7536.95		75369.52
11c	7/5/00	TMat1	OCR	0.68	7536.52		75365.19
13c	7/5/00	TMat1	OCR	1.30	7554.53		75545.34
15c	7/5/00	TMat1	OCR	1.36	7551.87		75518.74
17c	7/5/00	TMat1	OCR	1.11	7557.09		75570.94
19c	7/5/00	TMat1	OCR	0.95	7545.10		75450.95
21c	7/5/00	TMat1	OCR	1.03	7544.94		75449.38
23c	7/5/00	TMat1	OCR	1.79	7552.90		75528.98
25c	7/5/00	TMat1	OCR	1.01	7543.03	-0.42	75430.28
25c LD	7/5/00	TMat1	OCR	1.08	7574.60		75745.99
27c	7/5/00	TMat1	OCR	1.39	7542.22		75422.20
29c	7/5/00	TMat1	OCR	0.65	7553.74		75537.38
31c	7/5/00	TMat1	OCR	0.77	7515.35		75153.46
33c	7/5/00	TMat1	OCR		NO SAMPLE		
35c	7/5/00	TMat1	OCR	1.59	7533.87		75338.70
37c	7/5/00	TMat1	OCR	1.13	7524.90		75248.97
39c	7/5/00	TMat1	OCR	8.03	7531.18		75311.77
41c	7/5/00	TMat1	OCR		NO SAMPLE		
43c	7/5/00	TMat1	OCR		NO SAMPLE		
45c	7/5/00	TMat1	OCR	1.06	7522.03		75220.29
47c	7/5/00	TMat1	OCR	0.50	7520.22		75202.25
49c	7/5/00	TMat1	OCR	0.66	7521.99		75219.90
49c LD	7/5/00	TMat1	OCR	0.74			0.00
51c	7/5/00	TMat1	OCR	1.16	7526.31		75263.09
53c	7/5/00	TMat1	OCR	1.36	7519.44		75194.38
55c	7/5/00	TMat1	OCR	1.16	7516.61		75166.06
57c	7/5/00	TMat1	OCR	1.36	7520.63		75206.33
59c	7/5/00	TMat1	OCR		NO		

					SAMPLE	
61c	7/5/00	TMat1	OCR	4.14	7540.77	75407.67
63c	7/5/00	TMat1	OCR	0.52	7536.17	75361.74
65c	7/5/00	TMat1	OCR	0.53	7520.77	75207.68
65c LD	7/5/00	TMat1	OCR	0.74		0.00
67c	7/5/00	TMat1	OCR	0.93	7530.00	75299.95
69c	7/5/00	TMat1	OCR	3.73	7514.58	75145.78
71c	7/5/00	TMat1	OCR	0.95	7526.35	75263.47
73c	7/5/00	TMat1	OCR	0.76	7531.25	75312.55
75c	7/5/00	TMat1	OCR	3.04	7507.33	75073.31
75c LD	7/5/00	TMat1	OCR		7508.20	75081.98
77c	7/5/00	TMat1	OCR	1.05	7526.42	75264.16
79c	7/5/00	TMat1	OCR		NO SAMPLE	
81c	7/5/00	TMat1	OCR	0.55	7521.72	75217.18
83c	7/5/00	TMat1	OCR	0.54	7530.63	75306.32
85c	7/5/00	TMat1	OCR	1.31	7522.77	75227.75
87c	7/5/00	TMat1	OCR	1.72	7530.24	75302.39
89c	7/5/00	TMat1	OCR	1.27	7518.80	75187.98
91c	7/5/00	TMat1	OCR	13.69	7520.68	75206.79
91c LD	7/5/00	TMat1	OCR	12.51		0.00
93c	7/5/00	TMat1	OCR	14.54	7524.66	75246.61
95c	7/5/00	TMat1	OCR		7510.33	75103.32
97c	7/5/00	TMat1	OCR	17.98	7523.54	75235.44
97c LD	7/5/00	TMat1	OCR	16.92		0.00
99c	7/5/00	TMat1	OCR	9.68	7519.16	75191.61
101c	7/5/00	TMat1	OCR	9.81	7525.13	75251.30
101c LD	7/5/00	TMat1	OCR		7527.50	75274.98
103c	7/5/00	TMat1	OCR	12.30	7532.04	75320.41
105c	7/5/00	TMat1	OCR	17.21	7524.76	75247.60
105c LD	7/5/00	TMat1	OCR		7515.44	75154.41
1c	7/5/00	TMat1	<2mm	0.11	7508.24	75082.41
3c	7/5/00	TMat1	<2mm	0.06	7509.00	75089.95
5c	7/5/00	TMat1	<2mm	0.15	7508.24	75082.41
5c LD	7/5/00	TMat1	<2mm	0.10		0.00
7c	7/5/00	TMat1	<2mm	0.06	7506.87	75068.70
7c LD	7/5/00	TMat1	<2mm		7506.82	75068.20
9c	7/5/00	TMat1	<2mm	0.15	7507.34	75073.41
9c LD	7/5/00	TMat1	<2mm	0.10		0.00

11c	7/5/00	TMat1	<2mm	0.30	7506.20	75062.00
13c	7/5/00	TMat1	<2mm	0.10	7506.58	75065.80
13c LD	7/5/00	TMat1	<2mm		7506.56	75065.58
15c	7/5/00	TMat1	<2mm	0.45	7505.41	75054.15
15c LD	7/5/00	TMat1	<2mm	0.44		0.00
17c	7/5/00	TMat1	<2mm	0.10	7506.41	75064.08
17c LD	7/5/00	TMat1	<2mm	0.11		0.00
19c	7/5/00	TMat1	<2mm	0.91	7505.54	75055.40
21c	7/5/00	TMat1	<2mm	0.45	7505.73	75057.27
23c	7/5/00	TMat1	<2mm	0.10	7507.55	75075.48
25c	7/5/00	TMat1	<2mm	0.27	7505.82	75058.19
27c	7/5/00	TMat1	<2mm	0.19	7506.22	75062.16
27c LD	7/5/00	TMat1	<2mm	0.09		0.00
29c	7/5/00	TMat1	<2mm	0.28	7504.49	75044.94
31c	7/5/00	TMat1	<2mm	0.48	7504.01	75040.11
33c	7/5/00	TMat1	<2mm	0.82	7503.94	75039.43
35c	7/5/00	TMat1	<2mm	0.52	7505.89	75058.87
35c LD	7/5/00	TMat1	<2mm	0.38		0.00
37c	7/5/00	TMat1	<2mm	1.01	7503.58	75035.79
39c	7/5/00	TMat1	<2mm	0.55	7504.68	75046.85
41c	7/5/00	TMat1	<2mm	0.73	7504.16	75041.58
43c	7/5/00	TMat1	<2mm	0.56	7504.54	75045.37
43c LD	7/5/00	TMat1	<2mm		7504.20	75041.98
45c	7/5/00	TMat1	<2mm	0.70	7504.16	75041.63
47c	7/5/00	TMat1	<2mm	0.51	7504.83	75048.34
49c	7/5/00	TMat1	<2mm	0.67	7504.25	75042.46
51c	7/5/00	TMat1	<2mm	0.27	7504.56	75045.55
53c	7/5/00	TMat1	<2mm	0.73	7504.77	75047.65
55c	7/5/00	TMat1	<2mm	0.63	7504.20	75042.02
57c	7/5/00	TMat1	<2mm	1.74	7503.74	75037.37
59c	7/5/00	TMat1	<2mm	3.26	7503.55	75035.54
59c LD	7/5/00	TMat1	<2mm	3.19		0.00
61c	7/5/00	TMat1	<2mm	0.35	7507.72	75077.22
63c	7/5/00	TMat1	<2mm	0.10	7508.66	75086.62
63c LD	7/5/00	TMat1	<2mm		7508.75	75087.53
65c	7/5/00	TMat1	<2mm	0.39	7506.34	75063.37
65c LD	7/5/00	TMat1	<2mm		7506.18	75061.75
67c	7/5/00	TMat1	<2mm	0.39	7506.98	75069.78
69c	7/5/00	TMat1	<2mm	3.37	7505.82	75058.19

71c	7/5/00	TMat1	<2mm	1.05	7506.39	75063.87
73c	7/5/00	TMat1	<2mm	0.40	7506.85	75068.53
75c	7/5/00	TMat1	<2mm	3.22	7504.88	75048.80
77c	7/5/00	TMat1	<2mm	2.72	7506.07	75060.73
79c	7/5/00	TMat1	<2mm	2.24	7504.68	75046.79
79c LD	7/5/00	TMat1	<2mm		7502.44	75024.36
81c	7/5/00	TMat1	<2mm	1.39	7505.89	75058.93
83c	7/5/00	TMat1	<2mm	0.19	7506.81	75068.12
85c	7/5/00	TMat1	<2mm	0.70	7506.45	75064.50
87c	7/5/00	TMat1	<2mm	1.79	7505.49	75054.90
89c	7/5/00	TMat1	<2mm	2.17	7505.37	75053.74
91c	7/5/00	TMat1	<2mm	10.34	7511.87	75118.69
93c	7/5/00	TMat1	<2mm	15.12	7517.70	75176.97
95c	7/5/00	TMat1	<2mm	5.93	7506.36	75063.59
97c	7/5/00	TMat1	<2mm	13.07	7514.11	75141.13
99c	7/5/00	TMat1	<2mm	7.13	7507.45	75074.50
101c	7/5/00	TMat1	<2mm	6.80	7507.11	75071.14
103c	7/5/00	TMat1	<2mm	6.08	7506.48	75064.76
105c	7/5/00	TMat1	<2mm	8.26	7508.66	75086.63
1c	8/25/99	TNef1	<2mm	8.45	82608.04	826080.38
1c LD	8/25/99	TNef1	<2mm	8.15		0.00
3c	8/25/99	TNef1	<2mm	7.54	82607.53	826075.31
5c	8/25/99	TNef1	<2mm	8.48	82608.64	826086.40
7c	8/25/99	TNef1	<2mm	6.44	82606.08	826060.78
7c LD	8/25/99	TNef1	<2mm	6.07		0.00
9c	8/25/99	TNef1	<2mm	5.56	82605.12	826051.18
11c	8/25/99	TNef1	<2mm	6.30	82605.76	826057.61
13c	8/25/99	TNef1	<2mm	7.32	82607.11	826071.08
15c	8/25/99	TNef1	<2mm	5.32	82604.94	826049.45
17c	8/25/99	TNef1	<2mm	6.56	82606.18	826061.79
19c	8/25/99	TNef1	<2mm	6.23	82605.95	826059.52
21c	8/25/99	TNef1	<2mm	5.61	82605.50	826054.96
23c	8/25/99	TNef1	<2mm	3.92	82604.75	826047.53
25c	8/25/99	TNef1	<2mm	4.39	82606.36	826063.56
27c	8/25/99	TNef1	<2mm	1.08	82603.02	826030.16
27c LD	8/25/99	TNef1	<2mm	1.85		0.00
29c	8/25/99	TNef1	<2mm	2.36	82605.12	826051.21
31c	8/25/99	TNef1	<2mm	6.83	82606.31	826063.13
31c LD	8/25/99	TNef1	<2mm	7.85		0.00

33c	8/25/99	TNef1	<2mm	7.99	82608.10	826081.00
35c	8/25/99	TNef1	<2mm	8.55	82608.11	826081.06
35c LD	8/25/99	TNef1	<2mm	8.76		0.00
37c	8/25/99	TNef1	<2mm	6.45	82607.35	826073.55
37c LD	8/25/99	TNef1	<2mm	6.24		0.00
39c	8/25/99	TNef1	<2mm	3.69	82603.84	826038.39
41c	8/25/99	TNef1	<2mm	3.69	82606.24	826062.39
43c	8/25/99	TNef1	<2mm	3.38	82603.07	826030.70
45c	8/25/99	TNef1	<2mm	2.13	82603.31	826033.10
47c	8/25/99	TNef1	<2mm	2.74	82608.15	826081.54
49c	8/25/99	TNef1	<2mm	2.19	82606.75	826067.52
51c	8/25/99	TNef1	<2mm	1.05	82602.77	826027.66
53c	8/25/99	TNef1	<2mm	1.44	82604.40	826044.02
55c	8/25/99	TNef1	<2mm	0.65	82603.12	826031.19
57c	8/25/99	TNef1	<2mm	1.62	82606.76	826067.60
59c	8/25/99	TNef1	<2mm	1.04	82604.45	826044.47
61c	8/25/99	TNef1	<2mm	4.07	82604.25	826042.50
63c	8/25/99	TNef1	<2mm	2.50	82602.61	826026.10
65c	8/25/99	TNef1	<2mm	5.94	82606.28	826062.77
67c	8/25/99	TNef1	<2mm	3.91	82603.65	826036.54
69c	8/25/99	TNef1	<2mm	2.49	82602.16	826021.60
71c	8/25/99	TNef1	<2mm	1.87	82601.83	826018.27
73c	8/25/99	TNef1	<2mm	3.04	82602.65	826026.53
75c	8/25/99	TNef1	<2mm	3.68	82603.32	826033.24
77c	8/25/99	TNef1	<2mm	3.72	82603.38	826033.83
79c	8/25/99	TNef1	<2mm	2.40	82602.65	826026.48
81c	8/25/99	TNef1	<2mm	1.49	82601.76	826017.59
83c	8/25/99	TNef1	<2mm	1.23	82601.94	826019.42
85c	8/25/99	TNef1	<2mm	0.92	82603.43	826034.26
87c	8/25/99	TNef1	<2mm	2.26	82603.53	826035.29
89c	8/25/99	TNef1	<2mm	0.55	82611.59	826115.91
1c	8/25/99	TNef1	Oea	9.06	82628.09	826280.94
3c	8/25/99	TNef1	Oea	13.69	82648.83	826488.29
3c LD	8/25/99	TNef1	Oea	9.41		0.00
5c	8/25/99	TNef1	Oea	9.80	82642.51	826425.12
7c	8/25/99	TNef1	Oea	1.53	82622.79	826227.94
9c	8/25/99	TNef1	Oea	12.84	82631.97	826319.73
11c	8/25/99	TNef1	Oea	1.95	82625.33	826253.35
13c	8/25/99	TNef1	Oea	6.20	82632.60	826326.04

15c	8/25/99	TNef1	Oea	9.57	82644.43		826444.28
17c	8/25/99	TNef1	Oea	10.37	82636.94		826369.42
19c	8/25/99	TNef1	Oea	7.91	82625.21		826252.09
21c	8/25/99	TNef1	Oea	11.81	82635.99		826359.87
23c	8/25/99	TNef1	Oea	11.63	82648.57		826485.69
25c	8/25/99	TNef1	Oea	9.29	82650.71	0.00	826507.08
25c LD	8/25/99	TNef1	Oea	0.72	82649.56		826495.60
27c	8/25/99	TNef1	Oea	11.11	82651.76		826517.55
29c	8/25/99	TNef1	Oea	3.02	82657.93		826579.28
31c	8/25/99	TNef1	Oea	25.93	82642.52		826425.20
33c	8/25/99	TNef1	Oea	21.98	82652.88		826528.80
35c	8/25/99	TNef1	Oea	16.39	82647.96		826479.56
37c	8/25/99	TNef1	Oea	6.37	82658.77		826587.71
39c	8/25/99	TNef1	Oea	9.43	82675.61		826756.10
41c	8/25/99	TNef1	Oea	16.82	82688.52		826885.23
43c	8/25/99	TNef1	Oea	9.15	82633.81		826338.10
45c	8/25/99	TNef1	Oea	21.09	82653.49		826534.95
47c	8/25/99	TNef1	Oea	1.87	82626.53	0.00	826265.33
47c LD	8/25/99	TNef1	Oea	0.94	82629.00		826289.98
49c	8/25/99	TNef1	Oea	4.56	82637.59		826375.91
51c	8/25/99	TNef1	Oea	4.40	82637.70		826376.97
53c	8/25/99	TNef1	Oea	7.02	82643.26		826432.55
55c	8/25/99	TNef1	Oea	6.22	82634.51		826345.06
57c	8/25/99	TNef1	Oea	24.07	82687.63		826876.29
59c	8/25/99	TNef1	Oea	15.75	82646.12		826461.23
61c	8/25/99	TNef1	Oea	2.97	82624.86		826248.60
63c	8/25/99	TNef1	Oea	15.15	82638.08	0.01	826380.82
63c LD	8/25/99	TNef1	Oea	6.13	82627.21		826272.13
65c	8/25/99	TNef1	Oea	8.25	82641.48		826414.84
67c	8/25/99	TNef1	Oea	6.29	82631.99		826319.90
69c	8/25/99	TNef1	Oea	3.94	82635.70	0.00	826357.05
69c LD	8/25/99	TNef1	Oea	3.02	82636.58		826365.78
71c	8/25/99	TNef1	Oea	2.63	82632.38		826323.77
73c	8/25/99	TNef1	Oea	4.77	82639.04		826390.41
75c	8/25/99	TNef1	Oea	4.79	82620.07		826200.72
77c	8/25/99	TNef1	Oea	10.56	82643.16		826431.55
79c	8/25/99	TNef1	Oea	12.15	82647.55	0.01	826475.49
79c LD	8/25/99	TNef1	Oea	5.78	82643.40		826434.01
81c	8/25/99	TNef1	Oea	5.73	82637.26		826372.56

83c	8/25/99	TNef1	Oea	3.38	82638.23	826382.27
85c	8/25/99	TNef1	Oea	12.13	82635.22	826352.17
87c	8/25/99	TNef1	Oea	28.30	82690.69	826906.86
89c	8/25/99	TNef1	Oea	2.43	82686.49	826864.91

Appendix F. Soil texture data. R_1 are hydrometer readings at the specified time interval. Concentration of soil in suspension is R_1-R_L. The summation percentage is the ratio of C : W_t. n is solution viscosity, p_l is solution density, p_s is particle density, g is the gravitational constant, h' is the effective hydrometer depth, theta is the sedimentation parameter, and X is the mean particle diameter in suspension.

Site	Composited Sample ID	Time Interval (minutes)	R_1 (reading)	R_L (blank)	Temp ^OC	W_t (g treated soil)	105 ^0C Oven-dry Weight (g)	C, conc. of soil in suspension (g/L)
TNef1	1	0.5	13	1.5	23.9	18.68	9.98	11.5
	1	1	12.8875	1.5	23.9	18.68	9.98	11.3875
	1	90	9.5	1.5	22.9	18.68	9.98	8
	1	1440	6.9	2.2	19.8	18.68	9.98	4.7
TNef1	3	0.5	13.5	1.5	24.4	19.35	9.98	12
	3	1	13.3875	1.5	24.4	19.35	9.98	11.8875
	3	90	9	1.5	23.5	19.35	9.98	7.5
	3	1440	6.9	2.2	20.2	19.35	9.98	4.7
TNef1	5	0.5	8	0	25	15.13	9.98	8
	5	1	7.8875	0	25	15.13	9.98	7.8875
	5	90	4.5	-0.5	24	15.13	9.98	5
	5	1440	4.8	-0.5	21.5	15.13	9.98	5.3
TNef1	7	0.5	11	2.5	24.4	18.69	9.98	8.5
	7	1	10.8875	2.5	24.4	18.69	9.98	8.3875
	7	90	5.5	2.5	22.6	18.69	9.98	3
	7	1440	4	3	19.8	18.69	9.98	1
TNef1	9	0.5	11	-0.5	24.5	18.48	9.98	11.5
	9	1	10.8875	-0.5	24.5	18.48	9.98	11.3875
	9	90	5.2	1	23.2	18.48	9.98	4.2
	9	1440	4	2	20.2	18.48	9.98	2
TNef1	11	0.5	11	2.5	23.1	18.68	9.98	8.5
	11	1	10.8875	2.5	23.1	18.68	9.98	8.3875
	11	90	6.5	2.5	21.9	18.68	9.98	4
	11	1440	3.5	3	19.8	18.68	9.98	0.5
TNef1	13	0.5	11.5	1	23.6	18.39	9.98	10.5
	13	1	11.3875	1	23.6	18.39	9.98	10.3875
	13	90	7.7	0.8	21.9	18.39	9.98	6.9
	13	1440	6	0.8	20.6	18.39	9.98	5.2
TNef1	15	0.5	10.2	1	23.4	19.42	9.98	9.2
	15	1	10.0875	1	23.4	19.42	9.98	9.0875
	15	90	9.9	0.8	21.6	19.42	9.98	9.1

	15	1440	5.7	0.8	20.5	19.42	9.98	4.9
TNef1	17	0.5	10	2.5	23.4	18.6	9.98	7.5
	17	1	9.8875	2.5	23.4	18.6	9.98	7.3875
	17	90	7.5	2.5	22.6	18.6	9.98	5
	17	1440	5.5	3	19.9	18.6	9.98	2.5
TNef1	19	0.5	11.5	2.5	24.5	19.41	9.98	9
		1	11.3875	2.5	24.5	19.41	9.98	8.8875
	19	90	7.5	2.5	22.8	19.41	9.98	5
	19	1440	5.5	3	20	19.41	9.98	2.5
TNef1	21	0.5	12.5	-0.5	24.5	18.49	9.98	13
		1	12.3875	-0.5	24.5	18.49	9.98	12.8875
	21	90	9.2	1	23.2	18.49	9.98	8.2
	21	1440	6.5	2	20	18.49	9.98	4.5
TNef1	23	0.5	13.5	1.5	25	18.53	9.98	12
	23	1	13.3875	1.5	25	18.53	9.98	11.8875
	23	90	10.25	1.5	23.5	18.53	9.98	8.75
	23	1440	6.3	2.2	20.4	18.53	9.98	4.1
TNef1	25	0.5	16	1.5	22.7	18.91	9.98	14.5
	25	1	15.8875	1.5	22.7	18.91	9.98	14.3875
	25	90	10	1.5	22.3	18.91	9.98	8.5
	25	1440	6.8	2.2	20.4	18.91	9.98	4.6
TNef1	27	0.5	11	0	25	19.89	9.98	11
	27	1	10.8875	0	25	19.89	9.98	10.8875
	27	90	7	-0.5	24.4	19.89	9.98	7.5
	27	1440	3.2	-0.5	21.8	19.89	9.98	3.7
TNef1	29	0.5	13	1.5	23.6	18.95	9.98	11.5
	29	1	12.8875	1.5	23.6	18.95	9.98	11.3875
	29	90	9	1.5	22.7	18.95	9.98	7.5
	29	1440	6.5	2.2	20.4	18.95	9.98	4.3
TNef1	31	0.5	14	2.5	24.3	18.98	9.98	11.5
	31	1	13.8875	2.5	24.3	18.98	9.98	11.3875
	31	90	9.5	2.5	22.5	18.98	9.98	7
	31	1440	6	3	19.9	18.98	9.98	3
TNef1	33	0.5	16.5	1.5	24.6	20.28	9.98	15
	33	1	16.3875	1.5	24.6	20.28	9.98	14.8875
	33	90	12.5	1.5	23.1	20.28	9.98	11
	33	1440	9.9	2.2	20.4	20.28	9.98	7.7
TNef1	35	0.5	15	1.5	25.6	19.01	9.98	13.5
	35	1	14.8875	1.5	25.6	19.01	9.98	13.3875

	35	90	10	1.5	23.2	19.01	9.98	8.5
	35	1440	8	2.2	20.8	19.01	9.98	5.8
TNef1	37	0.5	11.5	2.5	23.9	18.51	9.98	9
	37	1	11.3875	2.5	23.9	18.51	9.98	8.8875
	37	90	6.5	2.5	22.6	18.51	9.98	4
	37	1440	4	3	19.9	18.51	9.98	1
TNef1	39	0.5	14	2.5	23	19.16	9.98	11.5
	39	1	13.8875	2.5	23	19.16	9.98	11.3875
	39	90	8	2.5	21.8	19.16	9.98	5.5
	39	1440	5.5	3	19.8	19.16	9.98	2.5
TNef1	41	0.5	7.1	1.2	22.9	9.28	9.98	5.9
	41	1	6.9875	1.2	22.9	9.28	9.98	5.7875
	41	90	5.5	1.5	22.1	9.28	9.98	4
	41	1440	4.7	2	20.2	9.28	9.98	2.7
TNef1	43	0.5	9	2.5	23.9	19.13	9.98	6.5
	43	1	8.8875	2.5	23.9	19.13	9.98	6.3875
	43	90	6	2.5	22.6	19.13	9.98	3.5
	43	1440	4	3	19.9	19.13	9.98	1
TNef1	45	0.5	11.5	2.5	23.6	18.31	9.98	9
	45	1	11.3875	2.5	23.6	18.31	9.98	8.8875
	45	90	7.5	2.5	22.2	18.31	9.98	5
	45	1440	6	3	19.6	18.31	9.98	3
TNef1	47	0.5	10	1.2	21.6	11.53	9.98	8.8
	47	1	9.8875	1.2	21.6	11.53	9.98	8.6875
	47	90	5.7	1.5	21	11.53	9.98	4.2
	47	1440	5	2	20.2	11.53	9.98	3
TNef1	49	0.5	6.8	1.2	23.2	8.97	9.98	5.6
	49	1	6.6875	1.2	23.2	8.97	9.98	5.4875
	49	90	5	1.5	22	8.97	9.98	3.5
	49	1440	4.1	2	20.2	8.97	9.98	2.1
TNef1	51	0.5	11.5	1.5	23	18.5	9.98	10
	51	1	11.3875	1.5	23	18.5	9.98	9.8875
	51	90	8.5	1.5	22.2	18.5	9.98	7
	51	1440	6.5	2.2	20.2	18.5	9.98	4.3
TNef1	53	0.5	12.5	1.5	23.5	17.29	9.98	11
	53	1	12.3875	1.5	23.5	17.29	9.98	10.8875
	53	90	9	1.5	22.5	17.29	9.98	7.5
	53	1440	7.1	2.2	20.4	17.29	9.98	4.9
TNef1	55	0.5	14	1.5	23.5	18.28	9.98	12.5

	55	1	13.8875	1.5	23.5	18.28	9.98	12.3875
	55	90	9	1.5	22.4	18.28	9.98	7.5
	55	1440	7	2.2	20	18.28	9.98	4.8
TNef1	57	0.5	5.5	0	24.5	4.52	9.98	5.5
	57	1	5.3875	0	24.5	4.52	9.98	5.3875
	57	90	4.8	0	22.7	4.52	9.98	4.8
	57	1440	3.5	0	21.8	4.52	9.98	3.5
TNef1	59	0.5	12	1	21.8	17.94	9.98	11
	59	1	11.8875	1	21.8	17.94	9.98	10.8875
	59	90	8.7	0.8	21.2	17.94	9.98	7.9
	59	1440	6.9	0.8	20.6	17.94	9.98	6.1
TNef1	61	0.5	10.5	2.5	24.1	17.04	9.98	8
	61	1	10.3875	2.5	24.1	17.04	9.98	7.8875
	61	90	7	2.5	22.4	17.04	9.98	4.5
	61	1440	4	3	19.8	17.04	9.98	1
TNef1	63	0.5	12	0.8	22.4	17.71	9.98	11.2
	63	1	11.8875	0.8	22.4	17.71	9.98	11.0875
	63	90	9.5	0.8	21.3	17.71	9.98	8.7
	63	1440	7.7	0.8	20.5	17.71	9.98	6.9
TNef1	65	0.5	7.5	1	22.4	18.58	9.98	6.5
	65	1	7.3875	1	22.4	18.58	9.98	6.3875
	65	90	6	0.8	21.3	18.58	9.98	5.2
	65	1440	4.9	0.8	20.6	18.58	9.98	4.1
TNef1	67	0.5	7.5	2.5	24.6	17.17	9.98	5
	67	1	7.3875	2.5	24.6	17.17	9.98	4.8875
	67	90	5	2.5	22.9	17.17	9.98	2.5
	67	1440	4	3	19.9	17.17	9.98	1
TNef1	69	0.5	10.5	2.5	24.2	18.34	9.98	8
	69	1	10.3875	2.5	24.2	18.34	9.98	7.8875
	69	90	7	2.5	22.4	18.34	9.98	4.5
	69	1440	5.5	3	19.9	18.34	9.98	2.5
TNef1	71	0.5	10	0.8	22.9	18.24	9.98	9.2
	71	1	9.8875	0.8	22.9	18.24	9.98	9.0875
	71	90	6.5	0.8	21.5	18.24	9.98	5.7
	71	1440	5	0.8	20.5	18.24	9.98	4.2
TNef1	73	0.5	10.5	2.5	23.3	18.13	9.98	8
	73	1	10.3875	2.5	23.3	18.13	9.98	7.8875
	73	90	6	2.5	21.8	18.13	9.98	3.5
	73	1440	3.5	3	19.8	18.13	9.98	0.5

TNef1	75	0.5	13	1.5	23.5	19.57	9.98	11.5
	75	1	12.8875	1.5	23.5	19.57	9.98	11.3875
	75	90	8.25	1.5	22.5	19.57	9.98	6.75
	75	1440	6.4	2.2	20.6	19.57	9.98	4.2
TNef1	77	0.5	12	1	22.8	17.52	9.98	11
	77	1	11.8875	1	22.8	17.52	9.98	10.8875
	77	90	8.3	0.8	21.2	17.52	9.98	7.5
	77	1440	5.9	0.8	20.4	17.52	9.98	5.1
TNef1	79	0.5	9.7	0.8	22.7	18.5	9.98	8.9
	79	1	9.5875	0.8	22.7	18.5	9.98	8.7875
	79	90	6.9	0.8	21.5	18.5	9.98	6.1
	79	1440	5.1	0.8	20.5	18.5	9.98	4.3
TNef1	81	0.5	11	1.5	23.5	18.13	9.98	9.5
	81	1	10.8875	1.5	23.5	18.13	9.98	9.3875
	81	90	8.5	1.5	22.5	18.13	9.98	7
	81	1440	6.3	2.2	19.6	18.13	9.98	4.1
TNef1	83	0.5	13	1.5	23.2	17.76	9.98	11.5
	83	1	12.8875	1.5	23.2	17.76	9.98	11.3875
	83	90	8.75	1.5	22.5	17.76	9.98	7.25
	83	1440	6.7	2.2	20.4	17.76	9.98	4.5
TNef1	85	0.5	12	1.5	23.8	18.75	9.98	10.5
	85	1	11.8875	1.5	23.8	18.75	9.98	10.3875
	85	90	8.25	1.5	22.9	18.75	9.98	6.75
	85	1440	6.2	2.2	20.4	18.75	9.98	4
TNef1	87	0.5	14	2.5	22.7	17.79	9.98	11.5
	87	1	13.8875	2.5	22.7	17.79	9.98	11.3875
	87	90	8.5	2.5	21.8	17.79	9.98	6
	87	1440	6	3	19.7	17.79	9.98	3
TNef1	89	0.5	10	1.2	23	15.52	9.98	8.8
	89	1	9.8875	1.2	23	15.52	9.98	8.6875
	89	90	5	1.5	21.8	15.52	9.98	3.5
	89	1440	3.9	2	20.2	15.52	9.98	1.9
TMat1	1	0.5	17.2	0	23	21.51	9.98	17.2
	1	1	17.0875	0	23	21.51	9.98	17.0875
	1	90	11	0	22.6	21.51	9.98	11
	1	1440	8	0	21.8	21.51	9.98	8
TMat1	3	0.5	13.8	0	22.4	16.24	9.98	13.8
	3	1	13.6875	0	22.4	16.24	9.98	13.6875
	3	90	8.7	0	22	16.24	9.98	8.7

	3	1440	6.7	0	22.1	16.24	9.98	6.7
TMat1	5	0.5	14.8	0	22.8	16.8	9.98	14.8
	5	1	14.6875	0	22.8	16.8	9.98	14.6875
	5	90	9.2	0	22.6	16.8	9.98	9.2
	5	1440	7.1	0	22	16.8	9.98	7.1
TMat1	7	0.5	14.2	0	23.2	17.49	9.98	14.2
	7	1	14.0875	0	23.2	17.49	9.98	14.0875
	7	90	9.5	0	22.5	17.49	9.98	9.5
	7	1440	7	0	21.8	17.49	9.98	7
TMat1	9	0.5	15	0	23	17.87	9.98	15
	9	1	14.8875	0	23	17.87	9.98	14.8875
	9	90	9.8	0	22.4	17.87	9.98	9.8
	9	1440	7.1	0	22	17.87	9.98	7.1
TMat1	11	0.5	15	0	22.4	18.78	9.98	15
	11	1	14.8875	0	22.4	18.78	9.98	14.8875
	11	90	9.2	0	22	18.78	9.98	9.2
	11	1440	6.9	0	22	18.78	9.98	6.9
TMat1	13	0.5	12.8	0	23.9	19.42	9.98	12.8
	13	1	12.6875	0	23.9	19.42	9.98	12.6875
	13	90	9.5	0	22.5	19.42	9.98	9.5
	13	1440	6.1	0	21.8	19.42	9.98	6.1
TMat1	15	0.5	13.9	0	24.5	18.93	9.98	13.9
	15	1	13.7875	0	24.5	18.93	9.98	13.7875
	15	90	10.5	0	22.6	18.93	9.98	10.5
	15	1440	7.1	0	22	18.93	9.98	7.1
TMat1	17	0.5	13.9	0	23.8	19.67	9.98	13.9
	17	1	13.7875	0	23.8	19.67	9.98	13.7875
	17	90	9.8	0	22.6	19.67	9.98	9.8
	17	1440	6.5	0	22	19.67	9.98	6.5
TMat1	19	0.5	15	0	23.5	19.79	9.98	15
	19	1	14.8875	0	23.5	19.79	9.98	14.8875
	19	90	11	0	22.4	19.79	9.98	11
	19	1440	9	0	21.6	19.79	9.98	9
TMat1	21	0.5	16.5	0	23.9	18.82	9.98	16.5
	21	1	16.3875	0	23.9	18.82	9.98	16.3875
	21	90	9.9	0	22.3	18.82	9.98	9.9
	21	1440	6.8	0	21.9	18.82	9.98	6.8
TMat1	23	0.5	13	0	24.6	19.04	9.98	13
	23	1	12.8875	0	24.6	19.04	9.98	12.8875

	23	90	9.2	0	22.7	19.04	9.98	9.2
	23	1440	6.4	0	21.8	19.04	9.98	6.4
TMat1	25	0.5	18	0	23	22.67	9.98	18
	25	1	17.8875	0	23	22.67	9.98	17.8875
	25	90	10.3	0	22.4	22.67	9.98	10.3
	25	1440	7.2	0	22	22.67	9.98	7.2
TMat1	27	0.5	16	0	22.6	19.99	9.98	16
	27	1	15.8875	0	22.6	19.99	9.98	15.8875
	27	90	10	0	22.2	19.99	9.98	10
	27	1440	7.2	0	22.2	19.99	9.98	7.2
TMat1	29	0.5	15.7	0	23	20.38	9.98	15.7
	29	1	15.5875	0	23	20.38	9.98	15.5875
	29	90	11	0	22.6	20.38	9.98	11
	29	1440	8.1	0	22	20.38	9.98	8.1
TMat1	31	0.5	11.5	0	22.6	18.52	9.98	11.5
	31	1	11.3875	0	22.6	18.52	9.98	11.3875
	31	90	7.3	0	22.2	18.52	9.98	7.3
	31	1440	6.2	0	22	18.52	9.98	6.2
TMat1	33	0.5	12	0	22.6	17.53	9.98	12
	33	1	11.8875	0	22.6	17.53	9.98	11.8875
	33	90	7.2	0	22	17.53	9.98	7.2
	33	1440	5.8	0	22	17.53	9.98	5.8
TMat1	35	0.5	11.2	0	23.1	18.4	9.98	11.2
	35	1	11.0875	0	23.1	18.4	9.98	11.0875
	35	90	7	0	22.2	18.4	9.98	7
	35	1440	6.3	0	22	18.4	9.98	6.3
TMat1	37	0.5	12.9	0	23	19.29	9.98	12.9
	37	1	12.7875	0	23	19.29	9.98	12.7875
	37	90	8.2	0	22.7	19.29	9.98	8.2
	37	1440	6.8	0	22	19.29	9.98	6.8
TMat1	39	0.5	12	0	22.6	17.85	9.98	12
	39	1	11.8875	0	22.6	17.85	9.98	11.8875
	39	90	7.1	0	22.3	17.85	9.98	7.1
	39	1440	6.5	0	22.2	17.85	9.98	6.5
TMat1	41	0.5	14.5	7	22.1	19.27	9.98	7.5
	41	1	14.3875	7	22.1	19.27	9.98	7.3875
	41	90	9.1	7	21.2	19.27	9.98	2.1
	41	1440	7.3	7.1	20.6	19.27	9.98	0.2
TMat1	43	0.5	10.5	0	24	17.47	9.98	10.5

	43	1	10.3875	0	24	17.47	9.98	10.3875
	43	90	9.8	0	22.6	17.47	9.98	9.8
	43	1440	6	0	21.9	17.47	9.98	6
TMat1	45	0.5	10	0	24.4	17.99	9.98	10
	45	1	9.8875	0	24.4	17.99	9.98	9.8875
	45	90	9	0	22.5	17.99	9.98	9
	45	1440	6.3	0	21.8	17.99	9.98	6.3
TMat1	47	0.5	8.5	0	23.2	18.33	9.98	8.5
	47	1	8.3875	0	23.2	18.33	9.98	8.3875
	47	90	7.9	0	22.1	18.33	9.98	7.9
	47	1440	5.2	0	21.6	18.33	9.98	5.2
TMat1	49	0.5	14.5	7	22	20.82	9.98	7.5
	49	1	14.3875	7	22	20.82	9.98	7.3875
	49	90	9.2	7	21.4	20.82	9.98	2.2
	49	1440	7.5	7.1	20.8	20.82	9.98	0.4
TMat1	51	0.5	16	7	22.2	22.94	9.98	9
	51	1	15.8875	7	22.2	22.94	9.98	8.8875
	51	90	10	7	21.4	22.94	9.98	3
	51	1440	7.9	7.1	20.7	22.94	9.98	0.8
TMat1	53	0.5	17	7	21.8	19.28	9.98	10
	53	1	16.8875	7	21.8	19.28	9.98	9.8875
	53	90	11.7	7	21.2	19.28	9.98	4.7
	53	1440	9.9	7.1	20.8	19.28	9.98	2.8
TMat1	55	0.5	14.2	7	22.1	19.42	9.98	7.2
	55	1	14.0875	7	22.1	19.42	9.98	7.0875
	55	90	8.4	7	21.4	19.42	9.98	1.4
	55	1440	6.8	7.1	20.7	19.42	9.98	-0.3
TMat1	57	0.5	18	7	22	20.99	9.98	11
	57	1	17.8875	7	22	20.99	9.98	10.8875
	57	90	12.1	7	21.4	20.99	9.98	5.1
	57	1440	10	7.1	20.7	20.99	9.98	2.9
TMat1	59	0.5	15.5	7	22	18.23	9.98	8.5
	59	1	15.3875	7	22	18.23	9.98	8.3875
	59	90	11.3	7	21.3	18.23	9.98	4.3
	59	1440	9.7	7.1	20.6	18.23	9.98	2.6
TMat1	61	0.5	15.1	1	24.5	18.12	9.98	14.1
	61	1	14.9875	1	24.5	18.12	9.98	13.9875
	61	90	10	1.1	23.3	18.12	9.98	8.9
	61	1440	7	2	21.3	18.12	9.98	5

TMat1	63	0.5	15	1	24.4	17.54	9.98	14
	63	1	14.8875	1	24.4	17.54	9.98	13.8875
	63	90	9.9	1.1	23.3	17.54	9.98	8.8
	63	1440	7.2	2	21.9	17.54	9.98	5.2
TMat1	65	0.5	14.2	1	24.4	17.99	9.98	13.2
	65	1	14.0875	1	24.4	17.99	9.98	13.0875
	65	90	9.2	1.1	23.3	17.99	9.98	8.1
	65	1440	6.6	2	21.5	17.99	9.98	4.6
TMat1	67	0.5	14.9	1	24.6	17.89	9.98	13.9
	67	1	14.7875	1	24.6	17.89	9.98	13.7875
	67	90	9.5	1.1	23.4	17.89	9.98	8.4
	67	1440	6.9	2	21.7	17.89	9.98	4.9
TMat1	69	0.5	14.8	1	24.2	17.87	9.98	13.8
	69	1	14.6875	1	24.2	17.87	9.98	13.6875
	69	90	9.3	1.1	23.3	17.87	9.98	8.2
	69	1440	7	2	21	17.87	9.98	5
TMat1	71	0.5	14.5	1	24.5	17.12	9.98	13.5
	71	1	14.3875	1	24.5	17.12	9.98	13.3875
	71	90	10	1.1	23.5	17.12	9.98	8.9
	71	1440	6.9	2	21.9	17.12	9.98	4.9
TMat1	73	0.5	12.5	2	25.6	17.54	9.98	10.5
	73	1	12.3875	2	25.6	17.54	9.98	10.3875
	73	90	8.1	1.5	23.6	17.54	9.98	6.6
	73	1440	6.8	2	21.3	17.54	9.98	4.8
TMat1	75	0.5	12.5	2	25.1	17.65	9.98	10.5
	75	1	12.3875	2	25.1	17.65	9.98	10.3875
	75	90	7.9	1.5	23.2	17.65	9.98	6.4
	75	1440	6	2	21.2	17.65	9.98	4
TMat1	77	0.5	13	2	26	18.63	9.98	11
	77	1	12.8875	2	26	18.63	9.98	10.8875
	77	90	7.9	1.5	23.4	18.63	9.98	6.4
	77	1440	5.7	2	21.5	18.63	9.98	3.7
TMat1	79	0.5	14	2	25.1	17.6	9.98	12
	79	1	13.8875	2	25.1	17.6	9.98	11.8875
	79	90	8.5	1.5	23	17.6	9.98	7
	79	1440	6.5	2	21.2	17.6	9.98	4.5
TMat1	81	0.5	13.5	2	25.6	18.03	9.98	11.5
	81	1	13.3875	2	25.6	18.03	9.98	11.3875
	81	90	9.1	1.5	23.6	18.03	9.98	7.6

	81	1440	7.1	2	21.3	18.03	9.98	5.1
TMat1	83	0.5	15.2	1	24.6	18.5	9.98	14.2
	83	1	15.0875	1	24.6	18.5	9.98	14.0875
	83	90	9.9	1.1	23.1	18.5	9.98	8.8
	83	1440	7.5	2	21.7	18.5	9.98	5.5
TMat1	85	0.5	16	1	23.9	14.61	9.98	15
	85	1	15.8875	1	23.9	14.61	9.98	14.8875
	85	90	10.2	1.1	23.1	14.61	9.98	9.1
	85	1440	7.1	2	21.3	14.61	9.98	5.1
TMat1	87	0.5	14.8	1	24.2	19.03	9.98	13.8
	87	1	14.6875	1	24.2	19.03	9.98	13.6875
	87	90	10	1.1	23.2	19.03	9.98	8.9
	87	1440	9.7	2	21.5	19.03	9.98	7.7
TMat1	89	0.5	14.5	1	24.4	17.07	9.98	13.5
	89	1	14.3875	1	24.4	17.07	9.98	13.3875
	89	90	9.5	1.1	23.4	17.07	9.98	8.4
	89	1440	6.9	2	21.6	17.07	9.98	4.9
TMat1	97	0.5	9.5	2	25.8	16.6	9.98	7.5
	97	1	9.3875	2	25.8	16.6	9.98	7.3875
	97	90	4	1.5	23.4	16.6	9.98	2.5
	97	1440	4.4	2	21.1	16.6	9.98	2.4
TMat1	99	0.5	13.9	2	25.1	18.1	9.98	11.9
	99	1	13.7875	2	25.1	18.1	9.98	11.7875
	99	90	7	1.5	23.4	18.1	9.98	5.5
	99	1440	5.7	2	21.1	18.1	9.98	3.7
TMat1	101	0.5	10	2	25.2	15.85	9.98	8
	101	1	9.8875	2	25.2	15.85	9.98	7.8875
	101	90	3.9	1.5	23.5	15.85	9.98	2.4
	101	1440	3.7	2	21	15.85	9.98	1.7
TMat1	103	0.5	10.7	2	25.6	15.65	9.98	8.7
	103	1	10.5875	2	25.6	15.65	9.98	8.5875
	103	90	6.7	1.5	23.6	15.65	9.98	5.2
	103	1440	5.3	2	21.1	15.65	9.98	3.3
TMat1	105	0.5	12.3	2	25.2	14.24	9.98	10.3
	105	1	12.1875	2	25.2	14.24	9.98	10.1875
	105	90	8.9	1.5	23.2	14.24	9.98	7.4
	105	1440	7	2	21	14.24	9.98	5

Site	Composited Sample ID	P, summation % for given time interval	n	p_l	p_s	g Grav. Const. (cm/s2)	B
TNef1	1	61.56	0.93	1.000	2.72	981	0.02
	1	60.96	0.93	1.000	2.72	981	0.02
	1	42.83	0.95	1.001	2.72	981	0.02
	1	25.16	1.02	1.001	2.72	981	0.02
TNef1	3	62.02	0.93	1.000	2.72	981	0.02
	3	61.43	0.93	1.000	2.72	981	0.02
	3	38.76	0.95	1.001	2.72	981	0.02
	3	24.29	1.02	1.001	2.72	981	0.02
TNef1	5	52.88	0.91	1.000	2.72	981	0.02
	5	52.13	0.91	1.000	2.72	981	0.02
	5	33.05	0.93	1.000	2.72	981	0.02
	5	35.03	1.00	1.001	2.72	981	0.02
TNef1	7	45.48	0.93	1.000	2.72	981	0.02
	7	44.88	0.93	1.000	2.72	981	0.02
	7	16.05	0.95	1.001	2.72	981	0.02
	7	5.35	1.02	1.001	2.72	981	0.02
TNef1	9	62.23	0.93	1.000	2.72	981	0.02
	9	61.62	0.93	1.000	2.72	981	0.02
	9	22.73	0.95	1.001	2.72	981	0.02
	9	10.82	1.02	1.001	2.72	981	0.02
TNef1	11	45.50	0.95	1.001	2.72	981	0.02
	11	44.90	0.95	1.001	2.72	981	0.02
	11	21.41	0.98	1.001	2.72	981	0.02
	11	2.68	1.02	1.001	2.72	981	0.02
TNef1	13	57.10	0.93	1.000	2.72	981	0.02
	13	56.48	0.93	1.000	2.72	981	0.02
	13	37.52	0.98	1.001	2.72	981	0.02
	13	28.28	1.00	1.001	2.72	981	0.02
TNef1	15	47.37	0.95	1.001	2.72	981	0.02
	15	46.79	0.95	1.001	2.72	981	0.02
	15	46.86	0.98	1.001	2.72	981	0.02
	15	25.23	1.02	1.001	2.72	981	0.02
TNef1	17	40.32	0.95	1.001	2.72	981	0.02
	17	39.72	0.95	1.001	2.72	981	0.02
	17	26.88	0.95	1.001	2.72	981	0.02

	17	13.44	1.02	1.001	2.72	981	0.02
TNef1	19	46.37	0.93	1.000	2.72	981	0.02
		45.79	0.93	1.000	2.72	981	0.02
	19	25.76	0.95	1.001	2.72	981	0.02
	19	12.88	1.02	1.001	2.72	981	0.02
TNef1	21	70.31	0.93	1.000	2.72	981	0.02
		69.70	0.93	1.000	2.72	981	0.02
	21	44.35	0.95	1.001	2.72	981	0.02
	21	24.34	1.02	1.001	2.72	981	0.02
TNef1	23	64.76	0.91	1.000	2.72	981	0.02
	23	64.15	0.91	1.000	2.72	981	0.02
	23	47.22	0.95	1.001	2.72	981	0.02
	23	22.13	1.02	1.001	2.72	981	0.02
TNef1	25	76.68	0.95	1.001	2.72	981	0.02
	25	76.08	0.95	1.001	2.72	981	0.02
	25	44.95	0.98	1.001	2.72	981	0.02
	25	24.33	1.02	1.001	2.72	981	0.02
TNef1	27	55.30	0.91	1.000	2.72	981	0.02
	27	54.74	0.91	1.000	2.72	981	0.02
	27	37.71	0.93	1.000	2.72	981	0.02
	27	18.60	0.98	1.001	2.72	981	0.02
TNef1	29	60.69	0.93	1.000	2.72	981	0.02
	29	60.09	0.93	1.000	2.72	981	0.02
	29	39.58	0.95	1.001	2.72	981	0.02
	29	22.69	1.02	1.001	2.72	981	0.02
TNef1	31	60.59	0.93	1.000	2.72	981	0.02
	31	60.00	0.93	1.000	2.72	981	0.02
	31	36.88	0.98	1.001	2.72	981	0.02
	31	15.81	1.02	1.001	2.72	981	0.02
TNef1	33	73.96	0.91	1.000	2.72	981	0.02
	33	73.41	0.91	1.000	2.72	981	0.02
	33	54.24	0.95	1.001	2.72	981	0.02
	33	37.97	1.02	1.001	2.72	981	0.02
TNef1	35	71.02	0.89	1.000	2.72	981	0.02
	35	70.42	0.89	1.000	2.72	981	0.02
	35	44.71	0.95	1.001	2.72	981	0.02
	35	30.51	1.00	1.001	2.72	981	0.02
TNef1	37	48.62	0.93	1.000	2.72	981	0.02
	37	48.01	0.93	1.000	2.72	981	0.02

	37	21.61	0.95	1.001	2.72	981	0.02
	37	5.40	1.02	1.001	2.72	981	0.02
TNef1	39	60.02	0.95	1.001	2.72	981	0.02
	39	59.43	0.95	1.001	2.72	981	0.02
	39	28.71	0.98	1.001	2.72	981	0.02
	39	13.05	1.02	1.001	2.72	981	0.02
TNef1	41	63.58	0.95	1.001	2.72	981	0.02
	41	62.37	0.95	1.001	2.72	981	0.02
	41	43.10	0.98	1.001	2.72	981	0.02
	41	29.09	1.02	1.001	2.72	981	0.02
TNef1	43	33.98	0.93	1.000	2.72	981	0.02
	43	33.39	0.93	1.000	2.72	981	0.02
	43	18.30	0.95	1.001	2.72	981	0.02
	43	5.23	1.02	1.001	2.72	981	0.02
TNef1	45	49.15	0.93	1.000	2.72	981	0.02
	45	48.54	0.93	1.000	2.72	981	0.02
	45	27.31	0.98	1.001	2.72	981	0.02
	45	16.38	1.02	1.001	2.72	981	0.02
TNef1	47	76.32	0.98	1.001	2.72	981	0.02
	47	75.35	0.98	1.001	2.72	981	0.02
	47	36.43	1.00	1.001	2.72	981	0.02
	47	26.02	1.02	1.001	2.72	981	0.02
TNef1	49	62.43	0.95	1.001	2.72	981	0.02
	49	61.18	0.95	1.001	2.72	981	0.02
	49	39.02	0.98	1.001	2.72	981	0.02
	49	23.41	1.02	1.001	2.72	981	0.02
TNef1	51	54.05	0.95	1.001	2.72	981	0.02
	51	53.45	0.95	1.001	2.72	981	0.02
	51	37.84	0.98	1.001	2.72	981	0.02
	51	23.24	1.02	1.001	2.72	981	0.02
TNef1	53	63.62	0.95	1.001	2.72	981	0.02
	53	62.97	0.95	1.001	2.72	981	0.02
	53	43.38	0.98	1.001	2.72	981	0.02
	53	28.34	1.02	1.001	2.72	981	0.02
TNef1	55	68.38	0.95	1.001	2.72	981	0.02
	55	67.77	0.95	1.001	2.72	981	0.02
	55	41.03	0.98	1.001	2.72	981	0.02
	55	26.26	1.02	1.001	2.72	981	0.02
TNef1	57	121.68	0.93	1.000	2.72	981	0.02

	57	119.19	0.93	1.000	2.72	981	0.02
	57	106.19	0.95	1.001	2.72	981	0.02
	57	77.43	0.98	1.001	2.72	981	0.02
TNef1	59	61.32	0.98	1.001	2.72	981	0.02
	59	60.69	0.98	1.001	2.72	981	0.02
	59	44.04	1.00	1.001	2.72	981	0.02
	59	34.00	1.00	1.001	2.72	981	0.02
TNef1	61	46.95	0.93	1.000	2.72	981	0.02
	61	46.29	0.93	1.000	2.72	981	0.02
	61	26.41	0.98	1.001	2.72	981	0.02
	61	5.87	1.02	1.001	2.72	981	0.02
TNef1	63	63.24	0.98	1.001	2.72	981	0.02
	63	62.61	0.98	1.001	2.72	981	0.02
	63	49.12	1.00	1.001	2.72	981	0.02
	63	38.96	1.02	1.001	2.72	981	0.02
TNef1	65	34.98	0.98	1.001	2.72	981	0.02
	65	34.38	0.98	1.001	2.72	981	0.02
	65	27.99	1.00	1.001	2.72	981	0.02
	65	22.07	1.00	1.001	2.72	981	0.02
TNef1	67	29.12	0.91	1.000	2.72	981	0.02
	67	28.47	0.91	1.000	2.72	981	0.02
	67	14.56	0.95	1.001	2.72	981	0.02
	67	5.82	1.02	1.001	2.72	981	0.02
TNef1	69	43.62	0.93	1.000	2.72	981	0.02
	69	43.01	0.93	1.000	2.72	981	0.02
	69	24.54	0.98	1.001	2.72	981	0.02
	69	13.63	1.02	1.001	2.72	981	0.02
TNef1	71	50.44	0.95	1.001	2.72	981	0.02
	71	49.82	0.95	1.001	2.72	981	0.02
	71	31.25	1.00	1.001	2.72	981	0.02
	71	23.03	1.02	1.001	2.72	981	0.02
TNef1	73	44.13	0.95	1.001	2.72	981	0.02
	73	43.51	0.95	1.001	2.72	981	0.02
	73	19.31	0.98	1.001	2.72	981	0.02
	73	2.76	1.02	1.001	2.72	981	0.02
TNef1	75	58.76	0.95	1.001	2.72	981	0.02
	75	58.19	0.95	1.001	2.72	981	0.02
	75	34.49	0.98	1.001	2.72	981	0.02
	75	21.46	1.00	1.001	2.72	981	0.02

TNef1	77	62.79	0.95	1.001	2.72	981	0.02
	77	62.14	0.95	1.001	2.72	981	0.02
	77	42.81	1.00	1.001	2.72	981	0.02
	77	29.11	1.02	1.001	2.72	981	0.02
TNef1	79	48.11	0.95	1.001	2.72	981	0.02
	79	47.50	0.95	1.001	2.72	981	0.02
	79	32.97	1.00	1.001	2.72	981	0.02
	79	23.24	1.02	1.001	2.72	981	0.02
TNef1	81	52.40	0.95	1.001	2.72	981	0.02
	81	51.78	0.95	1.001	2.72	981	0.02
	81	38.61	0.98	1.001	2.72	981	0.02
	81	22.61	1.02	1.001	2.72	981	0.02
TNef1	83	64.75	0.95	1.001	2.72	981	0.02
	83	64.12	0.95	1.001	2.72	981	0.02
	83	40.82	0.98	1.001	2.72	981	0.02
	83	25.34	1.02	1.001	2.72	981	0.02
TNef1	85	56.00	0.93	1.000	2.72	981	0.02
	85	55.40	0.93	1.000	2.72	981	0.02
	85	36.00	0.95	1.001	2.72	981	0.02
	85	21.33	1.02	1.001	2.72	981	0.02
TNef1	87	64.64	0.95	1.001	2.72	981	0.02
	87	64.01	0.95	1.001	2.72	981	0.02
	87	33.73	0.98	1.001	2.72	981	0.02
	87	16.86	1.02	1.001	2.72	981	0.02
TNef1	89	56.70	0.95	1.001	2.72	981	0.02
	89	55.98	0.95	1.001	2.72	981	0.02
	89	22.55	0.98	1.001	2.72	981	0.02
	89	12.24	1.02	1.001	2.72	981	0.02
TMat1	1	79.96	0.95	1.001	2.72	981	0.02
	1	79.44	0.95	1.001	2.72	981	0.02
	1	51.14	0.95	1.001	2.72	981	0.02
	1	37.19	0.98	1.001	2.72	981	0.02
TMat1	3	84.98	0.98	1.001	2.72	981	0.02
	3	84.28	0.98	1.001	2.72	981	0.02
	3	53.57	0.98	1.001	2.72	981	0.02
	3	41.26	0.98	1.001	2.72	981	0.02
TMat1	5	88.10	0.95	1.001	2.72	981	0.02
	5	87.43	0.95	1.001	2.72	981	0.02
	5	54.76	0.95	1.001	2.72	981	0.02

	5	42.26	0.98	1.001	2.72	981	0.02
TMat1	7	81.19	0.95	1.001	2.72	981	0.02
	7	80.55	0.95	1.001	2.72	981	0.02
	7	54.32	0.98	1.001	2.72	981	0.02
	7	40.02	0.98	1.001	2.72	981	0.02
TMat1	9	83.94	0.95	1.001	2.72	981	0.02
	9	83.31	0.95	1.001	2.72	981	0.02
	9	54.84	0.98	1.001	2.72	981	0.02
	9	39.73	0.98	1.001	2.72	981	0.02
TMat1	11	79.87	0.98	1.001	2.72	981	0.02
	11	79.27	0.98	1.001	2.72	981	0.02
	11	48.99	0.98	1.001	2.72	981	0.02
	11	36.74	0.98	1.001	2.72	981	0.02
TMat1	13	65.91	0.93	1.000	2.72	981	0.02
	13	65.33	0.93	1.000	2.72	981	0.02
	13	48.92	0.98	1.001	2.72	981	0.02
	13	31.41	0.98	1.001	2.72	981	0.02
TMat1	15	73.43	0.93	1.000	2.72	981	0.02
	15	72.83	0.93	1.000	2.72	981	0.02
	15	55.47	0.95	1.001	2.72	981	0.02
	15	37.51	0.98	1.001	2.72	981	0.02
TMat1	17	70.67	0.93	1.000	2.72	981	0.02
	17	70.09	0.93	1.000	2.72	981	0.02
	17	49.82	0.95	1.001	2.72	981	0.02
	17	33.05	0.98	1.001	2.72	981	0.02
TMat1	19	75.80	0.95	1.001	2.72	981	0.02
	19	75.23	0.95	1.001	2.72	981	0.02
	19	55.58	0.98	1.001	2.72	981	0.02
	19	45.48	0.98	1.001	2.72	981	0.02
TMat1	21	87.67	0.93	1.000	2.72	981	0.02
	21	87.07	0.93	1.000	2.72	981	0.02
	21	52.60	0.98	1.001	2.72	981	0.02
	21	36.13	0.98	1.001	2.72	981	0.02
TMat1	23	68.28	0.91	1.000	2.72	981	0.02
	23	67.69	0.91	1.000	2.72	981	0.02
	23	48.32	0.95	1.001	2.72	981	0.02
	23	33.61	0.98	1.001	2.72	981	0.02
TMat1	25	79.40	0.95	1.001	2.72	981	0.02
	25	78.90	0.95	1.001	2.72	981	0.02

	25	45.43	0.98	1.001	2.72	981	0.02
	25	31.76	0.98	1.001	2.72	981	0.02
TMat1	27	80.04	0.95	1.001	2.72	981	0.02
	27	79.48	0.95	1.001	2.72	981	0.02
	27	50.03	0.98	1.001	2.72	981	0.02
	27	36.02	0.98	1.001	2.72	981	0.02
TMat1	29	77.04	0.95	1.001	2.72	981	0.02
	29	76.48	0.95	1.001	2.72	981	0.02
	29	53.97	0.95	1.001	2.72	981	0.02
	29	39.74	0.98	1.001	2.72	981	0.02
TMat1	31	62.10	0.95	1.001	2.72	981	0.02
	31	61.49	0.95	1.001	2.72	981	0.02
	31	39.42	0.98	1.001	2.72	981	0.02
	31	33.48	0.98	1.001	2.72	981	0.02
TMat1	33	68.45	0.95	1.001	2.72	981	0.02
	33	67.81	0.95	1.001	2.72	981	0.02
	33	41.07	0.98	1.001	2.72	981	0.02
	33	33.09	0.98	1.001	2.72	981	0.02
TMat1	35	60.87	0.95	1.001	2.72	981	0.02
	35	60.26	0.95	1.001	2.72	981	0.02
	35	38.04	0.98	1.001	2.72	981	0.02
	35	34.24	0.98	1.001	2.72	981	0.02
TMat1	37	66.87	0.95	1.001	2.72	981	0.02
	37	66.29	0.95	1.001	2.72	981	0.02
	37	42.51	0.95	1.001	2.72	981	0.02
	37	35.25	0.98	1.001	2.72	981	0.02
TMat1	39	67.23	0.95	1.001	2.72	981	0.02
	39	66.60	0.95	1.001	2.72	981	0.02
	39	39.78	0.98	1.001	2.72	981	0.02
	39	36.41	0.98	1.001	2.72	981	0.02
TMat1	41	38.92	0.98	1.001	2.72	981	0.02
	41	38.34	0.98	1.001	2.72	981	0.02
	41	10.90	1.00	1.001	2.72	981	0.02
	41	1.04	1.00	1.001	2.72	981	0.02
TMat1	43	60.10	0.93	1.000	2.72	981	0.02
	43	59.46	0.93	1.000	2.72	981	0.02
	43	56.10	0.95	1.001	2.72	981	0.02
	43	34.34	0.98	1.001	2.72	981	0.02
TMat1	45	55.59	0.93	1.000	2.72	981	0.02

	45	54.96	0.93	1.000	2.72	981	0.02
	45	50.03	0.98	1.001	2.72	981	0.02
	45	35.02	0.98	1.001	2.72	981	0.02
TMat1	47	46.37	0.95	1.001	2.72	981	0.02
	47	45.76	0.95	1.001	2.72	981	0.02
	47	43.10	0.98	1.001	2.72	981	0.02
	47	28.37	0.98	1.001	2.72	981	0.02
TMat1	49	36.02	0.98	1.001	2.72	981	0.02
	49	35.48	0.98	1.001	2.72	981	0.02
	49	10.57	1.00	1.001	2.72	981	0.02
	49	1.92	1.00	1.001	2.72	981	0.02
TMat1	51	39.23	0.98	1.001	2.72	981	0.02
	51	38.74	0.98	1.001	2.72	981	0.02
	51	13.08	1.00	1.001	2.72	981	0.02
	51	3.49	1.00	1.001	2.72	981	0.02
TMat1	53	51.87	0.98	1.001	2.72	981	0.02
	53	51.28	0.98	1.001	2.72	981	0.02
	53	24.38	1.00	1.001	2.72	981	0.02
	53	14.52	1.00	1.001	2.72	981	0.02
TMat1	55	37.08	0.98	1.001	2.72	981	0.02
	55	36.50	0.98	1.001	2.72	981	0.02
	55	7.21	1.00	1.001	2.72	981	0.02
	55	-1.54	1.00	1.001	2.72	981	0.02
TMat1	57	52.41	0.98	1.001	2.72	981	0.02
	57	51.87	0.98	1.001	2.72	981	0.02
	57	24.30	1.00	1.001	2.72	981	0.02
	57	13.82	1.00	1.001	2.72	981	0.02
TMat1	59	46.63	0.98	1.001	2.72	981	0.02
	59	46.01	0.98	1.001	2.72	981	0.02
	59	23.59	1.00	1.001	2.72	981	0.02
	59	14.26	1.00	1.001	2.72	981	0.02
TMat1	61	77.81	0.93	1.000	2.72	981	0.02
	61	77.19	0.93	1.000	2.72	981	0.02
	61	49.12	0.95	1.001	2.72	981	0.02
	61	27.59	1.00	1.001	2.72	981	0.02
TMat1	63	79.82	0.93	1.000	2.72	981	0.02
	63	79.18	0.93	1.000	2.72	981	0.02
	63	50.17	0.95	1.001	2.72	981	0.02
	63	29.65	0.98	1.001	2.72	981	0.02

TMat1	65	73.37	0.93	1.000	2.72	981	0.02
	65	72.75	0.93	1.000	2.72	981	0.02
	65	45.03	0.95	1.001	2.72	981	0.02
	65	25.57	1.00	1.001	2.72	981	0.02
TMat1	67	77.70	0.91	1.000	2.72	981	0.02
	67	77.07	0.91	1.000	2.72	981	0.02
	67	46.95	0.95	1.001	2.72	981	0.02
	67	27.39	0.98	1.001	2.72	981	0.02
TMat1	69	77.22	0.93	1.000	2.72	981	0.02
	69	76.59	0.93	1.000	2.72	981	0.02
	69	45.89	0.95	1.001	2.72	981	0.02
	69	27.98	1.00	1.001	2.72	981	0.02
TMat1	71	78.86	0.93	1.000	2.72	981	0.02
	71	78.20	0.93	1.000	2.72	981	0.02
	71	51.99	0.95	1.001	2.72	981	0.02
	71	28.62	0.98	1.001	2.72	981	0.02
TMat1	73	59.86	0.89	1.000	2.72	981	0.02
	73	59.22	0.89	1.000	2.72	981	0.02
	73	37.63	0.93	1.000	2.72	981	0.02
	73	27.37	1.00	1.001	2.72	981	0.02
TMat1	75	59.49	0.91	1.000	2.72	981	0.02
	75	58.85	0.91	1.000	2.72	981	0.02
	75	36.26	0.95	1.001	2.72	981	0.02
	75	22.66	1.00	1.001	2.72	981	0.02
TMat1	77	59.04	0.89	1.000	2.72	981	0.02
	77	58.44	0.89	1.000	2.72	981	0.02
	77	34.35	0.95	1.001	2.72	981	0.02
	77	19.86	1.00	1.001	2.72	981	0.02
TMat1	79	68.18	0.91	1.000	2.72	981	0.02
	79	67.54	0.91	1.000	2.72	981	0.02
	79	39.77	0.95	1.001	2.72	981	0.02
	79	25.57	1.00	1.001	2.72	981	0.02
TMat1	81	63.78	0.89	1.000	2.72	981	0.02
	81	63.16	0.89	1.000	2.72	981	0.02
	81	42.15	0.93	1.000	2.72	981	0.02
	81	28.29	1.00	1.001	2.72	981	0.02
TMat1	83	76.76	0.91	1.000	2.72	981	0.02
	83	76.15	0.91	1.000	2.72	981	0.02
	83	47.57	0.95	1.001	2.72	981	0.02

	83	29.73	0.98	1.001	2.72	981	0.02
TMat1	85	102.67	0.93	1.000	2.72	981	0.02
	85	101.90	0.93	1.000	2.72	981	0.02
	85	62.29	0.95	1.001	2.72	981	0.02
	85	34.91	1.00	1.001	2.72	981	0.02
TMat1	87	72.52	0.93	1.000	2.72	981	0.02
	87	71.93	0.93	1.000	2.72	981	0.02
	87	46.77	0.95	1.001	2.72	981	0.02
	87	40.46	1.00	1.001	2.72	981	0.02
TMat1	89	79.09	0.93	1.000	2.72	981	0.02
	89	78.43	0.93	1.000	2.72	981	0.02
	89	49.21	0.95	1.001	2.72	981	0.02
	89	28.71	0.98	1.001	2.72	981	0.02
TMat1	97	45.18	0.89	1.000	2.72	981	0.02
	97	44.50	0.89	1.000	2.72	981	0.02
	97	15.06	0.95	1.001	2.72	981	0.02
	97	14.46	1.00	1.001	2.72	981	0.02
TMat1	99	65.75	0.91	1.000	2.72	981	0.02
	99	65.12	0.91	1.000	2.72	981	0.02
	99	30.39	0.95	1.001	2.72	981	0.02
	99	20.44	1.00	1.001	2.72	981	0.02
TMat1	101	50.47	0.91	1.000	2.72	981	0.02
	101	49.76	0.91	1.000	2.72	981	0.02
	101	15.14	0.95	1.001	2.72	981	0.02
	101	10.73	1.00	1.001	2.72	981	0.02
TMat1	103	55.59	0.89	1.000	2.72	981	0.02
	103	54.87	0.89	1.000	2.72	981	0.02
	103	33.23	0.93	1.000	2.72	981	0.02
	103	21.09	1.00	1.001	2.72	981	0.02
TMat1	105	72.33	0.91	1.000	2.72	981	0.02
	105	71.54	0.91	1.000	2.72	981	0.02
	105	51.97	0.95	1.001	2.72	981	0.02
	105	35.11	1.00	1.001	2.72	981	0.02

Site	Composited Sample ID	h'	Theta	X (um)
TNef1	1	14.17	484.20	114.13
	1	14.19	484.52	80.75

	1	14.74	499.83	8.78
	1	15.17	525.54	2.31
TNef1	3	14.09	482.80	113.80
	3	14.10	483.11	80.52
	3	14.82	501.22	8.81
	3	15.17	525.54	2.31
TNef1	5	14.99	492.40	116.06
	5	15.01	492.70	82.12
	5	15.56	507.46	8.92
	5	15.51	525.14	2.31
TNef1	7	14.50	489.77	115.44
	7	14.51	490.08	81.68
	7	15.40	510.83	8.97
	7	15.64	533.71	2.34
TNef1	9	14.50	489.77	115.44
	9	14.51	490.08	81.68
	9	15.45	511.65	8.99
	9	15.64	533.71	2.34
TNef1	11	14.50	495.65	116.82
	11	14.51	495.96	82.66
	11	15.23	514.06	9.03
	11	15.73	535.11	2.35
TNef1	13	14.41	488.39	115.11
	13	14.43	488.70	81.45
	13	15.04	510.72	8.97
	13	15.32	521.80	2.29
TNef1	15	14.63	497.88	117.35
	15	14.65	498.20	83.03
	15	14.68	504.56	8.86
	15	15.37	528.94	2.32
TNef1	17	14.66	498.44	117.48
	17	14.68	498.75	83.13
	17	15.07	505.36	8.88
	17	15.40	529.50	2.33
TNef1	19	14.41	488.39	115.11
		14.43	488.70	81.45
	19	15.07	505.36	8.88
	19	15.40	529.50	2.33
TNef1	21	14.25	485.60	114.46

		14.27	485.91	80.99
	21	14.79	500.67	8.80
	21	15.23	526.67	2.31
TNef1	23	14.09	477.35	112.51
	23	14.10	477.67	79.61
	23	14.62	497.74	8.74
	23	15.27	527.24	2.32
TNef1	25	13.68	481.42	113.47
	25	13.69	481.75	80.29
	25	14.66	504.28	8.86
	25	15.18	525.82	2.31
TNef1	27	14.50	484.25	114.14
	27	14.51	484.56	80.76
	27	15.15	500.73	8.80
	27	15.78	523.11	2.30
TNef1	29	14.17	484.20	114.13
	29	14.19	484.52	80.75
	29	14.82	501.22	8.81
	29	15.23	526.67	2.31
TNef1	31	14.00	481.39	113.46
	31	14.02	481.71	80.28
	31	14.74	505.69	8.88
	31	15.32	528.09	2.32
TNef1	33	13.59	468.98	110.54
	33	13.61	469.29	78.22
	33	14.25	491.42	8.63
	33	14.68	516.95	2.27
TNef1	35	13.84	467.74	110.25
	35	13.86	468.06	78.01
	35	14.66	498.44	8.76
	35	14.99	516.18	2.27
TNef1	37	14.41	488.39	115.11
	37	14.43	488.70	81.45
	37	15.23	508.11	8.93
	37	15.64	533.71	2.34
TNef1	39	14.00	487.16	114.83
	39	14.02	487.48	81.25
	39	14.99	509.89	8.96
	39	15.40	529.50	2.33

TNef1	41	15.14	506.46	119.37
	41	15.15	506.77	84.46
	41	15.40	516.82	9.08
	41	15.53	531.75	2.34
TNef1	43	14.82	495.28	116.74
	43	14.84	495.59	82.60
	43	15.32	509.47	8.95
	43	15.64	533.71	2.34
TNef1	45	14.41	488.39	115.11
	45	14.43	488.70	81.45
	45	15.07	511.28	8.98
	45	15.32	528.09	2.32
TNef1	47	14.66	504.28	118.86
	47	14.68	504.60	84.10
	47	15.37	522.64	9.18
	47	15.48	530.91	2.33
TNef1	49	15.18	507.28	119.57
	49	15.20	507.59	84.60
	49	15.48	518.19	9.10
	49	15.63	533.44	2.34
TNef1	51	14.41	494.24	116.49
	51	14.43	494.56	82.43
	51	14.91	508.49	8.93
	51	15.23	526.67	2.31
TNef1	53	14.25	491.42	115.83
	53	14.27	491.74	81.96
	53	14.82	507.09	8.91
	53	15.14	524.97	2.31
TNef1	55	14.00	487.16	114.83
	55	14.02	487.48	81.25
	55	14.82	507.09	8.91
	55	15.15	525.26	2.31
TNef1	57	15.40	504.78	118.98
	57	15.42	505.08	84.18
	57	15.51	512.73	9.01
	57	15.73	522.29	2.29
TNef1	59	14.33	498.61	117.52
	59	14.35	498.93	83.15
	59	14.87	514.20	9.03

	59	15.17	519.28	2.28
TNef1	61	14.58	491.16	115.77
	61	14.60	491.47	81.91
	61	15.15	512.67	9.01
	61	15.64	533.71	2.34
TNef1	63	14.33	498.61	117.52
	63	14.35	498.93	83.15
	63	14.74	511.93	8.99
	63	15.04	523.26	2.30
TNef1	65	15.07	511.28	120.51
	65	15.09	511.59	85.27
	65	15.32	521.80	9.17
	65	15.50	524.87	2.31
TNef1	67	15.07	493.74	116.38
	67	15.09	494.05	82.34
	67	15.48	512.19	9.00
	67	15.64	533.71	2.34
TNef1	69	14.58	491.16	115.77
	69	14.60	491.47	81.91
	69	15.15	512.67	9.01
	69	15.40	529.50	2.33
TNef1	71	14.66	498.44	117.48
	71	14.68	498.75	83.13
	71	15.23	520.40	9.14
	71	15.48	530.91	2.33
TNef1	73	14.58	497.05	117.15
	73	14.60	497.36	82.89
	73	15.32	515.44	9.06
	73	15.73	535.11	2.35
TNef1	75	14.17	490.01	115.50
	75	14.19	490.32	81.72
	75	14.95	509.19	8.95
	75	15.25	520.68	2.29
TNef1	77	14.33	492.83	116.16
	77	14.35	493.15	82.19
	77	14.94	515.34	9.05
	77	15.33	528.37	2.32
TNef1	79	14.71	499.28	117.68
	79	14.73	499.59	83.27

	79	15.17	519.28	9.12
	79	15.46	530.63	2.33
TNef1	81	14.50	495.65	116.82
	81	14.51	495.96	82.66
	81	14.91	508.49	8.93
	81	15.27	527.24	2.32
TNef1	83	14.17	490.01	115.50
	83	14.19	490.32	81.72
	83	14.87	507.79	8.92
	83	15.20	526.11	2.31
TNef1	85	14.33	486.99	114.79
	85	14.35	487.31	81.22
	85	14.95	503.30	8.84
	85	15.28	527.52	2.32
TNef1	87	14.00	487.16	114.83
	87	14.02	487.48	81.25
	87	14.91	508.49	8.93
	87	15.32	528.09	2.32
TNef1	89	14.66	498.44	117.48
	89	14.68	498.75	83.13
	89	15.48	518.19	9.10
	89	15.66	533.99	2.35
TMat1	1	13.48	477.95	112.65
	1	13.50	478.27	79.71
	1	14.50	495.65	8.71
	1	14.99	509.89	2.24
TMat1	3	14.04	493.44	116.31
	3	14.06	493.77	82.29
	3	14.87	507.93	8.92
	3	15.20	513.50	2.26
TMat1	5	13.87	484.87	114.29
	5	13.89	485.20	80.87
	5	14.79	500.67	8.80
	5	15.14	512.39	2.25
TMat1	7	13.97	486.59	114.69
	7	13.99	486.91	81.15
	7	14.74	505.69	8.88
	7	15.15	512.67	2.25
TMat1	9	13.84	484.30	114.15

	9	13.86	484.62	80.77
	9	14.69	504.84	8.87
	9	15.14	512.39	2.25
TMat1	11	13.84	489.97	115.49
	11	13.86	490.30	81.72
	11	14.79	506.53	8.90
	11	15.17	512.95	2.25
TMat1	13	14.20	484.76	114.26
	13	14.22	485.07	80.85
	13	14.74	505.69	8.88
	13	15.30	515.16	2.26
TMat1	15	14.02	481.67	113.53
	15	14.04	481.99	80.33
	15	14.58	497.05	8.73
	15	15.14	512.39	2.25
TMat1	17	14.02	481.67	113.53
	17	14.04	481.99	80.33
	17	14.69	499.00	8.77
	17	15.23	514.06	2.26
TMat1	19	13.84	484.30	114.15
	19	13.86	484.62	80.77
	19	14.50	501.45	8.81
	19	14.82	507.09	2.23
TMat1	21	13.59	474.29	111.79
	21	13.61	474.61	79.10
	21	14.68	504.56	8.86
	21	15.18	513.22	2.25
TMat1	23	14.17	478.74	112.84
	23	14.19	479.05	79.84
	23	14.79	500.67	8.80
	23	15.25	514.33	2.26
TMat1	25	13.35	475.61	112.10
	25	13.37	475.94	79.32
	25	14.61	503.43	8.84
	25	15.12	512.12	2.25
TMat1	27	13.68	481.42	113.47
	27	13.69	481.75	80.29
	27	14.66	504.28	8.86
	27	15.12	512.12	2.25

TMat1	29	13.73	482.29	113.68
	29	13.74	482.61	80.44
	29	14.50	495.65	8.71
	29	14.97	509.61	2.24
TMat1	31	14.41	494.24	116.49
	31	14.43	494.56	82.43
	31	15.10	511.84	8.99
	31	15.28	514.89	2.26
TMat1	33	14.33	492.83	116.16
	33	14.35	493.15	82.19
	33	15.12	512.12	9.00
	33	15.35	515.99	2.27
TMat1	35	14.46	495.08	116.69
	35	14.48	495.40	82.57
	35	15.15	512.67	9.01
	35	15.27	514.61	2.26
TMat1	37	14.18	490.29	115.56
	37	14.20	490.61	81.77
	37	14.96	503.43	8.84
	37	15.18	513.22	2.25
TMat1	39	14.33	492.83	116.16
	39	14.35	493.15	82.19
	39	15.14	512.39	9.00
	39	15.23	514.06	2.26
TMat1	41	13.92	491.42	115.83
	41	13.94	491.75	81.96
	41	14.81	513.07	9.01
	41	15.10	518.16	2.28
TMat1	43	14.58	491.16	115.77
	43	14.60	491.47	81.91
	43	14.69	499.00	8.77
	43	15.32	515.44	2.26
TMat1	45	14.66	492.54	116.09
	45	14.68	492.85	82.14
	45	14.82	507.09	8.91
	45	15.27	514.61	2.26
TMat1	47	14.91	502.61	118.47
	47	14.92	502.92	83.82
	47	15.00	510.17	8.96

	47	15.45	517.64	2.27
TMat1	49	13.92	491.42	115.83
	49	13.94	491.75	81.96
	49	14.79	512.78	9.01
	49	15.07	517.59	2.27
TMat1	51	13.68	487.06	114.80
	51	13.69	487.39	81.23
	51	14.66	510.51	8.97
	51	15.00	516.47	2.27
TMat1	53	13.51	484.13	114.11
	53	13.53	484.46	80.74
	53	14.38	505.63	8.88
	53	14.68	510.79	2.24
TMat1	55	13.97	492.29	116.03
	55	13.99	492.61	82.10
	55	14.92	515.05	9.05
	55	15.18	519.56	2.28
TMat1	57	13.35	481.18	113.42
	57	13.37	481.52	80.25
	57	14.32	504.47	8.86
	57	14.66	510.51	2.24
TMat1	59	13.76	488.52	115.14
	59	13.78	488.85	81.47
	59	14.45	506.78	8.90
	59	14.71	511.36	2.25
TMat1	61	13.82	478.28	112.73
	61	13.84	478.60	79.77
	61	14.66	498.44	8.76
	61	15.15	519.00	2.28
TMat1	63	13.84	478.56	112.80
	63	13.86	478.88	79.81
	63	14.68	498.72	8.76
	63	15.12	512.12	2.25
TMat1	65	13.97	480.83	113.33
	65	13.99	481.14	80.19
	65	14.79	500.67	8.80
	65	15.22	520.12	2.28
TMat1	67	13.86	473.45	111.59
	67	13.87	473.76	78.96

	67	14.74	499.83	8.78
	67	15.17	512.95	2.25
TMat1	69	13.87	479.13	112.93
	69	13.89	479.45	79.91
	69	14.77	500.39	8.79
	69	15.15	519.00	2.28
TMat1	71	13.92	479.98	113.13
	71	13.94	480.30	80.05
	71	14.66	498.44	8.76
	71	15.17	512.95	2.25
TMat1	73	14.25	474.58	111.86
	73	14.27	474.89	79.15
	73	14.97	497.74	8.74
	73	15.18	519.56	2.28
TMat1	75	14.25	480.12	113.17
	75	14.27	480.43	80.07
	75	15.00	504.26	8.86
	75	15.32	521.80	2.29
TMat1	77	14.17	473.22	111.54
	77	14.19	473.52	78.92
	77	15.00	504.26	8.86
	77	15.37	522.64	2.30
TMat1	79	14.00	475.96	112.19
	79	14.02	476.28	79.38
	79	14.91	502.61	8.83
	79	15.23	520.40	2.29
TMat1	81	14.09	471.85	111.22
	81	14.10	472.15	78.69
	81	14.81	495.01	8.70
	81	15.14	518.72	2.28
TMat1	83	13.81	472.61	111.39
	83	13.83	472.92	78.82
	83	14.68	498.72	8.76
	83	15.07	511.28	2.25
TMat1	85	13.68	475.72	112.13
	85	13.69	476.04	79.34
	85	14.63	497.88	8.75
	85	15.14	518.72	2.28
TMat1	87	13.87	479.13	112.93

	87	13.89	479.45	79.91
	87	14.66	498.44	8.76
	87	14.71	511.36	2.25
TMat1	89	13.92	479.98	113.13
	89	13.94	480.30	80.05
	89	14.74	499.83	8.78
	89	15.17	512.95	2.25
TMat1	97	14.74	482.71	113.78
	97	14.76	483.01	80.50
	97	15.64	514.90	9.05
	97	15.58	526.25	2.31
TMat1	99	14.02	476.24	112.25
	99	14.04	476.55	79.43
	99	15.15	506.74	8.90
	99	15.37	522.64	2.30
TMat1	101	14.66	486.98	114.78
	101	14.68	487.29	81.21
	101	15.66	515.17	9.05
	101	15.69	528.19	2.32
TMat1	103	14.55	479.47	113.01
	103	14.56	479.78	79.96
	103	15.20	501.54	8.81
	103	15.43	523.75	2.30
TMat1	105	14.28	480.68	113.30
	105	14.30	480.99	80.16
	105	14.84	501.50	8.81
	105	15.15	519.00	2.28

Site	Composited Sample ID	**Clay Fraction Procedure**	mCLAY	**Sand Fraction Calculation**	mSAND	**Silt Fraction Calculation**
TNef1	1	**23.27**	13.22	**0.31**	1.74	**76.43**
	1					
	1					
	1					
TNef1	3	**22.74**	10.81	**2.96**	1.68	**74.30**
	3					
	3					
	3					

TNef1	5 5 5 5	**35.24**	-1.47	**-4.06**	2.15	**68.82**
TNef1	7 7 7 7	**4.09**	7.97	**28.37**	1.74	**67.55**
TNef1	9 9 9 9	**9.42**	8.86	**-1.91**	1.76	**92.49**
TNef1	11 11 11 11	**0.43**	13.92	**28.31**	1.74	**71.26**
TNef1	13 13 13 13	**27.35**	6.77	**6.67**	1.77	**65.98**
TNef1	15 15 15 15	**22.81**	16.15	**27.88**	1.67	**49.31**
TNef1	17 17 17 17	**11.93**	10.03	**37.08**	1.75	**51.00**
TNef1	19 19 19	**11.43**	9.61	**29.49**	1.68	**59.08**
TNef1	21 21 21	**22.16**	14.98	**-16.08**	1.76	**93.92**
TNef1	23 23 23	**19.36**	18.89	**-6.13**	1.76	**86.77**

	23					
TNef1	25	**22.12**	15.34	**-24.51**	1.72	**102.39**
	25					
	25					
	25					
TNef1	27	**16.63**	14.23	**16.55**	1.64	**66.82**
	27					
	27					
	27					
TNef1	29	**20.85**	12.63	**3.22**	1.72	**75.93**
	29					
	29					
	29					
TNef1	31	**13.48**	15.69	**3.52**	1.71	**83.00**
	31					
	31					
	31					
TNef1	33	**36.42**	12.18	**-11.85**	1.60	**75.43**
	33					
	33					
	33					
TNef1	35	**29.19**	10.51	**-14.22**	1.71	**85.02**
	35					
	35					
	35					
TNef1	37	**3.48**	12.12	**22.15**	1.76	**74.37**
	37					
	37					
	37					
TNef1	39	**11.30**	11.61	**5.40**	1.70	**83.30**
	39					
	39					
	39					
TNef1	41	**27.49**	10.32	**-105.42**	3.50	**177.92**
	41					
	41					
	41					
TNef1	43	**3.68**	9.75	**49.57**	1.70	**46.76**
	43					

	43					
	43					
TNef1	45	**15.19**	8.07	**20.37**	1.78	**64.44**
	45					
	45					
	45					
TNef1	47	**24.85**	7.59	**-101.97**	2.82	**177.11**
	47					
	47					
	47					
TNef1	49	**21.59**	11.50	**-108.20**	3.63	**186.61**
	49					
	49					
	49					
TNef1	51	**21.67**	10.80	**12.59**	1.76	**65.74**
	51					
	51					
	51					
TNef1	53	**26.76**	11.13	**-11.46**	1.88	**84.70**
	53					
	53					
	53					
TNef1	55	**24.70**	10.93	**-13.97**	1.78	**89.28**
	55					
	55					
	55					
TNef1	57	**74.55**	21.03	**-730.56**	7.19	**756.01**
	57					
	57					
	57					
TNef1	59	**33.04**	7.29	**-3.26**	1.81	**70.21**
	59					
	59					
	59					
TNef1	61	**3.45**	15.26	**18.75**	1.91	**77.81**
	61					
	61					
	61					
TNef1	63	**37.93**	7.45	**-8.12**	1.84	**70.19**

	63					
	63					
	63					
TNef1	65	**21.46**	4.29	**46.40**	1.75	**32.14**
	65					
	65					
	65					
TNef1	67	**4.79**	6.49	**53.13**	1.89	**42.08**
	67					
	67					
	67					
TNef1	69	**12.42**	8.05	**30.32**	1.77	**57.26**
	69					
	69					
	69					
TNef1	71	**22.10**	6.02	**17.82**	1.78	**60.08**
	71					
	71					
	71					
TNef1	73	**0.78**	12.27	**28.64**	1.79	**70.58**
	73					
	73					
	73					
TNef1	75	**20.18**	9.55	**9.47**	1.66	**70.35**
	75					
	75					
	75					
TNef1	77	**27.61**	10.06	**-8.45**	1.86	**80.84**
	77					
	77					
	77					
TNef1	79	**22.15**	7.13	**23.06**	1.76	**54.79**
	79					
	79					
	79					
TNef1	81	**20.88**	11.85	**13.80**	1.79	**65.32**
	81					
	81					
	81					

TNef1	83	**23.68**	11.46	**-10.62**	1.83	**86.94**
	83					
	83					
	83					
TNef1	85	**19.72**	10.95	**10.34**	1.73	**69.94**
	85					
	85					
	85					
TNef1	87	**15.01**	12.51	**-10.25**	1.83	**95.24**
	87					
	87					
	87					
TNef1	89	**11.03**	7.60	**-9.48**	2.10	**98.45**
	89					
	89					
	89					
TMat1	1	**36.03**	10.27	**-14.55**	1.51	**78.52**
	1					
	1					
	1					
TMat1	3	**40.18**	8.95	**-61.34**	2.00	**121.16**
	3					
	3					
	3					
TMat1	5	**41.18**	9.17	**-62.08**	1.94	**120.90**
	5					
	5					
	5					
TMat1	7	**38.79**	10.41	**-42.89**	1.86	**104.10**
	7					
	7					
	7					
TMat1	9	**38.43**	11.02	**-44.89**	1.82	**106.46**
	9					
	9					
	9					
TMat1	11	**35.68**	8.92	**-30.86**	1.73	**95.18**
	11					
	11					

	11					
TMat1	13	**29.83**	12.80	**-3.21**	1.67	**73.38**
	13					
	13					
	13					
TMat1	15	**35.94**	13.25	**-18.79**	1.72	**82.84**
	15					
	15					
	15					
TMat1	17	**31.55**	12.37	**-9.79**	1.65	**78.24**
	17					
	17					
	17					
TMat1	19	**44.69**	7.35	**-17.55**	1.64	**72.86**
	19					
	19					
	19					
TMat1	21	**34.69**	12.03	**-44.13**	1.73	**109.43**
	21					
	21					
	21					
TMat1	23	**32.30**	10.82	**-9.32**	1.71	**77.02**
	23					
	23					
	23					
TMat1	25	**30.59**	9.99	**-7.93**	1.43	**77.34**
	25					
	25					
	25					
TMat1	27	**34.82**	10.22	**-23.30**	1.63	**88.48**
	27					
	27					
	27					
TMat1	29	**38.57**	10.47	**-16.16**	1.60	**77.60**
	29					
	29					
	29					
TMat1	31	**32.95**	4.30	**-1.44**	1.76	**68.49**
	31					

	31					
	31					
TMat1	33	**32.36**	5.79	**-18.91**	1.86	**86.55**
	33					
	33					
	33					
TMat1	35	**33.90**	2.75	**0.07**	1.77	**66.02**
	35					
	35					
	35					
TMat1	37	**34.62**	5.31	**-5.51**	1.69	**70.89**
	37					
	37					
	37					
TMat1	39	**36.12**	2.43	**-14.56**	1.82	**78.44**
	39					
	39					
	39					
TMat1	41	**0.11**	7.16	**41.56**	1.69	**58.32**
	41					
	41					
	41					
TMat1	43	**32.35**	16.07	**-3.77**	1.86	**71.42**
	43					
	43					
	43					
TMat1	45	**33.68**	10.94	**7.37**	1.81	**58.95**
	45					
	45					
	45					
TMat1	47	**26.99**	10.74	**25.45**	1.77	**47.56**
	47					
	47					
	47					
TMat1	49	**1.12**	6.28	**50.37**	1.56	**48.51**
	49					
	49					
	49					
TMat1	51	**2.61**	6.98	**50.32**	1.42	**47.07**

	51					
	51					
	51					
TMat1	53	**13.70**	7.16	**19.72**	1.69	**66.57**
	53					
	53					
	53					
TMat1	55	**-2.38**	6.35	**45.10**	1.67	**57.28**
	55					
	55					
	55					
TMat1	57	**12.94**	7.63	**25.35**	1.55	**61.71**
	57					
	57					
	57					
TMat1	59	**13.48**	6.77	**24.53**	1.78	**61.99**
	59					
	59					
	59					
TMat1	61	**25.50**	15.99	**-31.94**	1.79	**106.44**
	61					
	61					
	61					
TMat1	63	**27.87**	15.09	**-39.97**	1.85	**112.10**
	63					
	63					
	63					
TMat1	65	**23.65**	14.43	**-24.84**	1.81	**101.19**
	65					
	65					
	65					
TMat1	67	**25.68**	14.38	**-33.42**	1.82	**107.75**
	67					
	67					
	67					
TMat1	69	**26.24**	13.27	**-32.69**	1.82	**106.44**
	69					
	69					
	69					

TMat1	71	**26.57**	17.21	**-41.54**	1.90	**114.97**
	71					
	71					
	71					
TMat1	73	**26.36**	7.64	**-2.98**	1.85	**76.63**
	73					
	73					
	73					
TMat1	75	**21.29**	10.06	**-1.64**	1.84	**80.35**
	75					
	75					
	75					
TMat1	77	**18.38**	10.73	**4.40**	1.75	**77.22**
	77					
	77					
	77					
TMat1	79	**24.17**	10.51	**-18.01**	1.85	**93.84**
	79					
	79					
	79					
TMat1	81	**26.94**	10.35	**-7.30**	1.80	**80.36**
	81					
	81					
	81					
TMat1	83	**28.21**	13.10	**-27.41**	1.76	**99.20**
	83					
	83					
	83					
TMat1	85	**32.26**	20.35	**-118.65**	2.23	**186.39**
	85					
	85					
	85					
TMat1	87	**39.92**	4.63	**-16.62**	1.71	**76.70**
	87					
	87					
	87					
TMat1	89	**26.91**	15.07	**-42.39**	1.91	**115.48**
	89					
	89					

	89					
TMat1	97	**14.39**	0.44	**20.06**	1.96	**65.55**
	97					
	97					
	97					
TMat1	99	**19.43**	7.34	**-10.40**	1.80	**90.97**
	99					
	99					
	99					
TMat1	101	**10.24**	3.24	**5.50**	2.05	**84.26**
	101					
	101					
	101					
TMat1	103	**19.82**	9.04	**-6.36**	2.08	**86.54**
	103					
	103					
	103					
TMat1	105	**33.48**	12.47	**-54.96**	2.28	**121.47**
	105					
	105					
	105					

Site	Composited Sample ID	t 1.5 (min)	t 24 (min)	P 90	P 1440	X 90	X 1440	mclay	P 2um (% clay)
TNef1	1	90	1440	42.83	25.16	63.55	17223.12	-3.15	53.73
	1	90	1440						
	1	90	1440						
	1	90	1440						
TNef1	3	90	1440	38.76	24.29	64.26	17223.12	-2.59	47.74
	3	90	1440						
	3	90	1440						
	3	90	1440						
TNef1	5	90	1440	33.05	35.03	70.81	18014.10	0.36	31.77
	5	90	1440						
	5	90	1440						
	5	90	1440						
TNef1	7	90	1440	16.05	5.35	69.33	18320.10	-1.92	22.85
	7	90	1440						

	7	90	1440						
	7	90	1440						
TNef1	9	90	1440	22.73	10.82	69.77	18320.10	-2.14	30.32
	9	90	1440						
	9	90	1440						
	9	90	1440						
TNef1	11	90	1440	21.41	2.68	67.86	18512.66	-3.34	33.19
	11	90	1440						
	11	90	1440						
	11	90	1440						
TNef1	13	90	1440	37.52	28.28	66.12	17559.93	-1.66	43.31
	13	90	1440						
	13	90	1440						
	13	90	1440						
TNef1	15	90	1440	46.86	25.23	62.98	17672.93	-3.84	60.09
	15	90	1440						
	15	90	1440						
	15	90	1440						
TNef1	17	90	1440	26.88	13.44	66.41	17748.47	-2.41	35.31
	17	90	1440						
	17	90	1440						
	17	90	1440						
TNef1	19	90	1440	25.76	12.88	66.41	17748.47	-2.30	33.83
		90	1440						
	19	90	1440						
	19	90	1440						
TNef1	21	90	1440	44.35	24.34	63.97	17372.41	-3.57	56.72
		90	1440						
	21	90	1440						
	21	90	1440						
TNef1	23	90	1440	47.22	22.13	62.49	17447.30	-4.46	62.56
	23	90	1440						
	23	90	1440						
	23	90	1440						
TNef1	25	90	1440	44.95	24.33	62.84	17260.38	-3.67	57.61
	25	90	1440						
	25	90	1440						
	25	90	1440						
TNef1	27	90	1440	37.71	18.60	67.13	18628.67	-3.40	49.64

	27	90	1440						
	27	90	1440						
	27	90	1440						
TNef1	29	90	1440	39.58	22.69	64.26	17372.41	-3.02	50.04
	29	90	1440						
	29	90	1440						
	29	90	1440						
TNef1	31	90	1440	36.88	15.81	63.55	17559.93	-3.75	49.85
	31	90	1440						
	31	90	1440						
	31	90	1440						
TNef1	33	90	1440	54.24	37.97	59.38	16123.94	-2.90	64.09
	33	90	1440						
	33	90	1440						
	33	90	1440						
TNef1	35	90	1440	44.71	30.51	62.84	16815.88	-2.54	53.47
	35	90	1440						
	35	90	1440						
	35	90	1440						
TNef1	37	90	1440	21.61	5.40	67.86	18320.10	-2.90	31.81
	37	90	1440						
	37	90	1440						
	37	90	1440						
TNef1	39	90	1440	28.71	13.05	65.69	17748.47	-2.80	38.47
	39	90	1440						
	39	90	1440						
	39	90	1440						
TNef1	41	90	1440	43.10	29.09	69.33	18052.21	-2.52	52.03
	41	90	1440						
	41	90	1440						
	41	90	1440						
TNef1	43	90	1440	18.30	5.23	68.59	18320.10	-2.34	26.56
	43	90	1440						
	43	90	1440						
	43	90	1440						
TNef1	45	90	1440	27.31	16.38	66.41	17559.93	-1.96	34.17
	45	90	1440						
	45	90	1440						
	45	90	1440						

TNef1	47	90	1440	36.43	26.02	69.03	17938.00	-1.87	43.06
	47	90	1440						
	47	90	1440						
	47	90	1440						
TNef1	49	90	1440	39.02	23.41	70.07	18281.71	-2.81	48.99
	49	90	1440						
	49	90	1440						
	49	90	1440						
TNef1	51	90	1440	37.84	23.24	64.97	17372.41	-2.61	46.93
	51	90	1440						
	51	90	1440						
	51	90	1440						
TNef1	53	90	1440	43.38	28.34	64.26	17148.71	-2.69	52.72
	53	90	1440						
	53	90	1440						
	53	90	1440						
TNef1	55	90	1440	41.03	26.26	64.26	17185.89	-2.64	50.20
	55	90	1440						
	55	90	1440						
	55	90	1440						
TNef1	57	90	1440	106.19	77.43	70.37	18512.66	-5.16	124.57
	57	90	1440						
	57	90	1440						
	57	90	1440						
TNef1	59	90	1440	44.04	34.00	64.68	17223.12	-1.80	50.28
	59	90	1440						
	59	90	1440						
	59	90	1440						
TNef1	61	90	1440	26.41	5.87	67.13	18320.10	-3.66	39.27
	61	90	1440						
	61	90	1440						
	61	90	1440						
TNef1	63	90	1440	49.12	38.96	63.55	16926.46	-1.82	55.42
	63	90	1440						
	63	90	1440						
	63	90	1440						
TNef1	65	90	1440	27.99	22.07	68.59	17976.03	-1.06	31.75
	65	90	1440						
	65	90	1440						

	65	90	1440						
TNef1	67	90	1440	14.56	5.82	70.07	18320.10	-1.57	20.14
	67	90	1440						
	67	90	1440						
	67	90	1440						
TNef1	69	90	1440	24.54	13.63	67.13	17748.47	-1.96	31.41
	69	90	1440						
	69	90	1440						
	69	90	1440						
TNef1	71	90	1440	31.25	23.03	67.86	17938.00	-1.47	36.45
	71	90	1440						
	71	90	1440						
	71	90	1440						
TNef1	73	90	1440	19.31	2.76	68.59	18512.66	-2.96	29.75
	73	90	1440						
	73	90	1440						
	73	90	1440						
TNef1	75	90	1440	34.49	21.46	65.33	17409.84	-2.33	42.62
	75	90	1440						
	75	90	1440						
	75	90	1440						
TNef1	77	90	1440	42.81	29.11	65.26	17597.56	-2.45	51.34
	77	90	1440						
	77	90	1440						
	77	90	1440						
TNef1	79	90	1440	32.97	23.24	67.28	17900.02	-1.74	39.10
	79	90	1440						
	79	90	1440						
	79	90	1440						
TNef1	81	90	1440	38.61	22.61	64.97	17447.30	-2.86	48.56
	81	90	1440						
	81	90	1440						
	81	90	1440						
TNef1	83	90	1440	40.82	25.34	64.61	17297.68	-2.77	50.45
	83	90	1440						
	83	90	1440						
	83	90	1440						
TNef1	85	90	1440	36.00	21.33	65.33	17484.80	-2.62	45.15
	85	90	1440						

	85	90	1440						
	85	90	1440						
TNef1	87	90	1440	33.73	16.86	64.97	17559.93	-3.01	44.21
	87	90	1440						
	87	90	1440						
	87	90	1440						
TNef1	89	90	1440	22.55	12.24	70.07	18358.53	-1.85	29.14
	89	90	1440						
	89	90	1440						
	89	90	1440						
TMat1	1	90	1440	51.14	37.19	61.45	16815.88	-2.49	59.65
	1	90	1440						
	1	90	1440						
	1	90	1440						
TMat1	3	90	1440	53.57	41.26	64.68	17297.68	-2.20	61.23
	3	90	1440						
	3	90	1440						
	3	90	1440						
TMat1	5	90	1440	54.76	42.26	63.97	17148.71	-2.24	62.51
	5	90	1440						
	5	90	1440						
	5	90	1440						
TMat1	7	90	1440	54.32	40.02	63.55	17185.89	-2.55	63.14
	7	90	1440						
	7	90	1440						
	7	90	1440						
TMat1	9	90	1440	54.84	39.73	63.12	17148.71	-2.70	64.15
	9	90	1440						
	9	90	1440						
	9	90	1440						
TMat1	11	90	1440	48.99	36.74	63.97	17223.12	-2.19	56.57
	11	90	1440						
	11	90	1440						
	11	90	1440						
TMat1	13	90	1440	48.92	31.41	63.55	17522.35	-3.12	59.69
	13	90	1440						
	13	90	1440						
	13	90	1440						
TMat1	15	90	1440	55.47	37.51	62.14	17148.71	-3.20	66.45

	15	90	1440						
	15	90	1440						
	15	90	1440						
TMat1	17	90	1440	49.82	33.05	63.12	17372.41	-2.99	60.13
	17	90	1440						
	17	90	1440						
	17	90	1440						
TMat1	19	90	1440	55.58	45.48	61.45	16449.89	-1.81	61.78
	19	90	1440						
	19	90	1440						
	19	90	1440						
TMat1	21	90	1440	52.60	36.13	62.98	17260.38	-2.93	62.73
	21	90	1440						
	21	90	1440						
	21	90	1440						
TMat1	23	90	1440	48.32	33.61	63.97	17409.84	-2.62	57.41
	23	90	1440						
	23	90	1440						
	23	90	1440						
TMat1	25	90	1440	45.43	31.76	62.42	17111.57	-2.44	53.82
	25	90	1440						
	25	90	1440						
	25	90	1440						
TMat1	27	90	1440	50.03	36.02	62.84	17111.57	-2.50	58.64
	27	90	1440						
	27	90	1440						
	27	90	1440						
TMat1	29	90	1440	53.97	39.74	61.45	16779.10	-2.54	62.66
	29	90	1440						
	29	90	1440						
	29	90	1440						
TMat1	31	90	1440	39.42	33.48	66.70	17484.80	-1.07	43.16
	31	90	1440						
	31	90	1440						
	31	90	1440						
TMat1	33	90	1440	41.07	33.09	66.84	17635.23	-1.43	46.10
	33	90	1440						
	33	90	1440						
	33	90	1440						

TMat1	35	90	1440	38.04	34.24	67.13	17447.30	-0.68	40.45
	35	90	1440						
	35	90	1440						
	35	90	1440						
TMat1	37	90	1440	42.51	35.25	65.40	17260.38	-1.30	47.05
	37	90	1440						
	37	90	1440						
	37	90	1440						
TMat1	39	90	1440	39.78	36.41	66.99	17372.41	-0.60	41.90
	39	90	1440						
	39	90	1440						
	39	90	1440						
TMat1	41	90	1440	10.90	1.04	64.12	17074.47	-1.77	17.02
	41	90	1440						
	41	90	1440						
	41	90	1440						
TMat1	43	90	1440	56.10	34.34	63.12	17559.93	-3.86	69.44
	43	90	1440						
	43	90	1440						
	43	90	1440						
TMat1	45	90	1440	50.03	35.02	64.26	17447.30	-2.68	59.32
	45	90	1440						
	45	90	1440						
	45	90	1440						
TMat1	47	90	1440	43.10	28.37	65.83	17862.07	-2.63	52.28
	47	90	1440						
	47	90	1440						
	47	90	1440						
TMat1	49	90	1440	10.57	1.92	63.97	17000.38	-1.55	15.93
	49	90	1440						
	49	90	1440						
	49	90	1440						
TMat1	51	90	1440	13.08	3.49	62.84	16852.70	-1.72	18.99
	51	90	1440						
	51	90	1440						
	51	90	1440						
TMat1	53	90	1440	24.38	14.52	60.48	16123.94	-1.76	30.39
	53	90	1440						
	53	90	1440						

	53	90	1440						
TMat1	55	90	1440	7.21	-1.54	65.11	17260.38	-1.57	12.67
	55	90	1440						
	55	90	1440						
	55	90	1440						
TMat1	57	90	1440	24.30	13.82	59.93	16087.93	-1.87	30.67
	57	90	1440						
	57	90	1440						
	57	90	1440						
TMat1	59	90	1440	23.59	14.26	61.03	16196.09	-1.67	29.30
	59	90	1440						
	59	90	1440						
	59	90	1440						
TMat1	61	90	1440	49.12	27.59	62.84	17185.89	-3.84	62.34
	61	90	1440						
	61	90	1440						
	61	90	1440						
TMat1	63	90	1440	50.17	29.65	62.98	17111.57	-3.66	62.80
	63	90	1440						
	63	90	1440						
	63	90	1440						
TMat1	65	90	1440	45.03	25.57	63.97	17335.03	-3.47	57.06
	65	90	1440						
	65	90	1440						
	65	90	1440						
TMat1	67	90	1440	46.95	27.39	63.55	17223.12	-3.49	59.03
	67	90	1440						
	67	90	1440						
	67	90	1440						
TMat1	69	90	1440	45.89	27.98	63.83	17185.89	-3.20	56.97
	69	90	1440						
	69	90	1440						
	69	90	1440						
TMat1	71	90	1440	51.99	28.62	62.84	17223.12	-4.16	66.34
	71	90	1440						
	71	90	1440						
	71	90	1440						
TMat1	73	90	1440	37.63	27.37	65.54	17260.38	-1.84	44.05
	73	90	1440						

	73	90	1440						
	73	90	1440						
TMat1	75	90	1440	36.26	22.66	65.83	17559.93	-2.43	44.77
	75	90	1440						
	75	90	1440						
	75	90	1440						
TMat1	77	90	1440	34.35	19.86	65.83	17672.93	-2.59	43.41
	77	90	1440						
	77	90	1440						
	77	90	1440						
TMat1	79	90	1440	39.77	25.57	64.97	17372.41	-2.54	48.62
	79	90	1440						
	79	90	1440						
	79	90	1440						
TMat1	81	90	1440	42.15	28.29	64.12	17148.71	-2.48	50.75
	81	90	1440						
	81	90	1440						
	81	90	1440						
TMat1	83	90	1440	47.57	29.73	62.98	17000.38	-3.19	58.56
	83	90	1440						
	83	90	1440						
	83	90	1440						
TMat1	85	90	1440	62.29	34.91	62.56	17148.71	-4.88	79.08
	85	90	1440						
	85	90	1440						
	85	90	1440						
TMat1	87	90	1440	46.77	40.46	62.84	16196.09	-1.14	50.68
	87	90	1440						
	87	90	1440						
	87	90	1440						
TMat1	89	90	1440	49.21	28.71	63.55	17223.12	-3.66	61.87
	89	90	1440						
	89	90	1440						
	89	90	1440						
TMat1	97	90	1440	15.06	14.46	71.56	18166.78	-0.11	15.45
	97	90	1440						
	97	90	1440						
	97	90	1440						
TMat1	99	90	1440	30.39	20.44	67.13	17672.93	-1.78	36.66

	99	90	1440						
	99	90	1440						
	99	90	1440						
TMat1	101	90	1440	15.14	10.73	71.71	18435.51	-0.80	17.99
	101	90	1440						
	101	90	1440						
	101	90	1440						
TMat1	103	90	1440	33.23	21.09	67.57	17824.16	-2.18	40.89
	103	90	1440						
	103	90	1440						
	103	90	1440						
TMat1	105	90	1440	51.97	35.11	64.40	17185.89	-3.02	62.44
	105								
	105								
	105								

Site	Composited Sample ID	t 0.5 (min)	t 1.0 (min)	P 0.5	P 1.0	X 0.5	X 1.0	msand
TNef1	1	0.50	1.00	61.56	60.96	0.00	0.01	-0.43
	1	0.50	1.00					
	1	0.50	1.00					
	1	0.50	1.00					
TNef1	3	0.50	1.00	62.02	61.43	0.00	0.01	-0.42
	3	0.50	1.00					
	3	0.50	1.00					
	3	0.50	1.00					
TNef1	5	0.50	1.00	52.88	52.13	0.00	0.01	-0.54
	5	0.50	1.00					
	5	0.50	1.00					
	5	0.50	1.00					
TNef1	7	0.50	1.00	45.48	44.88	0.00	0.01	-0.43
	7	0.50	1.00					
	7	0.50	1.00					
	7	0.50	1.00					
TNef1	9	0.50	1.00	62.23	61.62	0.00	0.01	-0.44
	9	0.50	1.00					
	9	0.50	1.00					
	9	0.50	1.00					

TNef1	11	0.50	1.00	45.50	44.90	0.00	0.01	-0.43
	11	0.50	1.00					
	11	0.50	1.00					
	11	0.50	1.00					
TNef1	13	0.50	1.00	57.10	56.48	0.00	0.01	-0.44
	13	0.50	1.00					
	13	0.50	1.00					
	13	0.50	1.00					
TNef1	15	0.50	1.00	47.37	46.79	0.00	0.01	-0.42
	15	0.50	1.00					
	15	0.50	1.00					
	15	0.50	1.00					
TNef1	17	0.50	1.00	40.32	39.72	0.00	0.01	-0.44
	17	0.50	1.00					
	17	0.50	1.00					
	17	0.50	1.00					
TNef1	19	0.50	1.00	46.37	45.79	0.00	0.01	-0.42
		0.50	1.00					
	19	0.50	1.00					
	19	0.50	1.00					
TNef1	21	0.50	1.00	70.31	69.70	0.00	0.01	-0.44
		0.50	1.00					
	21	0.50	1.00					
	21	0.50	1.00					
TNef1	23	0.50	1.00	64.76	64.15	0.00	0.01	-0.44
	23	0.50	1.00					
	23	0.50	1.00					
	23	0.50	1.00					
TNef1	25	0.50	1.00	76.68	76.08	0.00	0.01	-0.43
	25	0.50	1.00					
	25	0.50	1.00					
	25	0.50	1.00					
TNef1	27	0.50	1.00	55.30	54.74	0.00	0.01	-0.41
	27	0.50	1.00					
	27	0.50	1.00					
	27	0.50	1.00					
TNef1	29	0.50	1.00	60.69	60.09	0.00	0.01	-0.43
	29	0.50	1.00					
	29	0.50	1.00					

	29	0.50	1.00					
TNef1	31	0.50	1.00	60.59	60.00	0.00	0.01	-0.43
	31	0.50	1.00					
	31	0.50	1.00					
	31	0.50	1.00					
TNef1	33	0.50	1.00	73.96	73.41	0.00	0.01	-0.40
	33	0.50	1.00					
	33	0.50	1.00					
	33	0.50	1.00					
TNef1	35	0.50	1.00	71.02	70.42	0.00	0.01	-0.43
	35	0.50	1.00					
	35	0.50	1.00					
	35	0.50	1.00					
TNef1	37	0.50	1.00	48.62	48.01	0.00	0.01	-0.44
	37	0.50	1.00					
	37	0.50	1.00					
	37	0.50	1.00					
TNef1	39	0.50	1.00	60.02	59.43	0.00	0.01	-0.42
	39	0.50	1.00					
	39	0.50	1.00					
	39	0.50	1.00					
TNef1	41	0.50	1.00	63.58	62.37	0.00	0.01	-0.87
	41	0.50	1.00					
	41	0.50	1.00					
	41	0.50	1.00					
TNef1	43	0.50	1.00	33.98	33.39	0.00	0.01	-0.42
	43	0.50	1.00					
	43	0.50	1.00					
	43	0.50	1.00					
TNef1	45	0.50	1.00	49.15	48.54	0.00	0.01	-0.44
	45	0.50	1.00					
	45	0.50	1.00					
	45	0.50	1.00					
TNef1	47	0.50	1.00	76.32	75.35	0.00	0.01	-0.70
	47	0.50	1.00					
	47	0.50	1.00					
	47	0.50	1.00					
TNef1	49	0.50	1.00	62.43	61.18	0.00	0.01	-0.90
	49	0.50	1.00					

	49	0.50	1.00					
	49	0.50	1.00					
TNef1	51	0.50	1.00	54.05	53.45	0.00	0.01	-0.44
	51	0.50	1.00					
	51	0.50	1.00					
	51	0.50	1.00					
TNef1	53	0.50	1.00	63.62	62.97	0.00	0.01	-0.47
	53	0.50	1.00					
	53	0.50	1.00					
	53	0.50	1.00					
TNef1	55	0.50	1.00	68.38	67.77	0.00	0.01	-0.44
	55	0.50	1.00					
	55	0.50	1.00					
	55	0.50	1.00					
TNef1	57	0.50	1.00	121.68	119.19	0.00	0.01	-1.79
	57	0.50	1.00					
	57	0.50	1.00					
	57	0.50	1.00					
TNef1	59	0.50	1.00	61.32	60.69	0.00	0.01	-0.45
	59	0.50	1.00					
	59	0.50	1.00					
	59	0.50	1.00					
TNef1	61	0.50	1.00	46.95	46.29	0.00	0.01	-0.48
	61	0.50	1.00					
	61	0.50	1.00					
	61	0.50	1.00					
TNef1	63	0.50	1.00	63.24	62.61	0.00	0.01	-0.46
	63	0.50	1.00					
	63	0.50	1.00					
	63	0.50	1.00					
TNef1	65	0.50	1.00	34.98	34.38	0.00	0.01	-0.44
	65	0.50	1.00					
	65	0.50	1.00					
	65	0.50	1.00					
TNef1	67	0.50	1.00	29.12	28.47	0.00	0.01	-0.47
	67	0.50	1.00					
	67	0.50	1.00					
	67	0.50	1.00					
TNef1	69	0.50	1.00	43.62	43.01	0.00	0.01	-0.44

	69	0.50	1.00					
	69	0.50	1.00					
	69	0.50	1.00					
TNef1	71	0.50	1.00	50.44	49.82	0.00	0.01	-0.44
	71	0.50	1.00					
	71	0.50	1.00					
	71	0.50	1.00					
TNef1	73	0.50	1.00	44.13	43.51	0.00	0.01	-0.45
	73	0.50	1.00					
	73	0.50	1.00					
	73	0.50	1.00					
TNef1	75	0.50	1.00	58.76	58.19	0.00	0.01	-0.41
	75	0.50	1.00					
	75	0.50	1.00					
	75	0.50	1.00					
TNef1	77	0.50	1.00	62.79	62.14	0.00	0.01	-0.46
	77	0.50	1.00					
	77	0.50	1.00					
	77	0.50	1.00					
TNef1	79	0.50	1.00	48.11	47.50	0.00	0.01	-0.44
	79	0.50	1.00					
	79	0.50	1.00					
	79	0.50	1.00					
TNef1	81	0.50	1.00	52.40	51.78	0.00	0.01	-0.45
	81	0.50	1.00					
	81	0.50	1.00					
	81	0.50	1.00					
TNef1	83	0.50	1.00	64.75	64.12	0.00	0.01	-0.46
	83	0.50	1.00					
	83	0.50	1.00					
	83	0.50	1.00					
TNef1	85	0.50	1.00	56.00	55.40	0.00	0.01	-0.43
	85	0.50	1.00					
	85	0.50	1.00					
	85	0.50	1.00					
TNef1	87	0.50	1.00	64.64	64.01	0.00	0.01	-0.46
	87	0.50	1.00					
	87	0.50	1.00					
	87	0.50	1.00					

TNef1	89	0.50	1.00	56.70	55.98	0.00	0.01	-0.52
	89	0.50	1.00					
	89	0.50	1.00					
	89	0.50	1.00					
TMat1	1	0.50	1.00	79.96	79.44	0.00	0.01	-0.38
	1	0.50	1.00					
	1	0.50	1.00					
	1	0.50	1.00					
TMat1	3	0.50	1.00	84.98	84.28	0.00	0.01	-0.50
	3	0.50	1.00					
	3	0.50	1.00					
	3	0.50	1.00					
TMat1	5	0.50	1.00	88.10	87.43	0.00	0.01	-0.48
	5	0.50	1.00					
	5	0.50	1.00					
	5	0.50	1.00					
TMat1	7	0.50	1.00	81.19	80.55	0.00	0.01	-0.46
	7	0.50	1.00					
	7	0.50	1.00					
	7	0.50	1.00					
TMat1	9	0.50	1.00	83.94	83.31	0.00	0.01	-0.45
	9	0.50	1.00					
	9	0.50	1.00					
	9	0.50	1.00					
TMat1	11	0.50	1.00	79.87	79.27	0.00	0.01	-0.43
	11	0.50	1.00					
	11	0.50	1.00					
	11	0.50	1.00					
TMat1	13	0.50	1.00	65.91	65.33	0.00	0.01	-0.42
	13	0.50	1.00					
	13	0.50	1.00					
	13	0.50	1.00					
TMat1	15	0.50	1.00	73.43	72.83	0.00	0.01	-0.43
	15	0.50	1.00					
	15	0.50	1.00					
	15	0.50	1.00					
TMat1	17	0.50	1.00	70.67	70.09	0.00	0.01	-0.41
	17	0.50	1.00					
	17	0.50	1.00					

	17	0.50	1.00					
TMat1	19	0.50	1.00	75.80	75.23	0.00	0.01	-0.41
	19	0.50	1.00					
	19	0.50	1.00					
	19	0.50	1.00					
TMat1	21	0.50	1.00	87.67	87.07	0.00	0.01	-0.43
	21	0.50	1.00					
	21	0.50	1.00					
	21	0.50	1.00					
TMat1	23	0.50	1.00	68.28	67.69	0.00	0.01	-0.43
	23	0.50	1.00					
	23	0.50	1.00					
	23	0.50	1.00					
TMat1	25	0.50	1.00	79.40	78.90	0.00	0.01	-0.36
	25	0.50	1.00					
	25	0.50	1.00					
	25	0.50	1.00					
TMat1	27	0.50	1.00	80.04	79.48	0.00	0.01	-0.41
	27	0.50	1.00					
	27	0.50	1.00					
	27	0.50	1.00					
TMat1	29	0.50	1.00	77.04	76.48	0.00	0.01	-0.40
	29	0.50	1.00					
	29	0.50	1.00					
	29	0.50	1.00					
TMat1	31	0.50	1.00	62.10	61.49	0.00	0.01	-0.44
	31	0.50	1.00					
	31	0.50	1.00					
	31	0.50	1.00					
TMat1	33	0.50	1.00	68.45	67.81	0.00	0.01	-0.46
	33	0.50	1.00					
	33	0.50	1.00					
	33	0.50	1.00					
TMat1	35	0.50	1.00	60.87	60.26	0.00	0.01	-0.44
	35	0.50	1.00					
	35	0.50	1.00					
	35	0.50	1.00					
TMat1	37	0.50	1.00	66.87	66.29	0.00	0.01	-0.42
	37	0.50	1.00					

	37	0.50	1.00					
	37	0.50	1.00					
TMat1	39	0.50	1.00	67.23	66.60	0.00	0.01	-0.45
	39	0.50	1.00					
	39	0.50	1.00					
	39	0.50	1.00					
TMat1	41	0.50	1.00	38.92	38.34	0.00	0.01	-0.42
	41	0.50	1.00					
	41	0.50	1.00					
	41	0.50	1.00					
TMat1	43	0.50	1.00	60.10	59.46	0.00	0.01	-0.46
	43	0.50	1.00					
	43	0.50	1.00					
	43	0.50	1.00					
TMat1	45	0.50	1.00	55.59	54.96	0.00	0.01	-0.45
	45	0.50	1.00					
	45	0.50	1.00					
	45	0.50	1.00					
TMat1	47	0.50	1.00	46.37	45.76	0.00	0.01	-0.44
	47	0.50	1.00					
	47	0.50	1.00					
	47	0.50	1.00					
TMat1	49	0.50	1.00	36.02	35.48	0.00	0.01	-0.39
	49	0.50	1.00					
	49	0.50	1.00					
	49	0.50	1.00					
TMat1	51	0.50	1.00	39.23	38.74	0.00	0.01	-0.35
	51	0.50	1.00					
	51	0.50	1.00					
	51	0.50	1.00					
TMat1	53	0.50	1.00	51.87	51.28	0.00	0.01	-0.42
	53	0.50	1.00					
	53	0.50	1.00					
	53	0.50	1.00					
TMat1	55	0.50	1.00	37.08	36.50	0.00	0.01	-0.42
	55	0.50	1.00					
	55	0.50	1.00					
	55	0.50	1.00					
TMat1	57	0.50	1.00	52.41	51.87	0.00	0.01	-0.39

	57	0.50	1.00					
	57	0.50	1.00					
	57	0.50	1.00					
TMat1	59	0.50	1.00	46.63	46.01	0.00	0.01	-0.44
	59	0.50	1.00					
	59	0.50	1.00					
	59	0.50	1.00					
TMat1	61	0.50	1.00	77.81	77.19	0.00	0.01	-0.45
	61	0.50	1.00					
	61	0.50	1.00					
	61	0.50	1.00					
TMat1	63	0.50	1.00	79.82	79.18	0.00	0.01	-0.46
	63	0.50	1.00					
	63	0.50	1.00					
	63	0.50	1.00					
TMat1	65	0.50	1.00	73.37	72.75	0.00	0.01	-0.45
	65	0.50	1.00					
	65	0.50	1.00					
	65	0.50	1.00					
TMat1	67	0.50	1.00	77.70	77.07	0.00	0.01	-0.45
	67	0.50	1.00					
	67	0.50	1.00					
	67	0.50	1.00					
TMat1	69	0.50	1.00	77.22	76.59	0.00	0.01	-0.45
	69	0.50	1.00					
	69	0.50	1.00					
	69	0.50	1.00					
TMat1	71	0.50	1.00	78.86	78.20	0.00	0.01	-0.47
	71	0.50	1.00					
	71	0.50	1.00					
	71	0.50	1.00					
TMat1	73	0.50	1.00	59.86	59.22	0.00	0.01	-0.46
	73	0.50	1.00					
	73	0.50	1.00					
	73	0.50	1.00					
TMat1	75	0.50	1.00	59.49	58.85	0.00	0.01	-0.46
	75	0.50	1.00					
	75	0.50	1.00					
	75	0.50	1.00					

TMat1	77	0.50	1.00	59.04	58.44	0.00	0.01	-0.43
	77	0.50	1.00					
	77	0.50	1.00					
	77	0.50	1.00					
TMat1	79	0.50	1.00	68.18	67.54	0.00	0.01	-0.46
	79	0.50	1.00					
	79	0.50	1.00					
	79	0.50	1.00					
TMat1	81	0.50	1.00	63.78	63.16	0.00	0.01	-0.45
	81	0.50	1.00					
	81	0.50	1.00					
	81	0.50	1.00					
TMat1	83	0.50	1.00	76.76	76.15	0.00	0.01	-0.44
	83	0.50	1.00					
	83	0.50	1.00					
	83	0.50	1.00					
TMat1	85	0.50	1.00	102.67	101.90	0.00	0.01	-0.55
	85	0.50	1.00					
	85	0.50	1.00					
	85	0.50	1.00					
TMat1	87	0.50	1.00	72.52	71.93	0.00	0.01	-0.43
	87	0.50	1.00					
	87	0.50	1.00					
	87	0.50	1.00					
TMat1	89	0.50	1.00	79.09	78.43	0.00	0.01	-0.47
	89	0.50	1.00					
	89	0.50	1.00					
	89	0.50	1.00					
TMat1	97	0.50	1.00	45.18	44.50	0.00	0.01	-0.49
	97	0.50	1.00					
	97	0.50	1.00					
	97	0.50	1.00					
TMat1	99	0.50	1.00	65.75	65.12	0.00	0.01	-0.45
	99	0.50	1.00					
	99	0.50	1.00					
	99	0.50	1.00					
TMat1	101	0.50	1.00	50.47	49.76	0.00	0.01	-0.51
	101	0.50	1.00					
	101	0.50	1.00					

	101	0.50	1.00					
TMat1	103	0.50	1.00	55.59	54.87	0.00	0.01	-0.52
	103	0.50	1.00					
	103	0.50	1.00					
	103	0.50	1.00					
TMat1	105	0.50	1.00	72.33	71.54	0.00	0.01	-0.57
	105							
	105							
	105							

Site	Composited Sample ID	P 50-200um (% sand)	% silt (by subtraction)	P 2um (% clay)
TNef1	1	41.48	4.79	53.73
	1			
	1			
	1			
TNef1	3	40.92	11.34	47.74
	3			
	3			
	3			
TNef1	5	50.82	17.41	31.77
	5			
	5			
	5			
TNef1	7	57.54	19.61	22.85
	7			
	7			
	7			
TNef1	9	40.82	28.86	30.32
	9			
	9			
	9			
TNef1	11	57.52	9.30	33.19
	11			
	11			
	11			
TNef1	13	45.97	10.71	43.31
	13			

	13			
	13			
TNef1	15	55.52	-15.62	60.09
	15			
	15			
	15			
TNef1	17	62.70	1.99	35.31
	17			
	17			
	17			
TNef1	19	56.54	9.63	33.83
	19			
	19			
TNef1	21	32.76	10.52	56.72
	21			
	21			
TNef1	23	38.31	-0.87	62.56
	23			
	23			
	23			
TNef1	25	26.35	16.04	57.61
	25			
	25			
	25			
TNef1	27	47.53	2.83	49.64
	27			
	27			
	27			
TNef1	29	42.31	7.65	50.04
	29			
	29			
	29			
TNef1	31	42.41	7.74	49.85
	31			
	31			
	31			
TNef1	33	28.87	7.05	64.09

	33			
	33			
	33			
TNef1	35	31.99	14.54	53.47
	35			
	35			
	35			
TNef1	37	54.43	13.76	31.81
	37			
	37			
	37			
TNef1	39	42.95	18.58	38.47
	39			
	39			
	39			
TNef1	41	42.42	5.54	52.03
	41			
	41			
	41			
TNef1	43	68.95	4.49	26.56
	43			
	43			
	43			
TNef1	45	53.93	11.90	34.17
	45			
	45			
	45			
TNef1	47	28.55	28.39	43.06
	47			
	47			
	47			
TNef1	49	43.77	7.23	48.99
	49			
	49			
	49			
TNef1	51	49.00	4.07	46.93
	51			
	51			
	51			

TNef1	53	39.66	7.63	52.72
	53			
	53			
	53			
TNef1	55	34.73	15.07	50.20
	55			
	55			
	55			
TNef1	57	-9.42	-15.15	124.57
	57			
	57			
	57			
TNef1	59	41.84	7.88	50.28
	59			
	59			
	59			
TNef1	61	56.36	4.37	39.27
	61			
	61			
	61			
TNef1	63	39.95	4.63	55.42
	63			
	63			
	63			
TNef1	65	68.02	0.24	31.75
	65			
	65			
	65			
TNef1	67	74.13	5.73	20.14
	67			
	67			
	67			
TNef1	69	59.45	9.14	31.41
	69			
	69			
	69			
TNef1	71	52.64	10.91	36.45
	71			
	71			

	71			
TNef1	73	58.98	11.27	29.75
	73			
	73			
	73			
TNef1	75	44.14	13.24	42.62
	75			
	75			
	75			
TNef1	77	40.44	8.22	51.34
	77			
	77			
	77			
TNef1	79	54.93	5.97	39.10
	79			
	79			
	79			
TNef1	81	50.71	0.72	48.56
	81			
	81			
	81			
TNef1	83	38.44	11.11	50.45
	83			
	83			
	83			
TNef1	85	47.02	7.84	45.15
	85			
	85			
	85			
TNef1	87	38.56	17.23	44.21
	87			
	87			
	87			
TNef1	89	46.92	23.94	29.14
	89			
	89			
	89			
TMat1	1	22.71	17.64	59.65
	1			

	1			
	1			
TMat1	3	18.53	20.24	61.23
	3			
	3			
	3			
TMat1	5	15.30	22.19	62.51
	5			
	5			
	5			
TMat1	7	22.07	14.79	63.14
	7			
	7			
	7			
TMat1	9	19.26	16.60	64.15
	9			
	9			
	9			
TMat1	11	23.17	20.26	56.57
	11			
	11			
	11			
TMat1	13	37.01	3.30	59.69
	13			
	13			
	13			
TMat1	15	29.58	3.97	66.45
	15			
	15			
	15			
TMat1	17	32.23	7.64	60.13
	17			
	17			
	17			
TMat1	19	27.09	11.13	61.78
	19			
	19			
	19			
TMat1	21	15.38	21.90	62.73

	21			
	21			
	21			
TMat1	23	34.70	7.89	57.41
	23			
	23			
	23			
TMat1	25	23.15	23.04	53.82
	25			
	25			
	25			
TMat1	27	22.83	18.53	58.64
	27			
	27			
	27			
TMat1	29	25.77	11.56	62.66
	29			
	29			
	29			
TMat1	31	40.95	15.89	43.16
	31			
	31			
	31			
TMat1	33	34.77	19.13	46.10
	33			
	33			
	33			
TMat1	35	42.20	17.36	40.45
	35			
	35			
	35			
TMat1	37	36.07	16.88	47.05
	37			
	37			
	37			
TMat1	39	35.94	22.16	41.90
	39			
	39			
	39			

TMat1	41	64.04	18.94	17.02
	41			
	41			
	41			
TMat1	43	43.12	-12.56	69.44
	43			
	43			
	43			
TMat1	45	47.54	-6.86	59.32
	45			
	45			
	45			
TMat1	47	56.68	-8.96	52.28
	47			
	47			
	47			
TMat1	49	66.72	17.35	15.93
	49			
	49			
	49			
TMat1	51	63.27	17.74	18.99
	51			
	51			
	51			
TMat1	53	51.12	18.49	30.39
	53			
	53			
	53			
TMat1	55	65.86	21.47	12.67
	55			
	55			
	55			
TMat1	57	50.34	18.99	30.67
	57			
	57			
	57			
TMat1	59	56.51	14.19	29.30
	59			
	59			

	59			
TMat1	61	25.34	12.32	62.34
	61			
	61			
	61			
TMat1	63	23.44	13.76	62.80
	63			
	63			
	63			
TMat1	65	29.79	13.15	57.06
	65			
	65			
	65			
TMat1	67	25.50	15.47	59.03
	67			
	67			
	67			
TMat1	69	25.97	17.06	56.97
	69			
	69			
	69			
TMat1	71	24.48	9.19	66.34
	71			
	71			
	71			
TMat1	73	43.37	12.58	44.05
	73			
	73			
	73			
TMat1	75	43.72	11.51	44.77
	75			
	75			
	75			
TMat1	77	44.00	12.59	43.41
	77			
	77			
	77			
TMat1	79	35.05	16.33	48.62
	79			

	79			
	79			
TMat1	81	39.37	9.88	50.75
	81			
	81			
	81			
TMat1	83	26.33	15.11	58.56
	83			
	83			
	83			
TMat1	85	1.25	19.67	79.08
	85			
	85			
	85			
TMat1	87	30.48	18.83	50.68
	87			
	87			
	87			
TMat1	89	24.26	13.88	61.87
	89			
	89			
	89			
TMat1	97	58.20	26.35	15.45
	97			
	97			
	97			
TMat1	99	37.40	25.94	36.66
	99			
	99			
	99			
TMat1	101	53.07	28.94	17.99
	101			
	101			
	101			
TMat1	103	48.01	11.10	40.89
	103			
	103			
	103			
TMat1	105	31.64	5.91	62.44

105
105
105

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