

# Investigations into Cellulolysis in Carbon Amended Tailings

by

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## **Author's Declaration**

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## Abstract

Modified cellulase enzyme assay methods were developed to determine the potential of using enzyme activities to evaluate the decomposition of organic matter in carbon amended mine tailings systems. Cellulase assays are commonly performed in soil science applications, industrial production and bio-energy research to determine organic matter response to physical, chemical or temporal variation but, they have not been applied in a mine waste environment. Heavy metal content is considered to be a potential inhibitor to cellulase enzyme activity.

Using samples collected from Greens Creek Mine in Juneau, Alaska, USA, the modified assay was evaluated to develop a method that provided reproducible results. It was determined that a sample mass of three grams is sufficient to provide consistent enzyme measurements. Each sample location was characterized by four replicates to ensure statistically representative data. Matrix interferences were determined to be inconsequential in this system. Despite the low organic content amended to the tailings, heavy metal content and potentially low enzyme activity, the modified enzyme assay method provided reproducible enzyme measurements.

Following the development of the cellulase assays, spatial and temporal variations in cellulase enzymes were investigated from carbon amended tailings samples collected at the Greens Creek Mine. Six test cells, containing a mixture of tailings and a combination of peat, spent brewery grain and/or municipal biosolids were sampled in the fall of 2005, 2007 and 2009. Exo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.91), Endo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.4) and  $\beta$ -glucosidase (EC 3.2.1.21) enzymes were assayed from core sections at five different depths. Enzyme activities were compared to sulfate reducing and acid producing bacterial enumerations,

sulfide trends and carbon content. General trends were consistent between enzyme activity and SRB enumerations. The range of total carbon values fell between 3 and 5 wt % in each test cell while the average inorganic carbon content was 3.5 wt %. The range of organic carbon content was between 0.2 and 1.2 wt %. Total, inorganic and organic carbon values were more characteristic of test cell carbon distribution.

Cellulase enzyme assays provide valuable information regarding the degradation of cellulose and hemi-cellulose. This study demonstrates that enzymes can be monitored in a tailings environment and that enzyme assays conducted for monitoring purposes may be a useful practice to indicate the sustained or declining performance of organic matter in a carbon amended remedial system.

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## **Dedication**

For my sweetie.

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## List of Abbreviations

TC – Test Cell  
OC – Organic Carbon  
SRB – Sulfate Reducing Bacteria  
APB – Acid Producing Bacteria  
BG –  $\beta$ -glucosidase  
CB – Exo 1,4- $\beta$ -glucanase  
EC – Endo 1,4- $\beta$ -glucanase  
ATP – Adenosine Triphosphate  
MB – Municipal Biosolids  
SBG – Spent Brewery Grain  
MUF-gul – 4-Methylumbelliferyl  $\beta$ -D-glucopyranoside  
MUF-bi – 4-Methylumbelliferyl  $\beta$ -D-cellobioside  
MUF-tri – 4-Methylumbelliferyl  $\beta$ -D-celotrioside  
4-MUF – 4-Methylumbelliferone  
PRB – Permeable Reactive Barrier  
CARS – Carbon amended Remediation System  
MDL – Method Detection Limit  
IDL – Instrument Detection Limit  
UN – Unknown Sample  
SB – Sample Blank  
MB – Method Blank  
STD – Standard Sample  
SPK – Spiked Sample  
DUP – Duplicate Sample

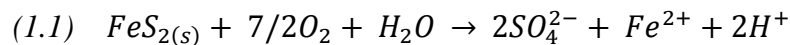
# Chapter 1:

## *Introduction*

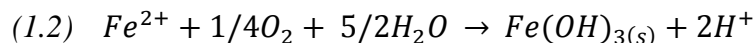
### 1.1 Background

#### 1.1.1 Mine Drainage

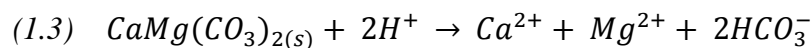
Waste products from mining operations can cause irreversible damage to surrounding ecosystems and affect the health and quality of life of nearby residents (Appelo and Postma, 2005). Mine tailings and waste rock generally contain elevated concentrations of sulfide minerals, most commonly pyrite ( $\text{FeS}_2$ ), that oxidize when exposed to the atmosphere. Sulfide oxidation generates acidity and releases dissolved sulfate and metal ions into pore water (Nordstrom and Alpers, 1999).



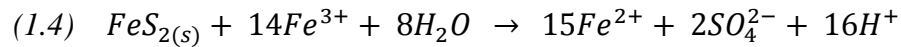
Further oxidation of free  $\text{Fe}^{2+}$  increases acidity in pore waters and leads to precipitation of  $\text{Fe}^{3+}$ .



Carbonates associated with mine waste contribute to neutralizing potential, counteracting the effects of acid generation due to mineral oxidation (Lindsay, 2009).



Ultimate depletion of carbonate minerals causes a decrease in pore-water pH creating the potential for acid mine drainage. As pH levels drop below 4, the solubility of  $\text{Fe}^{3+}$  increases (Appelo and Postma, 2005). Oxidation of pyrite by  $\text{Fe}^{3+}$  produces further acidity and releases additional  $\text{Fe}^{2+}$  and sulfate.



The continued development of mine drainage from mine waste can generate large plumes of contaminated groundwater (Doerr et al., 2005). The discharge of this groundwater to surface water bodies can cause further oxidation of iron species contributing to acidic surface waters, which can significantly alter the health and function of natural ecosystems.

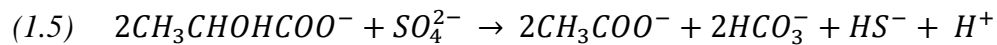
### **1.1.2 Passive Remediation**

A passive remediation system developed to treat mine drainage improves water quality using naturally-available energy sources, such as hydraulic gradients, gravity and microbial metabolic processes (Younger, 2007; Benner et al., 2000). The system design requires infrequent maintenance and has relatively low operation costs (Blowes et al., 2000). Passive systems used for mine waste remediation are largely anaerobic and include permeable reactive barriers (PRBs) (Blowes et al., 1995), constructed wetlands (Wieder, 1989), anaerobic bioreactors (Neculita and Zagury, 2008) and carbon amended tailings (Lindsay et al., 2009). Each system utilizes a source of organic carbon (OC) as host to microbial populations that assist in sulfate reduction.

Organic materials sustain microbial populations that require energy to survive and reproduce. An environment with elevated sulfur concentrations hosts microbes that use the element as an energy source. Sulfur specific bacteria either assimilate or dissimilate sulfur. A large group of organisms conduct assimilatory sulfate reduction in small amounts in order to synthesize sulfur-containing cell components (Peck, 1961). Dissimilatory sulfate reduction occurs within a much smaller group of bacteria, but they can reduce a large amount of sulfate

(Postgate, 1984). This small group of bacteria are called sulfate reducing bacteria (SRB) and exists largely in anaerobic environments.

SRB use the fermented degradation products of OC as an energy source during their life cycle. For example, the reaction between lactate and sulfate produces energy in the form of adenosine triphosphate (ATP) resulting in reduction of sulfate to sulfide (Berner, 1971; Barton and Hamilton, 2007).



Elevated pH and sulfide concentrations provided from equation 1.5 and the presence of dissolved heavy metals in tailings result in the precipitation of metal sulfides, as described in equation 1.6, and subsequently improves the quality of low quality mine drainage (Hulshof et al., 2006).



$Me^{2+}$  represents a divalent metal ion and  $MeS$  denotes a metal sulfide. Understanding the behaviour and requirements of anaerobic microbial communities in passive remediation systems is essential to improving the long term effectiveness of a treatment system.

### **1.1.3 Organic Carbon Degradation and Enzymes**

Sulfate reducing bacteria require fermented products or organic acids like lactate and acetate to perform dissimilatory sulfate reduction (equation 1.5) and minimize the discharge of sulfide oxidation products from low quality mine waste (Julies et al., 2010; Lindsay et al., 2008). This reaction provides SRB with energy in the form of adenosine triphosphate (ATP) used for growth or reproduction (Barton and Hamilton, 2007). Many classes of bacteria, including SRB, have been identified in carbon amended tailings (Lindsay et al., 2011). It is still unclear as to the

specific role or capacity of each individual bacterial class with regard to dissimilatory sulfate reduction however their function is necessary for low quality mine waste mitigation. SRB require other microbial populations to degrade OC, ferment the degradation products and provide energy in the form of organic acids.

Cellulose, hemicellulose, pectin and lignin are the primary components in organic matter that are broken down to supply energy to bacteria (Sinsabaugh et al., 2002). Cellulose and hemicellulose make up the majority of organic matter and consist of a range of complex molecules composed of carbon, hydrogen and oxygen. These polysaccharides form the building blocks of most organic plant and animal matter (Madigan and Martinko, 2006). Each polysaccharide is composed of a chain of glucose units linked by covalent  $\beta$ -1,4-glucosidic bonds (Zhang et al., 2006).

The variety of organic matter will determine the percent composition of cellulose and hemi-cellulose. For example, three peat varieties contain total cellulose values ranging from 22 to 42% and municipal biosolids generated in the U.S.A. contain approximately 40% (Rizzuti et al., 1999; Walker and Wilson, 1991).

Some varieties of bacteria may directly utilize low-molecular weight polysaccharides but complex polysaccharides require prior decomposition. Enzymes are proteins produced by bacteria. They are catalysts that are specific for the type of reaction in which they participate. Bacteria either enclose intracellular enzymes or excrete extracellular enzymes to catalyze the degradation of cellulose. Although most extracellular enzymes are rapidly denatured and only survive for short periods, they complex with polysaccharide substrates and hydrolyze molecules

that are too large to pass through bacterial cell walls (Sinsabaugh et al., 2002). Subsequently, low-molecular mass polysaccharides can be utilized as an energy source.

The composition of organic matter prescribes the microbial community as well as the associated enzyme distribution. Specific enzymes are associated with the decomposition of principal components of organic matter; cellulases, hemicellulases, pectinases, phenol oxidases, peroxidases, chitinases, peptidases, ureases and phosphatases (Sinsabaugh et al., 2002). Because cellulose is the most abundant substance in organic matter, cellulase enzymes are of particular interest with respect to decomposition in carbon amended tailings. Exo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.91), Endo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.4) and  $\beta$ -glucosidase (EC 3.2.1.21) are enzymes that have been studied to monitor cellulose hydrolysis in both aquatic and terrestrial systems (Sinsabaugh et al., 1981; Carreiro et al., 2000). Endo-(1,4)- $\beta$ -D-glucanase randomly attack interior cellulose polymer bonds while Exo-(1,4)- $\beta$ -D-glucanase act on the free ends (Walker and Wilson, 1999).  $\beta$ -glucosidase processes soluble polysaccharides and tends to be more active than the other two associated forms during the early stages of organic matter decomposition (Dilly and Munch, 1996).

## **1.2 Hypothesis Tested**

Cellulase enzyme assays have been successfully applied in agricultural studies to assess cellulose hydrolysis. It is hypothesized that enzyme activity is present in passive remediation systems containing low carbon content. The activities of cellulase enzymes may be minimal or close to the detection limit. It is therefore required to evaluate whether these activities can be detected in



a low organic carbon environment. This is to be achieved by modifying a pre-existing enzyme assay.

Once the initial hypothesis has been addressed the measurement of enzyme activities in carbon amended tailings will be conducted. Cellulase enzyme activities will be determined from samples obtained in 2005, 2007 and 2009. It is expected that the activities will correspond with the amount of carbon in the carbon amended tailings over the observed time span of 5 years.

### **1.3 Research Objectives**

The objectives of the research presented in this thesis were to develop procedures for measuring enzymes in a carbon amended tailings environment and assess the potential use of enzyme activity as an indicator of carbon degradation. Organic matter supports the life support systems of microbial populations. The accessibility of amended organic material in a remediation system is essential for the health of bacteria that help prevent or mitigate ecological damage caused by mine drainage. The goal of research on enzyme activity is to improve the understanding of the carbon cycle in carbon amended tailings in association with microbial activity and to develop a new technique for measuring carbon degradation in this type of remediation system. Specific objectives for this research include:

- Modifying an enzyme assay method to measure enzyme activity in carbon amended tailings and determine the effectiveness of the assay.
- Evaluating enzyme activity in relation to different organic carbon sources, bacterial enumerations and percent carbon in carbon amended tailings over a time span of 5 years.

## **1.4 Thesis Organization**

This thesis is presented as two research papers related to the objectives outlined in the previous section. The first research paper, which is presented as Chapter 2, describes a modified enzyme assay conducted to evaluate small enzyme activities in a low organic carbon environment. The second paper, presented as Chapter 3, compares enzyme activities over a time period of 5 years among different OC sources, bacterial enumerations and percent carbon in carbon amended tailings.

## **Chapter 2:**

*Determination of Cellulolysis in Carbon Amended  
Tailings by a Modified Enzyme Assay*

## **2.1 Summary**

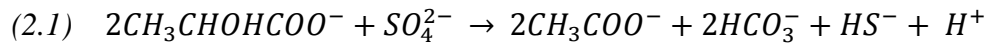
A modified enzyme assay method was described to determine the feasibility of using cellulase enzyme activities to evaluate the decomposition rate of organic matter in a carbon amended passive mine waste treatment system. To date, the assay of cellulose degrading enzymes has not yet been applied in a mine drainage environment. Cellulase enzyme assays have been performed in soil science applications, industrial production and bio-energy research to determine organic matter response to physical, chemical or temporal variation. The required sample mass, number of replicate samples and potential matrix interferences were evaluated to develop a reproducible method. It was determined that a sample mass of 3 g was sufficient to provide consistent enzyme measurements. Each sample location was characterized by four replicates to ensure statistical representativeness. Matrix interferences associated with sample content were determined to be minimal.

Cellulase enzyme assays provide valuable information regarding the degradation of cellulose and hemi-cellulose. This study demonstrated that enzymes can be monitored in a mine waste environment and that enzyme assays used in association with water-quality determinations can indicate the sustained or declining performance of a carbon amended remedial system.

## **2.2 Introduction**

Sulfide oxidation and the release of heavy metals from mine waste is a persistent concern for the mineral industry. Sulfide minerals that are exposed to air and water produce mine drainage that can be destructive to surrounding ecosystems. Cost effective, low maintenance and long term techniques to treat or prevent low quality mine drainage have been developed. These

technologies include permeable reactive barriers (PRBs) (Blowes et al., 1995), constructed wetlands (Wieder, 1989), bioreactors (Neculita and Zagury, 2008) and carbon amended tailings (Hulshof et al., 2006; Lindsay et al., 2009). Each of these approaches utilizes a source of OC to mitigate or prevent low quality mine drainage. The success of a carbon amended remediation system (CARS) is largely related to the activity of microbial populations that utilize the organic material (Kang and Freeman, 1998). Bacterial populations, for example sulfate reducing bacteria, create metabolic energy by utilizing the fermentation products of low molecular weight OC compounds as electron donors while reducing sulfate to sulfide (Berner, 1971; Barton and Hamilton, 2007)



where  $CH_3CHOHCOO^-$  represents a lactate molecule.

Elevated pH and sulfide concentrations provided from equation (2.1) and the presence of dissolved metals in tailings result in the precipitation of metal sulfides as described in equation (2.2) and subsequent prevention of harmful mine drainage (Hulshof et al., 2006).



where  $Me^{2+}$  represents a divalent metal ion and  $MeS$  denotes a metal sulfide.

CARS are typically designed to intercept groundwater which contains dissolved metals and sulfate. The organic matter (straw, saw dust, cow or sheep manure, beer brewery waste, peat, oak chips, municipal sewage, compost or leaf matter) promotes the growth of sulfate reducing bacteria and the precipitation of contaminants via a series of reactions (Benner et al., 1999; Blowes et al., 1995). Laboratory and field experiments have demonstrated that CARS are a viable approach to mitigating low quality mine drainage, yet longer-term studies indicate that the

performance of CARS can decline as the more labile forms of OC are depleted over time (Guo and Blowes, 2009; Waybrant et al., 2002; Webb et al., 1998).

To explain the decline in efficiency researchers have considered the physical and chemical components of CARS; the construction of the system itself (Malmstrom et al., 2008), the decline of reactive surface area caused by mineral precipitation (Benner et al., 1999), low seasonal temperatures (Tsukamoto et al., 2004), low pH values (Flores and Sola, 2010) and nutrient availability (Waybrant et al., 2000). Segments of the carbon path within a remedial system have also been examined; the type of organic medium (Santini et al., 2010), bacterial population size (Logan et al., 2005) and the diversity of microbial communities (Lindsay et al., 2011; Pereyra et al., 2010). The hydrolysis of organic matter, particularly cellulose, in a tailings environment is the primary reaction associated with carbon flow. Cellulose degradation is a part of the first trophic level during anaerobic organic matter degradation. Despite its importance in the regulation of carbon flow, the hydrolysis of organic matter in CARS has not yet been well documented (Kang and Freeman, 1998).

Cellulose is the most abundant organic material on the earth (Madigan and Martinko, 2006) and is subsequently a large percent of the material used in remedial systems. Cellulose is a complex molecule that can be difficult to degrade. Without the aid of enzymes the natural half-life of cellulose is 5 to 8 million years at 25°C (Wolfenden and Snider, 2001). The size of a cellulose molecule, *i.e.*, the degree of polymerization, depends on the number of individual glucose units that compose the molecule. The degree of polymerization can be as high as 14 000 glucose units (Leschine, 1995). Each glucose unit is bound by a  $\beta$ -1,4-glucosidic bond (Zhang et al., 2006).

Cellulose with a high degree of polymerization can only degrade quickly with the aid of bacterial enzymes. Complex organic matter in anaerobic environments, such as lignin, can often evade degradation all together (Berner, 1971). Microorganisms survive and reproduce only by acting synergistically to degrade complex cellulose structures and subsequent degradation products. Cellulolysis requires production of a sequence of enzymes used to depolymerise cellulose at the  $\beta$ -1,4-glucosidic bond, which produces sugars including cellobiose and glucose (Leschine, 1995). Syntrophic bacteria then ferment these sugars to produce CO<sub>2</sub>, H<sub>2</sub> and organic acids (Leschine, 1995). The reaction products are then used by SRB for sulfate reduction (Postgate, 1984).

Except for near the surface, the geochemical environment in mine tailings piles is predominantly anaerobic. Labile OC is quickly consumed by bacterial reactions (Logan et al, 2005). Depletion of labile OC can limit the rate of reaction within a remedial system to the degradation rate of more complex organic matter (Neculita et al., 2007). A series of enzymes are required to function together in a system to completely degrade cellulose. The most well understood cellulolysis enzyme system is Exo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.91), Endo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.4) and  $\beta$ -glucosidase (EC 3.2.1.21) (Felix and Ljungdahl, 1993). This cellulase enzyme system is best understood in aerobic environments but also occurs to a lesser degree anaerobically (Felix and Ljungdahl, 1993). Exo-(1,4)- $\beta$ -D-glucanase hydrolyzes cellulose molecules at the ends producing cellobiose or glucose molecules whereas interior  $\beta$ -1,4 bonds are randomly cleaved by Endo-(1,4)- $\beta$ -D-glucanase producing smaller cellulose molecules (Zhang et al, 2006) (Figure 2.1).  $\beta$ -glucosidase degrades cellulose molecules with up to 6 degrees of polymerization, resulting in the formation of glucose compounds (Leschine, 1995).

Enzyme assays are commonly performed in soil science applications (Anderson et al., 2004, Criquet, 2002), industrial production (Kirk et al., 2002, Cherry et al., 2003) and more recently bio-energy research (Himmel, et al., 1993) but they have only been applied in a limited fashion in a mine waste environment. Dehydrogenase (Hulshof et al., 2003) and esterase (Hulshof et al., 2003, 2006, Lindsay et al., 2008) activities have been determined in tailings mixed with organic matter but cellulose activities have not been measured in these systems.

Enzyme assays were developed for metal-rich samples and applied to core samples of tailings collected from the Greens Creek Mine in Alaska, USA. The Greens Creek tailings core samples were previously studied by Lindsay et al. (2009), and provide well characterized solids for this experiment. The purpose of this study is to modify an enzyme assay for application to mine waste environments. The difference in enzyme abundance between non-amended tailings and tailings amended with OC was evaluated.

### **2.2.1 Site Description**

Greens Creek Mine is located near Hawk Inlet on Admiralty Island in Alaska, USA. In 2004 a pilot test was initiated on the tailings pile to determine the potential benefits of adding OC to the full-scale tailings pile (Lindsay et al., 2009). Seven test cells (TC) were installed measuring 3 m wide by 3 m long by 4 m deep. Two controls were assembled, containing unexcavated (TC1) tailings and excavated and mixed tailings (TC2) (Lindsay et al., 2009). Individual and mixed OC materials were amended to five additional test cells (TC3 – TC7) with the exception of the bottom 0.5 m which was backfilled with non-amended tailings (Lindsay et al., 2009). Test cells TC3 to TC6 contain a mixture of 95 volume % tailings and 5 volume % OC. Test cell TC7 contains 90 volume % tailings and 10 volume % OC. The OC amendment in TC3 contains only



peat. The TC4 amendment includes equal amounts of peat and spent brewery grain (SBG) whereas the TC5 amendment contains equal amounts of peat and municipal biosolids (MB). The TC6 and TC7 amendments include peat, SBG and MB. TC7 contains twice the volume of all three amendment materials. A detailed description of the test site and results of the pilot test can be found in Lindsay et al. (2009).

## **2.3 Materials and Methods**

### **2.3.1 Sampling Procedure**

During the fall of each year between 2004 and 2009, core samples were extracted from each of the test cells using a piston coring method described by Star and Ingleton (1992). The core samples were collected in 5 cm diameter, thin-walled aluminum tubing. Immediately following recovery, the aluminum tubing containing the tailings material was cut into 30 - 40 cm sections, which were capped using low density polyethylene tubing caps, and sealed with vinyl tape. The capped and sealed core samples were frozen at -18°C until processed.

Samples from 2005 were selected for method development, because this date provided sufficient time for the bacterial population to become established, but likely did not provide an opportunity for excessive depletion of OC. Five frozen core sections were selected from each test cell. Using a pipe cutter, the core samples were sub-sampled into 10 to 15 cm long sections, centred at depths of 0.5 or 0.6, 1.0, 1.75, 2.5 and 3.25 meters below ground surface (m.b.g.s.). All frozen core sections were divided in two along the long axis using a circular saw. The exposed tailings surfaces were removed to prevent potential sample contamination. The

remaining tailings were mixed thoroughly in a 250 mL beaker and then divided into 3 g samples in 14 mL capped test tubes. All samples were frozen at -18°C until analysis.

### **2.3.2 Enzyme Assays**

The activities of  $\beta$ -glucosidase, Exo-(1,4)- $\beta$ -D-glucanase and Endo-(1,4)- $\beta$ -D-glucanase were measured in field samples by a fluorogenic substrate. The assays were performed using a modification of the methods described by Tilbeurgh et al. (1982) and Tilbeurgh et al. (1984) with modifications by Debosz et al. (1999).

### **2.3.3 $\beta$ -glucosidase Assay**

$\beta$ -glucosidase activity was determined by adding 4 mL of pH 5.0, 0.05 M sodium acetate buffer to 3 g of carbon amended tailings in a 14 mL glass test tube. The samples were incubated for 10 minutes in a 30°C water bath. After incubation 1 mL of 100  $\mu$ M 4-Methylumbelliferyl  $\beta$ -D-glucopyranoside (MUF-glu) solution was added, and the samples were incubated for an additional 30 minutes at 30°C. Subsequent to each addition of solution the sample was mixed using a Vortex swirler. To stop the reaction, 5 mL of 95 % ethanol was added and the samples were cooled at 4°C for 30 minutes. Following cooling, each sample was centrifuged at 5000 rotations per minute (RPM) for 15 minutes and then brought to room temperature. Using a pipette, 7 mL of the supernatant was then transferred to a 14 mL glass test tube containing 1 mL of 2.5 M TRIS buffer. The TRIS buffer was adjusted to pH 10.32 with concentrated hydrochloric acid to ensure substrate fluorescence for 12 hours. An aliquot of 3 mL of the supernatant-TRIS mixture was then transferred to a disposable cuvette and placed into the fluorometer for analysis.

### **2.3.4 Exo-(1,4)- $\beta$ -D-glucanase Assay**

The assay conditions and preparation of samples for Exo-(1,4)- $\beta$ -D-glucanase was the same as described for  $\beta$ -glucosidase with the following exceptions; The activity of Exo-(1,4)- $\beta$ -D-glucanase was determined using 4-Methylumbeliferyl  $\beta$ -D-cellobioside (MUF-bi) as a substrate instead of MUF-glu. The substrate concentration was 100  $\mu$ M.

### **2.3.5 Endo-(1,4)- $\beta$ -D-glucanase Assay**

The assay conditions and preparation of samples was the same as described for  $\beta$ -glucosidase with the following exceptions; the activity of Endo-(1,4)- $\beta$ -D-glucanase was determined using 4-Methylumbeliferyl  $\beta$ -D-celotrioside (MUF-tri) as a substrate. The substrate concentration was 25  $\mu$ M and the incubation period was increased to 1 hour.

The fluorescence for all three enzymes was determined using a digital filter fluorometer with an excitation frequency of 365 nm and an emission frequency of 448 nm. All solutions used in the enzyme assays were prepared within one week of analysis with the exception of the enzyme substrate which was prepared on the day of analysis.

### **2.3.6 Standard Fluorescence Curve**

The 4 – Methylumbelliferone (4-MUF) solution was used to produce standard solutions for enzyme analysis. The fluorescence of 4-MUF is pH-dependent and increases to a maximum at pH 10 (Sigma-Aldrich, 2007). At pH 10.32 the fluorescence of 4-MUF is stable for at least 12 hours (Sigma-Aldrich, 2007). The 4-MUF salt is insoluble in water but soluble in acetone or methanol. Standards were produced by the following procedure;

Four independent stock solutions were prepared by dissolving 10 mg of 4-Methylumbelliferone with 50 mL of methanol in a 50 mL glass crimp top vial. Each of the four stock solutions was then diluted with methanol to provide nine solution standards. The standard solutions were stored at 4°C but brought to room temperature before use to be consistent with the temperature of the unknown samples. A volume of 1 mL of each standard was mixed with 6 mL of matrix solution (sodium acetate buffer, enzyme substrate and ethanol) and 1 mL of TRIS buffer for a total of 8 mL to parallel the unknown sample volume. Each standard mixture was then transferred into a disposable cuvette before measuring the fluorescence. The standard concentrations prior to analysis were 75, 66, 57, 48, 39, 30, 21, 12, 2 ppb and a blank.

Each enzyme assay had an individual enzyme substrate; the matrix solution consequently differed between assay types. Subsequently a new standard fluorescence curve was produced for each enzyme assay.

### **2.3.7 Tailings Mass vs. Activity**

The volume of amendment material introduced to a tailings pile is usually kept to a minimum to reduce the land area affected by tailings disposal at the end of mining. The modest proportion of organic material present in the tailings mass may affect the consistent detection of any type of enzyme activity.

Thirty samples were prepared according to the  $\beta$ -glucosidase assay with the following exceptions: There were five sample groups containing six samples each. All five groups had a specific mass of 0.5, 1, 2, 3 and 5 grams  $\pm$  0.04 g. To determine an appropriate mass of sample, and attain a reliable detection of enzyme activity, an ANOVA F-test calculation was conducted. The ANOVA F-test is a one-way analysis of variance used to determine whether the expected

values of a quantitative variable within several groups differ from each other. This statistical test was chosen to decipher whether the means of each sample mass group differed from each other. To conduct the ANOVA F-test an F-ratio is calculated by dividing the between-group variance by the within-group variance.

### **2.3.8 Determination of Replicate Samples**

Soil samples and carbon amended tailings are inherently heterogeneous and as such assay analyses were conducted to determine the number of replicate samples needed to provide statistically representative data. Eighteen 3 g samples, from one sample location, were randomly divided into groups of six, five, four and three. All samples were then analyzed according to the  $\beta$ -glucosidase assay method. The appropriate number of replicate samples was determined by conducting the standard ANOVA F-test described above. If the ratio of variance between and within each of the four groups is lower than the critical-F value used to represent the groups, then each set of replicates can be considered comparable (i.e. a group of 3 replicates will provide a statistically similar mean to a group of 6 replicates). Conversely if the ratio of variance is higher than the critical-F value then the F-test would need to be repeated with only groups four, five and six.

### **2.3.9 Matrix Effects**

Due to the heterogeneity between each sample location in the carbon amended tailings, it is difficult to account for all matrix effects. A series of standard addition curves was produced to evaluate the statistical significance of any potential matrix interference. Raw fluorescence mode was selected to measure each sample on the digital fluorometer. Raw fluorescence mode does

not require the use of a standard curve and reports the level of fluorescence determined by the fluorometer (Barnstead&Thermolyne Corp.).

Nine standard addition curves were produced; three curves for each enzyme type. Analysis of six groups of four replicate samples were used to produce each curve. Standard spikes with a concentration of 39, 30, 21, 12, 2 ppb and a blank were added to each group of four replicates.

Twenty-four 3 g samples were prepared for each curve according to either the  $\beta$ -glucosidase, Exo-(1,4)- $\beta$ -D-glucanase or Endo-(1,4)- $\beta$ -D-glucanase assay with the following exceptions; 6 mL of supernatant from each sample was mixed with 1 mL of TRIS buffer in a 15 mL glass crimp top bottle. An aliquot of 1 mL of a known standard spike concentration was then syringed into each vial and mixed well. A 3.5 mL aliquot of the mixture was then transferred into a disposable cuvette. The fluorescence was measured and recorded.

To determine if the sample matrix influenced the measured enzyme activity, the concentration of the unknown sample from the standard addition curve, to which the blank was added, was compared to the concentration of the same unknown sample when determined using the standard fluorescence curve described above. If the unknown sample, established using the standard fluorescence curve, was statistically similar to the standard addition curve sample then the matrix effect was considered negligible.

### **2.3.10 Instrument and Method Detection Limits**

The instrument detection limit (IDL) was determined according to Skoog et al. (1998). Thirty sample blanks were prepared according to the  $\beta$ -glucosidase assay with the following exceptions;

6 mL of supernatant was mixed with 1 mL of TRIS buffer in a 15 mL glass crimp top bottle. One mL of the standard blank was then syringed into each bottle and mixed well.

The method detection limit (MDL) was determined using the Electronic Code of Federal Regulations (40 CFR, Part 136, appendix B). An MDL of 1 ppb was the initial estimate. The lowest prepared standard at a concentration of 2 ppb was prepared and measured 16 times using the standard fluorescence curve described above. Enzyme activity in field samples was expected to be minimal; therefore measuring the IDL and MDL on the fluorometer provided a lower limit to which unknown values could be accurately measured.

## **2.4 Results and Discussion**

### **2.4.1 Tailings Mass vs. Activity**

Most soils contain only 2 to 10 weight percent of organic matter (Bot and Benites, 2005). The amount of amended material in each test cell was either 5 (TC3 to TC6) or 10 (TC7) vol % and the equivalent amount of organic material in weight percent would be less than 1% (Lindsay et al., 2011). Deboz et al. (1999) and Tilbeurgh et al. (1982) conducted enzyme assays using agricultural soil, extracting only 0.2 to 0.8 g of soil per sample, whereas Criquet (1999) used a sample size of 1 g or less and Deng and Tabatabai (1998) conducted enzyme assays with a maximum sample size of 7 g. Cellulase activity increases proportionally to sample size (Criquet, 1999) and testing to determine the size of sample that was sufficient to measure enzyme activities from the carbon amended tailings at Greens Creek was important. When comparing sample mass groups of 2, 3 and 5 g, the mean squared ratio of variance between and within each group was 0.59 (Table 1). The ratio fell below the critical F-value of 3.68 indicating that a

sample mass of at least 2 grams or more was within the 95 % confidence interval ( $p > 0.05$ ) and was sufficient to attain a reproducible result. The mean squared ratio of variance for sample mass groups of 3 and 5 grams was 0.005. This ratio was significantly lower than the ratio determined when comparing sample mass groups of 2, 3 and 5 grams. This observation indicates that a sample of at least 2 grams provided a statistically reproducible enzyme activity. However, 3 gram samples were chosen to provide improved accuracy.

### **2.4.2 Determination of Replicate Samples**

Assays were performed to evaluate the number of replicate samples required to produce statistically representative estimates of enzyme activity. This evaluation was required because of the potentially low enzyme activity within the tailings mixtures as well as the inherent heterogeneity of the tailings blend. Tailings from each test-cell location were crudely mixed, using a backhoe, with amendment material before being replaced in the test cell plot.

Assay results were used to calculate a ratio of variance between and within each group of six, five, four and three replicates. The ANOVA F-test results (Table 2) indicate that three replicates are statistically similar to 6 replicates ( $p > 0.05$ ) and represent the minimum necessary to provide a statistically accurate analysis at each sample location. Regardless, 4 replicates were utilized throughout analysis to increase reproducibility of the measurements. The mean values are reported in the assay results below.

### **2.4.3 Matrix Effects**

Assays conducted to determine the activity of enzymes on organic matter degradation are commonly used with substrates that contain a significant amount of cellulose and/or



hemicellulose (Boschker and Cappenberg, 1994; Debosz et al, 1999). Matrix effects from substrate compositions are not of concern in these studies due to the abundance of enzyme activity. Test cells at Greens Creek were amended with either 5 or 10 vol % organic matter. In comparison to other study sites involving cellulase enzyme assays, the amount of organic matter in each test cell is very small. Subsequently matrix interferences from the tailings are a concern when conducting cellulase assays.

Testing for substrate matrix interferences was also important because other researchers have determined that interferences can occur with the measurement of enzyme activities. Criquet (2002) determined that tannins from leaf litter can interfere with the measurement of enzyme activities and Kang and Freeman (1998) adjusted the calibration curve for enzyme assays, which were conducted in a matrix including peat. Although the volume of peat added to each test cell was relatively small, it was present within each of the cells with the exception of the control.

The concentration of an unknown sample from each standard addition curve, to which a blank solution was added, was compared to the concentration of the same unknown sample when determined using the standard fluorescence calibration curve. The concentration of each unknown sample measured while using the standard fluorescence calibration curve was within a 95% confidence interval of the unknown sample measured from the standard addition curve indicating that the matrix effect was negligible (Table 3).

#### **2.4.4 Instrument and Method Detection Limits**

The mean ( $\bar{y}$ ) and standard deviation ( $s$ ) of 30 blanks were -0.61 ppb and 0.99 ppb, respectively (Table 4). These values were used to determine a minimum distinguishable analytical signal ( $x$ )

of 2.38 ppb using equation 2.3. Using a slope of 14.95 from the standard curve and equation 2.4, the instrument detection limit was determined to be 0.20 ppb.

$$(2.3) \quad x = \bar{y} + 3s$$

$$(2.4) \quad IDL = \frac{x - \bar{y}}{m}$$

To determine the MDL, the standard deviation of all 16 standards and the value given by 40 CFR, Part 136, appendix B was used to determine an MDL of 1 ppb. This concentration converted into nano-moles per gram per hour is  $2.4 \times 10^{-3} \text{ nmol g}^{-1} \text{ h}^{-1}$ . All significant values determined and presented in the data below exceed the MDL. Enzyme values provided in the assay results below that have significant error bars lie on or below the MDL.

### 2.4.5 Assay Results

The results of the enzyme assays indicate that  $\beta$ -glucosidase and Exo-(1,4)- $\beta$ -D-glucanase activities were detected in most test cells (Figure 2.2). Endo-(1,4)- $\beta$ -D-glucanase activity was observed in a few test cells but to a lesser extent than the other two enzymes. The excavated control test cell (TC2) showed no detectable enzyme activity. Enzyme activity in TC3 was close to or below the detection limit with minimal Exo-(1,4)- $\beta$ -D-glucanase activity located in the upper half of the cell. Peat generally consists of more complex organic molecules as labile OC is quickly consumed during the formation of peat (Wakesman and Stevens, 1929). The presence of Exo-(1,4)- $\beta$ -D-glucanase and absence of the other two enzymes was consistent with this characteristic, because Exo-(1,4)- $\beta$ -D-glucanase predominantly attacks large polysaccharide molecules and is more closely associated with the presence of cellulose and hemicellulose (Lynd et al., 2002). Enzyme activity values in TC4 indicated an opposite trend to TC3.  $\beta$ -glucosidase

and Endo-(1,4)- $\beta$ -D-glucanase activity were present but Exo-(1,4)- $\beta$ -D-glucanase values were below detection. This enzyme distribution indicates that low molecular weight polysaccharides were readily available in TC4 and were being consumed, with only modest degradation of long chain polysaccharides. It is likely, therefore, that the SBG contained short chain polysaccharide molecules that were not present in peat. Comparing TC5 to TC4 the only variation in organic content was the addition of MB in place of SBG. In TC5, the  $\beta$ -glucosidase activity was more pronounced than in TC4 indicating that the rate of low molecular weight polysaccharide degradation is greater in the presence of MB, and Exo-(1,4)- $\beta$ -D-glucanase was present at a concentration above the MDL, indicating degradation of cellulose and/or hemicellulose was occurring. The enzyme activity in TC5 was very similar to activities in TC6 and TC7 although the latter two cells contained SBG in addition to MB. The percent volume of MB added to TC6 was half of that added to TC5 (Lindsay et al., 2009). The amount of Exo-(1,4)- $\beta$ -D-glucanase and  $\beta$ -glucosidase was slightly reduced in TC6 when compared to TC5 however the assay results suggest that low molecular weight polysaccharides were available and cellulose degradation was taking place. Twice the amount of peat, SBG and MB were added to TC7 compared to TC6. The enzyme activity in TC7 was, as expected; approximately two times greater than that observed in TC6.

There was a concern that the cellulase enzyme system may be drastically inhibited by the high metal content of the tailings environments. Many studies have indicated that trace elements negatively affect a wide variety of soil enzymes (Hinojosa et al., 2004, Eivazi and Tabatabai, 1990, Giller et al., 1998). Metal ions may inhibit enzyme activity by complexing with the substrate, reacting with the enzyme-substrate complex or by reacting with a functional group at

the active site of the enzyme (Eivazi and Tabatabai, 1990; Deng and Tabatabai, 1995). Metal ions also may inactivate enzymes by reacting with sulfhydryl groups (Eivazi and Tabatabai, 1990) that are abundant in a tailings environment. In a laboratory study, Deng and Tabatabai (1995) studied the effect of heavy metals on the cellulase enzyme system in soils concluding that cellulase activity was repressed by heavy metals and trace elements however, the degree of inhibition varied greatly depending on the soil used and type of element applied. Tailings solids at the study site contain metals and trace elements in the following abundance: Zn, Pb > Mn > As, Cu > Sb > Ag > Cd, Ni, Mo, Tl, Cr > Se (Lindsay et al., 2008). Zinc and Pb concentrations were > 1000 mg kg<sup>-1</sup>, average Mn concentrations were 2330 mg kg<sup>-1</sup> and As and Cu concentrations were 1360 and 1310 mg kg<sup>-1</sup> (Lindsay et al., 2008). Assay results are consistent with the observations made by the Eivazi and Tabatabai (1990) and Deng and Tabatabai (1995); TC2 contained the most amount of metal content and expressed little to no enzyme activity, whereas TC3 to TC6 had enzyme activities of similar proportion and less metal content due to the amendment of OC. Test cell 7 possessed the highest level of activity as well as the lowest concentration of heavy metals.

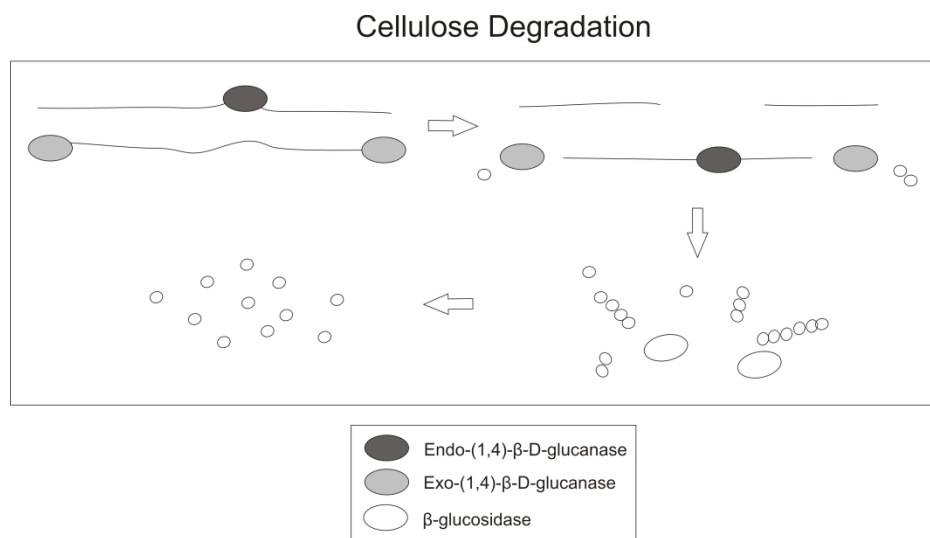
Andersson et al. (2004) and Criquet (2002) indicate that the cellulose enzyme activity is directly proportional to the volume of organic matter. Based on these observations, it would be anticipated that TC2 should have little to no enzyme activity, whereas TC3 to TC6 should all have similar enzyme activities, and TC7 should have the highest level of activity. The control test cell and TC7 follow this trend however there are slight variations between enzyme activities in TC3 to TC6. These differences may be due to the composition of organic substrate used in

each test cell. The assay results indicate that there is minimal cellulose and/or hemicellulose in peat and that SBG and MB contain similar amounts of cellulose.

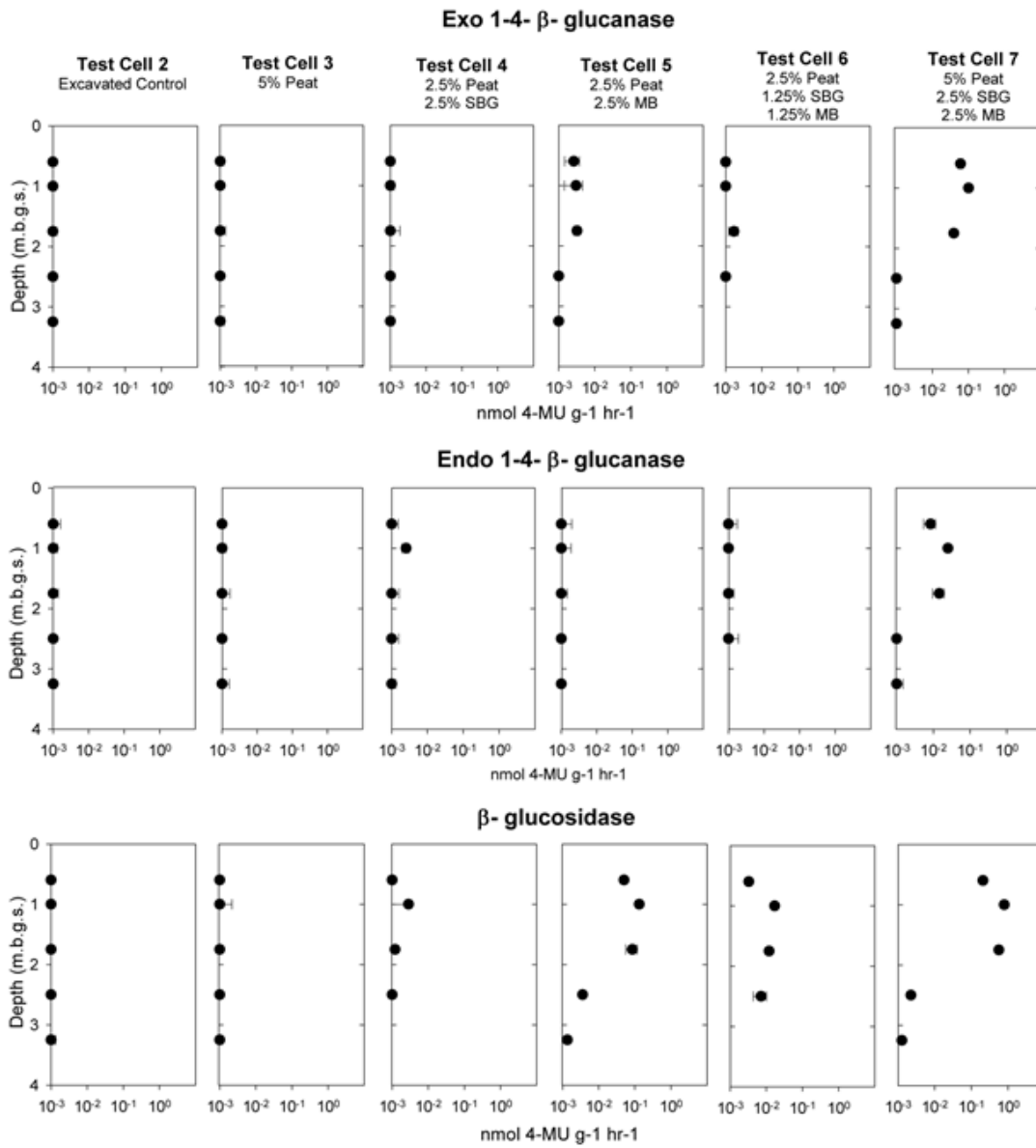
The data from 2005 provided a snapshot of information with respect to OC degradation. As the predominant enzyme,  $\beta$ -glucosidase activities denote a general surplus of low-molecular-weight OC compounds in TC4 to TC7 consisting of six degrees of polymerization or less (Leschine, 1995). Endo-(1,4)- $\beta$ -D-glucanase and Exo-(1,4)- $\beta$ -D-glucanase was not detectable in TC6, but was measurable in TC7. Considering that the type of OC added to both TC6 and TC7 was the same, the contrast between Endo-(1,4)- $\beta$ -D-glucanase and Exo-(1,4)- $\beta$ -D-glucanase activities in TC6 and TC7 indicates that the enzyme activities were below detection in TC6 due to the lower amount of OC.

## **2.5 Conclusions**

- Despite low organic carbon content, the modified enzyme assay method provided reproducible measurements of enzyme activity in carbon amended tailings.
- The method potentially provides a useful tool to assess the extent of organic carbon degradation and to decipher the role of the cellulase enzyme systems in the degradation of organic matter in organic carbon amended remediation systems.
- For new study sites, especially those dealing with carbon amended tailings, the sample mass, potential matrix effects and the number of replicate samples should be evaluated on a case by case basis as these variables may differ depending on the volume of amendment, type of substrate and the original host environment.



**Figure 2.1** Cellulose degradation by three primary enzymes; Exo-(1,4)-β-D-glucanase, Endo-(1,4)-β-D-glucanase and β-glucosidase. Diagram has been modified from Zhang et al., 2006.



**Figure 2.2** Assay results for Exo-(1,4)-β-D-glucanase, Endo-(1,4)-β-D-glucanase and β-glucosidase. Values for TC1 and TC2 are equivalent; subsequently TC1 is not presented here.

**Table 2.1** ANOVA F-test results conducted by finding the mean square ratio of enzyme activities between and within groups of varying sample masses.

<b>Sample Mass Analyzed (g)</b>	<b>Mean Squared Ratio of Variance</b>	<b>Critical F-value</b>
0.5, 1.0, 2.0, 3.0, 5.0	21.9	2.76
1.0, 2.0, 3.0, 5.0	16.6	3.10
2.0, 3.0, 5.0	0.59	3.68
3.0, 5.0	0.005	4.96

**Table 2.2** ANOVA F-Test calculation results determined by taking the ratio of the mean square between and within groups of replicate samples.

<b>Replicates per Group</b>	<b>Mean Squared Ratio of Variance</b>	<b>Critical F-value</b>
3, 4, 5 and 6	0.21	3.34
4, 5 and 6		
5 and 6		

**Table 2.3** Results of standard addition tests indicating that matrix effects are negligible.

<b>Enzyme</b>	<b>Sample ID</b>	<b>Mean concentration of unknown from standard addition (ppb)</b>	<b>Upper 95% confidence interval</b>	<b>Lower 95% confidence interval</b>	<b>Mean concentration of unknown from standard analysis (ppb)</b>
$\beta$ -glucosidase	TC6 1.0 m	9.24	11.32	7.15	7.97
Exo-(1,4)- $\beta$ -D-glucanase	TC5 1.0 m	6.32	6.83	5.81	6.24
Endo-(1,4)- $\beta$ -D-glucanase	TC6 0.5 m	Below detection	Below detection	Below detection	Below detection



**Table 2.4** Raw data and calculation of instrument detection limit (IDL)

<b>Blank ID</b>	<b>Concentration (ppb)</b>	<b>Blank ID</b>	<b>Concentration (ppb)</b>
1	0.21	16	-2.06
2	-0.4	17	-2.5
3	-2.02	18	-0.68
4	-2.19	19	-0.39
5	0.23	20	-0.16
6	-0.67	21	-1.7
7	-1.57	22	-2.06
8	0.61	23	0.31
9	0.99	24	0.65
10	0.57	25	-0.88
11	-0.63	26	-0.41
12	-0.4	27	0.05
13	0.12	28	-0.09
14	0.34	29	-0.8
15	-2.17	30	-0.57

Mean	-0.61
SD	0.99
x	2.38
IDL	0.20

## **Chapter 3:**

### *Cellulolysis in Carbon Amended Tailings: A Field Study*

### 3.1 Summary

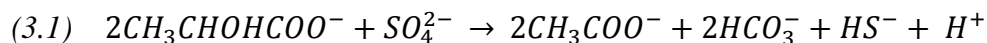
Temporal variations in cellulase enzyme activities were investigated from carbon amended tailings from the Greens Creek Mine in Juneau, Alaska over a period of 5 years following organic carbon amendment. The effectiveness of enzyme activity was assessed as a monitoring tool for organic carbon degradation and sulfate reduction. Six test cells, containing a mixture of tailings and individual or varied organic materials, were sampled in the fall of 2005, 2007 and 2009. Exo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.91), Endo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.4) and  $\beta$ -glucosidase (EC 3.2.1.21) enzymes were assayed from core sections. Enzyme activities fell below detection in the control cell indicating that organic material is required to sustain microbial populations. Peat was not observed to support microbial populations, as indicated by low cellulase activities. Substantial enzyme activity associated with municipal biosolids and spent brewery grain indicate that these organic sources sustain microbial life in a tailings environment. General trends between cellulase enzyme activities and sulfate reducing bacteria populations were consistent indicating the importance of cellulolysis for dissimilatory sulfate reduction. Total, inorganic and organic carbon content was measured for each year and compared to measured enzyme activities. Carbon values were more reflective of organic matter distribution in each test cell rather than cellulolysis. Organic matter is comprised of various forms of organic carbon (polysaccharide, organic acid or bacterial) and therefore does not provide a sensitive indication of amendment degradation.

## 3.2 Introduction

Low-quality mine drainage is one of the most widespread problems facing the mining industry. When exposed to the atmosphere, sulfide minerals from mine waste oxidize, producing effluent with elevated concentrations of sulfate and dissolved metals. The effluent can be detrimental to surrounding ecosystems and should be treated to remove harmful components. Treatment technologies that have been successful at removing sulfate and metals from mine drainage include; permeable reactive barriers (PRBs) (Benner et al., 2002; Costa et al., 2008), constructed anaerobic wetlands (Wieder, 1989) and sulphidogenic bioreactors (Gonçalves et al., 2007; Neculita and Zagury, 2008). The success of their passive technologies depends on the addition of organic carbon (OC) to support microbial activity, which reduces sulfate to sulfide and promotes metal-sulfide precipitation. Long term studies indicate that the performance of passive remediation technologies can deteriorate as the more labile forms of OC are depleted (Guo and Blowes, 2009; Waybrant et al., 2002; Webb et al., 1998). There is little information available which characterizes OC degradation in passive remediation systems. Further knowledge about processes affecting OC degradation and degradation rates may aid in the understanding of the long term efficacy of passive remediation systems.

Sulfidogenesis is the biological generation of hydrogen sulfide as a result of reductive metabolic processes. Passive remediation systems used to treat or prevent low quality mine drainage that is heavily influenced by sulfate are largely anaerobic. Sulfidogenesis is the dominant biochemical process as long as sulfate remains present (Barton and Hamilton, 2007). Sulfate reducing bacteria (SRB) are the prevailing microbial population associated with sulphidogenesis. The major energy input to SRB comes from organic acids derived from the

breakdown of organic matter. SRB cannot directly utilize products from OC degradation. The degradation products of polysaccharides are fermented by organisms capable of carbohydrate catabolism, such as acid producing bacteria (APB). SRB then derive energy from the fermented products while reducing sulfate to sulfide (equation 3.1) (Barton and Hamilton, 2007).



The stoichiometric increase in sulfide and elevated concentration of metals in mine waste create a chemical gradient which drives the precipitation of metal sulfide (equation 3.2).



$Me^{2+}$  represents a divalent metal ion and  $MeS$  denotes a metal sulfide.

Sites which require a passive treatment system typically have relied on access to local resources for a supply of organic matter to reduce transportation costs. Depending on the location of the site, local sources have included agricultural resources such as manure, straw, peat, compost and mulch; or an industrial source such as sawdust, woodchips, pulp mill biosolids, brewery solids and municipal biosolids. Studies involved in the relative potential of an OC source to aid in sulfate reduction concluded that a mixture of organic resources provides the most effective outcome (Zagury et al. 2006; Waybrant et al. 1998).

Organic matter is largely composed of cellulose, hemi-cellulose, lignin and pectin. Cellulose and hemi-cellulose make up approximately 57 to 77 % of all plant matter (Benner et al., 1987) but, the percent composition of cellulose and hemi-cellulose in individual materials can vary greatly. The average cellulose content in municipal biosolids contains 40% cellulose whereas certain varieties of peat contain only 22% cellulose (Walker and Wilson, 1991 and Rizzuti et al., 1999).

Cellulose and hemi-cellulose are both polysaccharides composed of glucose units which are bound by  $\beta$ -1,4-glucosidic bonds (Zhang et al., 2006). The degree of polymerization of cellulose or hemi-cellulose depends on the number of individual glucose units that compose the molecule. Because glucose units bind strongly to each other, cellulose degradation is a difficult process to accomplish without the aid of enzyme activity. Specific enzymes catalyze the degradation of cellulose and hemi-cellulose, producing smaller polysaccharide molecules or individual glucose units that can be used by microorganisms for energy (Nannipieri et al., 2002).

The most common group of enzymes to perform cellulolysis are Exo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.91), Endo-(1,4)- $\beta$ -D-glucanase (EC 3.2.1.4) and  $\beta$ -glucosidase (EC 3.2.1.21) (Felix and Ljungdahl, 1993). Exo-(1,4)- $\beta$ -D-glucanase hydrolyze the bonds located at the ends of a cellulose molecule whereas interior  $\beta$ -1,4 bonds are randomly cleaved by Endo-(1,4)- $\beta$ -D-glucanase producing smaller polysaccharide units (Zhang et al, 2006).  $\beta$ -glucosidase degrades cellulose molecules that are up to 6 degrees of polymerization resulting in small soluble glucose units (Leschine, 1995).

In this study, assays were conducted on three enzymes in carbon amended tailings samples collected over a time period of 5 years. The purpose of the study was to determine if enzyme activity could be used as a reliable indicator for OC degradation in a passive remediation system. Enzyme activities were compared to the organic matter source, the volume of amended material, relative SRB and APB populations and the carbon content.

### **3.2.1 Site Description**

All field samples were acquired from Greens Creek Mine, located on Admiralty Island in Alaska, USA. A pilot test was initiated in 2004 on the tailings pile to evaluate the prospect of adding OC to the full scale tailings pile (Lindsay, 2009). Seven test cells (TC) were installed measuring 3 m wide by 3 m long by 4 m deep. Two controls were assembled, containing unexcavated (TC1) and excavated (TC2) tailings (Lindsay, 2011). Individual and mixed OC materials were amended to test cells 3 to 7 (TC3 – TC7) with the exception of the bottom 0.5 m which was backfilled with non-amended tailings (Lindsay, 2011). Test cells 3 to 6 (TC3 – TC6) contain a mixture of 95 vol % tailings and 5 volume % OC, whereas test cell 7 (TC7) contains 90 vol % of tailings and 10 vol % OC (Table 1). TC3 contains only peat. TC4 includes equal amounts of peat and spent brewery grain (SBG) whereas TC5 contains equal amounts of peat and municipal biosolids (MB). TC6 and TC7 include peat, SBG and MB but TC7 contains twice as much of all three materials. A detailed description of the test site and results of the pilot test can be found in Lindsay et al., (2009) and Lindsay et al., (2011).

## **3.3 Materials and Methods**

### **3.3.1 Sampling Procedure**

During the fall of 2004 to 2009, tailings core samples from Greens Creek were extracted from each test cell using a piston coring method described by Star and Ingleton (1992). The core samples were collected in 5 cm diameter, thin-walled aluminum tubing. Immediately following recovery, the aluminum tubing containing the tailings material was cut into 30 - 40 cm sections,

which were capped using low density polyethylene tubing caps, and sealed with vinyl tape. The capped and sealed core samples were frozen at  $-18^{\circ}\text{C}$  until processing.

Cores from 2005, 2007 and 2009 were selected for analysis from the six years of archived core. The core samples were sub-sampled into 10 to 15 cm long sections, centred at a depth of 0.5 or 0.6, 1.0, 1.75, 2.5 and 3.25 m below ground surface (m.b.g.s.) (Figure 3.1). All core sections were divided in two along the long axis using a circular saw. The exposed tailings surfaces were removed to prevent potential sample contamination. The remaining tailings were well mixed and divided into 3 g samples in 14 mL capped test tubes. All samples were frozen at  $-18^{\circ}\text{C}$  until ready for analysis.

### **3.3.2 Enzyme Assays**

The activities of  $\beta$ -glucosidase, Exo-(1,4)- $\beta$ -D-glucanase and Endo-(1,4)- $\beta$ -D-glucanase were measured in field samples by a fluorogenic substrate. The assays were performed using a modification of the methods described by Tilbeurgh et al. (1982) and Tilbeurgh et al. (1984) with modifications by Debosz et al. (1999). These modifications, the degree of reproducibility, optimum sample size and degree of replication were evaluated in Chapter 2. The optimized conditions are used in this chapter.

#### ***3.3.2.1 $\beta$ -glucosidase Assay***

$\beta$ -glucosidase activity was determined by adding 4 mL of pH 5.0, 0.05 M sodium acetate buffer to 3 g of carbon amended tailings in a 14 mL glass test tube. Samples were incubated in a  $30^{\circ}\text{C}$  water bath for 10 minutes and then 1 mL of 4-Methylumbelliferyl  $\beta$ -D-glucopyranoside (MUF-glu) was added and incubated for an additional 30 minutes at  $30^{\circ}\text{C}$ . The concentration of MUF-



glu was 100  $\mu$ M. To stop the reaction, 5 mL of 95% ethanol was added and the samples were cooled at 4°C for 30 minutes. Following refrigeration, each sample was centrifuged at 5000 rotations per minute (RPM) for 15 minutes and then brought to room temperature. Using a pipette, 7 mL of the supernatant was then transferred to a 14 mL glass test tube containing 1 mL of 2.5 M TRIS buffer. The TRIS buffer was adjusted to pH 10.32 with concentrated hydrochloric acid to ensure substrate fluorescence for 12 hours. An aliquot of 3 mL of the supernatant-TRIS mixture was then transferred to a disposable cuvette and placed into the fluorometer for analysis.

### ***3.3.2.2 Exo-(1,4)- $\beta$ -D-glucanase Assay***

The assay conditions and preparation of samples for Exo-(1,4)- $\beta$ -D-glucanase was the same as described for  $\beta$ -glucosidase with the following exceptions; The activity of Exo-(1,4)- $\beta$ -D-glucanase was determined using 4-Methylumbeliferyl  $\beta$ -D-cellobioside (MUF-bi) as a substrate instead of MUF-glu. The substrate concentration was 100  $\mu$ M.

### ***3.3.2.3 Endo-(1,4)- $\beta$ -D-glucanase Assay***

The assay conditions and preparation of samples was the same as described for  $\beta$ -glucosidase with the following exceptions; The activity of Endo-(1,4)- $\beta$ -D-glucanase was determined using 4-Methylumbeliferyl  $\beta$ -D-celotrioside (MUF-tri) as a substrate. The substrate concentration was 25  $\mu$ M and the incubation period was increased to 1 hour.

The fluorescence for all three enzymes was determined by using a digital filter fluorometer with an excitation frequency of 365 nm and an emission frequency of 448 nm.

### 3.3.3 Microbial Populations

Microbial population enumerations for SRB and APB were conducted by Lindsay et al., (2011) using a five-tube most probable number (MPN) method (Cochran, 1950). Detailed descriptions of these methods are presented in Lindsay et al., (2011) and a brief description is mentioned here. A modified Postgate C medium (Benner et al., 1999) was prepared to promote SRB growth. The medium was then bubbled with N<sub>2</sub> for 1-2 hours and placed in an anaerobic chamber. The solution was transferred into serum bottles. The serum bottles were capped, sealed and sterilized in an autoclave. Inoculation was performed by adding  $1 \pm 0.05$  g of tailings core to the sterilized bottles. Nine serial dilutions were then obtained to achieve a 10 order of magnitude range in concentration. The serum bottles for SRB enumeration were left untouched at room temperature to incubate for 4 weeks. Positive results for SRB were indicated by the presence of black FeS precipitate.

For APB enumeration a medium consisting of dextrose, beef extract, protease peptone, sodium chloride and bromothymol blue was prepared and adjusted to a pH of 7.2 (Hulshof et al., 2003). Test tubes were filled with 9 mL of medium and autoclaved prior to inoculation. One gram of tailings was added to each of five replicate test tubes. Samples were diluted successively to a final dilution of 10<sup>10</sup> and then incubated for 96 hours at room temperature before analysis. A decrease in pH <6 and a change in the colour from green to yellow of the growth medium indicated the presence of APB. An MPN table was used to enumerate populations as cells g<sup>-1</sup> of bulk sample (Alexandar, 1965).

### **3.3.4 Organic and Inorganic Carbon Content**

Total carbon content of field samples was determined with an ELTRA CS 2000 Carbon Sulfur Determinator. Amended tailings samples 4 to 7 grams (wet wt.) were dried in an oven at 36 °C. Moisture content varied from 7 to 28 % in all seven test cells and between each year. The samples used for carbon analysis came from core locations that corresponded to sample depths used to determine enzyme activity. Oven dried samples weighing approximately 50 mg were mixed with roughly 100 mg of iron ore filings prior to analysis to improve combustion. The solid mixture was incinerated in an induction furnace.

Inorganic carbon in tailing samples was initially dissolved and converted to CO<sub>2</sub> gas prior to OC analysis on a resistance furnace. Oven dry samples weighing  $1 \pm 0.03$  g were placed in individual 30 mL crimp top vials. Using a pipette, 2 ml of 3 M hydrochloric acid was added to each 1 g tailings sample. The slurry was then gently heated in a fume hood to improve acid-dolomite reaction. Samples were again dried, weighed and then analyzed for the remaining OC fraction.

OC content was determined with an ELTRA CS 2000 Carbon Sulfur Determinator. Oven dried samples (100 mg) were burned at 1350 °C in a resistance furnace. Subsequently OC values were subtracted from total carbon values to determine the inorganic carbon content.

### **3.3.5 Acid Volatile Sulfides**

The sulfide content of the tailings was measured from frozen core samples representing TC2, TC5 and TC7 in 2009. A detailed description of the AVS method can be found in Zhabina and Volkov (1978) and Canfield et al. (1986). Samples were extracted from a depth of 0.30, 1.15,

1.50 and 2.90 m.b.g.s. and were analyzed in triplicate. Carbon amended tailings samples weighing  $3 \pm 0.2$  g were added to 60 mL of 6 N HCl containing 15 weight percent  $\text{SnCl}_2$ . Hydrogen sulfide gas is generated by the acidification of acid volatile sulfides and then carried in a stream of  $\text{N}_2$  gas into a trapping vessel containing 30 mL of 10 vol.%  $\text{NH}_4\text{OH}$  with 3 wt. % Zn acetate. The evolved  $\text{H}_2\text{S}$  reacts with the solution and is then trapped as ZnS. The amount of ZnS is measured by iodimetric titration using a 1% starch indicator solution. Both reactive solutions were deoxygenated by bubbling with  $\text{N}_2$  for approximately 20 minutes prior to use.

The acid volatile sulfide method measures sulfide content in samples primarily found as monosulfides as well as any dissolved sulfide found in pore water. The sulfide content in the unsaturated zone of the tailings compound at the Greens Creek tailings is low and does not contribute to the sulfide content in the tailings.

## **3.4 Results and Discussion**

### **3.4.1 Enzyme Activity and Microbial Trends**

Results for TC1 and TC2 are similar and therefore the results of TC2 were used to characterize both sets of data. Enzyme activities representing exo-(1,4)- $\beta$ -D-glucanase, endo-(1,4)- $\beta$ -D-glucanase and  $\beta$ -glucosidase in the control (TC2) were below the method detection limit of  $2.4 \times 10^{-3}$   $\eta\text{mol g}^{-1} \text{h}^{-1}$  (Figure 3.2). Acid producing bacteria (APB) and sulfate reducing bacteria (SRB) enumerations were less than  $10^2$  cells per gram. Without the presence of organic matter, enzymatic and bacterial data indicate that the organic content of these cells is insufficient to support substantial microbial activity and subsequent sulfate reduction and metal precipitation.

Peat was the only organic amendment to TC3 and is primarily composed of very complex polysaccharides and lignin. Enzyme activity indicated a very low rate of organic degradation occurring in TC3 (Figure 3.2). Exo-(1,4)- $\beta$ -D-glucanase and  $\beta$ -glucosidase activities were below detection except for at an isolated depth of 1.75 m for exo-(1,4)- $\beta$ -D-glucanase in 2007. Endo-(1,4)- $\beta$ -D-glucanase activity was also below the detection limit in 2005 and 2007 but was detected in 2009. Acid producing bacteria were below detection in TC3 indicating a lack of low-molecular weight polysaccharides available for fermentation. Sulfate reducing bacteria decreased between 2005 and 2007 representing a decrease in energy supply for sulfate reduction and then increased in 2009.

The amendment of SBG in addition to peat in TC4 resulted in a considerable increase in enzyme and microbial activity (Figure 3.2). Exo-(1,4)- $\beta$ -D-glucanase and endo-(1,4)- $\beta$ -D-glucanase activity increased progressively from 2005 to 2009 representing the degradation of complex polysaccharides and increase in supply of simple carbohydrates. Between 2005 and 2007 there was a surge of  $\beta$ -glucosidase activity which declined slightly in 2009. Acid producing bacteria were consistently present between 2005 and 2009 and SRB populations continued to increase during the study period.

A combination of peat and MB were added to TC5. Exo-(1,4)- $\beta$ -D-glucanase activity increased at isolated depths between 2005 and 2009 (Figure 3.2). Endo-(1,4)- $\beta$ -D-glucanase activity was less than the detection limit in 2005 and slight in 2007 and 2009.  $\beta$ -glucosidase activity was significant; increasing at 1.75 and 2.5 m.b.g.s but decreasing at 0.5 and 1.0 m.b.g.s. between 2005 and 2009. Enzyme activity suggests that low-molecular weight organic matter dominates the composition of MB. Bacterial activity measurements are consistent with this

observation as APB increased from 2005 to 2007 but decreased slightly from 2007 to 2009. SRB enumerations increased from 2005 to 2009.

A combination of peat, SBG and MB were amended to TC6. Exo-(1,4)- $\beta$ -D-glucanase and endo-(1,4)- $\beta$ -D-glucanase activities were below detection except at depth 2.5 m in 2007 and 2009 (Figure 3.2).  $\beta$ -glucosidase activity was initially present in 2005 but decreased subsequently with the exception of depths 0.5 and 2.5 m where the enzyme activity increased gradually. APB activity increased from 2005 to 2009. The activity of SRB increased between 2005 and 2007 and then decreased slightly from 2007 to 2009.

The composition of organic matter added to TC7 paralleled TC6 but the percent volume doubled. All enzyme activities in TC7 were at least double that of TC6 (Figure 3.2). Exo-(1,4)- $\beta$ -D-glucanase and endo-(1,4)- $\beta$ -D-glucanase activities decreased slightly from 2005 to 2007 then increased in 2009.  $\beta$ -glucosidase activity decreased somewhat during the study period. The activity of APB decreased slightly between 2005 and 2009. SRB enumerations increased slightly from 2005 to 2007 and then maintained constant activity in 2009. A comparison between TC6 and TC7 indicates how a larger volume of amended carbon directly affected the activity of cellulolysis and microbial life in a tailings environment.

### **3.4.2 Enzyme and Bacterial Population Comparison**

In Figure 3.3 the overall trend each year between all enzyme activities and both sets of bacterial enumerations were comparable. Endo 1,4- $\beta$ -glucanase and exo 1,4- $\beta$ -glucanase were closely associated with the degradation of cellulose and hemi-cellulose molecules.  $\beta$ -glucosidase enzymes attack low-molecular weight polysaccharides which supply APB with carbohydrates.

APB then ferments the carbohydrates and provides an energy source to SRB which consume the fermented products. It is therefore expected to observe a direct correlation between  $\beta$ -glucosidase and both endo 1,4- $\beta$ -glucanase and exo 1,4- $\beta$ -glucanase;  $\beta$ -glucosidase and APB and lastly between APB and SRB.

Concentrations of  $\beta$ -glucosidase and both endo 1,4- $\beta$ -glucanase and exo 1,4- $\beta$ -glucanase were observed to closely parallel each other indicating that endo 1,4- $\beta$ -glucanase and exo 1,4- $\beta$ -glucanase activities provided a source of low-molecular weight polysaccharides for  $\beta$ -glucosidase to degrade further. This trend occurred each year and was most apparent in 2005 and 2009. Test cells with either MB and/or SBG were closely associated with this enzymatic relationship.

There was a weak correlation between  $\beta$ -glucosidase concentrations and APB but no apparent correlation between APB and SRB. Even though a weak affiliation was observed between  $\beta$ -glucosidase and APB, trends between  $\beta$ -glucosidase and SRB are strong, particularly in 2007 and 2009. Comparing the means of  $\beta$ -glucosidase and SRB each year indicate a relationship between  $\beta$ -glucosidase activity and SRB growth.

The APB assay denotes that a positive APB reading was signified by a reduction in pH from 7.2 to less than 6. Carbonate content in the tailings, measured at approximately 30 wt %, may have influenced APB results especially if APB enumerations were initially low.

Logan et al. (2005) conducted a laboratory study examining the activities of fermenting bacteria and SRB activity in relation to the availability of carbon sources and cellulose degradation. When adding lactate as an energy source to microbial communities, including APB and SRB, they found that the activity of SRB improved. The population of fermenting bacteria

did not mimic SRB activity but it did not limit the sulfate reducers. Similarly, APB populations in this study were not consistent with SRB enumerations and did not seem to affect SRB activities from year to year.

### **3.4.3 Acid Volatile Sulfides**

In the control cell (TC2), secondary sulfide values were observed to decrease with depth from an initial mean value of 0.14 to 0.08 % indicating that sulfate reduction was minimal in the cell without carbon amendment and consistent SRB activity (Figure 3.4). In TC5, mean sulfide concentrations increased with depth from 0.10 to 0.16 % and in TC7 values increased with depth from 0.02 to 1.94 %. The results indicate that sulfate precipitation was taking place at depth in test cells with active microbial populations.

### **3.4.4 Total, Organic and Inorganic Carbon Content**

Total carbon % in all test cells was greater in 2007 than in 2005 with the exception of TC7 (Figure 3.5). When comparing total carbon data between 2007 and 2009 in all test cells, values were lower in 2009 with the exception of TC2 and TC3. In the control cell, the total carbon values were more variable, increasing with some depths and decreasing with others. Total carbon values in TC3 either maintained their level or decreased.

Between 2005 and 2007 the OC content generally increased in all test cells except TC4 and TC6 where concentrations were variable. Between 2007 and 2009 OC content decreased in all test cells.



The inorganic carbon content increased in all test cells with the odd exception between 2005 and 2007. Between 2007 and 2009 there was no discernable trend with the inorganic carbon content. Values of inorganic carbon increased in the control cell, were variable in TC3, maintained observed 2007 values in 2009 for TC4, decreased in TC5 and TC6 and were variable in TC7. Inorganic carbon % was on average 3.5 wt % in each test cell.

Mineralogical analysis of the tailings at Greens Creek identified significant carbonate content largely consisting of dolomite at  $27.2 \pm 3.0$  weight % and calcite at  $3.4 \pm 0.8$  weight % (Lindsay, 2009). The calculated inorganic carbon content from the mineralogical values presented in Lindsay et al., (2009) is  $3.9 \pm 0.5$  wt %. This value corresponds well with the measured inorganic carbon content presented above.

A limitation to measuring OC with the ELTRA CS 2000 Carbon Sulfur Determinator method is that it is not affected by stages in the transformation of OC from amendment material to fermentation products. These measurements encompass all forms of OC including intermediate degradation products.

During the installation of the test cells, organic amendments were mixed with tailings using a backhoe and then placed back into each test cell. Sample cores extracted yearly from test cells were extracted from separate locations in each individual cell. Variability in the reported carbon data could also in part be attributed to the heterogeneity of the organic amendment in each test cell rather than microbial degradation.

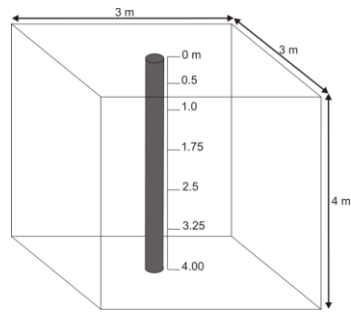
The overall difference between % carbon observed in the control cell in comparison to the amount in TC3 to TC6 was minimal. Carbon amendment in TC3 to TC6 was only 5 vol %.

When converted to weight percent and compared to TC2, it is clear how modest this addition was and what a significant effect it had on the activity and survival of bacteria and enzymes.

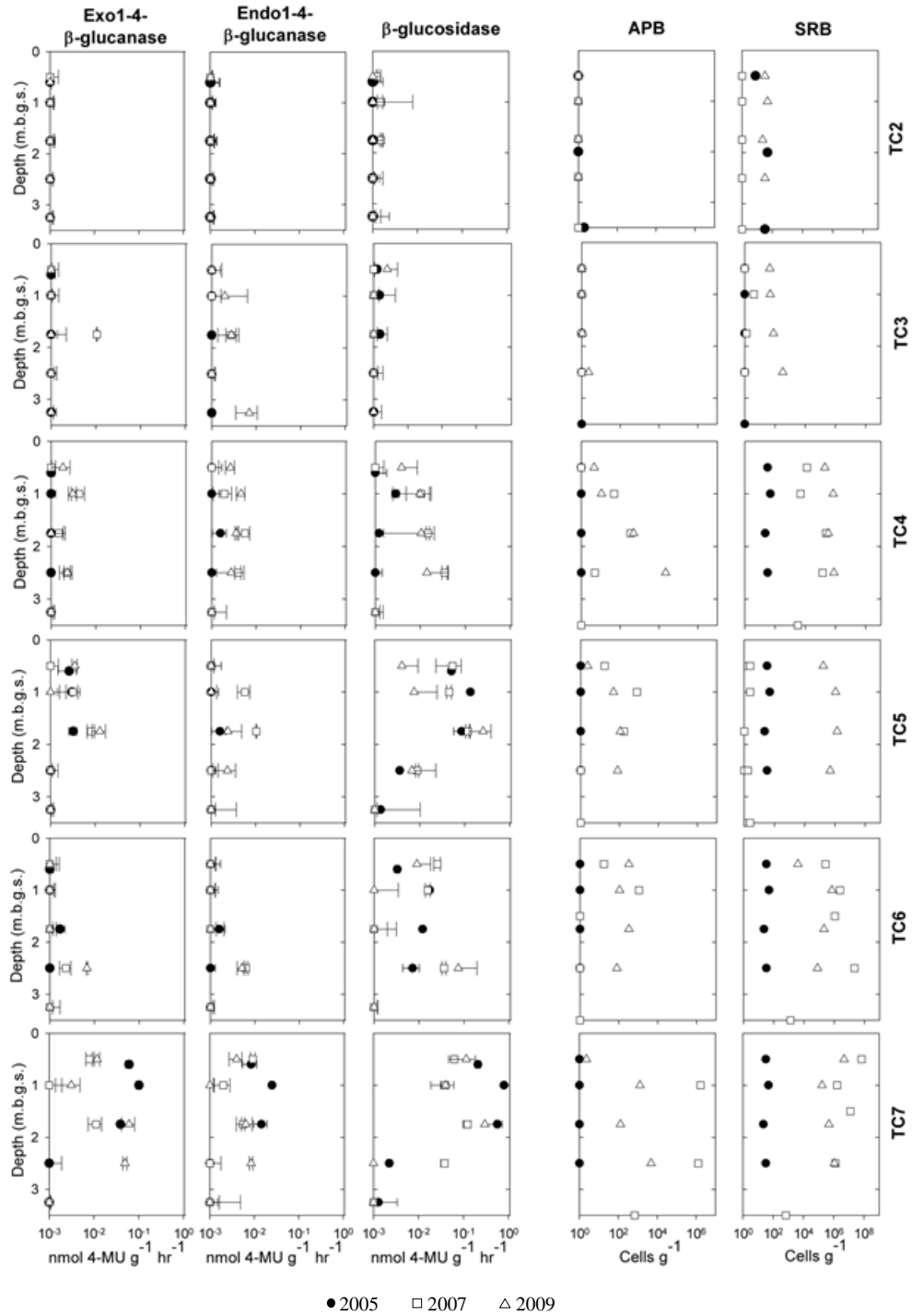
### 3.5 Conclusions

- Parallel trends between mean endo 1,4- $\beta$ -glucanase, exo 1,4- $\beta$ -glucanase activities and  $\beta$ -glucosidase indicate that cellulose and hemi-cellulose degradation occurred, supplying a source of low-molecular weight polysaccharides for degradation by  $\beta$ -glucosidase. This occurrence was observed in test cells that have been amended with MB and/or SBG.
- The similar trends between  $\beta$ -glucosidase and SRB indicate that cellulolysis is an important factor in sustaining dissimilatory sulfate reduction regardless of trends associated with APB activity.
- Spent brewery grain was an optimal source of carbon in this study, as indicated by elevated concentrations of all three cellulase enzymes as well as large APB and SRB populations.
- A larger mass of organic carbon in a low carbon environment is accompanied by greater enzyme activity, and subsequently more labile organic carbon will be available to sustain SRB activity.
- Enzyme activity associated with MB suggests the material was composed of primarily low molecular weight polysaccharides. Initially the availability of an excess amount of labile organic carbon may be beneficial to provide bacteria with available energy sources however this carbon source may not support long term remediation.

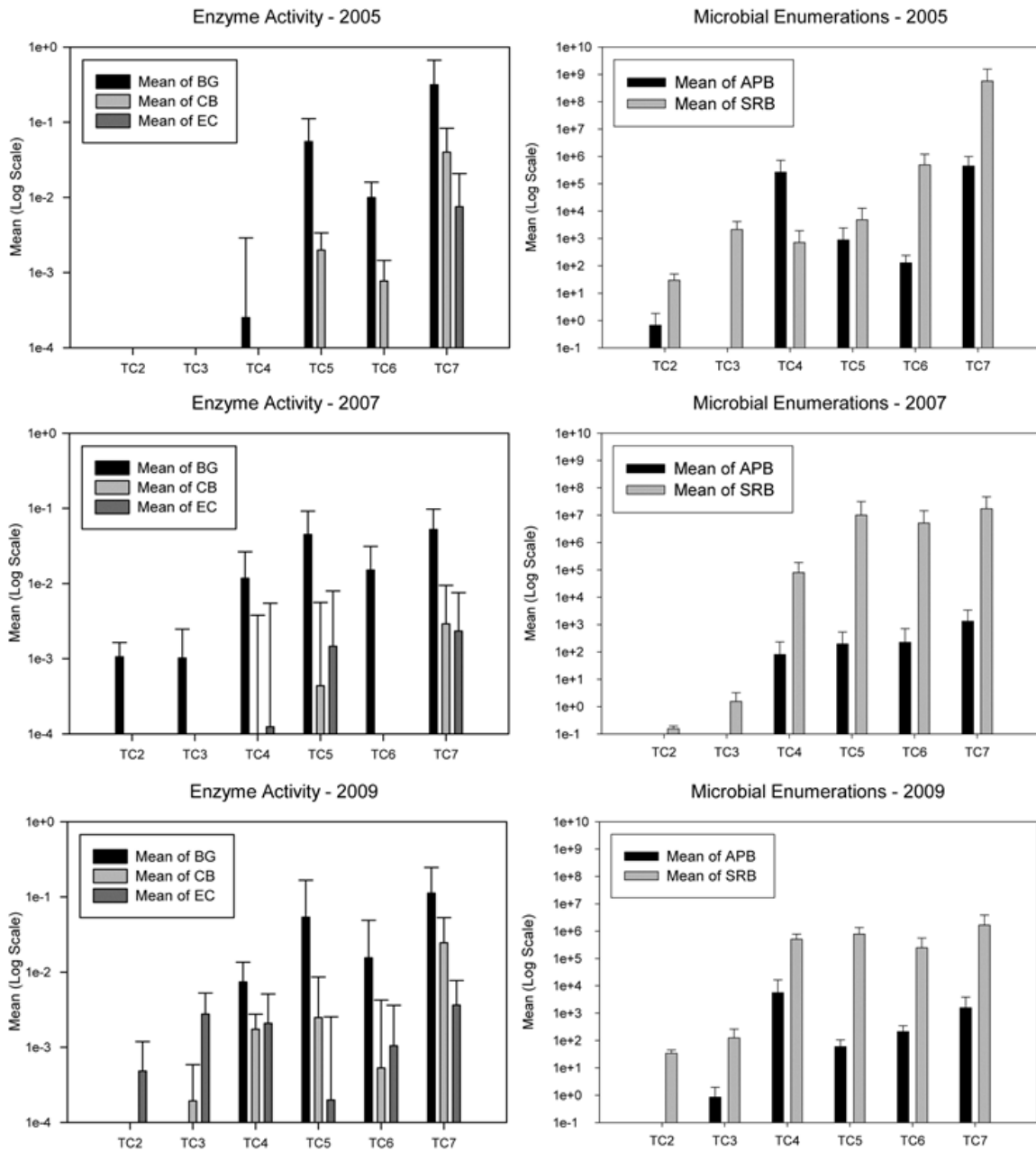
- Peat degrades slowly. Enzyme activities associated with peat does not provide a source of low molecular weight organic carbon that is sufficient to sustain larger microbial populations.
- Carbon values could not be used as indicators of organic degradation. These measurements are not suitable to distinguish the various organic carbon forms or the transitions between forms of organic carbon.
- Due to the heterogeneity of organic matter and sampling procedure of the test cells as well as the low amendment content in the tailings, it was not easy to evaluate carbon degradation by measuring total and organic carbon content over a number of years.



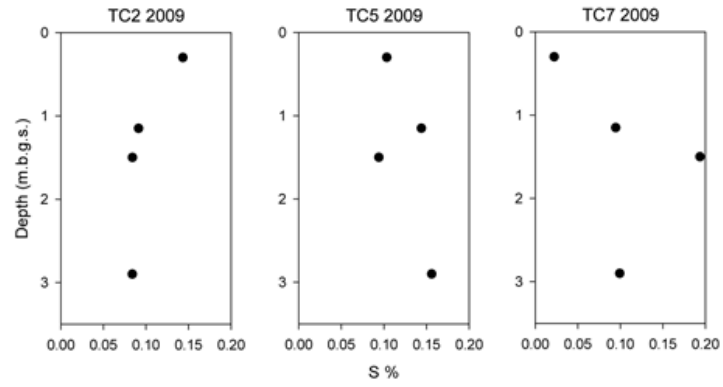
**Figure 3.1** Schematic of a single test cell. Depth locations at 0.5, 1.00, 1.75, 2.50 and 3.25 meters below ground surface represent the sample location from each core.



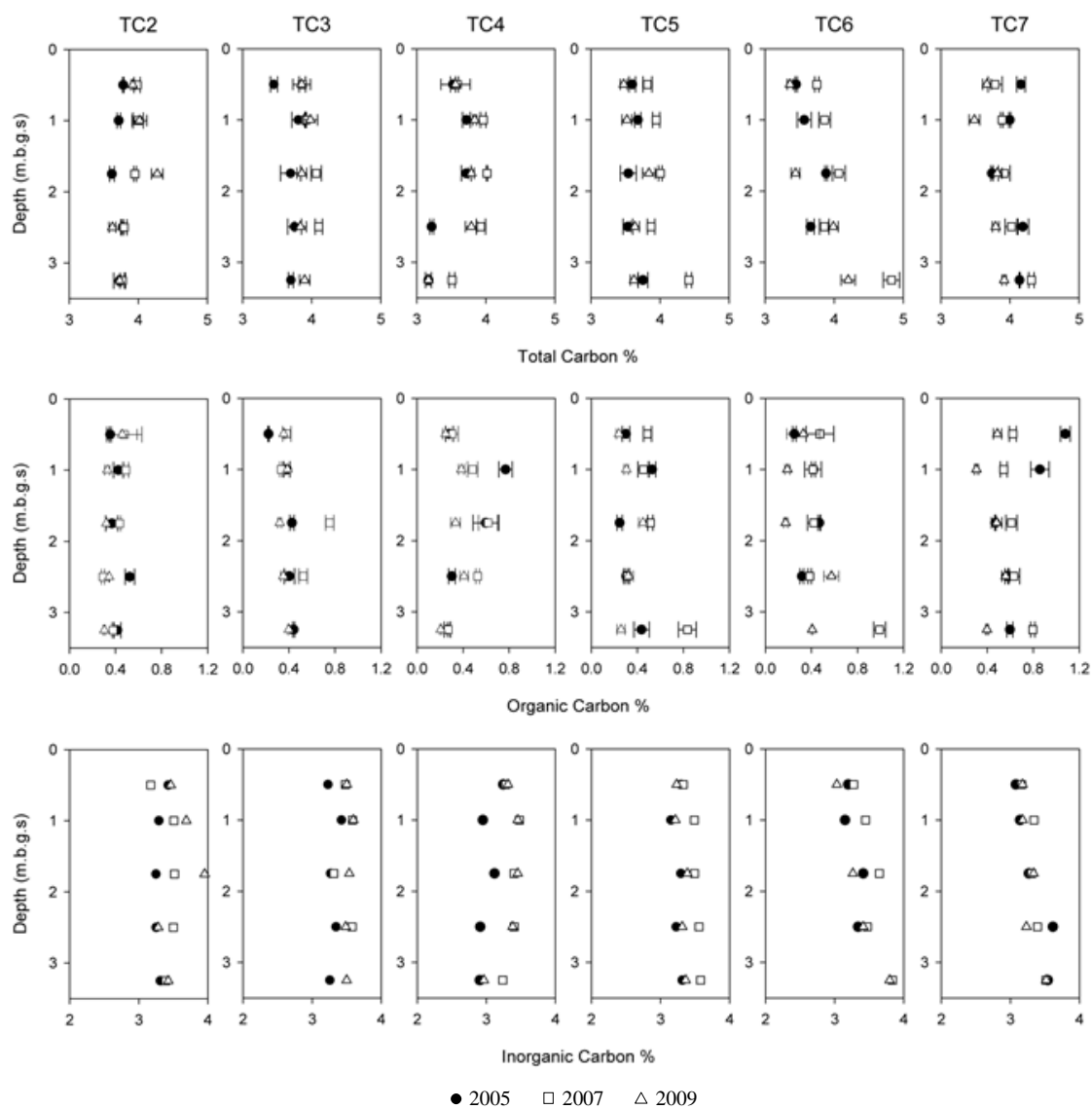
**Figure 3.2** Exo 1,4-β-glucanase, endo 1,4-β-glucanase and β-glucosidase activity and sulfate reducing bacteria (SRB) and acid producing bacteria (APB) enumerations for 2005, 2007 and 2009.



**Figure 3.3** Bar charts on the left of the page present mean values of exo 1,4- $\beta$ -glucanase (CB), endo 1,4- $\beta$ -glucanase (EC) and  $\beta$ -glucosidase (BG) activity for each test cell in 2005, 2007 and 2009. On the right side of the page mean values of sulfate reducing bacteria (SRB) and acid producing bacteria (APB) enumerations for each test cell are presented for 2005, 2007 and 2009.



**Figure 3.4** Sulfide content in TC2, TC5 and TC7 in 2009



**Figure 3.5** Percent of total, organic and inorganic carbon in carbon amended tailings samples for 2005, 2007 and 2009.



**Table 3.1** Composition and volume content in carbon amended test cells

<b>Test Cell</b>	<b>Tailings</b>	<b>Peat</b>	<b>Brewery Waste</b>	<b>Municipal Biosolids</b>	<b>Description</b>
	<b>Volume %</b>	<b>Volume %</b>	<b>Volume %</b>	<b>Volume %</b>	
TC1	100	0	0	0	Unexcavated Control
TC2	100	0	0	0	Excavated Control
TC3	95	5	0	0	5% Organic Carbon
TC4	95	2.5	2.5	0	5% Organic Carbon
TC5	95	2.5	0	2.5	5% Organic Carbon
TC6	95	2.5	1.25	1.25	5% Organic Carbon
TC7	90	5	2.5	2.5	10% Organic Carbon

# **Chapter 4:**

## *Conclusions*

## **4.1 Summary of Findings**

The modified enzyme assay presented in Chapter 2 was successful in measuring enzyme activity in tailings amended with a minimal amount of organic matter. The assay is not site specific however aspects of the method should be evaluated prior to implementation at another location. These aspects include; the mass of each sample, number of replicates and potential matrix effects due to the composition of the remedial site, should be assessed prior to analysis.

In comparison to test cells amended with carbon, the lack of enzyme and microbial activity (Chapters 2 and 3), as well as the decreased levels of secondary sulfide in the control cell (Chapter 3) indicate that carbon amendment greatly improves the population of SRB, APB and enzyme activity.

The composition of the organic amendment greatly affects the consortium of bacteria and enzyme activities. Test cell 3 (TC3) contained only peat. The low enzyme activity observed in TC3 indicates that peat does not contain a significant quantity of material that can be easily or quickly degraded by cellulase enzymes. As a consequence the populations of APB and SRB in TC3 were low. Test cells 4 to 7 were able to effectively support APB and SRB to varying degrees. The activity of all three cellulase enzymes in TC4 to TC7 supports carbon degradation of both low and high molecular weight polysaccharides.

An increase in the amount of amended material positively influenced cellulase enzyme activity and microbial populations. The same mixture of organic material was contained in TC7 as TC6 but there was twice as much material added to TC7. Enzyme activity and microbial activity closely paralleled this increase.

General trends were observed between endo 1,4- $\beta$ -glucanase, exo 1,4- $\beta$ -glucanase and  $\beta$ -glucosidase activities as well as between  $\beta$ -glucosidase and SRB when comparing the mean of all activities in each test cell (Chapter 3). The similar activities between endo 1,4- $\beta$ -glucanase, exo 1,4- $\beta$ -glucanase and  $\beta$ -glucosidase in all three years indicate that cellulose degradation and hemi-cellulose degradation occurred and provided a source of low-molecular weight polysaccharides which was further degraded by  $\beta$ -glucosidase. This sequence primarily took place in test cells that had either MB or SBG amendments. The similarity of trends between the mean of  $\beta$ -glucosidase and SRB populations indicate that cellulolysis was an important factor in dissimilatory sulfate reduction regardless of trends associated with APB activity.

Due to the heterogeneity of the organic matter in the test cells and sampling procedure conducted to extract the tailings core as well as the low amendment content in the tailings, it was very difficult to quantify OC degradation by measuring total and OC content over a relatively short time period of 5 years (Chapter 3).

Observations of total, organic and inorganic % carbon did not change measurably over the five years of study (Chapter 3). The consumption of OC can occur through biological uptake, biochemical conversion to an inorganic form of carbon or dissolution. The latter would be the most likely to transport OC from its original location but other biochemical processes would not transport or eliminate carbon quickly. Therefore, total carbon measurements represent both organic and inorganic values.

## 4.2 Recommendations

Exo-(1,4)- $\beta$ -D-glucanase, endo-(1,4)- $\beta$ -D-glucanase and  $\beta$ -glucosidase are good indicators of both low and high molecular weight polysaccharides in substrates that contain OC however, they are limited to providing information on cellulose and hemi-cellulose. Organic matter can contain a significant amount of lignin and pectin. It would benefit our understanding of organic matter degradation in a tailings environment by studying predominant enzymes specific to the breakdown of these substrates.

The source of carbon amendment used for mine drainage remediation can greatly affect the activity of microbial populations. Cellulase enzyme activity can help determine the effectiveness of a carbon source. Peat is not a recommended resource to provide bacteria with an initial energy source as is apparent by the very low enzyme activities observed (Chapter 3). Municipal biosolids, SBG or a mixture of the two sources provided a sufficient supply of labile OC, but they also had elevated concentrations of all three cellulase enzymes suggesting the presence of more complex polysaccharides (Chapter 3). Information from cellulase enzyme assays prior to carbon amendment may aid in determining the initial supply of labile OC. Cellulase enzyme assays in conjunction with column studies or batch experiments may help determine the potential of a locally available carbon source prior to its use in the field.

Measuring total, organic and inorganic carbon content in field samples was ineffective for determining OC degradation. OC can be transformed, chemically or biologically, to alternate organic forms but the carbon itself is not very mobile. A limitation to measuring OC with this method is that total OC is measured and the transformation products are incorporated in this total.

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***Appendix A:***  
***Summary of Data Presented in Chapter 2***

**Table A.1** Raw data for  $\beta$ -Glucosidase activity in 2005.

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
UN	TC1	0.60	1	3.01	-1.34	-2.89E-03	-1.29	-1.29	-2.79E-03	-2.79E-03	1.30E-04	
UN	TC1	0.60	2	3.01	-1.34	-2.89E-03						
UN	TC1	0.60	3	3.00	-1.21	-2.62E-03						
UN	TC1	0.60	4	3.02	-1.28	-2.75E-03						
SPK #1	TC1	0.60	1	3.01	69.48	1.50E-01	66.06	66.06	1.42E-01	1.42E-01	7.71E-03	
SPK #1	TC1	0.60	2	3.02	68.70	1.48E-01						
SPK #1	TC1	0.60	3	3.03	63.07	1.35E-01						
SPK #1	TC1	0.60	4	3.01	63.00	1.36E-01						
SB	TC1	0.60	1	3.02	-1.80	-3.87E-03	-1.80	-1.80	-3.85E-03	-3.85E-03	1.20E-04	
SB	TC1	0.60	2	3.02	-1.80	-3.87E-03						
SB	TC1	0.60	3	3.03	-1.86	-3.98E-03						
SB	TC1	0.60	4	3.04	-1.73	-3.69E-03						
UN	TC1	1.00	1	3.02	-1.41	-3.03E-03	-1.49	-1.49	-3.20E-03	-3.20E-03	2.18E-04	
UN	TC1	1.00	2	3.04	-1.41	-3.01E-03						
UN	TC1	1.00	3	3.03	-1.54	-3.30E-03						
UN	TC1	1.00	4	3.00	-1.60	-3.46E-03						
UN	TC1	1.75	1	3.02	-1.47	-3.16E-03	-1.54	-1.54	-3.30E-03	-3.30E-03	1.68E-04	
UN	TC1	1.75	2	3.02	-1.47	-3.16E-03						
UN	TC1	1.75	3	3.01	-1.60	-3.45E-03						
UN	TC1	1.75	4	3.01	-1.60	-3.45E-03						
UN	TC1	2.50	1	3.00	-1.73	-3.74E-03	-1.63	-1.63	-3.51E-03	-3.51E-03	2.66E-04	
UN	TC1	2.50	2	3.03	-1.73	-3.71E-03						
UN	TC1	2.50	3	3.01	-1.60	-3.45E-03						
UN	TC1	2.50	4	3.01	-1.47	-3.16E-03						
STD (75 ppb)			1	0.00	72.65	2.20E+00	72.65	72.65				
UN	TC1	3.25	1	3.02	-1.54	-3.31E-03	-1.47	-1.47	-3.16E-03	-3.16E-03	2.02E-04	
UN	TC1	3.25	2	3.03	-1.34	-2.87E-03						
UN	TC1	3.25	3	3.03	-1.54	-3.30E-03						
UN	TC1	3.25	4	3.02	-1.47	-3.16E-03						
UN	TC2	0.60	1	3.03	-1.47	-3.15E-03	-1.54	-1.54	-3.29E-03	-3.29E-03	1.11E-04	
UN	TC2	0.60	2	3.04	-1.54	-3.29E-03						
UN	TC2	0.60	3	3.02	-1.54	-3.31E-03						
UN	TC2	0.60	4	3.03	-1.60	-3.42E-03						
UN	TC2	1.00	1	3.01	-1.54	-3.32E-03	-1.46	-1.46	-3.14E-03	-3.14E-03	1.32E-04	
UN	TC2	1.00	2	3.03	-1.47	-3.15E-03						
UN	TC2	1.00	3	3.00	-1.41	-3.05E-03						
UN	TC2	1.00	4	3.01	-1.41	-3.04E-03						
DUP	TC2	1.00	1	3.01	-1.86	-4.01E-03	-1.70	-1.70	-3.67E-03	-3.67E-03	3.72E-04	
DUP	TC2	1.00	2	3.01	-1.80	-3.88E-03						
DUP	TC2	1.00	3	3.00	-1.67	-3.61E-03						
DUP	TC2	1.00	4	3.01	-1.47	-3.17E-03						
SB	TC2	1.00	1	3.01	-1.41	-3.04E-03	-1.47	-1.47	-3.18E-03	-3.18E-03	1.18E-04	
SB	TC2	1.00	2	3.00	-1.47	-3.18E-03						
SB	TC2	1.00	3	3.00	-1.54	-3.33E-03						
SB	TC2	1.00	4	3.01	-1.47	-3.17E-03						
MB	Blank		1	0.00	-1.73	-4.49E-02	-1.70	-1.70	-4.41E-02	-4.41E-02	8.99E-04	
MB	Blank		2	0.00	-1.67	-4.33E-02						
MB	Blank		3	0.00	-1.67	-4.33E-02						
MB	Blank		4	0.00	-1.73	-4.49E-02						
UN	TC2	1.75	1	3.03	-1.41	-3.02E-03	-1.43	-1.43	-3.06E-03	-3.06E-03	7.21E-05	
UN	TC2	1.75	2	3.03	-1.41	-3.02E-03						
UN	TC2	1.75	3	3.01	-1.47	-3.17E-03						
UN	TC2	1.75	4	3.01	-1.41	-3.04E-03						
UN	TC2	2.50	1	3.02	-1.41	-3.03E-03	-1.36	-1.36	-2.93E-03	-2.93E-03	6.83E-05	
UN	TC2	2.50	2	3.00	-1.34	-2.89E-03						
UN	TC2	2.50	3	3.01	-1.34	-2.89E-03						
UN	TC2	2.50	4	3.01	-1.34	-2.89E-03						
UN	TC2	3.25	1	3.00	-1.86	-4.02E-03	-1.81	-1.81	-3.91E-03	-3.91E-03	2.11E-04	
UN	TC2	3.25	2	3.02	-1.86	-4.00E-03						
UN	TC2	3.25	3	3.02	-1.67	-3.59E-03						
UN	TC2	3.25	4	3.00	-1.86	-4.02E-03						



**Table A.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)		(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
STD (21 ppb)			2	0.00	20.28	6.14E-01	20.28	20.28				
UN	TC3	0.60	1	3.02	-1.67	-3.58E-03	-1.70	-1.70	-3.65E-03	-3.65E-03	1.35E-04	
UN	TC3	0.60	2	3.03	-1.80	-3.86E-03						
UN	TC3	0.60	3	3.02	-1.67	-3.59E-03						
UN	TC3	0.60	4	3.02	-1.67	-3.59E-03						
UN	TC3	1.00	1	3.02	-0.50	-1.07E-03	-0.60	-0.60	-1.29E-03	-1.29E-03	3.42E-04	
UN	TC3	1.00	2	3.00	-0.83	-1.79E-03						
UN	TC3	1.00	3	3.02	-0.57	-1.23E-03						
UN	TC3	1.00	4	3.02	-0.50	-1.08E-03						
UN	TC3	1.75	1	3.02	-0.89	-1.91E-03	-0.97	-0.97	-2.09E-03	-2.09E-03	1.39E-04	
UN	TC3	1.75	2	3.01	-1.02	-2.20E-03						
UN	TC3	1.75	3	3.01	-1.02	-2.20E-03						
UN	TC3	1.75	4	3.02	-0.95	-2.04E-03						
SPK #7	TC3	1.75	1	3.02	20.02	4.31E-02	19.83	19.83	4.27E-02	4.27E-02	3.57E-04	
SPK #7	TC3	1.75	2	3.00	19.57	4.23E-02						
SPK #7	TC3	1.75	3	3.01	19.95	4.29E-02						
SPK #7	TC3	1.75	4	3.01	19.76	4.26E-02						
SB	TC3	1.75	1	3.03	-1.28	-2.74E-03	-1.28	-1.28	-2.74E-03	-2.74E-03	2.95E-04	
SB	TC3	1.75	2	3.00	-1.15	-2.48E-03						
SB	TC3	1.75	3	3.03	-1.21	-2.59E-03						
SB	TC3	1.75	4	3.02	-1.47	-3.16E-03						
UN	TC3	2.50	1	3.02	-1.47	-3.16E-03	-1.51	-1.51	-3.23E-03	-3.23E-03	8.59E-05	
UN	TC3	2.50	2	3.03	-1.54	-3.30E-03						
UN	TC3	2.50	3	3.02	-1.54	-3.31E-03						
UN	TC3	2.50	4	3.03	-1.47	-3.15E-03						
UN	TC3	3.25	1	3.02	-1.21	-2.60E-03	-1.18	-1.18	-2.53E-03	-2.53E-03	1.86E-04	
UN	TC3	3.25	2	3.02	-1.08	-2.32E-03						
UN	TC3	3.25	3	3.03	-1.15	-2.47E-03						
UN	TC3	3.25	4	3.02	-1.28	-2.75E-03						
STD (21 ppb)				0.00	20.47	6.20E-01	20.47	20.47				
UN	TC4	0.60	1	3.01	-1.41	-3.04E-03	-1.42	-1.42	-3.06E-03	-3.06E-03	1.24E-04	
UN	TC4	0.60	2	3.02	-1.47	-3.16E-03						
UN	TC4	0.60	3	3.01	-1.34	-2.89E-03						
UN	TC4	0.60	4	3.04	-1.47	-3.14E-03						
UN	TC4	1.00	1	3.01	1.38	2.98E-03	1.33	1.33	2.85E-03	2.86E-03	5.15E-04	
UN	TC4	1.00	2	3.03	1.63	3.49E-03						
UN	TC4	1.00	3	3.01	1.05	2.26E-03						
UN	TC4	1.00	4	3.01	1.25	2.69E-03						
MB			1	0.00	-1.99	-5.16E-02	-2.06	-2.06	-5.33E-02	-5.33E-02	2.99E-03	
MB			2	0.00	-2.18	-5.66E-02						
MB			3	0.00	-2.12	-5.50E-02						
MB			4	0.00	-1.93	-5.01E-02						
UN	TC4	1.75	1	3.03	0.66	1.41E-03	0.57	0.57	1.21E-03	1.21E-03	3.31E-04	
UN	TC4	1.75	2	3.04	0.73	1.56E-03						
UN	TC4	1.75	3	3.02	0.40	8.61E-04						
UN	TC4	1.75	4	3.04	0.47	1.00E-03						
UN	TC4	2.50	1	3.01	-1.54	-3.32E-03	-1.57	-1.57	-3.38E-03	-3.38E-03	6.77E-05	
UN	TC4	2.50	2	3.01	-1.54	-3.32E-03						
UN	TC4	2.50	3	3.03	-1.60	-3.42E-03						
UN	TC4	2.50	4	3.00	-1.60	-3.46E-03						
DUP	TC4	2.50	1	3.03	0.15	3.21E-04	0.18	0.18	3.88E-04	3.87E-04	1.85E-04	
DUP	TC4	2.50	2	3.02	0.08	1.72E-04						
DUP	TC4	2.50	3	3.01	0.21	4.53E-04						
DUP	TC4	2.50	4	3.00	0.28	6.05E-04						
SB	TC4	2.50	1	3.04	0.20	4.27E-04	0.33	0.33	6.97E-04	6.96E-04	2.57E-04	
SB	TC4	2.50	2	3.01	0.48	1.04E-03						
SB	TC4	2.50	3	3.04	0.34	7.25E-04						
SB	TC4	2.50	4	3.03	0.28	6.00E-04						
UN	TC4	3.25	1	3.02	0.15	3.22E-04	0.15	0.15	3.23E-04	3.23E-04	1.75E-06	
UN	TC4	3.25	2	3.04	0.15	3.20E-04						

**Table A.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
UN	TC5	0.60	1	3.01	21.12	4.55E-02	23.51	23.51	5.07E-02	5.07E-02	4.92E-03	
UN	TC5	0.60	2	3.01	25.65	5.53E-02						
UN	TC5	0.60	3	3.01	Dropped Sample	#VALUE!						
UN	TC5	0.60	4	3.01	23.77	5.12E-02						
UN	TC5	0.60	1	3.03	21.96	4.70E-02	18.30	18.30	3.94E-02	3.93E-02	4.63E-03	
UN	TC5	0.60	2	3.02	18.53	3.98E-02						
UN	TC5	0.60	3	3.02	17.58	3.78E-02						
UN	TC5	0.60	4	3.01	17.32	3.73E-02						
UN	TC5	0.60	1	3.00	16.12	3.49E-02						
SB	TC5	0.60	2	3.00	-1.77	-3.82E-03	-1.75	-1.75	-3.78E-03	-3.78E-03	4.89E-04	
SB	TC5	0.60	3	3.01	-1.97	-4.25E-03						
SB	TC5	0.60	4	3.01	-1.52	-3.27E-03						
UN	TC5	1.00	1	3.01	64.30	1.39E-01	61.98	61.98	1.34E-01	1.34E-01	5.03E-03	
UN	TC5	1.00	2	3.00	60.41	1.31E-01						
UN	TC5	1.00	3	3.00	59.51	1.29E-01						
UN	TC5	1.00	4	3.00	63.71	1.38E-01						
UN	TC5	1.00	1	3.03	95.20	2.04E-01	91.92	91.92	1.97E-01	1.97E-01	1.46E-02	
UN	TC5	1.00	2	3.03	96.75	2.07E-01						
UN	TC5	1.00	3	3.02	88.55	1.90E-01						
UN	TC5	1.00	4	3.03	97.10	2.08E-01						
UN	TC5	1.00	5	3.01	94.55	2.04E-01						
UN	TC5	1.00	6	3.02	79.35	1.70E-01						
SB	TC5	1.00	1	3.02	-1.13	-2.43E-03	-0.72	-0.72	-1.55E-03	-1.57E-03	1.70E-03	
SB	TC5	1.00	2	3.02	-1.64	-3.52E-03						
SB	TC5	1.00	3	2.85	-0.06	-1.37E-04						
SB	TC5	1.00	4	3.03	-0.06	-1.28E-04						
STD (30 ppb)			1	0.00	31.35	9.49E-01	31.35	31.35				
UN	TC5	1.75	1	3.03	28.95	6.19E-02	39.85	39.85	8.57E-02	8.58E-02	2.90E-02	
UN	TC5	1.75	2	3.04	52.69	1.13E-01						
UN	TC5	1.75	3	3.04	58.34	1.24E-01						
UN	TC5	1.75	4	3.03	47.85	1.02E-01						
SB	TC5	1.75	1	3.00	-1.64	-3.55E-03	-1.56	-1.56	-3.38E-03	-3.38E-03	2.88E-04	
SB	TC5	1.75	2	3.00	-1.45	-3.14E-03						
SB	TC5	1.75	3	3.00	-1.71	-3.70E-03						
SB	TC5	1.75	4	3.00	-1.45	-3.14E-03						
UN	TC5	2.50	1	3.02	1.70	3.65E-03	1.68	1.68	3.61E-03	3.61E-03	3.86E-04	
UN	TC5	2.50	2	3.02	1.70	3.65E-03						
UN	TC5	2.50	3	3.04	1.89	4.04E-03						
UN	TC5	2.50	4	3.02	1.44	3.10E-03						
UN	TC5	3.25	1	3.01	0.66	1.42E-03	0.63	0.63	1.36E-03	1.36E-03	7.42E-05	
UN	TC5	3.25	2	3.02	0.66	1.42E-03						
UN	TC5	3.25	3	3.02	0.60	1.29E-03						
UN	TC5	3.25	4	3.01	0.60	1.29E-03						
SPK #13	TC5	3.25	1	3.04	76.66	1.64E-01	75.07	75.07	1.61E-01	1.61E-01	2.22E-03	
SPK #13	TC5	3.25	2	3.01	74.54	1.61E-01						
SPK #13	TC5	3.25	3	3.02	73.80	1.58E-01						
SPK #13	TC5	3.25	4	3.02	75.27	1.62E-01						
SB	TC5	3.25	1	3.02	0.60	1.29E-03	0.70	0.70	1.49E-03	1.49E-03	4.25E-04	
SB	TC5	3.25	2	3.03	0.92	1.97E-03						
SB	TC5	3.25	3	3.02	0.79	1.70E-03						
SB	TC5	3.25	4	3.01	0.47	1.01E-03						
STD (12 ppb)			1	0.00	12.57	3.81E-01	12.57	12.57				
MB			1	0.00	0.15	3.89E-03	0.31	0.31	7.98E-03	7.98E-03	2.82E-03	
MB			2	0.00	0.34	8.82E-03						
MB			3	0.00	0.34	8.82E-03						
MB			4	0.00	0.40	1.04E-02						
UN	TC6	0.60	1	3.01	2.28	4.91E-03	2.53	1.54	5.44E-03	3.31E-03	4.66E-04	
UN	TC6	0.60	2	3.01	2.74	5.91E-03						
UN	TC6	0.60	3	3.01	2.41	5.20E-03						

**Table A.1** Continued

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
DUP	TC6	0.60	1	3.01	2.48	5.35E-03	3.34	3.34	7.21E-03	7.21E-03	3.07E-03	
DUP	TC6	0.60	2	3.00	2.61	5.64E-03						
DUP	TC6	0.60	3	3.00	2.80	6.05E-03						
DUP	TC6	0.60	4	3.00	5.45	1.18E-02						
SB	TC6	0.60	1	3.00	1.12	2.42E-03	0.99	0.99	2.14E-03	2.14E-03	2.57E-04	
SB	TC6	0.60	2	3.00	0.86	1.86E-03						
SB	TC6	0.60	3	3.00	1.05	2.27E-03						
SB	TC6	0.60	4	3.00	0.92	1.99E-03						
UN	TC6	1.00	1	3.01	6.65	1.43E-02	7.97	7.97	1.72E-02	1.72E-02	2.47E-03	
UN	TC6	1.00	2	3.00	7.40	1.60E-02						
UN	TC6	1.00	3	3.01	9.14	1.97E-02						
UN	TC6	1.00	4	3.01	8.69	1.87E-02						
SB	TC6	1.00	1	3.00	-1.26	-2.72E-03	-1.38	-1.38	-2.97E-03	-2.97E-03	1.50E-03	
SB	TC6	1.00	2	3.00	-0.44	-9.51E-04						
SB	TC6	1.00	3	3.00	-1.90	-4.11E-03						
SB	TC6	1.00	4	3.00	-1.90	-4.11E-03						
UN	TC6	1.75	1	3.03	5.52	1.18E-02	5.59	5.59	1.20E-02	1.20E-02	3.62E-04	
UN	TC6	1.75	2	3.01	5.78	1.25E-02						
UN	TC6	1.75	3	3.03	5.65	1.21E-02						
UN	TC6	1.75	4	3.00	5.39	1.17E-02						
UN	TC6	1.75	1	3.04	4.96	1.06E-02	5.61	5.61	1.20E-02	1.20E-02	1.68E-03	
UN	TC6	1.75	2	3.02	5.46	1.17E-02						
UN	TC6	1.75	3	3.03	6.73	1.44E-02						
UN	TC6	1.75	4	3.02	5.27	1.13E-02						
UN	TC6	1.75	5	3.04	2.86	6.11E-03						
UN	TC6	1.75	6	3.01	3.56	7.68E-03						
SB	TC6	1.75	1	3.00	-0.82	-1.77E-03	-0.73	-0.73	-1.58E-03	-1.58E-03	4.43E-04	
SB	TC6	1.75	2	3.02	-0.50	-1.08E-03						
SB	TC6	1.75	3	3.01	-0.88	-1.90E-03						
SB	TC6	1.75	4	3.00	-0.63	-1.36E-03						
UN	TC6	2.50	1	3.03	2.61	5.59E-03	3.37	3.37	7.23E-03	7.23E-03	2.88E-03	
UN	TC6	2.50	2	3.01	2.86	6.16E-03						
UN	TC6	2.50	3	3.01	2.61	5.63E-03						
UN	TC6	2.50	4	3.03	5.39	1.15E-02						
UN	TC6	2.50	1	3.02	-1.52	-3.27E-03	0.63	0.63	1.35E-03	1.35E-03	5.13E-03	
UN	TC6	2.50	2	3.02	2.48	5.33E-03						
UN	TC6	2.50	3	3.04	-0.06	-1.28E-04						
UN	TC6	2.50	4	3.03	-1.20	-2.57E-03						
UN	TC6	2.50	5	3.01	-0.50	-1.08E-03						
UN	TC6	2.50	6	3.03	4.57	9.78E-03						
SB	TC6	2.50	1	3.03	-1.96	-4.20E-03	-2.02	-2.02	-4.35E-03	-4.35E-03	1.39E-04	
SB	TC6	2.50	2	3.03	-2.09	-4.47E-03						
SB	TC6	2.50	3	3.00	-2.02	-4.37E-03						
SB	TC6	2.50	4	3.02	-1.96	-4.22E-03						
STD (145ppb)			6	0.00	148.64	4.50E+00	148.64	148.64				
UN	TC7	0.60	1	3.01	122.29	2.64E-01	109.97	109.97	2.37E-01	2.37E-01	3.16E-02	
UN	TC7	0.60	2	3.02	104.97	2.26E-01						
UN	TC7	0.60	3	3.01	120.75	2.61E-01						
UN	TC7	0.60	4	3.03	91.86	1.97E-01						
UN	TC7	0.60	1	3.02	82.80	1.78E-01	98.73	97.64	2.12E-01	2.09E-01	2.67E-02	
UN	TC7	0.60	2	3.04	110.40	2.36E-01						
UN	TC7	0.60	3	3.03	96.15	2.06E-01						
UN	TC7	0.60	4	3.03	87.25	1.87E-01						
UN	TC7	0.60	5	3.00	113.25	2.45E-01						
UN	TC7	0.60	6	3.03	102.50	2.20E-01						
SB	TC7	0.60	1	3.01	1.02	2.20E-03	1.09	1.09	2.34E-03	2.34E-03	4.91E-04	
SB	TC7	0.60	2	3.02	1.34	2.88E-03						
SB	TC7	0.60	3	3.03	0.90	1.93E-03						
MB			1	0.00	0.60	1.56E-02	0.65	0.65	1.67E-02	1.67E-02	7.78E-04	
MB			2	0.00	0.66	1.71E-02						
MB			3	0.00	0.66	1.71E-02						

**Table A.1** Continued

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
UN	TC7	1.00	1	3.01	404.45	8.71E-01	383.79	369.90	8.25E-01	7.95E-01	3.11E-02	
UN	TC7	1.00	2	3.02	379.35	8.15E-01						
UN	TC7	1.00	3	3.02	378.35	8.12E-01						
UN	TC7	1.00	4	3.01	373.00	8.03E-01						
DUP	TC7	1.00	1	3.00	408.15	8.82E-01	402.45	388.57	8.66E-01	8.36E-01	1.42E-02	
DUP	TC7	1.00	2	3.01	399.10	8.59E-01						
DUP	TC7	1.00	3	3.04	408.15	8.72E-01						
DUP	TC7	1.00	4	3.01	394.40	8.50E-01						
SB	TC7	1.00	1	3.01	11.09	2.39E-02	13.89	13.89	2.98E-02	2.98E-02	8.14E-03	
SB	TC7	1.00	2	3.02	10.11	2.17E-02						
SB	TC7	1.00	3	3.02	17.43	3.75E-02						
SB	TC7	1.00	4	3.04	16.91	3.60E-02						
UN	TC7	1.75	1	3.01	321.15	6.92E-01	292.91	292.91	6.30E-01	6.30E-01	6.25E-02	
UN	TC7	1.75	2	3.02	295.25	6.35E-01						
UN	TC7	1.75	3	3.02	302.40	6.49E-01						
UN	TC7	1.75	4	3.02	252.85	5.44E-01						
UN	TC7	1.75	1	3.01	245.20	5.28E-01	266.68	263.35	5.74E-01	5.67E-01	6.28E-02	
UN	TC7	1.75	2	3.01	269.65	5.81E-01						
UN	TC7	1.75	3	3.01	250.60	5.41E-01						
UN	TC7	1.75	4	3.03	234.10	5.01E-01						
UN	TC7	1.75	5	3.00	293.75	6.34E-01						
UN	TC7	1.75	6	3.01	306.75	6.60E-01						
SB	TC7	1.75	1	3.02	3.24	6.96E-03	3.32	3.32	7.15E-03	7.14E-03	1.40E-03	
SB	TC7	1.75	2	3.01	4.00	8.63E-03						
SB	TC7	1.75	3	3.02	2.73	5.86E-03						
SB	TC7	1.75	4	3.02	3.43	7.37E-03						
STD (85 ppb)			7	0.00	82.23	2.49E+00	82.23	82.23				
UN	TC7	2.50	1	3.00	1.12	2.42E-03	1.05	1.05	2.26E-03	2.26E-03	2.54E-04	
UN	TC7	2.50	2	3.03	0.92	1.97E-03						
UN	TC7	2.50	3	3.02	0.99	2.13E-03						
UN	TC7	2.50	4	3.04	1.18	2.52E-03						
UN	TC7	3.25	1	3.02	0.60	1.29E-03	0.60	0.60	1.29E-03	1.29E-03	3.36E-06	
UN	TC7	3.25	2	3.03	0.60	1.29E-03						
UN	TC7	3.25	3	3.03	0.60	1.29E-03						
UN	TC7	3.25	4	3.01	0.60	1.29E-03						

**Table A.2** Raw data for exo 1,4- $\beta$ -glucanase activity in 2005

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)					
UN	TC1	0.6	1	3.03	-0.74	-1.58E-03	-0.69	-0.69	-1.47E-03	-1.47E-03	1.48E-04
UN	TC1	0.6	2	3.04	-0.67	-1.43E-03					
UN	TC1	0.6	3	3.00	-0.74	-1.60E-03					
UN	TC1	0.6	4	3.03	-0.60	-1.28E-03					
UN	TC1	1	1	3.00	-1.01	-2.18E-03	-0.88	-0.88	-1.89E-03	-1.89E-03	2.04E-04
UN	TC1	1	2	3.02	-0.88	-1.89E-03					
UN	TC1	1	3	3.00	-0.81	-1.75E-03					
UN	TC1	1	4	3.00	-0.81	-1.75E-03					
UN	TC1	1.75	1	3.03	-1.15	-2.46E-03	-1.24	-1.24	-2.65E-03	-2.65E-03	1.84E-04
UN	TC1	1.75	2	3.04	-1.22	-2.60E-03					
UN	TC1	1.75	3	3.01	-1.22	-2.63E-03					
UN	TC1	1.75	4	3.04	-1.36	-2.90E-03					
UN	TC1	2.5	1	3.01	-1.08	-2.32E-03	-1.06	-1.06	-2.28E-03	-2.28E-03	7.92E-05
UN	TC1	2.5	2	3.01	-1.08	-2.33E-03					
UN	TC1	2.5	3	3.03	-1.01	-2.17E-03					
UN	TC1	2.5	4	3.02	-1.08	-2.32E-03					
SPK #9	TC1	2.5	1	3.02	1.46	3.13E-03	1.63	1.63	3.49E-03	3.49E-03	2.46E-04
SPK #9	TC1	2.5	2	3.03	1.73	3.70E-03					
SPK #9	TC1	2.5	3	3.02	1.66	3.57E-03					
SPK #9	TC1	2.5	4	3.03	1.66	3.56E-03					
SB	TC1	2.5	1	3.02	-1.15	-2.47E-03	-1.12	-1.12	-2.39E-03	-2.39E-03	9.13E-05
SB	TC1	2.5	2	3.03	-1.08	-2.31E-03					
SB	TC1	2.5	3	3.02	-1.15	-2.47E-03					
SB	TC1	2.5	4	3.04	-1.08	-2.31E-03					
STD (2 ppb)			1		1.87	5.66E-02	1.87	1.87			
UN	TC1	3.25	1	3.02	-1.29	-2.78E-03	-1.26	-1.26	-2.70E-03	-2.70E-03	9.53E-05
UN	TC1	3.25	2	3.03	-1.22	-2.61E-03					
UN	TC1	3.25	3	3.01	-1.29	-2.78E-03					
UN	TC1	3.25	4	3.03	-1.22	-2.62E-03					
UN	TC2	0.6	1	3.04	-1.08	-2.31E-03	-1.10	-1.10	-2.35E-03	-2.35E-03	7.53E-05
UN	TC2	0.6	2	3.04	-1.08	-2.31E-03					
UN	TC2	0.6	3	3.03	-1.08	-2.31E-03					
UN	TC2	0.6	4	3.03	-1.15	-2.46E-03					
UN	TC2	1	1	3.01	-1.22	-2.63E-03	-1.13	-1.13	-2.44E-03	-2.44E-03	2.30E-04
UN	TC2	1	2	3.01	-1.22	-2.63E-03					
UN	TC2	1	3	3.00	-1.08	-2.33E-03					
UN	TC2	1	4	3.03	-1.01	-2.16E-03					
MB			1	0.00	-0.94	-2.44E-02	-0.88	-0.88	-2.27E-02	-2.27E-02	2.45E-03
MB			2	0.00	-0.94	-2.44E-02					
MB			3	0.00	-0.88	-2.28E-02					
MB			4	0.00	-0.74	-1.92E-02					
UN	TC2	1.75	1	3.01	-0.33	-7.12E-04	-0.42	-0.42	-8.95E-04	-8.95E-04	2.77E-04
UN	TC2	1.75	2	3.00	-0.33	-7.13E-04					
UN	TC2	1.75	3	3.00	-0.60	-1.30E-03					
UN	TC2	1.75	4	3.02	-0.40	-8.59E-04					
STD (12 ppb)			2		12.77	3.87E-01	12.77	12.77			
UN	TC2	2.5	1	3.00	-0.67	-1.45E-03	-0.64	-0.64	-1.37E-03	-1.37E-03	1.52E-04
UN	TC2	2.5	2	3.02	-0.53	-1.14E-03					
UN	TC2	2.5	3	3.03	-0.67	-1.44E-03					
UN	TC2	2.5	4	3.01	-0.67	-1.45E-03					
UN	TC2	3.25	1	3.02	-0.74	-1.59E-03	-0.69	-0.69	-1.48E-03	-1.48E-03	1.44E-04
UN	TC2	3.25	2	3.02	-0.67	-1.44E-03					
UN	TC2	3.25	3	3.01	-0.60	-1.29E-03					

**Table A.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
DUP	TC2	3.25	1	3.00	-1.08	-2.33E-03	-0.96	-0.96	-2.07E-03	-2.07E-03	1.87E-04	
DUP	TC2	3.25	2	3.02	-0.94	-2.02E-03						
DUP	TC2	3.25	3	3.01	-0.88	-1.90E-03						
DUP	TC2	3.25	4	3.01	-0.94	-2.03E-03						
SB	TC2	3.25	1	3.02	-0.81	-1.74E-03	-0.76	-0.76	-1.63E-03	-1.63E-03	8.53E-05	
SB	TC2	3.25	2	3.01	-0.74	-1.59E-03						
SB	TC2	3.25	3	3.02	-0.74	-1.59E-03						
SB	TC2	3.25	4	3.02	-0.74	-1.59E-03						
UN	TC3	0.6	1	3.02	-1.08	-2.32E-03	-0.96	-0.96	-2.06E-03	-2.06E-03	2.52E-04	
UN	TC3	0.6	2	3.02	-1.01	-2.17E-03						
UN	TC3	0.6	3	3.04	-0.81	-1.73E-03						
UN	TC3	0.6	4	3.02	-0.94	-2.02E-03						
UN	TC3	1	1	3.00	0.22	4.75E-04	0.29	0.29	6.26E-04	6.26E-04	1.23E-04	
UN	TC3	1	2	3.01	0.36	7.76E-04						
UN	TC3	1	3	3.00	0.29	6.27E-04						
UN	TC3	1	4	3.01	0.29	6.25E-04						
UN	TC3	1.75	1	3.04	0.22	4.69E-04	0.29	0.29	6.21E-04	6.21E-04	3.87E-04	
UN	TC3	1.75	2	3.04	0.50	1.07E-03						
UN	TC3	1.75	3	3.01	0.36	7.75E-04						
UN	TC3	1.75	4	3.01	0.08	1.73E-04						
UN	TC3	2.5	1	3.03	-0.40	-8.57E-04	-0.43	-0.43	-9.24E-04	-9.24E-04	7.33E-05	
UN	TC3	2.5	2	3.00	-0.40	-8.64E-04						
UN	TC3	2.5	3	3.03	-0.46	-9.86E-04						
UN	TC3	2.5	4	3.02	-0.46	-9.88E-04						
UN	TC3	3.25	1	3.01	-0.33	-7.10E-04	-0.16	-0.16	-3.34E-04	-3.34E-04	3.13E-04	
UN	TC3	3.25	2	3.03	0.02	4.29E-05						
UN	TC3	3.25	3	3.01	-0.12	-2.59E-04						
UN	TC3	3.25	4	3.02	-0.19	-4.08E-04						
SPK #8	TC3	3.25	1	3.01	12.02	2.59E-02	12.24	12.24	2.64E-02	2.64E-02	5.13E-04	
SPK #8	TC3	3.25	2	3.01	12.36	2.66E-02						
SPK #8	TC3	3.25	3	3.00	12.50	2.70E-02						
SPK #8	TC3	3.25	4	3.02	12.09	2.60E-02						
SB	TC3	3.25	1	3.01	-0.40	-8.62E-04	-0.43	-0.43	-9.23E-04	-9.23E-04	7.08E-05	
SB	TC3	3.25	2	3.04	-0.46	-9.83E-04						
SB	TC3	3.25	3	3.03	-0.40	-8.58E-04						
SB	TC3	3.25	4	3.02	-0.46	-9.88E-04						
STD (21 ppb)					23.26	7.04E-01	23.26	23.26				
UN	TC4	0.6	1	3.01	-0.19	-4.10E-04	-0.07	-0.07	-1.46E-04	-1.46E-04	1.90E-04	
UN	TC4	0.6	2	3.00	-0.05	-1.08E-04						
UN	TC4	0.6	3	3.02	0.02	4.29E-05						
UN	TC4	0.6	4	3.01	-0.05	-1.08E-04						
UN	TC4	1	1	3.01	2.48	5.34E-03	2.35	2.35	5.06E-03	5.06E-03	5.37E-04	
UN	TC4	1	2	3.01	2.62	5.65E-03						
UN	TC4	1	3	3.01	2.21	4.77E-03						
UN	TC4	1	4	3.01	2.07	4.47E-03						
SB	TC4	1	1	3.00	-1.08	-2.34E-03	-1.13	-1.13	-2.44E-03	-2.44E-03	2.60E-04	
SB	TC4	1	2	3.00	-1.19	-2.57E-03						
SB	TC4	1	3	3.00	-1.32	-2.85E-03						
SB	TC4	1	4	3.00	-0.93	-2.01E-03						
MB			1	0.00	-0.33	-8.56E-03	-0.41	-0.41	-1.07E-02	-1.07E-02	1.60E-03	
MB			2	0.00	-0.40	-1.04E-02						
MB			3	0.00	-0.46	-1.19E-02						
MB			4	0.00	-0.46	-1.19E-02						

**Table A.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC4	1.75	1	3.03	1.94	4.16E-03	1.48	1.48	3.16E-03	3.16E-03	6.74E-04	
UN	TC4	1.75	2	3.02	1.39	2.99E-03						
UN	TC4	1.75	3	3.03	1.25	2.68E-03						
UN	TC4	1.75	4	3.02	1.32	2.84E-03						
SB	TC4	1.75	1	3.00	-1.08	-2.34E-03	-1.13	-1.13	-2.44E-03	-2.44E-03	2.60E-04	
SB	TC4	1.75	2	3.00	-1.19	-2.57E-03						
SB	TC4	1.75	3	3.00	-1.32	-2.85E-03						
SB	TC4	1.75	4	3.00	-0.93	-2.01E-03						
UN	TC4	2.5	1	3.01	-0.60	-1.29E-03	-0.58	-0.58	-1.26E-03	-1.26E-03	1.47E-04	
UN	TC4	2.5	2	3.01	-0.53	-1.14E-03						
UN	TC4	2.5	3	3.02	-0.53	-1.14E-03						
UN	TC4	2.5	4	3.00	-0.67	-1.45E-03						
STD (21 ppb)						23.26	7.04E-01	23.26	23.26			
UN	TC4	3.25	1	3.03	-0.81	-1.73E-03	-0.74	-0.74	-1.59E-03	-1.59E-03	2.13E-04	
UN	TC4	3.25	2	3.01	-0.81	-1.75E-03						
UN	TC4	3.25	3	3.02	-0.60	-1.29E-03						
UN	TC4	3.25	4	3.00	-0.74	-1.60E-03						
DUP	TC4	3.25	1	3.03	-0.74	-1.59E-03	-0.65	-0.65	-1.40E-03	-1.40E-03	3.34E-04	
DUP	TC4	3.25	2	3.01	-0.46	-9.91E-04						
DUP	TC4	3.25	3	3.01	-0.81	-1.75E-03						
DUP	TC4	3.25	4	3.02	-0.60	-1.29E-03						
SB	TC4	3.25	1	3.01	-0.74	-1.60E-03	-0.67	-0.67	-1.44E-03	-1.44E-03	9.01E-05	
SB	TC4	3.25	2	3.03	-0.74	-1.59E-03						
SB	TC4	3.25	3	3.03	-0.67	-1.44E-03						
SB	TC4	3.25	4	3.01	-0.53	-1.14E-03						
UN	TC5	0.6	1	3.02	1.94	4.17E-03	1.63	1.23	3.15E-03	2.62E-03	1.16E-03	
UN	TC5	0.6	2	3.05	0.84	1.79E-03						
UN	TC5	0.6	3	3.04	1.04	2.22E-03						
UN	TC5	0.6	4	3.04	2.07	4.42E-03						
UN	TC5	0.6	5	3.01	1.94	4.18E-03						
UN	TC5	0.6	6	3.04	1.94	4.14E-03						
SB	TC5	0.6	1	3.02	0.22	4.73E-04	0.40	0.40	8.61E-04	8.61E-04	5.50E-04	
SB	TC5	0.6	2	3.05	0.70	1.49E-03						
SB	TC5	0.6	3	3.04	0.29	6.19E-04						
UN	TC5	1	1	3.03	6.26	1.34E-02	6.24	5.37	1.37E-02	1.15E-02	3.45E-03	
UN	TC5	1	2	3.02	5.02	1.08E-02						
UN	TC5	1	3	3.03	9.21	1.97E-02						
UN	TC5	1	4	3.01	5.09	1.10E-02						
UN	TC5	1	5	3.04	5.16	1.10E-02						
UN	TC5	1	6	3.01	6.67	1.44E-02						
SB	TC5	1	1	3.02	0.50	1.07E-03	0.86	0.86	1.84E-03	1.84E-03	8.85E-04	
SB	TC5	1	2	3.05	1.32	2.81E-03						
SB	TC5	1	3	3.04	0.77	1.64E-03						
STD (30 ppb)						33.07	1.00E+00					
UN	TC5	1.75	1	3.05	1.73	3.68E-03	2.02	1.51	4.31E-03	3.23E-03	6.54E-04	
UN	TC5	1.75	2	3.04	1.80	3.84E-03						
UN	TC5	1.75	3	3.05	2.21	4.70E-03						
UN	TC5	1.75	4	3.03	2.35	5.03E-03						
SPK #7	TC5	1.75	1	3.05	23.74	5.06E-02	22.68	22.68	4.86E-02	4.86E-02	1.68E-03	
SPK #7	TC5	1.75	2	3.01	22.44	4.83E-02						
SPK #7	TC5	1.75	3	3.03	22.92	4.91E-02						
SPK #7	TC5	1.75	4	3.02	21.62	4.65E-02						
SB	TC5	1.75	1	3.03	0.56	1.20E-03	0.51	0.51	1.10E-03	1.10E-03	6.15E-04	

**Table A.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
UN	TC5	2.5	1	3.01	0.36	7.77E-04		0.41	0.41	8.85E-04	8.85E-04	1.42E-04
UN	TC5	2.5	2	3.02	0.50	1.07E-03						
UN	TC5	2.5	3	3.05	0.43	9.15E-04						
UN	TC5	2.5	4	3.02	0.36	7.75E-04						
UN	TC5	3.25	1	3.01	0.08	1.73E-04		0.07	0.07	1.40E-04	1.40E-04	6.45E-05
UN	TC5	3.25	2	3.01	0.08	1.72E-04						
UN	TC5	3.25	3	3.01	0.02	4.32E-05						
UN	TC5	3.25	4	3.02	0.08	1.72E-04						
STD (30 ppb)			5			32.87		32.87	32.87			
MB			1	0.00	-0.05	-1.30E-03		0.05	0.05	1.30E-03	1.30E-03	2.21E-03
MB			2	0.00	0.08	2.08E-03						
MB			3	0.00	0.02	5.19E-04						
MB			4	0.00	0.15	3.89E-03						
UN	TC6	0.6	1	3.02	0.22	4.73E-04		0.17	0.17	3.63E-04	3.63E-04	2.14E-04
UN	TC6	0.6	2	3.05	0.22	4.68E-04						
UN	TC6	0.6	3	3.04	0.22	4.69E-04						
UN	TC6	0.6	4	3.04	0.02	4.27E-05						
UN	TC6	1	1	3.00	0.36	7.78E-04		0.40	0.40	8.49E-04	8.49E-04	1.47E-04
UN	TC6	1	2	3.01	0.36	7.76E-04						
UN	TC6	1	3	3.03	0.36	7.72E-04						
UN	TC6	1	4	3.03	0.50	1.07E-03						
SB	TC6	1	1	3.00	0.02	4.32E-05		0.02	0.02	4.32E-05	4.32E-05	2.98E-07
SB	TC6	1	2	3.03	0.02	4.28E-05						
SB	TC6	1	3	2.99	0.02	4.34E-05						
UN	TC6	1.75	1	3.01	0.98	2.12E-03		1.05	0.79	2.25E-03	1.70E-03	4.91E-04
UN	TC6	1.75	2	3.02	1.11	2.39E-03						
UN	TC6	1.75	3	3.02	0.77	1.66E-03						
UN	TC6	1.75	4	3.03	1.32	2.83E-03						
DUP	TC6	1.75	1	3.02	0.63	1.35E-03		0.84	0.84	1.81E-03	1.81E-03	3.23E-04
DUP	TC6	1.75	2	3.00	0.91	1.97E-03						
DUP	TC6	1.75	3	3.04	0.98	2.09E-03						
DUP	TC6	1.75	4	3.00	0.84	1.81E-03						
SB	TC6	1.75	1	3.02	0.22	4.72E-04		0.26	0.26	5.47E-04	5.47E-04	2.30E-04
SB	TC6	1.75	2	3.04	0.15	3.21E-04						
SB	TC6	1.75	3	3.02	0.36	7.72E-04						
SB	TC6	1.75	4	3.01	0.29	6.24E-04						
UN	TC6	2.5	1	3.01	0.08	1.73E-04		0.08	0.08	1.78E-04	1.78E-04	1.15E-04
UN	TC6	2.5	2	3.00	0.15	3.24E-04						
UN	TC6	2.5	3	3.03	0.08	1.71E-04						
UN	TC6	2.5	4	3.01	0.02	4.31E-05						
STD (12 ppb)			6	0.00	13.05	3.95E-01		13.05	13.05			
UN	TC7	0.6	1	3.03	34.24	7.33E-02		31.72	28.21	6.81E-02	6.06E-02	1.02E-02
UN	TC7	0.6	2	3.02	36.43	7.83E-02						
UN	TC7	0.6	3	3.02	30.88	6.63E-02						
UN	TC7	0.6	4	3.00	25.32	5.47E-02						
SPK #6	TC7	0.6	1	3.01	49.94	1.08E-01		52.62	52.62	1.13E-01	1.13E-01	8.43E-03
SPK #6	TC7	0.6	2	3.01	58.38	1.26E-01						
SPK #6	TC7	0.6	3	3.01	51.59	1.11E-01						
SPK #6	TC7	0.6	4	3.01	50.56	1.09E-01						
SB	TC7	0.6	1	3.02	3.51	7.55E-03		3.51	3.51	7.54E-03	7.54E-03	6.18E-04
SB	TC7	0.6	2	3.01	3.99	8.61E-03						
SB	TC7	0.6	3	3.03	3.51	7.52E-03						
SB	TC7	0.6	4	3.03	3.03	6.48E-03						



**Table A.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
UN	TC7	1	1	3.01	48.65	1.05E-01	61.05	46.83	1.32E-01	1.01E-01	1.39E-02
UN	TC7	1	2	3.01	61.83	1.33E-01					
UN	TC7	1	3	3.01	61.71	1.33E-01					
UN	TC7	1	4	3.01	67.11	1.45E-01					
UN	TC7	1	5	3.01	62.59	1.35E-01					
UN	TC7	1	6	3.01	64.41	1.39E-01					
SB	TC7	1	1	3.00	12.73	2.75E-02	14.22	14.22	3.07E-02	3.07E-02	2.35E-03
SB	TC7	1	2	3.00	14.61	3.16E-02					
SB	TC7	1	3	3.00	14.61	3.16E-02					
SB	TC7	1	4	3.00	14.93	3.23E-02					
UN	TC7	1.75	1	3.01	18.25	3.93E-02	20.54	18.17	4.43E-02	3.92E-02	3.36E-03
UN	TC7	1.75	2	3.01	19.64	4.23E-02					
UN	TC7	1.75	3	3.01	20.89	4.51E-02					
UN	TC7	1.75	4	3.01	22.27	4.80E-02					
UN	TC7	1.75	5	3.01	22.15	4.78E-02					
UN	TC7	1.75	6	3.01	20.01	4.32E-02					
SB	TC7	1.75	1	3.00	2.24	4.84E-03	2.37	2.37	5.12E-03	5.12E-03	7.11E-04
SB	TC7	1.75	2	3.00	2.12	4.58E-03					
SB	TC7	1.75	3	3.00	2.74	5.93E-03					
SB	TC7	1.75	4	3.00	2.37	5.12E-03					
STD (12 ppb)			7		13.25	4.01E-01	13.25	13.25			
UN	TC7	2.5	1	3.01	-0.05	-1.08E-04	0.02	0.02	3.77E-05	3.77E-05	1.15E-04
UN	TC7	2.5	2	3.02	0.02	4.29E-05					
UN	TC7	2.5	3	3.01	0.08	1.72E-04					
UN	TC7	2.5	4	3.02	0.02	4.30E-05					
UN	TC7	3.25	1	3.01	-0.26	-5.61E-04	-0.30	-0.30	-6.36E-04	-6.36E-04	8.64E-05
UN	TC7	3.25	2	3.01	-0.33	-7.11E-04					
UN	TC7	3.25	3	3.01	-0.26	-5.61E-04					
UN	TC7	3.25	4	3.01	-0.33	-7.11E-04					

**Table A.3** Raw data for endo 1,4- $\beta$ -glucanase activity in 2005

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
UN	TC1	0.6	1	3.02	-2.02	-8.68E-03		-1.95	-1.95	-8.38E-03	-8.38E-03	5.29E-04
UN	TC1	0.6	2	3.02	-2.08	-8.94E-03						
UN	TC1	0.6	3	3.04	-1.82	-7.77E-03						
UN	TC1	0.6	4	3.02	-1.89	-8.12E-03						
UN	TC1	1	1	3.03	-1.95	-8.35E-03	-2.00	-2.00	-8.60E-03	-8.60E-03	1.70E-04	
UN	TC1	1	2	3.02	-2.02	-8.68E-03						
UN	TC1	1	3	3.02	-2.02	-8.68E-03						
UN	TC1	1	4	3.01	-2.02	-8.71E-03						
UN	TC1	1.75	1	3.01	-2.08	-8.97E-03	-1.99	-1.99	-8.54E-03	-8.54E-03	3.54E-04	
UN	TC1	1.75	2	3.02	-1.89	-8.12E-03						
UN	TC1	1.75	3	3.04	-2.02	-8.62E-03						
UN	TC1	1.75	4	3	-1.95	-8.43E-03						
UN	TC1	2.5	1	3.008	-1.58	-6.82E-03	-1.60	-1.60	-6.85E-03	-6.85E-03	1.27E-04	
UN	TC1	2.5	2	3.03	-1.62	-6.94E-03						
UN	TC1	2.5	3	3.018	-1.62	-6.96E-03						
UN	TC1	2.5	4	3.027	-1.56	-6.69E-03						
STD												
(39 ppb)			1	0	38.04	5.76E-01	38.04	38.04				
UN	TC1	3.25	1	3.012	-1.69	-7.28E-03	-1.71	-1.71	-7.34E-03	-7.34E-03	1.01E-04	
UN	TC1	3.25	2	3.01	-1.69	-7.28E-03						
UN	TC1	3.25	3	3.031	-1.75	-7.49E-03						
UN	TC1	3.25	4	3.002	-1.69	-7.30E-03						
SPK #5	TC1	3.25	1	3.003	34.81	1.50E-01	34.22	34.22	1.47E-01	1.47E-01	3.21E-03	
SPK #5	TC1	3.25	2	3.03	34.81	1.49E-01						
SPK #5	TC1	3.25	3	3.009	33.69	1.45E-01						
SPK #5	TC1	3.25	4	3.033	33.55	1.44E-01						
SB	TC1	3.25	1	3.029	-1.82	-7.80E-03	-1.84	-1.84	-7.90E-03	-7.90E-03	2.81E-04	
SB	TC1	3.25	2	3.006	-1.75	-7.55E-03						
SB	TC1	3.25	3	3.014	-1.89	-8.14E-03						
SB	TC1	3.25	4	3.018	-1.89	-8.13E-03						
MB			1		-0.83	-1.08E-02	-0.80	-0.80	-1.03E-02	-1.03E-02	2.12E-03	
MB			2		-0.57	-7.40E-03						
MB			3		-0.83	-1.08E-02						
MB			4		-0.96	-1.25E-02						
UN	TC2	0.6	1	3.031	-1.82	-7.79E-03	-1.97	-1.97	-8.46E-03	-8.46E-03	6.03E-04	
UN	TC2	0.6	2	3.03	-2.02	-8.65E-03						
UN	TC2	0.6	3	3.014	-2.08	-8.95E-03						
UN	TC2	1	1	3.032	-2.35	-1.01E-02	-2.29	-2.29	-9.83E-03	-9.83E-03	3.18E-04	
UN	TC2	1	2	3.004	-2.22	-9.59E-03						
UN	TC2	1	3	3.003	-2.35	-1.02E-02						
UN	TC2	1	4	3.022	-2.22	-9.53E-03						
UN	TC2	1.75	1	3.034	-2.02	-8.64E-03	-2.14	-2.14	-9.17E-03	-9.17E-03	3.75E-04	
UN	TC2	1.75	2	3.011	-2.15	-9.26E-03						
UN	TC2	1.75	3	3.018	-2.15	-9.24E-03						
UN	TC2	1.75	4	3.024	-2.22	-9.52E-03						
STD												
(0 ppb)			1	0	-1.42	-2.15E-02	-1.42	-1.42				
UN	TC2	2.5	1	3.009	-2.15	-9.27E-03	-2.20	-2.20	-9.49E-03	-9.49E-03	1.45E-04	
UN	TC2	2.5	2	3.02	-2.22	-9.54E-03						
UN	TC2	2.5	3	3.009	-2.22	-9.57E-03						
UN	TC2	2.5	4	3.011	-2.22	-9.57E-03						
DUP	TC2	2.5	1	3.028	-1.89	-8.10E-03	-1.84	-1.84	-7.89E-03	-7.89E-03	1.40E-04	
DUP	TC2	2.5	2	3.017	-1.82	-7.83E-03						
DUP	TC2	2.5	3	3.009	-1.82	-7.85E-03						
DUP	TC2	2.5	4	3.031	-1.82	-7.79E-03						
SB	TC2	2.5	1	3.02	-2.02	-8.68E-03	-1.94	-1.94	-8.31E-03	-8.31E-03	2.75E-04	
SB	TC2	2.5	2	3.03	-1.89	-8.09E-03						
SB	TC2	2.5	3	3.031	-1.95	-8.35E-03						
SB	TC2	2.5	4	3.026	-1.89	-8.10E-03						
UN	TC2	3.25	1	3.021	-1.89	-8.12E-03	-1.87	-1.87	-7.98E-03	-7.98E-03	1.87E-04	
UN	TC2	3.25	2	3.019	-1.89	-8.12E-03						
UN	TC2	3.25	3	3.029	-1.82	-7.80E-03						

**Table A.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC3	0.6	1	3.03	-1.16	-4.97E-03	-1.16	-1.16	-4.97E-03	-4.97E-03	1.00E-05	
UN	TC3	0.6	2	3.034	-1.16	-4.96E-03						
UN	TC3	0.6	3	3.022	-1.16	-4.98E-03						
UN	TC3	0.6	4	3.023	-1.16	-4.98E-03						
UN	TC3	1	1	3.036	-0.3	-1.28E-03	-0.35	-0.35	-1.50E-03	-1.50E-03	2.71E-04	
UN	TC3	1	2	3.012	-0.43	-1.85E-03						
UN	TC3	1	3	3.03	-0.37	-1.58E-03						
UN	TC3	1	4	3.006	-0.3	-1.29E-03						
UN	TC3	1.75	1	3.036	-0.57	-2.44E-03	-0.75	-0.75	-3.20E-03	-3.20E-03	6.97E-04	
UN	TC3	1.75	2	3.024	-0.7	-3.00E-03						
UN	TC3	1.75	3	3.02	-0.76	-3.27E-03						
UN	TC3	1.75	4	3.03	-0.96	-4.11E-03						
SB	TC3	1.75	1	3.036	-1.23	-5.26E-03	-1.08	-1.08	-4.62E-03	-4.62E-03	9.18E-04	
SB	TC3	1.75	2	3.024	-1.16	-4.98E-03						
SB	TC3	1.75	3	3.02	-1.16	-4.98E-03						
SB	TC3	1.75	4	3.03	-0.76	-3.25E-03						
UN	TC3	2.5	1	3.004	-1.36	-5.87E-03	-1.39	-1.39	-5.99E-03	-5.99E-03	1.50E-04	
UN	TC3	2.5	2	3.006	-1.42	-6.13E-03						
UN	TC3	2.5	3	3.012	-1.42	-6.12E-03						
UN	TC3	2.5	4	3.014	-1.36	-5.85E-03						
SPK												
Blank	TC3	2.5	1	3.011	-1.16	-5.00E-03	-1.28	-1.28	-5.48E-03	-5.48E-03	3.49E-04	
SPK												
Blank	TC3	2.5	2	3.023	-1.36	-5.84E-03						
SPK												
Blank	TC3	2.5	3	3.011	-1.29	-5.56E-03						
SPK												
Blank	TC3	2.5	4	3.039	-1.29	-5.51E-03						
SB	TC3	2.5	1	3.008	-1.75	-7.55E-03	-1.74	-1.74	-7.46E-03	-7.46E-03	3.57E-04	
SB	TC3	2.5	2	3.01	-1.62	-6.98E-03						
SB	TC3	2.5	3	3.034	-1.75	-7.48E-03						
SB	TC3	2.5	4	3.011	-1.82	-7.84E-03						
MB			1	0	-0.5	-6.49E-03	-0.57	-0.57	-7.36E-03	-7.36E-03	6.90E-04	
MB			2	0	-0.63	-8.17E-03						
MB			3	0	-0.57	-7.40E-03						
MB			4	0	-0.57	-7.40E-03						
UN	TC3	3.25	1	3.017	-0.7	-3.01E-03	-0.67	-0.67	-2.86E-03	-2.86E-03	6.04E-04	
UN	TC3	3.25	2	3.036	-0.5	-2.14E-03						
UN	TC3	3.25	3	3.028	-0.63	-2.70E-03						
UN	TC3	3.25	4	3.006	-0.83	-3.58E-03						
UN	TC4	0.6	1	3.021	-1.23	-5.28E-03	-1.20	-1.20	-5.17E-03	-5.17E-03	5.32E-04	
UN	TC4	0.6	2	3.003	-1.32	-5.70E-03						
UN	TC4	0.6	3	3.024	-1.23	-5.28E-03						
UN	TC4	0.6	4	3.013	-1.03	-4.44E-03						
UN	TC4	1	1	3.019	0.88	3.78E-03	0.86	0.59	3.71E-03	2.53E-03	5.77E-04	
UN	TC4	1	2	3.019	1.02	4.38E-03						
UN	TC4	1	3	3.01	0.69	2.97E-03						
UN	TC4	1	4	3.002	0.86	3.72E-03						
DUP	TC4	1	1	3.006	1.08	4.66E-03	1.02	1.02	4.37E-03	4.37E-03	3.30E-04	
DUP	TC4	1	2	3.022	0.95	4.08E-03						
DUP	TC4	1	3	3.009	0.95	4.10E-03						
DUP	TC4	1	4	3.009	1.08	4.66E-03						
SB	TC4	1	1	3.013	0.29	1.25E-03	0.28	0.28	1.18E-03	1.18E-03	7.35E-04	
SB	TC4	1	2	3.027	0.42	1.80E-03						
SB	TC4	1	3	3.011	0.03	1.29E-04						
SB	TC4	1	4	3.036	0.36	1.54E-03						
UN	TC4	1.75	1	3.009	-1.42	-6.12E-03	-1.23	-1.23	-5.27E-03	-5.27E-03	6.20E-04	
UN	TC4	1.75	2	3.008	-1.23	-5.31E-03						
UN	TC4	1.75	3	3.031	-1.16	-4.97E-03						
UN	TC4	1.75	4	3.013	-1.09	-4.69E-03						
UN	TC4	2.5	1	3.007	-2.48	-1.07E-02	-2.37	-2.37	-1.02E-02	-1.02E-02	5.82E-04	
UN	TC4	2.5	2	3.029	-2.48	-1.06E-02						
UN	TC4	2.5	3	3.003	-2.28	-9.85E-03						

**Table A.3** Continued

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)		(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
STD (0 ppb)				0	0.95	1.44E-02	0.95	0.95			
UN	TC4	3.25	1	3.012	-2.48	-1.07E-02	-2.45	-2.45	-1.05E-02	-1.05E-02	3.12E-04
UN	TC4	3.25	2	3.018	-2.48	-1.07E-02					
UN	TC4	3.25	3	3.011	-2.48	-1.07E-02					
UN	TC4	3.25	4	3.033	-2.35	-1.01E-02					
UN	TC5	0.6	1	3	-1.42	-6.14E-03	-1.42	-1.42	-6.12E-03	-6.12E-03	9.56E-04
UN	TC5	0.6	2	3.022	-1.42	-6.10E-03					
UN	TC5	0.6	3	3.004	-1.69	-7.30E-03					
UN	TC5	0.6	4	3.036	-1.16	-4.96E-03					
SB	TC5	0.6	1	3.014	-1.62	-6.97E-03	-1.44	-1.44	-6.19E-03	-6.19E-03	5.41E-04
SB	TC5	0.6	2	3.015	-1.36	-5.85E-03					
SB	TC5	0.6	3	3.011	-1.42	-6.12E-03					
SB	TC5	0.6	4	3.038	-1.36	-5.81E-03					
UN	TC5	1	1	3.041	0.42	1.79E-03	0.19	0.19	8.16E-04	8.16E-04	8.75E-04
UN	TC5	1	2	3.044	-0.04	-1.70E-04					
UN	TC5	1	3	3.004	0.09	3.89E-04					
UN	TC5	1	4	3.004	0.29	1.25E-03					
SB	TC5	1	1	3.024	-1.09	-4.68E-03	-0.88	-0.88	-3.77E-03	-3.77E-03	8.17E-04
SB	TC5	1	2	3.044	-0.9	-3.84E-03					
SB	TC5	1	3	3.036	-0.63	-2.69E-03					
SB	TC5	1	4	3.005	-0.9	-3.89E-03					
STD (56 ppb)			1	0	57.25	8.67E-01					
UN	TC5	1.75	1	3.031	-1.42	-6.08E-03	-1.26	-1.26	-5.39E-03	-5.39E-03	4.82E-04
UN	TC5	1.75	2	3.006	-1.23	-5.31E-03					
UN	TC5	1.75	3	3.047	-1.23	-5.24E-03					
UN	TC5	1.75	4	3.041	-1.16	-4.95E-03					
SB	TC5	1.75	1	3.02	-1.75	-7.52E-03	-1.67	-1.67	-7.16E-03	-7.16E-03	2.73E-04
SB	TC5	1.75	2	3.03	-1.69	-7.24E-03					
SB	TC5	1.75	3	3.02	-1.62	-6.96E-03					
SB	TC5	1.75	4	3.03	-1.62	-6.94E-03					
UN	TC5	2.5	1	3.023	-1.62	-6.95E-03	-1.59	-1.59	-6.84E-03	-6.84E-03	1.44E-04
UN	TC5	2.5	2	3.01	-1.62	-6.98E-03					
UN	TC5	2.5	3	3.011	-1.56	-6.72E-03					
UN	TC5	2.5	4	3.014	-1.56	-6.72E-03					
SPK	TC5	2.5	1	3.006	0.29	1.25E-03	0.26	0.26	1.11E-03	1.11E-03	2.80E-04
SPK	TC5	2.5	2	3.015	0.29	1.25E-03					
SPK	TC5	2.5	3	3.008	0.16	6.90E-04					
SPK	TC5	2.5	4	3.014	0.29	1.25E-03					
SB	TC5	2.5	1	3.023	-1.89	-8.11E-03	-1.77	-1.77	-7.61E-03	-7.61E-03	4.33E-04
SB	TC5	2.5	2	3.023	-1.69	-7.25E-03					
SB	TC5	2.5	3	3.027	-1.69	-7.24E-03					
SB	TC5	2.5	4	3.014	-1.82	-7.83E-03					
UN	TC5	3.25	1	3.007	-2.02	-8.72E-03	-2.07	-2.07	-8.90E-03	-8.90E-03	1.25E-04
UN	TC5	3.25	2	3.009	-2.08	-8.97E-03					
UN	TC5	3.25	3	3.019	-2.08	-8.94E-03					
UN	TC5	3.25	4	3.004	-2.08	-8.98E-03					
MB			1	0	-0.7	-9.08E-03	-0.62	-0.62	-8.01E-03	-8.01E-03	1.29E-03
MB			2	0	-0.5	-6.49E-03					
MB			3	0	-0.7	-9.08E-03					
MB			4	0	-0.57	-7.40E-03					
STD (2 ppb)			1	0	1.08	1.63E-02	1.08	1.08	1.63E-02	1.63E-02	7.62E-04
UN	TC6	0.6	1	3	-1.69	-7.31E-03	-1.59	-1.59	-6.84E-03	-6.84E-03	7.62E-04
UN	TC6	0.6	2	3.022	-1.75	-7.51E-03					
UN	TC6	0.6	3	3.004	-1.56	-6.74E-03					
UN	TC6	0.6	4	3.036	-1.36	-5.81E-03					
UN	TC6	1	1	3.012	-1.42	-6.12E-03	-1.42	-1.42	-6.11E-03	-6.11E-03	2.15E-04
UN	TC6	1	2	3.018	-1.36	-5.85E-03					
UN	TC6	1	3	3.011	-1.42	-6.12E-03					
UN	TC6	1	4	3.033	-1.49	-6.37E-03					
UN	TC6	1.75	1	3.028	-0.96	-4.11E-03	-0.90	-0.90	-3.84E-03	-3.84E-03	4.14E-04

**Table A.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
SB	TC6	1.75	1	3.03	-1.23	-5.27E-03	-1.39	-1.39	-5.96E-03	-5.96E-03	5.90E-04	
SB	TC6	1.75	2	3.04	-1.36	-5.80E-03						
SB	TC6	1.75	3	3.02	-1.42	-6.10E-03						
SB	TC6	1.75	4	3.03	-1.56	-6.68E-03						
UN	TC6	2.5	1	3.008	-1.56	-6.73E-03	-1.53	-1.53	-6.56E-03	-6.56E-03	8.92E-04	
UN	TC6	2.5	2	3.003	-1.62	-7.00E-03						
UN	TC6	2.5	3	3.021	-1.69	-7.26E-03						
UN	TC6	2.5	4	3.031	-1.23	-5.27E-03						
STD (48 ppb)			6	0	49.53	7.50E-01	49.53			7.50E-01		
UN	TC7	0.6	1	3.025	6.96	2.99E-02	5.74	3.68	2.47E-02	1.59E-02	3.44E-03	
UN	TC7	0.6	2	3.001	5.31	2.30E-02						
UN	TC7	0.6	3	3.002	5.24	2.26E-02						
UN	TC7	0.6	4	3.014	5.44	2.34E-02						
SB	TC7	0.6	1	3.01	2.4	1.03E-02	2.06	2.06	6.82E-03	6.82E-03	4.69E-03	
SB	TC7	0.6	2	3.05	2.27	9.66E-03						
SB	TC7	0.6	3	3.01	1.87	8.06E-05						
SB	TC7	0.6	4	3.03	1.68	7.19E-03						
UN	TC7	0.6	1	3	4.51	1.95E-02	3.49	1.95	1.51E-02	8.41E-03	2.98E-03	
UN	TC7	0.6	2	3	3.06	1.32E-02						
UN	TC7	0.6	3	3	3.88	1.68E-02						
UN	TC7	0.6	4	3	3.12	1.35E-02						
UN	TC7	0.6	5	3	2.87	1.24E-02						
UN	TC7	0.6	6	3	3.5	1.51E-02						
SB	TC7	0.6	1	3	1.67	7.22E-03	1.55	1.55	6.68E-03	6.68E-03	4.98E-04	
SB	TC7	0.6	2	3	1.61	6.96E-03						
SB	TC7	0.6	3	3	1.48	6.40E-03						
SB	TC7	0.6	4	3	1.42	6.14E-03						
UN	TC7	1	1	3.014	20.09	8.65E-02	22.40	7.64	9.66E-02	3.29E-02	1.29E-02	
UN	TC7	1	2	3.014	19.76	8.51E-02						
UN	TC7	1	3	3.005	25.77	1.11E-01						
UN	TC7	1	4	3.001	23.98	1.04E-01						
SB	TC7	1	1	3.002	15.6	6.74E-02	14.76	14.76	6.37E-02	6.37E-02	2.51E-03	
SB	TC7	1	2	3.017	14.48	6.23E-02						
SB	TC7	1	3	3.002	14.55	6.29E-02						
SB	TC7	1	4	3.007	14.41	6.22E-02						
UN	TC7	1	1	3	9.56	4.13E-02	8.70	5.80	3.76E-02	2.51E-02	3.23E-03	
UN	TC7	1	2	3	9.37	4.05E-02						
UN	TC7	1	3	3	8.55	3.70E-02						
UN	TC7	1	4	3	4.2	1.82E-02						
UN	TC7	1	5	3	8.24	3.56E-02						
UN	TC7	1	6	3	7.8	3.37E-02						
SB	TC7	1	1	3	2.87	1.24E-02	2.90	2.90	1.26E-02	1.26E-02	1.72E-03	
SB	TC7	1	2	3	3.31	1.43E-02						
SB	TC7	1	3	3	3.06	1.32E-02						
SB	TC7	1	4	3	2.37	1.02E-02						
UN	TC7	1.75	1	3.014	6.43	2.77E-02	6.89	3.37	2.97E-02	1.45E-02	4.97E-03	
UN	TC7	1.75	2	3.007	8.54	3.68E-02						
UN	TC7	1.75	3	3.01	6.69	2.88E-02						
UN	TC7	1.75	4	3.011	5.9	2.54E-02						
DUP	TC7	1.75	1	3.022	7.88	3.38E-02	7.70	7.70	3.31E-02	3.31E-02	1.61E-03	
DUP	TC7	1.75	2	3.016	7.22	3.11E-02						
DUP	TC7	1.75	3	3.011	7.62	3.28E-02						
DUP	TC7	1.75	4	3.009	8.08	3.48E-02						
SB	TC7	1.75	1	3.002	3.59	1.55E-02	3.52	3.52	1.52E-02	1.52E-02	3.08E-03	
SB	TC7	1.75	2	3.029	2.53	1.08E-02						
SB	TC7	1.75	3	3.005	4.18	1.80E-02						
SB	TC7	1.75	4	3.01	3.79	1.63E-02						
STD (48 ppb)			7	0	48.67	7.37E-01	48.67	48.67		7.37E-01		
UN	TC7	2.5	1	3.029	-0.76	-3.26E-03	-0.80	-0.80	-3.41E-03	-3.41E-03	1.74E-04	
UN	TC7	2.5	2	3.012	-0.83	-3.58E-03						
UN	TC7	2.5	3	3.012	-0.76	-3.27E-03						

**Table A.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
MB		(m.b.g.s)	4	0	-0.9	-1.17E-02						
UN	TC7	3.25	1	3.028	-1.56	-6.68E-03	-1.66	-1.66	-7.12E-03	-7.12E-03	5.03E-04	
UN	TC7	3.25	2	3.028	-1.56	-6.68E-03						
UN	TC7	3.25	3	3.007	-1.75	-7.55E-03						
UN	TC7	3.25	4	3.003	-1.75	-7.56E-03						

***Appendix B:***

***Summary of Data Presented in Chapter 3***

**Table B.1** Raw data for  $\beta$ -glucosidase activity in 2007

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )					
UN	TC1	0.50	1	3.00	0.56	1.21E-03	0.57	0.57	1.23E-03	1.23E-03	5.87E-05	
UN	TC1	0.50	2	3.05	0.56	1.19E-03						
UN	TC1	0.50	3	3.00	0.61	1.32E-03						
UN	TC1	0.50	4	3.01	0.56	1.21E-03						
UN	TC1	1.00	1	3.01	0.25	5.39E-04	0.27	0.27	5.69E-04	5.69E-04	1.45E-04	
UN	TC1	1.00	2	3.04	0.20	4.27E-04						
UN	TC1	1.00	3	3.01	0.25	5.39E-04						
UN	TC1	1.00	4	3.03	0.36	7.71E-04						
MB			1	0.00	0.66	1.87E-02	0.61	0.61	1.73E-02	1.73E-02	1.16E-03	
MB			2	0.00	0.61	1.73E-02						
MB			3	0.00	0.56	1.59E-02						
MB			4	0.00	0.61	1.73E-02						
UN	TC1	1.75	1	3.03	0.51	1.09E-03	0.49	0.49	1.04E-03	1.04E-03	6.02E-05	
UN	TC1	1.75	2	3.01	0.51	1.10E-03						
UN	TC1	1.75	3	3.01	0.46	9.91E-04						
UN	TC1	1.75	4	3.01	0.46	9.91E-04						
UN	TC1	2.50	1	3.00	0.56	1.21E-03	0.57	0.57	1.23E-03	1.23E-03	1.09E-04	
UN	TC1	2.50	2	3.01	0.61	1.31E-03						
UN	TC1	2.50	3	3.00	0.61	1.32E-03						
UN	TC1	2.50	4	3.04	0.51	1.09E-03						
STD												
(12 ppb)			1		10.69	4.05E-01	10.69	10.69				
UN	TC1	3.25	1	3.03	0.56	1.20E-03	0.64	0.64	1.36E-03	1.36E-03	2.09E-04	
UN	TC1	3.25	2	3.02	0.66	1.42E-03						
UN	TC1	3.25	3	3.01	0.76	1.64E-03						
UN	TC1	3.25	4	3.02	0.56	1.20E-03						
SPK #8	TC1	3.25	1	3.04	9.88	2.11E-02	9.78	9.78	2.10E-02	2.10E-02	1.98E-04	
SPK #8	TC1	3.25	2	3.02	9.88	2.12E-02						
SPK #8	TC1	3.25	3	3.01	9.63	2.08E-02						
SPK #8	TC1	3.25	4	3.01	9.73	2.10E-02						
SB	TC1	3.25	1	3.04	0.31	6.62E-04	0.40	0.40	8.51E-04	8.51E-04	1.37E-04	
SB	TC1	3.25	2	3.02	0.46	9.88E-04						
SB	TC1	3.25	3	3.02	0.41	8.81E-04						
SB	TC1	3.25	4	3.04	0.41	8.75E-04						
UN	TC2	0.50	1	3.01	0.61	1.31E-03	0.59	0.59	1.26E-03	1.26E-03	5.88E-05	
UN	TC2	0.50	2	3.04	0.61	1.30E-03						
UN	TC2	0.50	3	3.00	0.56	1.21E-03						
UN	TC2	0.50	4	3.02	0.56	1.20E-03						
UN	TC2	1.00	1	3.02	0.56	1.20E-03	0.69	0.69	1.48E-03	1.48E-03	1.90E-04	
UN	TC2	1.00	2	3.01	0.71	1.53E-03						
UN	TC2	1.00	3	3.00	0.76	1.64E-03						
UN	TC2	1.00	4	3.01	0.71	1.53E-03						
MB			1	0.00	0.96	2.72E-02	0.99	0.99	2.80E-02	2.80E-02	1.56E-03	
MB			2	0.00	0.96	2.72E-02						
MB			3	0.00	0.96	2.72E-02						
MB			4	0.00	1.07	3.04E-02						
UN	TC2	1.75	1	3.02	0.76	1.63E-03	0.71	0.71	1.53E-03	1.53E-03	8.39E-05	
UN	TC2	1.75	2	3.02	0.71	1.53E-03						
UN	TC2	1.75	3	3.00	0.66	1.43E-03						
UN	TC2	1.75	4	3.01	0.71	1.53E-03						
STD												
(48 ppb)			2	0.00	45.14	1.71E+00	45.14	45.14				
UN	TC2	2.50	1	3.00	0.86	1.86E-03	0.81	0.05	1.74E-03	1.08E-04	9.51E-05	
UN	TC2	2.50	2	3.00	0.81	1.75E-03						
UN	TC2	2.50	3	3.02	0.81	1.74E-03						
UN	TC2	2.50	4	3.03	0.76	1.63E-03						
DUP	TC2	2.50	5	3.03	0.96	2.06E-03	0.89	0.89	1.90E-03	1.90E-03	1.03E-04	
DUP	TC2	2.50	6	3.03	0.86	1.84E-03						
DUP	TC2	2.50	5	3.01	0.86	1.85E-03						
DUP	TC2	2.50	6	3.01	0.86	1.85E-03						
SB	TC2	2.50	1	3.02	0.76	1.63E-03	0.76	0.76	1.63E-03	1.63E-03	8.73E-05	
SB	TC2	2.50	2	3.04	0.81	1.73E-03						
SB	TC2	2.50	3	3.03	0.76	1.63E-03						
SB	TC2	2.50	4	3.04	0.71	1.52E-03						



**Table B.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)		(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC2	3.25	1	3.02	0.41	8.81E-04	0.44	0.44	9.33E-04	9.33E-04	1.35E-04
UN	TC2	3.25	2	3.01	0.36	7.76E-04					
UN	TC2	3.25	3	3.04	0.51	1.09E-03					
UN	TC2	3.25	4	3.02	0.46	9.88E-04					
UN	TC3	0.50	1	3.03	0.71	1.52E-03	0.69	0.69	1.47E-03	1.47E-03	5.50E-05
UN	TC3	0.50	2	3.01	0.66	1.42E-03					
UN	TC3	0.50	3	3.00	0.66	1.43E-03					
UN	TC3	0.50	4	3.03	0.71	1.52E-03					
STD											
(48 ppb)			3	0.00	44.13	1.67E+00	44.13	44.13	1.67E+00	8.35E-04	
STD											
(12 ppb)			4	0.00	10.64	4.03E-01	10.64	10.64	4.03E-01	2.01E-04	
UN	TC3	1.00	1	3.03	0.54	1.16E-03	0.62	0.62	1.32E-03	1.32E-03	4.20E-04
UN	TC3	1.00	2	3.00	0.90	1.95E-03					
UN	TC3	1.00	5	3.03	0.48	1.03E-03					
UN	TC3	1.00	6	3.01	0.54	1.16E-03					
UN	TC3	1.75	1	3.03	3.69	7.90E-03	3.87	1.09	8.32E-03	2.34E-03	3.01E-04
UN	TC3	1.75	2	3.02	3.87	8.32E-03					
UN	TC3	1.75	3	3.01	3.99	8.61E-03					
UN	TC3	1.75	4	3.03	3.93	8.43E-03					
SPK #8	TC3	1.75	5	3.01	12.40	2.68E-02	12.43	12.43	2.67E-02	2.67E-02	3.13E-04
SPK #8	TC3	1.75	6	3.03	12.28	2.63E-02					
SPK #8	TC3	1.75	7	3.03	12.46	2.67E-02					
SPK #8	TC3	1.75	8	3.01	12.59	2.71E-02					
SB	TC3	1.75	9	3.03	2.60	5.58E-03	2.78	2.78	5.98E-03	5.98E-03	5.62E-04
SB	TC3	1.75	10	3.01	3.14	6.77E-03					
SB	TC3	1.75	11	3.03	2.60	5.57E-03					
SB	TC3	1.75	12	3.01	2.78	6.00E-03					
UN	TC3	2.50	1	3.01	-0.55	-1.19E-03	-0.49	-0.49	-1.05E-03	-1.05E-03	3.37E-04
UN	TC3	2.50	2	3.02	-0.42	-9.03E-04					
UN	TC3	2.50	3	3.01	-0.67	-1.44E-03					
UN	TC3	2.50	4	3.01	-0.31	-6.68E-04					
STD											
(30 ppb)				0.00	31.40	1.19E+00	31.40	31.40	1.19E+00	0.00E+00	
UN	TC4	0.50	1	3.04	-0.01	-2.14E-05	-0.39	-0.39	-8.25E-04	-8.24E-04	5.59E-04
UN	TC4	0.50	2	3.03	-0.49	-1.05E-03					
UN	TC4	0.50	3	3.03	-0.43	-9.21E-04					
UN	TC4	0.50	4	3.03	-0.61	-1.31E-03					
UN	TC4	1.00	1	3.04	3.69	7.89E-03	4.90	4.90	1.05E-02	1.05E-02	5.67E-03
UN	TC4	1.00	2	3.01	2.72	5.87E-03					
UN	TC4	1.00	3	3.03	4.47	9.57E-03					
UN	TC4	1.00	4	3.02	8.71	1.87E-02					
UN	TC4	1.00	1	3.00	2.00	4.32E-03	2.02	2.02	4.37E-03	4.37E-03	1.02E-03
UN	TC4	1.00	2	3.00	1.57	3.39E-03					
UN	TC4	1.00	3	3.00	1.69	3.65E-03					
UN	TC4	1.00	4	3.00	1.69	3.65E-03					
UN	TC4	1.00	5	3.00	2.74	5.93E-03					
UN	TC4	1.00	6	3.00	2.43	5.25E-03					
SB	TC4	1.00	1	3.00	-0.03	-6.49E-05	-0.05	-0.05	-9.73E-05	-9.73E-05	6.49E-05
SB	TC4	1.00	2	3.00	-0.09	-1.95E-04					
SB	TC4	1.00	3	3.00	-0.03	-6.49E-05					
SB	TC4	1.00	4	3.00	-0.03	-6.49E-05					
MB			1	0.00	na	na	-0.57	-0.57	-1.62E-02	-1.62E-02	9.83E-04
MB			2	0.00	-0.61	-1.73E-02					
MB			3	0.00	-0.55	-1.56E-02					
MB			4	0.00	-0.55	-1.56E-02					
UN	TC4	1.75	1	3.02	15.31	3.29E-02	13.11	13.11	2.82E-02	2.82E-02	4.12E-03
UN	TC4	1.75	2	3.02	11.92	2.56E-02					
UN	TC4	1.75	5	3.04							
UN	TC4	1.75	6	3.02	12.10	2.60E-02					
UN	TC4	1.75	1	3.00	6.37	1.38E-02	6.82	6.65	1.47E-02	1.47E-02	1.21E-03
UN	TC4	1.75	2	3.00	7.41	1.60E-02					

**Table B.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC4	2.50	1	3.01	18.76	4.04E-02	16.32	14.89	3.51E-02	3.51E-02	4.97E-03	
UN	TC4	2.50	2	3.03	17.49	3.74E-02						
UN	TC4	2.50	3	3.03	13.49	2.89E-02						
UN	TC4	2.50	4	3.00	15.55	3.36E-02						
DUP	TC4	2.50	1	3.04	16.04	3.42E-02	14.47	14.47	3.11E-02	3.11E-02	8.48E-03	
DUP	TC4	2.50	2	3.02	19.37	4.16E-02						
DUP	TC4	2.50	3	3.00	11.50	2.49E-02						
DUP	TC4	2.50	4	3.01	10.95	2.36E-02						
SB	TC4	2.50	1	3.05	0.78	1.66E-03	1.43	1.43	3.08E-03	3.08E-03	1.86E-03	
SB	TC4	2.50	2	3.01	2.54	5.48E-03						
SB	TC4	2.50	3	3.00	0.72	1.55E-03						
SB	TC4	2.50	4	3.01	1.69	3.64E-03						
STD (48 ppb)				0.00	49.03	1.86E+00	49.03	49.03	1.86E+00	9.28E-04		
UN	TC4	3.25	1	3.01	-0.25	-5.39E-04	-0.39	-0.39	-8.31E-04	-8.31E-04	2.67E-04	
UN	TC4	3.25	2	3.01	-0.49	-1.06E-03						
UN	TC4	3.25	3	3.00	-0.49	-1.06E-03						
UN	TC4	3.25	4	3.00	-0.31	-6.70E-04						
UN	TC5	0.50	1	3.03	24.57	5.26E-02	24.74	24.74	5.33E-02	5.33E-02	3.03E-02	
UN	TC5	0.50	2	3.01	44.55	9.61E-02						
UN	TC5	0.50	3	3.01	16.58	3.57E-02						
UN	TC5	0.50	4	3.01	13.25	2.86E-02						
UN	TC5	1.00	1	3.02	19.79	4.25E-02	23.00	23.00	4.95E-02	4.95E-02	4.86E-03	
UN	TC5	1.00	2	3.02	23.66	5.08E-02						
UN	TC5	1.00	3	3.01	23.72	5.11E-02						
UN	TC5	1.00	4	3.00	24.81	5.36E-02						
UN	TC5	1.00	1	3.00	17.88	3.87E-02	20.92	19.93	4.52E-02	4.52E-02	5.36E-03	
UN	TC5	1.00	2	3.00	21.94	4.74E-02						
UN	TC5	1.00	3	3.00	19.85	4.29E-02						
UN	TC5	1.00	4	3.00	20.03	4.33E-02						
UN	TC5	1.00	5	3.00	20.59	4.45E-02						
UN	TC5	1.00	6	3.00	25.21	5.45E-02						
SB	TC5	1.00	1	3.00	1.01	2.18E-03	0.98	0.98	2.12E-03	2.12E-03	2.58E-04	
SB	TC5	1.00	2	3.00	1.14	2.47E-03						
SB	TC5	1.00	3	3.00	0.89	1.92E-03						
SB	TC5	1.00	4	3.00	0.89	1.92E-03						
STD (0 ppb)	TC5		1	0.00	-0.66	-2.50E-02						
STD (39 ppb)	TC5		1	0.00	41.29	1.56E+00						
MB			1	0.00	-0.67	-1.90E-02	-0.63	-0.63	-1.77E-02	-1.77E-02	2.55E-03	
MB			2	0.00	-0.67	-1.90E-02						
MB			3	0.00	-0.67	-1.90E-02						
MB			4	0.00	-0.49	-1.39E-02						
UN	TC5	1.75	1	3.01	71.50	1.54E-01	76.13	76.13	1.63E-01	1.63E-01	1.33E-02	
UN	TC5	1.75	2	3.03	80.75	1.73E-01						
UN	TC5	1.75	3	3.01								
UN	TC5	1.75	4	3.02								
UN	TC5	1.75	1	3.00	56.36	1.22E-01	54.59	53.08	1.18E-01	1.18E-01	1.32E-02	
UN	TC5	1.75	2	3.00	65.41	1.41E-01						
UN	TC5	1.75	3	3.00	51.55	1.11E-01						
UN	TC5	1.75	4	3.00	47.92	1.04E-01						
UN	TC5	1.75	5	3.00	51.12	1.11E-01						
UN	TC5	1.75	6	3.00	55.19	1.19E-01						
SB	TC5	1.75	7	3.00	1.44	3.11E-03	1.51	1.51	3.27E-03	3.27E-03	7.57E-04	
SB	TC5	1.75	8	3.00	1.89	4.09E-03						
SB	TC5	1.75	9	3.00	1.20	2.59E-03						
UN	TC5	2.50	1	3.03	3.75	8.03E-03	4.11	4.11	8.83E-03	8.83E-03	6.58E-04	
UN	TC5	2.50	2	3.03	4.05	8.67E-03						
UN	TC5	2.50	3	3.00	4.17	9.02E-03						
UN	TC5	2.50	4	3.02	4.47	9.60E-03						
SPK #6	TC5	2.50	1	3.03	29.41	6.30E-02	30.87	30.87	6.63E-02	6.63E-02	4.72E-03	

**Table B.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
SB	TC5	2.50	1	3.01	-0.25	-5.39E-04	-0.28	-0.28	-6.02E-04	-6.02E-04	7.34E-05	
SB	TC5	2.50	2	3.01	-0.25	-5.39E-04						
SB	TC5	2.50	3	3.01	-0.31	-6.68E-04						
SB	TC5	2.50	4	3.03	-0.31	-6.64E-04						
UN	TC5	3.25	1	3.02	-0.49	-1.05E-03	-0.54	-0.54	-1.15E-03	-1.15E-03	1.24E-04	
UN	TC5	3.25	2	3.01	-0.49	-1.06E-03						
UN	TC5	3.25	3	3.01	-0.61	-1.31E-03						
UN	TC5	3.25	4	3.02	-0.55	-1.18E-03						
STD (30 ppb)			1		31.96	1.21E+00	31.96	31.96	1.21E+00	6.05E-04		
UN	TC6	0.50	1	3.03	28.45	6.09E-02	23.18	23.18	4.97E-02	4.97E-02	8.68E-03	
UN	TC6	0.50	2	3.04	19.55	4.17E-02						
UN	TC6	0.50	3	3.04	24.33	5.19E-02						
UN	TC6	0.50	4	3.00	20.39	4.41E-02						
UN	TC6	0.50	1	3.00	11.66	2.52E-02	11.84	11.47	2.56E-02	2.56E-02	4.17E-03	
UN	TC6	0.50	2	3.00	10.25	2.22E-02						
UN	TC6	0.50	3	3.00	9.63	2.08E-02						
UN	TC6	0.50	4	3.00	11.23	2.43E-02						
UN	TC6	0.50	5	3.00	14.56	3.15E-02						
UN	TC6	0.50	6	3.00	13.69	2.96E-02						
SB	TC6	0.50	1	3.00	0.27	5.84E-04	0.37	0.37	7.89E-04	7.89E-04	1.37E-04	
SB	TC6	0.50	2	3.00	0.40	8.65E-04						
SB	TC6	0.50	3	3.00	0.40	8.65E-04						
SB	TC6	0.50	4	3.00	0.39	8.43E-04						
UN	TC6	1.00	1	3.02	10.89	2.34E-02	9.44	9.44	2.02E-02	2.02E-02	3.02E-03	
UN	TC6	1.00	2	3.03	9.68	2.07E-02						
UN	TC6	1.00	3	3.04	9.68	2.07E-02						
UN	TC6	1.00	4	3.02	7.50	1.61E-02						
UN	TC6	1.00	1	3.00	6.37	1.38E-02	7.25	7.01	1.57E-02	1.57E-02	1.83E-03	
UN	TC6	1.00	2	3.00	7.54	1.63E-02						
UN	TC6	1.00	3	3.00	6.37	1.38E-02						
UN	TC6	1.00	4	3.00	6.92	1.50E-02						
UN	TC6	1.00	5	3.00	8.46	1.83E-02						
UN	TC6	1.00	6	3.00	7.85	1.70E-02						
SB	TC6	1.00	1	3.00	0.21	4.54E-04	0.24	0.24	5.24E-04	5.24E-04	1.76E-04	
SB	TC6	1.00	2	3.00	0.34	7.35E-04						
SB	TC6	1.00	3	3.00	0.15	3.24E-04						
SB	TC6	1.00	4	3.00	0.27	5.84E-04						
MB			1	0.00	-0.37	-1.05E-02	-0.40	-0.40	-1.14E-02	-1.14E-02	2.20E-03	
MB			2	0.00	-0.31	-8.80E-03						
MB			3	0.00	-0.49	-1.39E-02						
MB			4	0.00	-0.43	-1.22E-02						
UN	TC6	1.75	1	3.03	3.08	6.59E-03	2.45	2.45	5.24E-03	5.24E-03	1.07E-03	
UN	TC6	1.75	2	3.02	2.11	4.53E-03						
UN	TC6	1.75	3	3.02	2.60	5.59E-03						
UN	TC6	1.75	4	3.03	1.99	4.26E-03						
SB	TC6	1.75	1	3.00	-0.94	-2.03E-03	-0.75	-0.75	-1.63E-03	-1.63E-03	2.70E-04	
SB	TC6	1.75	2	3.00	-0.69	-1.49E-03						
SB	TC6	1.75	3	3.00	-0.69	-1.49E-03						
SB	TC6	1.75	4	3.00	-0.69	-1.49E-03						
UN	TC6	1.75	1	3.00	-0.50	-1.08E-03	-0.22	-0.22	-4.65E-04	-4.65E-04	9.78E-04	
UN	TC6	1.75	2	3.00	0.45	9.73E-04						
UN	TC6	1.75	3	3.00	-0.50	-1.08E-03						
UN	TC6	1.75	4	3.00	-0.31	-6.70E-04						
UN	TC6	1.75	5	3.00	0.32	6.92E-04						
UN	TC6	1.75	6	3.00	-0.37	-8.00E-04						
UN	TC6	2.50	1	3.01	17.73	3.82E-02	16.64	16.64	3.58E-02	3.58E-02	3.58E-03	
UN	TC6	2.50	2	3.01	18.34	3.95E-02						
UN	TC6	2.50	3	3.02	15.37	3.30E-02						
UN	TC6	2.50	4	3.02	15.13	3.25E-02						
STD (66 ppb)			1		63.13	2.39E+00	63.13	63.13	2.39E+00	1.19E-03		

**Table B.1 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
DUP	TC6	3.25	1	3.01	-0.67	-1.44E-03	-0.73	-0.73	-1.57E-03	-1.57E-03	1.51E-04
DUP	TC6	3.25	2	3.03	-0.67	-1.43E-03					
DUP	TC6	3.25	3	3.01	-0.79	-1.70E-03					
DUP	TC6	3.25	4	3.02	-0.79	-1.70E-03					
SB	TC6	3.25	1	3.04	-0.73	-1.56E-03	-0.66	-0.66	-1.40E-03	-1.40E-03	1.21E-04
SB	TC6	3.25	2	3.02	-0.61	-1.31E-03					
SB	TC6	3.25	3	3.02	-0.67	-1.44E-03					
SB	TC6	3.25	4	3.04	-0.61	-1.30E-03					
UN	TC7	0.50	1	3.02	39.42	8.47E-02	40.30	40.30	8.64E-02	8.64E-02	3.95E-03
UN	TC7	0.50	2	3.03	43.07	9.22E-02					
UN	TC7	0.50	3	3.03	39.05	8.36E-02					
UN	TC7	0.50	4	3.03	39.66	8.49E-02					
SB	TC7	0.50	4	3.00	-0.69	-1.49E-03	-0.60	-0.60	-1.30E-03	-1.30E-03	2.55E-04
SB	TC7	0.50	3	3.00	-0.69	-1.49E-03					
SB	TC7	0.50	2	3.00	-0.59	-1.28E-03					
SB	TC7	0.50	1	3.00	-0.44	-9.51E-04					
UN	TC7	0.50	6	3.00	28.74	6.21E-02	28.92	28.92	6.25E-02	6.25E-02	4.03E-03
UN	TC7	0.50	5	3.00	31.60	6.83E-02					
UN	TC7	0.50	6	3.00	27.79	6.01E-02					
UN	TC7	0.50	5	3.00	27.54	5.96E-02					
UN	TC7	0.50	6	3.00	26.97	5.83E-02					
UN	TC7	0.50	5	3.00	25.57	5.53E-02					
UN	TC7	1.00	1	3.01	15.67	3.38E-02	18.40	18.04	3.96E-02	3.89E-02	7.97E-03
UN	TC7	1.00	2	3.01	15.73	3.39E-02					
UN	TC7	1.00	3	3.01	18.64	4.02E-02					
UN	TC7	1.00	4	3.01	23.54	5.07E-02					
DUP	TC7	1.00	5	3.02	22.39	4.81E-02	19.94	19.94	4.28E-02	4.28E-02	4.46E-03
DUP	TC7	1.00	6	3.00	19.12	4.13E-02					
DUP	TC7	1.00	5	3.03	17.55	3.76E-02					
DUP	TC7	1.00	6	3.03	20.70	4.43E-02					
SB	TC7	1.00	1	3.00	0.42	9.08E-04	0.36	0.36	7.77E-04	7.77E-04	1.50E-04
SB	TC7	1.00	2	3.01	0.42	9.05E-04					
SB	TC7	1.00	3	3.00	0.30	6.49E-04					
SB	TC7	1.00	4	3.01	0.30	6.47E-04					
UN	TC7	1.75	1	3.03	67.18	1.44E-01	66.66	66.66	1.44E-01	1.44E-01	1.33E-02
UN	TC7	1.75	2	3.01	70.95	1.53E-01					
UN	TC7	1.75	3	3.00	57.68	1.25E-01					
UN	TC7	1.75	4	3.00	70.83	1.53E-01					
SB	TC7	1.75	1	3.00	-1.39	-3.01E-03	-1.31	-1.31	-2.83E-03	-2.83E-03	2.80E-04
SB	TC7	1.75	2	3.00	-1.20	-2.59E-03					
SB	TC7	1.75	3	3.00	-1.45	-3.14E-03					
SB	TC7	1.75	4	3.00	-1.20	-2.59E-03					
UN	TC7	1.75	1	3.00	57.92	1.25E-01	56.75	56.75	1.23E-01	1.23E-01	2.39E-02
UN	TC7	1.75	2	3.00	40.35	8.73E-02					
UN	TC7	1.75	3	3.00	52.09	1.13E-01					
UN	TC7	1.75	4	3.00	73.59	1.59E-01					
UN	TC7	1.75	5	3.00	54.50	1.18E-01					
UN	TC7	1.75	6	3.00	62.05	1.34E-01					
STD											
(85 ppb)			1		86.90	3.29E+00	86.90	86.90	3.29E+00	1.64E-03	
UN	TC7	2.50	1	3.04	22.94	4.90E-02	22.27	22.27	4.77E-02	4.77E-02	6.49E-03
UN	TC7	2.50	2	3.04	18.28	3.90E-02					
UN	TC7	2.50	3	3.03	25.54	5.47E-02					
UN	TC7	2.50	4	3.00	22.33	4.83E-02					
SB	TC7	2.50	1	3.00	-1.71	-3.70E-03	-1.71	-1.71	-3.69E-03	-3.69E-03	1.15E-04
SB	TC7	2.50	2	3.00	-1.71	-3.70E-03					
SB	TC7	2.50	3	3.00	-1.64	-3.55E-03					
SB	TC7	2.50	4	3.00	-1.77	-3.83E-03					
UN	TC7	2.50	1	3.00	15.23	3.29E-02	17.56	17.56	3.80E-02	3.80E-02	6.77E-03
UN	TC7	2.50	2	3.00	22.02	4.76E-02					
UN	TC7	2.50	3	3.00	15.55	3.36E-02					
UN	TC7	2.50	4	3.00	17.45	3.77E-02					

**Table B.1** Continued

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)		(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC7	3.25	1	3.01	-0.43	-9.27E-04	-0.46	-0.46	-9.90E-04	-9.90E-04	7.65E-05
UN	TC7	3.25	2	3.03	-0.43	-9.21E-04					
UN	TC7	3.25	3	3.00	-0.49	-1.06E-03					
UN	TC7	3.25	4	3.02	-0.49	-1.05E-03					

**Table B.2** Raw data for exo 1,4- $\beta$ -glucanase activity in 2007

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)		(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC1	0.50	1	3.00	0.03	6.49E-05	0.00	0.00	-5.48E-06	-5.48E-06	1.75E-04
UN	TC1	0.50	2	3.03	0.09	1.93E-04					
UN	TC1	0.50	3	3.01	-0.03	-6.47E-05					
UN	TC1	0.50	4	3.02	-0.10	-2.15E-04					
UN	TC1	1.00	1	3.00	0.22	4.76E-04	-0.03	-0.03	-6.98E-05	-6.98E-05	4.30E-04
UN	TC1	1.00	2	3.02	-0.16	-3.44E-04					
UN	TC1	1.00	3	3.01	0.03	6.47E-05					
UN	TC1	1.00	4	3.00	-0.22	-4.76E-04					
UN	TC1	1.75	1	3.01	-0.16	-3.45E-04	-0.21	-0.21	-4.43E-04	-4.43E-04	6.52E-05
UN	TC1	1.75	2	3.00	-0.22	-4.76E-04					
UN	TC1	1.75	3	3.00	-0.22	-4.76E-04					
UN	TC1	1.75	4	3.01	-0.22	-4.74E-04					
SPK #2	TC1	1.75	1	3.00	58.51	1.27E-01	58.88	58.88	1.27E-01	1.27E-01	5.06E-04
SPK #2	TC1	1.75	2	3.01	59.08	1.27E-01					
SPK #2	TC1	1.75	3	3.02	59.27	1.27E-01					
SPK #2	TC1	1.75	4	3.01	58.64	1.26E-01					
SB	TC1	1.75	1	3.01	-0.10	-2.16E-04	-0.10	-0.10	-2.10E-04	-2.10E-04	1.14E-04
SB	TC1	1.75	2	3.01	-0.10	-2.16E-04					
SB	TC1	1.75	3	3.02	-0.16	-3.44E-04					
SB	TC1	1.75	4	3.00	-0.03	-6.49E-05					
UN	TC1	2.50	1	3.02	0.03	6.44E-05	0.03	0.03	6.47E-05	6.47E-05	2.06E-07
UN	TC1	2.50	2	3.01	0.03	6.47E-05					
UN	TC1	2.50	3	3.00	0.03	6.49E-05					
UN	TC1	2.50	4	3.00	0.03	6.49E-05					
STD (30 ppb)			1	0.00	31.06	1.18E+00	31.06	31.06	1.18E+00	1.18E+00	
UN	TC1	3.25	1	3.02	0.22	4.73E-04	0.27	0.27	5.70E-04	5.70E-04	1.22E-04
UN	TC1	3.25	2	3.01	0.28	6.03E-04					
UN	TC1	3.25	3	3.03	0.34	7.28E-04					
UN	TC1	3.25	4	3.01	0.22	4.74E-04					
UN	TC2	0.50	1	3.02	-0.10	-2.15E-04	-0.19	-0.19	-4.09E-04	-4.09E-04	1.29E-04
UN	TC2	0.50	2	3.00	-0.22	-4.76E-04					
UN	TC2	0.50	3	3.04	-0.22	-4.69E-04					
UN	TC2	0.50	4	3.01	-0.22	-4.74E-04					
UN	TC2	1.00	1	3.00	-0.16	-3.46E-04	-0.16	-0.16	-3.45E-04	-3.45E-04	1.06E-04
UN	TC2	1.00	2	3.02	-0.22	-4.73E-04					
UN	TC2	1.00	3	3.03	-0.10	-2.14E-04					
UN	TC2	1.00	4	3.00	-0.16	-3.46E-04					
MB			1	0.00	0.40	1.14E-02	0.34	0.34	2.84E-03	2.84E-03	5.67E-03
MB			2	0.00	0.34	4.82E-06					
MB			3	0.00	0.28	3.97E-06					
MB			4	0.00	0.34	4.82E-06					
UN	TC2	1.75	1	3.01	-0.16	-3.45E-04	-0.11	-0.11	-2.41E-04	-2.41E-04	2.29E-04
UN	TC2	1.75	2	3.04	-0.22	-4.69E-04					
UN	TC2	1.75	3	3.04	-0.10	-2.13E-04					
UN	TC2	1.75	4	3.02	0.03	6.44E-05					
DUP	TC2	1.75	1	3.00	-0.16	-3.46E-04	-0.13	-0.13	-2.74E-04	-2.74E-04	1.75E-04
DUP	TC2	1.75	2	3.02	-0.22	-4.73E-04					
DUP	TC2	1.75	3	3.03	-0.10	-2.14E-04					
DUP	TC2	1.75	4	3.03	-0.03	-6.42E-05					
SB	TC2	1.75	1	3.00	-0.35	-7.57E-04	-0.19	-0.19	-4.09E-04	-4.09E-04	2.87E-04
SB	TC2	1.75	2	3.04	-0.22	-4.69E-04					
SB	TC2	1.75	3	3.01	-0.16	-3.45E-04					
SB	TC2	1.75	4	3.03	-0.03	-6.42E-05					
STD (66 ppb)			2	0.00	63.03	2.39E+00	63.03	63.03	2.39E+00	2.39E+00	
UN	TC2	2.50	1	3.03	-0.03	-6.42E-05	-0.07	-0.07	-1.39E-04	-1.39E-04	8.70E-05
UN	TC2	2.50	2	3.02	-0.10	-2.15E-04					
UN	TC2	2.50	3	3.02	-0.10	-2.15E-04					
UN	TC2	2.50	4	3.04	-0.03	-6.40E-05					
UN	TC2	3.25	1	3.03	-0.10	-2.14E-04	-0.10	-0.10	-2.04E-04	-2.04E-04	1.93E-04
UN	TC2	3.25	2	3.02	-0.03	-6.44E-05					

**Table B.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC3	0.50	3	3.01	-2.10	-4.53E-03						
UN	TC3	0.50	4	3.04	-2.10	-4.48E-03						
UN	TC3	1.00	1	3.00	-1.41	-3.05E-03	-1.10	-1.10	-2.37E-03	-2.37E-03	4.83E-04	
UN	TC3	1.00	2	3.01	-1.10	-2.37E-03						
UN	TC3	1.00	3	3.01	-0.98	-2.11E-03						
UN	TC3	1.00	4	3.02	-0.91	-1.95E-03						
UN	TC3	1.75	1	3.03	2.28	4.88E-03	2.20	2.20	4.73E-03	4.73E-03	2.34E-04	
UN	TC3	1.75	2	3.03	2.28	4.88E-03						
UN	TC3	1.75	3	3.00	2.03	4.39E-03						
UN	TC3	1.75	4	3.01	2.22	4.78E-03						
SB	TC3	1.75	1	1.00	-2.10	-1.36E-02	-1.89	-1.89	-1.22E-02	-1.22E-02	1.05E-03	
SB	TC3	1.75	2	1.00	-1.90	-1.23E-02						
SB	TC3	1.75	3	1.00	-1.71	-1.11E-02						
SB	TC3	1.75	4	1.00	-1.84	-1.19E-02						
UN	TC3	1.75	1	3.00	5.32	1.15E-02	4.92	4.92	1.06E-02	1.06E-02	1.12E-03	
UN	TC3	1.75	2	3.00	5.32	1.15E-02						
UN	TC3	1.75	3	3.00	4.82	1.04E-02						
UN	TC3	1.75	4	3.00	5.26	1.14E-02						
UN	TC3	1.75	5	3.00	5.00	1.08E-02						
UN	TC3	1.75	6	3.00	5.82	1.26E-02						
UN	TC3	1.75	7	3.00	4.50	9.73E-03						
UN	TC3	1.75	8	3.00	4.31	9.32E-03						
UN	TC3	1.75	9	3.00	4.19	9.06E-03						
UN	TC3	1.75	10	3.00	4.63	1.00E-02						
UN	TC3	2.50	1	3.01	-2.17	-4.68E-03	-2.07	-2.07	-4.46E-03	-4.46E-03	1.75E-04	
UN	TC3	2.50	2	3.03	-2.10	-4.50E-03						
UN	TC3	2.50	3	3.01	-1.98	-4.27E-03						
UN	TC3	2.50	4	3.02	-2.04	-4.38E-03						
SPK #8	TC3	2.50	1	3.02	8.43	1.81E-02	8.62	8.62	1.85E-02	1.85E-02	4.04E-04	
SPK #8	TC3	2.50	2	3.01	8.43	1.82E-02						
SPK #8	TC3	2.50	3	3.03	8.74	1.87E-02						
SPK #8	TC3	2.50	4	3.04	8.87	1.89E-02						
SB	TC3	2.50	1	3.02	-2.17	-4.66E-03	-2.11	-2.11	-4.52E-03	-4.52E-03	1.87E-04	
SB	TC3	2.50	2	3.04	-2.10	-4.48E-03						
SB	TC3	2.50	3	3.02	-2.17	-4.66E-03						
SB	TC3	2.50	4	3.01	-1.98	-4.27E-03						
STD												
(12 ppb)				0.00	9.05	3.42E-01	9.05	9.05	3.42E-01	3.42E-01		
UN	TC4	0.50	1	3.00	-1.98	-4.28E-03	-1.89	-1.89	-4.06E-03	-4.06E-03	2.66E-04	
UN	TC4	0.50	2	3.02	-1.85	-3.97E-03						
UN	TC4	0.50	3	3.02	-1.73	-3.72E-03						
UN	TC4	0.50	4	3.02	-1.98	-4.25E-03						
					Messed							
UN	TC4	1.00	1	3.03	Up	#VALUE!	1.03	1.03	2.21E-03	2.21E-03	1.27E-03	
UN	TC4	1.00	2	3.03	1.72	3.68E-03						
UN	TC4	1.00	3	3.00	0.65	1.41E-03						
UN	TC4	1.00	4	3.01	0.72	1.55E-03						
SB	TC4	1.00	1	3.00	-2.23	-4.82E-03	-2.31	-2.31	-5.00E-03	-5.00E-03	3.57E-04	
SB	TC4	1.00	2	3.00	-2.23	-4.82E-03						
SB	TC4	1.00	3	3.00	-2.23	-4.82E-03						
SB	TC4	1.00	4	3.00	-2.56	-5.54E-03						
UN	TC4	1.00	1	3.00	2.43	5.25E-03	2.59	1.96	5.60E-03	4.24E-03	1.37E-03	
UN	TC4	1.00	2	3.00	2.12	4.58E-03						
UN	TC4	1.00	3	3.00	2.24	4.84E-03						
UN	TC4	1.00	4	3.00	1.99	4.30E-03						
UN	TC4	1.00	5	3.00	3.50	7.57E-03						
UN	TC4	1.00	6	3.00	3.25	7.03E-03						
SB	TC4	1.00	1	3.00	0.61	1.32E-03	0.63	0.63	1.36E-03	1.36E-03	2.56E-04	
SB	TC4	1.00	2	3.00	0.55	1.19E-03						
SB	TC4	1.00	3	3.00	0.80	1.73E-03						
SB	TC4	1.00	4	3.00	0.55	1.19E-03						
MB			1	0.00	-2.17	-6.16E-02	-2.17	-2.17	-1.54E-02	-1.54E-02	3.08E-02	

**Table B.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC4	1.75	1	3.00	0.40	8.65E-04	0.70	0.70	1.50E-03	1.50E-03	5.79E-04	
UN	TC4	1.75	2	3.03	0.59	1.26E-03						
UN	TC4	1.75	3	3.01	1.03	2.22E-03						
UN	TC4	1.75	4	3.03	0.78	1.67E-03						
DUP	TC4	1.75	1	3.03	0.78	1.67E-03	0.95	0.95	2.04E-03	2.04E-03	1.02E-03	
DUP	TC4	1.75	2	3.04	0.72	1.54E-03						
DUP	TC4	1.75	3	3.01	0.65	1.40E-03						
DUP	TC4	1.75	4	3.02	1.66	3.57E-03						
SB	TC4	1.75	1	3.00	0.47	1.02E-03	0.58	0.58	1.25E-03	1.25E-03	2.42E-03	
SB	TC4	1.75	2	3.04	0.15	3.20E-04						
SB	TC4	1.75	3	3.00	2.16	4.67E-03						
SB	TC4	1.75	4	3.02	-0.46	-9.88E-04						
UN	TC4	2.50	1	3.03	0.59	1.26E-03	1.05	1.05	2.24E-03	2.24E-03	6.99E-04	
UN	TC4	2.50	2	3.04	1.28	2.73E-03						
UN	TC4	2.50	3	3.01	1.03	2.22E-03						
UN	TC4	2.50	4	3.01	1.28	2.76E-03						
STD												
(75 ppb)				0.00	71.43	2.70E+00	71.43	71.43	2.70E+00	2.70E+00		
UN	TC4	3.25	1	3.04	-1.85	-3.95E-03	-1.81	-1.81	-3.86E-03	-3.86E-03	1.11E-04	
UN	TC4	3.25	2	3.02	-1.73	-3.72E-03						
UN	TC4	3.25	3	3.03	-1.79	-3.83E-03						
UN	TC4	3.25	4	3.04	-1.85	-3.95E-03						
UN	TC5	0.50	1	3.01	-0.47	-1.01E-03	-0.54	-0.54	-1.16E-03	-1.16E-03	5.04E-04	
UN	TC5	0.50	2	3.01	-0.85	-1.83E-03						
UN	TC5	0.50	3	3.01	-0.54	-1.16E-03						
UN	TC5	0.50	4	3.02	-0.29	-6.23E-04						
SPK #1	TC5	0.50	1	3.04	68.79	1.47E-01	67.87	67.87	1.46E-01	1.46E-01	1.83E-03	
SPK #1	TC5	0.50	2	3.00	67.60	1.46E-01						
SPK #1	TC5	0.50	3	3.02	68.61	1.47E-01						
SPK #1	TC5	0.50	4	3.01	66.47	1.43E-01						
SB	TC5	0.50	1	3.01	-0.85	-1.83E-03	-1.15	-1.15	-2.47E-03	-2.47E-03	4.82E-04	
SB	TC5	0.50	2	3.02	-1.35	-2.90E-03						
SB	TC5	0.50	3	3.00	-1.10	-2.38E-03						
SB	TC5	0.50	4	3.01	-1.29	-2.78E-03						
UN	TC5	1.00	1	3.03	2.03	4.35E-03	1.61	1.61	3.46E-03	3.46E-03	2.08E-03	
UN	TC5	1.00	2	3.03	2.79	5.97E-03						
UN	TC5	1.00	3	3.00	0.91	1.97E-03						
UN	TC5	1.00	4	3.00	0.72	1.56E-03						
SB	TC5	1.00	1	1.00	-1.90	-1.23E-02	-2.00	-2.00	-1.30E-02	-1.30E-02	7.24E-04	
SB	TC5	1.00	2	1.00	-2.16	-1.40E-02						
SB	TC5	1.00	3	1.00	-1.97	-1.28E-02						
SB	TC5	1.00	4	1.00	-1.97	-1.28E-02						
UN	TC5	1.00	1	3.00	2.43	5.25E-03	2.78	1.46	6.00E-03	3.16E-03	9.33E-04	
UN	TC5	1.00	2	3.00	3.00	6.49E-03						
UN	TC5	1.00	3	3.00	2.30	4.97E-03						
UN	TC5	1.00	4	3.00	2.74	5.93E-03						
UN	TC5	1.00	5	3.00	3.50	7.57E-03						
UN	TC5	1.00	6	3.00	2.68	5.80E-03						
SB	TC5	1.00	1	3.00	1.30	2.81E-03	1.32	1.32	2.84E-03	2.84E-03	1.24E-04	
SB	TC5	1.00	2	3.00	1.36	2.94E-03						
SB	TC5	1.00	3	3.00	1.24	2.68E-03						
SB	TC5	1.00	4	3.00	1.36	2.94E-03						
UN	TC5	1.75	1	3.01	6.48	1.40E-02	5.50	5.50	1.18E-02	1.18E-02	2.56E-03	
UN	TC5	1.75	2	3.02	4.67	1.00E-02						
UN	TC5	1.75	3	3.02	6.55	1.41E-02						
UN	TC5	1.75	4	3.02	4.29	9.22E-03						
SB	TC5	1.75	1	1.00	-2.03	-1.32E-02	-2.13	-2.13	-1.38E-02	-1.38E-02	5.53E-04	
SB	TC5	1.75	2	1.00	-2.23	-1.45E-02						
SB	TC5	1.75	3	1.00	-2.10	-1.36E-02						
SB	TC5	1.75	4	1.00	-2.16	-1.40E-02						
UN	TC5	1.75	1	3.00	5.27	1.14E-02	5.72	3.73	1.24E-02	8.06E-03	1.46E-03	
UN	TC5	1.75	2	3.00	5.19	1.12E-02						



**Table B.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
SB	TC5	1.75	1	3.00	1.99	4.30E-03		1.99	1.99	4.30E-03	4.30E-03	2.97E-04
SB	TC5	1.75	2	3.00	1.80	3.89E-03						
SB	TC5	1.75	3	3.00	2.12	4.58E-03						
SB	TC5	1.75	4	3.00	2.05	4.43E-03						
UN	TC5	2.50	1	3.02	-1.60	-3.44E-03	-1.60	-1.60	-3.44E-03	-3.44E-03	-3.44E-03	1.06E-04
UN	TC5	2.50	2	3.03	-1.66	-3.55E-03						
UN	TC5	2.50	3	3.00	-1.60	-3.46E-03						
UN	TC5	2.50	4	3.03	-1.54	-3.30E-03						
UN	TC5	3.25	1	3.02	-2.04	-4.38E-03	-2.07	-2.07	-4.45E-03	-4.45E-03	-4.45E-03	7.44E-05
UN	TC5	3.25	2	3.02	-2.04	-4.38E-03						
UN	TC5	3.25	3	3.02	-2.10	-4.51E-03						
UN	TC5	3.25	4	3.02	-2.10	-4.51E-03						
STD												
(39 ppb)			5	0.00	37.70	1.43E+00	37.70	37.70	1.43E+00	1.43E+00	1.43E+00	
MB			1	0.00	-2.17	-6.16E-02	-2.06	-2.06	-1.54E-02	-1.54E-02	-1.54E-02	3.08E-02
MB			2	0.00	-2.17	-3.08E-05						
MB			3	0.00	-1.98	-2.81E-05						
MB			4	0.00	-1.92	-2.72E-05						
UN	TC6	0.50	1	3.04	0.09	1.92E-04	0.09	0.09	1.98E-04	1.98E-04	1.98E-04	6.15E-04
UN	TC6	0.50	2	3.00	-0.22	-4.76E-04						
UN	TC6	0.50	3	3.03	0.03	6.42E-05						
UN	TC6	0.50	4	3.01	0.47	1.01E-03						
UN	TC6	1.00	1	3.00	-1.29	-2.79E-03	-1.28	-1.28	-2.74E-03	-2.74E-03	-2.74E-03	3.46E-04
UN	TC6	1.00	2	3.02	-1.23	-2.64E-03						
UN	TC6	1.00	3	3.02	-1.48	-3.18E-03						
UN	TC6	1.00	4	3.04	-1.10	-2.35E-03						
UN	TC6	1.75	1	3.04	-0.66	-1.41E-03	-0.90	-0.90	-1.92E-03	-1.92E-03	-1.92E-03	4.06E-04
UN	TC6	1.75	2	3.02	-0.98	-2.11E-03						
UN	TC6	1.75	3	3.03	-0.85	-1.82E-03						
UN	TC6	1.75	4	3.03	-1.10	-2.36E-03						
UN	TC6	2.50	1	3.02	1.34	2.88E-03	1.08	1.08	2.30E-03	2.30E-03	2.30E-03	6.44E-04
UN	TC6	2.50	2	3.02	1.09	2.34E-03						
UN	TC6	2.50	3	3.04	1.22	2.60E-03						
UN	TC6	2.50	4	3.02	0.65	1.40E-03						
DUP	TC6	2.50	1	3.02	1.22	2.62E-03	1.00	1.00	2.15E-03	2.15E-03	2.15E-03	1.22E-03
DUP	TC6	2.50	2	3.03	0.34	7.28E-04						
DUP	TC6	2.50	3	3.00	0.78	1.69E-03						
DUP	TC6	2.50	4	3.03	1.66	3.55E-03						
SB	TC6	2.50	1	3.02	-0.16	-3.44E-04	-0.02	-0.02	-3.67E-05	-3.67E-05	-3.67E-05	3.92E-04
SB	TC6	2.50	2	3.00	0.22	4.76E-04						
SB	TC6	2.50	3	3.00	0.03	6.49E-05						
SB	TC6	2.50	4	3.02	-0.16	-3.44E-04						
STD												
(57 ppb)			6	0.00	54.38	2.06E+00	54.38	54.38	2.06E+00	2.06E+00	2.06E+00	
UN	TC6	3.25	1	3.02	-1.98	-4.25E-03	-2.07	-2.07	-4.46E-03	-4.46E-03	-4.46E-03	1.66E-04
UN	TC6	3.25	2	3.00	-2.04	-4.41E-03						
UN	TC6	3.25	3	3.03	-2.17	-4.65E-03						
UN	TC6	3.25	4	3.02	-2.10	-4.51E-03						
UN	TC7	0.50	1	3.00	3.41	7.37E-03	4.17	4.17	8.94E-03	8.94E-03	8.94E-03	1.45E-03
UN	TC7	0.50	2	3.04	4.79	1.02E-02						
UN	TC7	0.50	3	3.03	4.73	1.01E-02						
UN	TC7	0.50	4	3.01	3.73	8.04E-03						
SB	TC7	0.50	1	1.00	-0.99	-6.42E-03	-0.96	-0.96	-6.23E-03	-6.23E-03	-6.23E-03	5.53E-04
SB	TC7	0.50	2	1.00	-0.86	-5.58E-03						
SB	TC7	0.50	3	1.00	-1.06	-6.88E-03						
SB	TC7	0.50	4	1.00	-0.93	-6.03E-03						
UN	TC7	0.50	1	3.00	5.07	1.10E-02	5.51	3.66	1.19E-02	7.91E-03	7.91E-03	1.32E-03
UN	TC7	0.50	2	3.00	6.07	1.31E-02						
UN	TC7	0.50	3	3.00	5.38	1.16E-02						
UN	TC7	0.50	4	3.00	5.88	1.27E-02						
UN	TC7	0.50	5	3.00	4.57	9.88E-03						
UN	TC7	0.50	6	3.00	6.07	1.31E-02						

**Table B.2 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
SB	TC7	0.50	1	3.00	1.80	3.89E-03	1.85	1.85	4.00E-03	4.00E-03	2.98E-04	
SB	TC7	0.50	2	3.00	2.05	4.43E-03						
SB	TC7	0.50	3	3.00	1.80	3.89E-03						
SB	TC7	0.50	4	3.00	1.74	3.76E-03						
UN	TC7	1.00	1	3.03	0.53	1.13E-03	-0.07	-0.07	-1.40E-04	-1.40E-04	9.22E-04	
UN	TC7	1.00	2	3.00	-0.03	-6.49E-05						
UN	TC7	1.00	3	3.04	-0.41	-8.75E-04						
UN	TC7	1.00	4	3.01	-0.35	-7.54E-04						
UN	TC7	1.75	1	3.04	8.62	1.84E-02	7.88	7.88	1.69E-02	1.69E-02	1.11E-03	
UN	TC7	1.75	2	3.01	7.49	1.61E-02						
UN	TC7	1.75	3	3.01	7.42	1.60E-02						
UN	TC7	1.75	4	3.01	7.99	1.72E-02						
SB	TC7	1.75	1	3.00	-1.32	-2.85E-03	-1.50	-1.50	-3.24E-03	-3.24E-03	3.08E-04	
SB	TC7	1.75	2	3.00	-1.58	-3.42E-03						
SB	TC7	1.75	3	3.00	-1.45	-3.14E-03						
SB	TC7	1.75	4	3.00	-1.64	-3.55E-03						
UN	TC7	1.75	1	3.00	5.19	1.12E-02	6.66	5.14	1.44E-02	1.11E-02	3.69E-03	
UN	TC7	1.75	2	3.00	6.83	1.48E-02						
UN	TC7	1.75	3	3.00	9.71	2.10E-02						
UN	TC7	1.75	4	3.00	5.00	1.08E-02						
UN	TC7	1.75	5	3.00	6.20	1.34E-02						
UN	TC7	1.75	6	3.00	7.01	1.52E-02						
SB	TC7	1.75	1	3.00	1.49	3.22E-03	1.52	1.52	3.29E-03	3.29E-03	3.92E-04	
SB	TC7	1.75	2	3.00	1.74	3.76E-03						
SB	TC7	1.75	3	3.00	1.30	2.81E-03						
SB	TC7	1.75	4	3.00	1.55	3.35E-03						
STD (57 ppb)			7		56.63	2.14E+00	56.63	56.63	2.14E+00	2.14E+00		
UN	TC7	2.50	1	3.04	-0.35	-7.47E-04	0.36	0.36	7.73E-04	7.73E-04	1.12E-03	
UN	TC7	2.50	2	3.01	0.91	1.96E-03						
UN	TC7	2.50	3	3.00	0.40	8.65E-04						
UN	TC7	2.50	4	3.01	0.47	1.01E-03						
SPK #5	TC7	2.50	1	3.02	36.57	7.86E-02	35.23	35.23	7.58E-02	7.58E-02	1.92E-03	
SPK #5	TC7	2.50	2	3.03	34.63	7.41E-02						
SPK #5	TC7	2.50	3	3.00	34.69	7.50E-02						
SPK #5	TC7	2.50	4	3.01	35.01	7.55E-02						
SB	TC7	2.50	1	3.03	-1.41	-3.02E-03	-1.49	-1.49	-3.21E-03	-3.21E-03	2.14E-04	
SB	TC7	2.50	2	3.02	-1.54	-3.31E-03						
SB	TC7	2.50	3	3.00	-1.60	-3.46E-03						
SB	TC7	2.50	4	3.01	-1.41	-3.04E-03						
UN	TC7	3.25	1	3.00	-2.41	-5.21E-03	-2.39	-2.39	-5.15E-03	-5.15E-03	8.69E-05	
UN	TC7	3.25	2	3.02	-2.35	-5.05E-03						
UN	TC7	3.25	4	3.03	-2.42	-5.18E-03						

**Table B.3** Raw data for endo 1,4- $\beta$ -glucanase activity in 2007

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
UN	TC1	0.50	1	3.03	-0.78	-3.34E-03	-0.91	-0.91	-3.91E-03	-3.91E-03	5.25E-04	
UN	TC1	0.50	2	3.03	-1.04	-4.45E-03						
UN	TC1	0.50	3	3.00	-0.98	-4.24E-03						
UN	TC1	0.50	4	3.03	-0.84	-3.60E-03						
UN	TC1	1.00	1	3.00	-0.78	-3.37E-03	-0.75	-0.75	-3.20E-03	-3.20E-03	1.72E-04	
UN	TC1	1.00	2	3.03	-0.71	-3.04E-03						
UN	TC1	1.00	3	3.00	-0.71	-3.07E-03						
UN	TC1	1.00	4	3.04	-0.78	-3.33E-03						
SPK #3	TC1	1.00	1	3.04	56.09	2.39E-01	56.01	56.01	2.40E-01	2.40E-01	1.41E-03	
SPK #3	TC1	1.00	2	3.03	55.89	2.39E-01						
SPK #3	TC1	1.00	3	3.02	56.36	2.42E-01						
SPK #3	TC1	1.00	4	3.02	55.69	2.39E-01						
SB	TC1	1.00	1	3.00	-1.44	-6.23E-03	-1.49	-1.49	-6.40E-03	-6.40E-03	2.65E-04	
SB	TC1	1.00	2	3.01	-1.51	-6.51E-03						
SB	TC1	1.00	3	3.04	-1.44	-6.15E-03						
SB	TC1	1.00	4	3.03	-1.57	-6.72E-03						
UN	TC1	1.75	1	3.02	-1.57	-6.75E-03	-1.41	-1.41	-6.05E-03	-6.05E-03	4.81E-04	
UN	TC1	1.75	2	3.01	-1.31	-5.65E-03						
UN	TC1	1.75	3	3.01	-1.37	-5.91E-03						
UN	TC1	1.75	4	3.02	-1.37	-5.89E-03						
UN	TC1	2.50	1	3.02	-0.98	-4.21E-03	-0.98	-0.98	-4.22E-03	-4.22E-03	1.62E-05	
UN	TC1	2.50	2	3.02	-0.98	-4.21E-03						
UN	TC1	2.50	3	3.00	-0.98	-4.24E-03						
UN	TC1	2.50	4	3.00	-0.98	-4.24E-03						
STD (12 ppb)	TC1		1	0.00	10.92	1.03E-01	10.92	10.92	1.03E-01	2.07E-04		
UN	TC1	3.25	1	3.02	-1.11	-4.77E-03	-1.16	-1.16	-4.99E-03	-4.99E-03	4.24E-04	
UN	TC1	3.25	2	3.01	-1.11	-4.78E-03						
UN	TC1	3.25	3	3.01	-1.11	-4.78E-03						
UN	TC1	3.25	4	3.02	-1.31	-5.63E-03						
UN	TC2	0.50	1	3.02	-1.37	-5.89E-03	-1.34	-1.34	-5.77E-03	-5.77E-03	5.45E-04	
UN	TC2	0.50	2	3.02	-1.51	-6.49E-03						
UN	TC2	0.50	3	3.02	-1.24	-5.33E-03						
UN	TC2	0.50	4	3.00	-1.24	-5.36E-03						
UN	TC2	1.00	1	3.01	-1.17	-5.04E-03	-1.19	-1.19	-5.10E-03	-5.10E-03	1.63E-04	
UN	TC2	1.00	2	3.01	-1.24	-5.34E-03						
UN	TC2	1.00	3	3.03	-1.17	-5.01E-03						
UN	TC2	1.00	4	3.03	-1.17	-5.01E-03						
DUP	TC2	1.00	1	3.03	0.55	2.36E-03	-0.33	-0.33	-1.41E-03	-1.41E-03	3.44E-03	
DUP	TC2	1.00	2	3.04	0.15	6.40E-04						
DUP	TC2	1.00	3	3.03	-0.98	-4.20E-03						
DUP	TC2	1.00	4	3.03	-1.04	-4.45E-03						
SB	TC2	1.00	1	3.00	-1.04	-4.50E-03	-1.17	-1.17	-5.04E-03	-5.04E-03	3.92E-04	
SB	TC2	1.00	2	3.04	-1.17	-4.99E-03						
SB	TC2	1.00	3	3.01	-1.24	-5.34E-03						
SB	TC2	1.00	4	3.03	-1.24	-5.31E-03						
MB	TC2		1	0.00	-0.51	-7.24E-06	-0.68	-0.68	-9.58E-06	-9.58E-06	1.95E-06	
MB	TC2		2	0.00	-0.64	-9.08E-06						
MB	TC2		3	0.00	-0.71	-1.01E-05						
MB	TC2		4	0.00	-0.84	-1.19E-05						
UN	TC2	1.75	1	3.00	-1.37	-5.93E-03	-1.41	-1.41	-6.05E-03	-6.05E-03	1.63E-04	
UN	TC2	1.75	2	3.02	-1.44	-6.19E-03						
UN	TC2	1.75	3	3.02	-1.37	-5.89E-03						
UN	TC2	1.75	4	3.02	-1.44	-6.19E-03						
STD (30 ppb)	TC2		2	0.00	29.52	2.79E-01	29.52	29.52	2.79E-01	5.59E-04		
UN	TC2	2.50	1	3.00	-1.37	-5.93E-03	-1.33	-1.33	-5.72E-03	-5.72E-03	1.36E-04	
UN	TC2	2.50	2	3.01	-1.31	-5.65E-03						
UN	TC2	2.50	3	3.01	-1.31	-5.65E-03						
UN	TC2	2.50	4	3.00	-1.31	-5.67E-03						
UN	TC2	3.25	1	3.04	-1.24	-5.29E-03	-1.26	-1.26	-5.40E-03	-5.40E-03	1.68E-04	
UN	TC2	3.25	2	3.03	-1.24	-5.31E-03						

**Table B.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	
UN	TC3	1.00	1	3.02	-0.05	-2.15E-04	-0.23	-0.23	-9.91E-04	-9.91E-04	6.30E-04
UN	TC3	1.00	2	3.01	-0.18	-7.76E-04					
UN	TC3	1.00	3	3.02	-0.31	-1.33E-03					
UN	TC3	1.00	4	3.00	-0.38	-1.64E-03					
SPK #8	TC3	1.00	1	3.02	10.52	4.52E-02	10.09	10.09	4.33E-02	6.31E-05	1.59E-03
SPK #8	TC3	1.00	2	3.03	9.85	4.22E-02					
SPK #8	TC3	1.00	3	3.01	10.19	4.39E-02					
SPK #8	TC3	1.00	4	3.04	9.79	4.18E-02					
SB	TC3	1.00	1	3.02	-0.78	-3.35E-03	-0.59	-0.59	-2.55E-03	-2.79E-06	6.47E-04
SB	TC3	1.00	2	3.00	-0.64	-2.77E-03					
SB	TC3	1.00	3	3.03	-0.44	-1.88E-03					
SB	TC3	1.00	4	3.01	-0.51	-2.20E-03					
UN	TC3	1.75	1	3.00	2.62	1.13E-02	2.68	0.32	1.16E-02	2.72E-03	1.34E-03
UN	TC3	1.75	2	3.00	2.87	1.24E-02					
UN	TC3	1.75	3	3.00	2.18	9.43E-03					
UN	TC3	1.75	4	3.00	3.06	1.32E-02					
UN	TC3	1.75	5	3.00	2.87	1.24E-02					
UN	TC3	1.75	6	3.00	2.56	1.11E-02					
SB	TC3	1.75	1	3.00	2.30	9.95E-03	2.37	2.37	1.02E-02	1.02E-02	6.01E-04
SB	TC3	1.75	2	3.00	2.56	1.11E-02					
SB	TC3	1.75	3	3.00	2.24	9.69E-03					
SB	TC3	1.75	4	3.00	2.37	1.02E-02					
UN	TC3	2.50	1	3.02	-1.71	-7.35E-03	-1.69	-1.69	-7.28E-03	-7.28E-03	1.55E-04
UN	TC3	2.50	2	3.01	-1.71	-7.37E-03					
UN	TC3	2.50	3	3.02	-1.71	-7.35E-03					
UN	TC3	2.50	4	3.02	-1.64	-7.05E-03					
STD (57 ppb)				0.00	56.96	5.39E-01	56.96	56.96	5.39E-01	5.39E-01	
UN	TC4	0.50	1	3.01	-1.04	-4.48E-03	-0.93	-0.93	-3.98E-03	-3.98E-03	4.45E-04
UN	TC4	0.50	2	3.00	-0.98	-4.24E-03					
UN	TC4	0.50	3	3.02	-0.84	-3.61E-03					
UN	TC4	0.50	4	3.02	-0.84	-3.61E-03					
UN	TC4	1.00	1	3.02	0.62	2.66E-03	0.45	0.45	1.95E-03	1.95E-03	8.64E-04
UN	TC4	1.00	2	3.02	0.22	9.45E-04					
UN	TC4	1.00	3	3.01	0.62	2.67E-03					
UN	TC4	1.00	4	3.02	0.35	1.50E-03					
UN	TC4	1.75	1	3.00	1.36	5.88E-03	1.71	0.65	7.46E-03	5.62E-03	1.56E-03
UN	TC4	1.75	2	3.00	1.36	5.88E-03					
UN	TC4	1.75	3	3.00	2.11	9.13E-03					
UN	TC4	1.75	4	3.00	1.99	8.61E-03					
UN	TC4	1.75	5	3.00	2.05	8.87E-03					
UN	TC4	1.75	6	3.00	1.48	6.40E-03					
SB	TC4	1.75	1	3.00	0.85	3.68E-03	1.06	1.06	4.56E-03	4.56E-03	6.08E-04
SB	TC4	1.75	2	3.00	1.10	4.76E-03					
SB	TC4	1.75	3	3.00	1.17	5.06E-03					
SB	TC4	1.75	4	3.00	1.10	4.76E-03					
UN	TC4	2.50	1	3.04	0.75	3.20E-03	0.92	0.92	3.93E-03	3.93E-03	5.98E-04
UN	TC4	2.50	2	3.02	1.08	4.64E-03					
UN	TC4	2.50	3	3.03	0.95	4.07E-03					
UN	TC4	2.50	4	3.01	0.88	3.79E-03					
DUP	TC4	2.50	1	3.03	1.55	6.64E-03	1.20	1.20	5.15E-03	5.15E-03	1.17E-03
DUP	TC4	2.50	2	3.02	0.95	4.08E-03					
DUP	TC4	2.50	3	3.02	1.02	4.38E-03					
DUP	TC4	2.50	4	3.01	1.28	5.52E-03					
SB	TC4	2.50	1	3.01	-0.84	-3.62E-03	-0.31	-0.31	-1.33E-03	-1.33E-03	1.60E-03
SB	TC4	2.50	2	3.02	0.02	8.59E-05					
SB	TC4	2.50	3	3.03	-0.24	-1.03E-03					
SB	TC4	2.50	4	3.01	-0.18	-7.76E-04					
STD (39 ppb)				0.00	40.55	3.84E-01	40.55	40.55	3.84E-01	7.67E-04	
UN	TC4	3.25	1	3.00	-1.57	-6.79E-03	-1.61	-1.61	-6.89E-03	-6.89E-03	1.42E-04
UN	TC4	3.25	2	3.03	-1.64	-7.02E-03					

**Table B.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	
UN	TC5	0.50	1	3.02	-0.11	-4.73E-04	-0.08	-0.08	-3.44E-04	-3.44E-04	1.50E-04
UN	TC5	0.50	2	3.04	-0.05	-2.13E-04					
UN	TC5	0.50	3	3.00	-0.11	-4.76E-04					
UN	TC5	0.50	4	3.00	-0.05	-2.16E-04					
UN	TC5	1.00	1	3.00	1.29	5.58E-03	1.18	0.66	5.54E-03	5.71E-03	1.78E-03
UN	TC5	1.00	2	3.00	1.61	6.96E-03					
UN	TC5	1.00	3	3.00	0.91	3.94E-03					
UN	TC5	1.00	4	3.00	0.91	3.94E-03					
UN	TC5	1.00	5	3.00	1.04	4.50E-03					
UN	TC5	1.00	6	3.00	1.92	8.30E-03					
SB	TC5	1.00	1	3.00	0.41	1.77E-03	0.52	0.52	2.25E-03	2.25E-03	9.75E-04
SB	TC5	1.00	2	3.00	0.35	1.51E-03					
SB	TC5	1.00	3	3.00	0.85	3.68E-03					
SB	TC5	1.00	4	3.00	0.47	2.03E-03					
STD											
(57 ppb)			4	0.00	59.94	5.67E-01					
MB			1	0.00	-0.44	-6.24E-06	-0.39	-0.39	-5.57E-06	-5.57E-06	8.78E-07
MB			2	0.00	-0.38	-5.39E-06					
MB			3	0.00	-0.31	-4.40E-06					
MB			4	0.00	-0.44	-6.24E-06					
UN	TC5	1.75	1	3.04	1.81	7.72E-03	1.87	1.22	8.01E-03	1.04E-02	2.73E-04
UN	TC5	1.75	2	3.02	1.95	8.38E-03					
UN	TC5	1.75	3	3.04	1.88	8.02E-03					
UN	TC5	1.75	4	3.03	1.85	7.92E-03					
SPK #4	TC5	1.75	1	3.02	48.25	2.07E-01	48.68	48.68	2.09E-01	2.09E-01	3.02E-03
SPK #4	TC5	1.75	2	3.04	48.25	2.06E-01					
SPK #4	TC5	1.75	3	3.00	49.05	2.12E-01					
SPK #4	TC5	1.75	4	3.02	49.18	2.11E-01					
SB	TC5	1.75	1	3.03	0.69	2.95E-03	0.66	0.66	2.81E-03	2.81E-03	7.13E-04
SB	TC5	1.75	2	3.01	0.42	1.81E-03					
SB	TC5	1.75	3	3.04	0.82	3.50E-03					
SB	TC5	1.75	4	3.00	0.69	2.98E-03					
UN	TC5	2.50	1	3.04	-0.84	-3.59E-03	-0.73	-0.73	-3.11E-03	-3.11E-03	4.33E-04
UN	TC5	2.50	2	3.02	-0.64	-2.75E-03					
UN	TC5	2.50	3	3.00	-0.78	-3.37E-03					
UN	TC5	2.50	4	3.03	-0.64	-2.74E-03					
UN	TC5	3.25	1	3.01	-1.64	-7.07E-03	-1.24	-1.24	-5.36E-03	-5.36E-03	2.70E-03
UN	TC5	3.25	2	3.01	-1.51	-6.51E-03					
UN	TC5	3.25	3	3.02	-0.31	-1.33E-03					
UN	TC5	3.25	4	3.00	-1.51	-6.53E-03					
STD											
(48 ppb)			5		48.65	4.60E-01	48.65	48.65	4.60E-01	4.60E-01	
UN	TC6	0.50	1	3.00	-0.31	-1.34E-03	-0.26	-0.26	-1.12E-03	-1.12E-03	2.72E-04
UN	TC6	0.50	2	3.03	-0.18	-7.71E-04					
UN	TC6	0.50	3	3.02	-0.31	-1.33E-03					
UN	TC6	0.50	4	3.00	-0.24	-1.04E-03					
UN	TC6	1.00	1	3.03	-0.38	-1.63E-03	-0.39	-0.39	-1.69E-03	-1.69E-03	2.69E-04
UN	TC6	1.00	2	3.01	-0.44	-1.90E-03					
UN	TC6	1.00	3	3.02	-0.31	-1.33E-03					
UN	TC6	1.00	4	3.01	-0.44	-1.90E-03					
DUP	TC6	1.00	1	3.02	-0.31	-1.33E-03	-0.35	-0.35	-1.48E-03	-1.48E-03	1.78E-04
DUP	TC6	1.00	2	3.03	-0.31	-1.33E-03					
DUP	TC6	1.00	3	3.01	-0.38	-1.64E-03					
DUP	TC6	1.00	4	3.01	-0.38	-1.64E-03					
SB	TC6	1.00	1	3.00	-0.58	-2.51E-03	-0.71	-0.71	-3.07E-03	-3.07E-03	3.97E-04
SB	TC6	1.00	2	3.01	-0.71	-3.06E-03					
SB	TC6	1.00	3	3.01	-0.78	-3.36E-03					
SB	TC6	1.00	4	3.03	-0.78	-3.34E-03					
MB	TC6		1	0.00	-0.24	-3.41E-06	-0.16	-0.16	-2.27E-06	-2.27E-06	8.90E-07
MB	TC6		2	0.00	-0.11	-1.56E-06					
MB	TC6		3	0.00	-0.18	-2.55E-06					
MB	TC6		4	0.00	-0.11	-1.56E-06					

**Table B.3 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
UN	TC6	1.75	1	3.00	0.09	3.89E-04		0.20	0.20	8.70E-04	8.70E-04	1.02E-03
UN	TC6	1.75	2	3.03	0.55	2.36E-03						
UN	TC6	1.75	3	3.00	0.15	6.49E-04						
UN	TC6	1.75	4	3.02	0.02	8.59E-05						
UN	TC6	2.50	1	3.02	1.68	7.22E-03	1.47	1.47	6.30E-03	6.30E-03	7.72E-04	
UN	TC6	2.50	2	3.00	1.28	5.54E-03						
UN	TC6	2.50	3	3.03	1.55	6.64E-03						
UN	TC6	2.50	4	3.02	1.35	5.80E-03						
STD (39 ppb)	TC6		6	0.00	38.29	3.62E-01	38.29	38.29	3.62E-01	3.62E-01		
UN	TC6	3.25	1	3.02	-1.37	-5.89E-03	-1.36	-1.36	-5.83E-03	-5.83E-03	1.25E-04	
UN	TC6	3.25	2	3.03	-1.37	-5.87E-03						
UN	TC6	3.25	3	3.01	-1.31	-5.65E-03						
UN	TC6	3.25	4	3.00	-1.37	-5.93E-03						
UN	TC7	0.50	1	3.00	2.05	8.87E-03	1.94	1.08	7.73E-03	9.30E-03	1.10E-03	
UN	TC7	0.50	2	3.00	1.80	7.78E-03						
UN	TC7	0.50	3	3.00	1.99	8.61E-03						
UN	TC7	0.50	4	3.00	1.92	8.30E-03						
UN	TC7	0.50	5	3.00	1.42	6.14E-03						
UN	TC7	0.50	6	3.00	1.54	6.66E-03						
SB	TC7	0.50	1	3.00	0.91	3.94E-03	0.87	0.87	3.74E-03	3.74E-03	4.77E-04	
SB	TC7	0.50	2	3.00	0.72	3.11E-03						
SB	TC7	0.50	3	3.00	0.85	3.68E-03						
SB	TC7	0.50	4	3.00	0.98	4.24E-03						
UN	TC7	1.00	1	3.02	0.62	2.66E-03	0.47	0.47	2.01E-03	2.01E-03	8.23E-04	
UN	TC7	1.00	2	3.04	0.42	1.79E-03						
UN	TC7	1.00	3	3.03	0.22	9.42E-04						
UN	TC7	1.00	4	3.03	0.62	2.65E-03						
UN	TC7	1.75	1	3.00	1.35	5.84E-03	1.30	1.30	5.62E-03	5.62E-03	4.45E-04	
UN	TC7	1.75	2	3.02	1.22	5.24E-03						
UN	TC7	1.75	3	3.00	1.42	6.14E-03						
UN	TC7	1.75	4	3.01	1.22	5.26E-03						
SPK #5	TC7	1.75	1	3.03	41.14	1.76E-01	39.57	39.57	1.70E-01	1.70E-01	5.26E-03	
SPK #5	TC7	1.75	2	3.02	39.88	1.71E-01						
SPK #5	TC7	1.75	3	3.02	38.95	1.67E-01						
SPK #5	TC7	1.75	4	3.03	38.29	1.64E-01						
SB	TC7	1.75	1	3.03	0.02	8.56E-05	-0.05	-0.05	-2.05E-04	-2.05E-04	2.29E-04	
SB	TC7	1.75	2	3.00	-0.05	-2.16E-04						
SB	TC7	1.75	3	3.03	-0.05	-2.14E-04						
SB	TC7	1.75	4	3.01	-0.11	-4.74E-04						
UN	TC7	2.50	1	3.03	-0.38	-1.63E-03	-0.55	-0.55	-2.35E-03	-2.35E-03	7.72E-04	
UN	TC7	2.50	2	3.00	-0.44	-1.90E-03						
UN	TC7	2.50	3	3.02	-0.58	-2.49E-03						
UN	TC7	2.50	4	3.00	-0.78	-3.37E-03						
UN	TC7	3.25	1	3.00	-1.71	-7.40E-03	-0.68	-0.68	-2.93E-03	-2.93E-03	3.86E-03	
UN	TC7	3.25	2	3.01	-0.16	-6.77E-04						
UN	TC7	3.25	4	3.03	-0.17	-7.32E-04						

**Table B.4** Raw data for  $\beta$ -glucosidase activity in 2009

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )					
UN	TC1	0.50	1	3.04	-0.22	-1.88E-03		-0.21	-0.21	-4.40E-04	-4.40E-04	2.51E-04
UN	TC1	0.50	2	3.02	-0.22	-1.89E-03						
UN	TC1	0.50	3	3.03	-0.22	-1.89E-03						
UN	TC1	0.50	4	3.00	-0.16	-1.38E-03						
SPK#9	TC1	0.50	1	3.00	1.81	1.56E-02	2.27	2.27	4.87E-03	4.87E-03	8.29E-03	
SPK	TC1	0.50	2	3.03	1.69	1.45E-02						
SPK	TC1	0.50	3	3.03	3.72	3.19E-02						
SPK	TC1	0.50	4	3.04	1.87	1.60E-02						
SB	TC1	0.50	1	3.01	-0.40	-3.44E-03	3.95	3.95	8.49E-03	8.49E-03	4.89E-02	
SB	TC1	0.50	2	3.03	4.83	4.14E-02						
SB	TC1	0.50	3	3.01	-0.28	-2.42E-03						
SB	TC1	0.50	4	3.01	11.63	1.00E-01						
UN	TC1	1.00	1	3.03	-0.28	-2.40E-03	-0.28	-0.28	-6.01E-04	-6.01E-04	8.16E-06	
UN	TC1	1.00	2	3.01	-0.28	-2.42E-03						
UN	TC1	1.00	3	3.02	-0.28	-2.41E-03						
UN	TC1	1.00	4	3.02	-0.28	-2.41E-03						
UN	TC1	1.75	1	3.02	-0.16	-1.38E-03	-0.08	-0.08	-1.77E-04	-1.77E-04	2.03E-03	
UN	TC1	1.75	2	3.03	0.27	2.31E-03						
UN	TC1	1.75	3	3.01	-0.22	-1.90E-03						
UN	TC1	1.75	4	3.03	-0.22	-1.88E-03						
UN	TC1	2.50	1	3.02	-0.22	-1.89E-03	-0.28	-0.28	-6.01E-04	-6.01E-04	4.13E-04	
UN	TC1	2.50	2	3.02	-0.28	-2.40E-03						
UN	TC1	2.50	3	3.04	-0.34	-2.90E-03						
UN	TC1	2.50	4	3.01	-0.28	-2.41E-03						
STD			1		30.44	1.15E+00	30.44		1.15E+00			
UN	TC1	3.25	1	3.03	-0.28	-2.40E-03	-0.30	-0.30	-6.34E-04	-6.34E-04	4.86E-04	
UN	TC1	3.25	2	3.03	-0.34	-2.91E-03						
UN	TC1	3.25	3	3.00	-0.22	-1.90E-03						
UN	TC1	3.25	4	3.02	-0.34	-2.92E-03						
UN	TC2	0.50	1	3.01	-0.28	-2.42E-03	-0.31	-0.31	-6.68E-04	-6.68E-04	5.19E-04	
UN	TC2	0.50	2	3.01	-0.28	-2.42E-03						
UN	TC2	0.50	3	3.02	-0.28	-2.41E-03						
UN	TC2	0.50	4	3.01	-0.40	-3.45E-03						
UN	TC2	1.00	1	3.01	1.26	1.09E-02	0.08	0.08	1.62E-04	1.62E-04	6.84E-03	
UN	TC2	1.00	2	3.01	-0.22	-1.90E-03						
UN	TC2	1.00	3	3.01	-0.34	-2.94E-03						
UN	TC2	1.00	4	3.02	-0.40	-3.44E-03						
DUP	TC2	1.00	1	3.01	-0.22	-1.89E-03	-0.24	-0.24	-5.07E-04	-5.07E-04	2.61E-04	
DUP	TC2	1.00	2	3.02	-0.22	-1.89E-03						
DUP	TC2	1.00	3	3.01	-0.22	-1.90E-03						
DUP	TC2	1.00	4	3.01	-0.28	-2.42E-03						
SB	TC2	1.00	1	3.02	-0.59	-5.08E-03	-0.42	-0.42	-9.01E-04	-9.01E-04	2.29E-03	
SB	TC2	1.00	2	3.04	-0.47	-4.01E-03						
SB	TC2	1.00	3	3.01	-0.59	-5.08E-03						
SB	TC2	1.00	4	3.03	-0.03	-2.57E-04						
MB			1		0.21	5.96E-06	0.18	0.18	1.80E-01	1.80E-01	1.70E-06	
MB			2		0.21	5.96E-06						
MB			3		0.21	5.96E-06						
MB			4		0.09	2.55E-06						
UN	TC2	1.75	1	3.03	-0.03	-2.57E-04	-0.05	-0.05	-1.02E-04	-1.02E-04	6.89E-04	
UN	TC2	1.75	2	3.01	-0.03	-2.59E-04						
UN	TC2	1.75	3	3.02	-0.16	-1.37E-03						
UN	TC2	1.75	4	3.01	0.03	2.58E-04						
UN	TC2	2.50	1	3.03	-0.16	-1.37E-03	-0.05	-0.05	-1.02E-04	-1.02E-04	6.86E-04	
UN	TC2	2.50	2	3.03	-0.03	-2.57E-04						
UN	TC2	2.50	3	3.03	-0.03	-2.57E-04						
UN	TC2	2.50	4	3.04	0.03	2.56E-04						
UN	TC2	3.25	1	3.03	0.03	2.57E-04	0.06	0.06	1.29E-04	1.29E-04	5.14E-04	
UN	TC2	3.25	2	3.03	0.15	1.29E-03						
UN	TC2	3.25	3	3.02	0.03	2.57E-04						
UN	TC2	3.25	4	3.01	0.03	2.59E-04						
STD			2		2.37	8.97E-02	2.37		8.97E-02			

**Table B.4 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
SB	TC3	0.50	1	3.00	0.40	3.46E-03		0.44	0.44	9.56E-04	9.56E-04	2.67E-03
SB	TC3	0.50	2	3.00	0.27	2.33E-03						
SB	TC3	0.50	3	3.01	0.21	1.81E-03						
SB	TC3	0.50	4	3.00	0.89	7.69E-03						
UN	TC3	1.00	1	3.01	-0.47	-4.05E-03		-0.36	-0.36	-7.74E-04	-7.74E-04	3.33E-03
UN	TC3	1.00	2	3.03	-0.53	-4.53E-03						
UN	TC3	1.00	3	3.01	0.21	1.81E-03						
UN	TC3	1.00	4	3.01	-0.65	-5.61E-03						
SB	TC3	1.00	1	3.02	-0.90	-7.72E-03		-0.76	-0.76	-1.63E-03	-1.63E-03	1.08E-03
SB	TC3	1.00	2	3.00	-0.65	-5.62E-03						
SB	TC3	1.00	3	3.00	-0.65	-5.61E-03						
SB	TC3	1.00	4	3.01	-0.83	-7.16E-03						
UN	TC3	1.75	1	3.01	-0.22	-1.90E-03		-0.26	-0.26	-5.65E-04	-5.65E-04	1.52E-03
UN	TC3	1.75	2	3.02	-0.40	-3.44E-03						
UN	TC3	1.75	3	3.01	-0.40	-3.45E-03						
UN	TC3	1.75	4	3.02	-0.03	-2.58E-04						
SPK#2	TC3	1.75	1	3.00	10.12	8.74E-02		10.15	10.15	2.19E-02	2.19E-02	2.34E-03
SPK	TC3	1.75	2	3.01	10.49	9.05E-02						
SPK	TC3	1.75	3	3.02	10.12	8.71E-02						
SPK	TC3	1.75	4	3.02	9.88	8.48E-02						
SB	TC3	1.75	1	3.00	-0.71	-6.14E-03		-0.45	-0.45	-9.65E-04	-9.65E-04	4.88E-03
SB	TC3	1.75	2	3.02	-0.71	-6.11E-03						
SB	TC3	1.75	3	3.01	0.40	3.44E-03						
SB	TC3	1.75	4	3.01	-0.77	-6.64E-03						
UN	TC3	2.50	1	3.02	-0.16	-1.37E-03		-0.16	-0.16	-3.39E-04	-3.39E-04	8.77E-04
UN	TC3	2.50	2	3.01	-0.16	-1.38E-03						
UN	TC3	2.50	3	3.02	-0.03	-2.58E-04						
UN	TC3	2.50	4	3.02	-0.28	-2.41E-03						
UN	TC3	3.25	1	3.00	-0.53	-4.58E-03		-0.44	-0.44	-9.39E-04	-9.39E-04	7.15E-04
UN	TC3	3.25	2	3.01	-0.47	-4.05E-03						
UN	TC3	3.25	3	3.00	-0.34	-2.94E-03						
UN	TC3	3.25	4	3.00	-0.40	-3.46E-03						
STD					10.12	3.83E-01		10.12		3.83E-01		
UN	TC4	0.50	1	3.03	1.75	1.50E-02		1.88	1.79	4.03E-03	3.85E-03	4.76E-03
UN	TC4	0.50	2	3.01	2.31	1.99E-02						
UN	TC4	0.50	3	3.00	1.14	9.86E-03						
UN	TC4	0.50	4	3.04	2.31	1.98E-02						
SB	TC4	0.50	1	3.00	0.21	1.81E-03		0.09	0.09	1.88E-04	1.88E-04	1.44E-03
SB	TC4	0.50	2	3.01	0.15	1.29E-03						
SB	TC4	0.50	3	3.04	-0.16	-1.37E-03						
SB	TC4	0.50	4	3.01	0.15	1.29E-03						
UN	TC4	1.00	1	3.00	7.05	6.09E-02		5.82	4.62	1.25E-02	9.95E-03	7.47E-03
UN	TC4	1.00	2	3.02	5.08	4.37E-02						
UN	TC4	1.00	3	3.02	5.57	4.78E-02						
UN	TC4	1.00	4	3.01	5.57	4.81E-02						
SB	TC4	1.00	1	3.03	1.14	9.76E-03		1.20	1.20	2.57E-03	2.57E-03	5.37E-03
SB	TC4	1.00	2	3.01	1.01	8.70E-03						
SB	TC4	1.00	3	3.03		0.00E+00						
SB	TC4	1.00	4	3.02	1.44	1.24E-02						
MB			1		-0.34	-9.65E-06		-0.42	-0.42	-4.18E-01	-4.18E-01	2.27E-06
MB			2		-0.40	-1.14E-05						
MB			3		-0.40	-1.14E-05						
MB			4		-0.53	-1.50E-05						
UN	TC4	1.75	1	3.02	4.58	3.94E-02		5.74	4.91	1.23E-02	1.05E-02	9.85E-03
UN	TC4	1.75	2	3.02	6.98	5.99E-02						
UN	TC4	1.75	3	3.03	6.43	5.51E-02						
UN	TC4	1.75	4	3.02	4.95	4.26E-02						
SB	TC4	1.75	1	3.01	1.07	9.22E-03		0.83	0.83	1.78E-03	1.78E-03	1.50E-03
SB	TC4	1.75	2	3.01	0.70	6.04E-03						
SB	TC4	1.75	3	3.03	0.83	7.12E-03						
SB	TC4	1.75	4	3.01	0.70	6.03E-03						
UN	TC4	2.50	1	3.02	12.89	1.11E-01		8.88	6.53	1.90E-02	1.40E-02	2.74E-02



**Table B.4 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
STD					45.71		1.73E+00	45.71		1.73E+00		
SB	TC4	2.50	1	3.01	0.46		3.97E-03	2.34	2.34	5.04E-03	5.04E-03	1.77E-02
SB	TC4	2.50	2	3.03	1.07		9.17E-03					
SB	TC4	2.50	3	3.01	5.04		4.35E-02					
SB	TC4	2.50	4	3.00	2.80		2.42E-02					
UN	TC4	3.25	1	3.02	-0.77		-6.62E-03	-0.68	-0.68	-1.46E-03	-1.46E-03	5.09E-04
UN	TC4	3.25	2	3.02	-0.65		-5.59E-03					
UN	TC4	3.25	3	3.01	-0.65		-5.60E-03					
UN	TC4	3.25	4	3.01	-0.65		-5.60E-03					
UN	TC5	0.50	1	3.03	2.74		2.34E-02	1.88	1.88	4.02E-03	4.02E-03	5.17E-03
UN	TC5	0.50	2	3.02	1.32		1.13E-02					
UN	TC5	0.50	3	3.02	1.69		1.45E-02					
UN	TC5	0.50	4	3.02	1.75		1.51E-02					
SB	TC5	0.50	1	3.02	-0.21		-1.78E-03	-1.61	-1.61	-3.46E-03	-3.46E-03	8.15E-03
SB	TC5	0.50	2	3.01	-2.19		-1.89E-02					
SB	TC5	0.50	3	3.00	-2.16		-1.87E-02					
SB	TC5	0.50	4	3.03	-1.88		-1.61E-02					
UN	TC5	1.00	1	3.02	3.47		2.98E-02	3.51	3.51	7.53E-03	7.53E-03	1.68E-02
UN	TC5	1.00	2	3.03	3.54		3.03E-02					
UN	TC5	1.00	3	3.01	0.21		1.81E-03					
UN	TC5	1.00	4	3.03	0.03		2.57E-04					
SB	TC5	1.00	1	3.03	-1.51		-1.29E-02	-1.88	-1.88	-4.04E-03	-4.04E-03	2.23E-03
SB	TC5	1.00	2	3.03	-1.94		-1.66E-02					
SB	TC5	1.00	3	3.00	-2.07		-1.79E-02					
SB	TC5	1.00	4	3.01	-2.00		-1.73E-02					
STD			4		62.64		2.37E+00					
UN	TC5	1.75	1	3.04	129.10		1.10E+00	119.19	119.19	2.56E-01	2.56E-01	1.28E-01
UN	TC5	1.75	2	3.02	100.80		8.67E-01					
UN	TC5	1.75	3	3.04	134.35		1.15E+00					
UN	TC5	1.75	4	3.01	112.50		9.70E-01					
SB	TC5	1.75	1	3.00	-0.22		-1.90E-03	-0.17	-0.17	-3.72E-04	-3.72E-04	3.14E-03
SB	TC5	1.75	2	3.00	-0.03		-2.59E-04					
SB	TC5	1.75	3	3.01	-0.65		-5.61E-03					
SB	TC5	1.75	4	3.01	0.21		1.81E-03					
UN	TC5	2.50	1	3.04	1.63		1.39E-02	3.14	3.14	6.73E-03	6.73E-03	1.60E-02
UN	TC5	2.50	2	3.01	5.81		5.01E-02					
UN	TC5	2.50	3	3.03	2.24		1.92E-02					
UN	TC5	2.50	4	3.02	2.86		2.46E-02					
SB	TC5	2.50	1	3.03	-1.82		-1.56E-02	-1.87	-1.87	-4.02E-03	-4.02E-03	3.14E-04
SB	TC5	2.50	2	3.01	-1.88		-1.62E-02					
SB	TC5	2.50	3	3.01	-1.88		-1.62E-02					
SB	TC5	2.50	4	3.00	-1.88		-1.62E-02					
UN	TC5	3.25	1	3.01	-2.07		-1.79E-02	-2.13	-2.13	-4.59E-03	-4.59E-03	9.19E-03
UN	TC5	3.25	2	3.02	-2.13		-1.83E-02					
UN	TC5	3.25	3	3.01			0.00E+00					
UN	TC5	3.25	4	3.00	-2.19		-1.89E-02					
STD			5		63.31		2.40E+00	63.31		2.40E+00		
MB			1		-2.13		-6.05E-05	-2.02	-2.02	-2.02E+00	-2.02E+00	5.03E-06
MB			2		-2.07		-5.88E-05					
MB			3		-1.76		-5.00E-05					
MB			4		-2.13		-6.05E-05					
UN	TC6	0.50	1	3.04	4.77		4.08E-02	4.20	4.20	9.03E-03	9.03E-03	9.11E-03
UN	TC6	0.50	2	3.02	5.08		4.37E-02					
UN	TC6	0.50	3	3.00	2.67		2.31E-02					
UN	TC6	0.50	4	3.02	4.28		3.68E-02					
DUP	TC6	0.50	1	3.01	1.69		1.46E-02	2.86	2.86	6.13E-03	6.13E-03	1.03E-02
DUP	TC6	0.50	2	3.02	1.94		1.67E-02					
DUP	TC6	0.50	3	3.05	3.78		3.22E-02					
DUP	TC6	0.50	4	3.04	4.03		3.44E-02					
SB	TC6	0.50	1	3.02	-1.59		-1.37E-02	-1.67	-1.67	-3.59E-03	-3.59E-03	4.47E-04
SB	TC6	0.50	2	3.05	-1.70		-1.45E-02					
SB	TC6	0.50	3	3.00	-1.70		-1.47E-02					

**Table B.4 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
UN	TC6	1.00	1	3.00	-1.57	-1.36E-02	-1.76	-1.76	-3.77E-03	-3.77E-03	2.49E-03	
UN	TC6	1.00	2	3.04	-1.45	-1.24E-02						
UN	TC6	1.00	3	3.03	-2.00	-1.71E-02						
UN	TC6	1.00	4	3.01	-2.00	-1.72E-02						
SB	TC6	1.00	1	3.04	-1.33	-1.13E-02	-1.59	-1.59	-3.39E-03	-3.39E-03	3.58E-03	
SB	TC6	1.00	2	3.04	-1.14	-9.74E-03						
SB	TC6	1.00	3	3.04	-1.88	-1.60E-02						
SB	TC6	1.00	4	3.03	-2.00	-1.71E-02						
UN	TC6	1.75	1	3.02	0.58	4.99E-03	0.29	0.29	6.32E-04	6.32E-04	2.14E-03	
UN	TC6	1.75	2	3.01	3.17	2.73E-02						
UN	TC6	1.75	3	3.01	0.15	1.29E-03						
UN	TC6	1.75	4	3.01	0.15	1.29E-03						
SB	TC6	1.75	1	3.01	3.97	3.42E-02	-1.41	-1.41	-1.21E-02	-1.21E-02	2.32E-02	
SB	TC6	1.75	2	3.01	-1.70	-1.46E-02						
SB	TC6	1.75	3	3.01	-1.20	-1.03E-02						
SB	TC6	1.75	4	3.02	-1.33	-1.14E-02						
UN	TC6	2.50	1	3.00	29.08	2.51E-01	34.78	34.78	7.48E-02	7.48E-02	1.20E-01	
UN	TC6	2.50	2	3.04	55.80	4.76E-01						
UN	TC6	2.50	3	3.01	25.27	2.18E-01						
UN	TC6	2.50	4	3.02	28.95	2.49E-01						
STD			6		18.93	7.16E-01	18.93		7.16E-01			
UN	TC6	3.25	1	3.03	-1.57	-1.34E-02	-1.56	-1.56	-3.34E-03	-3.34E-03	2.15E-04	
UN	TC6	3.25	2	3.01	-1.57	-1.35E-02						
UN	TC6	3.25	3	3.00	-1.51	-1.30E-02						
UN	TC6	3.25	4	3.03	-1.57	-1.34E-02						
UN	TC7	0.50	1	3.04	48.78	4.17E-01	54.20	53.73	1.16E-01	1.15E-01	6.82E-02	
UN	TC7	0.50	2	3.02	46.51	4.00E-01						
UN	TC7	0.50	3	3.03	59.00	5.06E-01						
UN	TC7	0.50	4	3.00	62.51	5.40E-01						
SB	TC7	0.50	1	3.00	-0.10	-8.65E-04	0.47	0.47	1.02E-03	1.02E-03	9.19E-03	
SB	TC7	0.50	2	3.02	2.06	1.77E-02						
SB	TC7	0.50	3	3.01	-0.22	-1.90E-03						
SB	TC7	0.50	4	3.04	0.15	1.28E-03						
MB			1		-1.88	-5.34E-05	-2.19	-2.19	-2.19E+00	-2.19E+00	1.21E-05	
MB			2		-2.07	-5.88E-05						
MB			3		-2.00	-5.68E-05						
MB			4		-2.82	-8.00E-05						
UN	TC7	1.00	1	3.02	20.96	1.80E-01	18.73	18.73	4.02E-02	4.02E-02	2.13E-02	
UN	TC7	1.00	2	3.02	16.34	1.41E-01						
UN	TC7	1.00	3	3.02	16.83	1.44E-01						
UN	TC7	1.00	4	3.02	20.77	1.79E-01						
SPK #												
7	TC7	1.00	1	3.01	36.10	3.11E-01	34.52	34.52	7.42E-02	7.42E-02	1.18E-02	
SPK	TC7	1.00	2	3.04	33.39	2.85E-01						
SPK	TC7	1.00	3	3.01	34.99	3.02E-01						
SPK	TC7	1.00	4	3.01	33.58	2.89E-01						
SB	TC7	1.00	1	3.03	-0.77	-6.60E-03	-0.58	-0.58	-1.24E-03	-1.24E-03	1.13E-03	
SB	TC7	1.00	2	3.01	-0.53	-4.58E-03						
SB	TC7	1.00	3	3.00	-0.47	-4.06E-03						
SB	TC7	1.00	4	3.02	-0.53	-4.56E-03						
UN	TC7	1.75	1	3.01	110.65	9.54E-01	138.43	138.43	2.98E-01	2.98E-01	4.26E-01	
UN	TC7	1.75	2	3.00	202.05	1.75E+00						
UN	TC7	1.75	3	3.02	150.35	1.29E+00						
UN	TC7	1.75	4	3.02	90.65	7.80E-01						
SB	TC7	1.75	1	3.02	-0.96	-8.25E-03	-1.00	-1.00	-2.15E-03	-2.15E-03	4.84E-03	
SB	TC7	1.75	2	3.01	-0.71	-6.12E-03						
SB	TC7	1.75	3	3.01	-1.33	-1.15E-02						
SB	TC7	2.50	3	3.01		0.00E+00						
SB	TC7	2.50	4	3.01		0.00E+00						
UN	TC7	3.25	1	3.03	-1.57	-1.35E-02	-1.97	-1.97	-4.23E-03	-4.23E-03	2.41E-03	
UN	TC7	3.25	2	3.02	-2.00	-1.72E-02						
UN	TC7	3.25	3	3.04	-2.13	-1.82E-02						

**Table B.5** Raw data for exo 1,4- $\beta$ -glucanase activity in 2009

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
UN	TC1	0.50	1	3.04	0.11	2.35E-04	0.30	-0.02	6.35E-04	-3.23E-05	2.91E-04	
UN	TC1	0.50	2	3.01	0.29	6.24E-04						
UN	TC1	0.50	3	3.00	0.36	7.78E-04						
UN	TC1	0.50	4	3.01	0.42	9.06E-04						
UN	TC1	1.00	1	3.02	0.36	7.74E-04	0.36	0.05	7.67E-04	1.02E-04	1.94E-04	
UN	TC1	1.00	2	3.02	0.42	9.02E-04						
UN	TC1	1.00	3	3.02	0.42	9.03E-04						
UN	TC1	1.00	4	3.04	0.23	4.92E-04						
UN	TC1	1.75	1	3.02	0.48	1.03E-03	0.41	0.10	8.72E-04	2.04E-04	3.05E-04	
UN	TC1	1.75	2	3.00	0.55	1.19E-03						
UN	TC1	1.75	3	3.03	0.23	4.93E-04						
UN	TC1	1.75	4	3.01	0.36	7.76E-04						
SPK	TC1	1.75	1	3.03	46.26	9.89E-02	45.60	45.60				
SPK	TC1	1.75	2	3.01	45.63	9.84E-02						
SPK	TC1	1.75	3	3.01	45.70	9.86E-02						
SPK	TC1	1.75	4	3.00	44.82	9.68E-02						
SB	TC1	1.75	1	3.01	0.48	1.03E-03	0.31	0.31	6.66E-04	6.66E-04		
SB	TC1	1.75	2	3.01	0.24	5.17E-04						
SB	TC1	1.75	3	3.04	0.23	4.91E-04						
SB	TC1	1.75	4	3.02	0.29	6.23E-04						
UN	TC1	2.50	1	3.01	0.67	1.44E-03	0.72	0.41	1.55E-03	8.78E-04	1.34E-04	
UN	TC1	2.50	2	3.02	0.67	1.44E-03						
UN	TC1	2.50	3	3.01	0.73	1.58E-03						
UN	TC1	2.50	4	3.01	0.80	1.72E-03						
STD			1	0.00	45.19	1.71E+00	45.19	45.19				
UN	TC1	3.25	1	3.00	0.36	7.78E-04	0.42	0.11	9.04E-04	2.37E-04	1.05E-04	
UN	TC1	3.25	2	3.02	0.42	9.02E-04						
UN	TC1	3.25	3	3.02	0.42	9.02E-04						
UN	TC1	3.25	4	3.01	0.48	1.03E-03						
UN	TC2	0.50	1	3.01	0.36	7.76E-04	0.34	0.03	7.26E-04	5.75E-05	8.59E-05	
UN	TC2	0.50	3	3.01	0.29	6.25E-04						
UN	TC2	0.50	4	3.02	0.36	7.73E-04						
UN	TC2	1.00	1	3.00	0.17	3.67E-04	0.22	-0.10	4.64E-04	-2.05E-04	1.24E-04	
UN	TC2	1.00	2	3.01	0.17	3.67E-04						
UN	TC2	1.00	3	3.01	0.29	6.26E-04						
UN	TC2	1.00	4	3.01	0.23	4.95E-04						
MB			1		3.56	1.01E-01	3.37	3.37		9.57E-02		
MB			2		6.89	1.96E-01						
MB			3		1.61	4.57E-02						
MB			4		1.43	4.06E-02						
UN	TC2	1.75	1	3.03	0.42	9.00E-04	0.34	0.03	7.24E-04	5.73E-05	2.09E-04	
UN	TC2	1.75	2	3.03	0.23	4.92E-04						
UN	TC2	1.75	4	3.01	0.36	7.77E-04						
UN	TC2	2.50	1	3.04	0.36	7.68E-04	0.30	-0.02	6.32E-04	-3.21E-05	1.91E-04	
UN	TC2	2.50	2	3.02	0.17	3.65E-04						
UN	TC2	2.50	3	3.03	0.29	6.22E-04						
UN	TC2	2.50	4	3.03	0.36	7.72E-04						
UN	TC2	3.25	1	3.04	0.23	4.92E-04	0.22	-0.10	4.62E-04	-2.04E-04	1.62E-04	
UN	TC2	3.25	2	3.02	0.11	2.36E-04						
UN	TC2	3.25	3	3.00	0.23	4.97E-04						
UN	TC2	3.25	4	3.02	0.29	6.23E-04						
STD			2	0.00	13.86	5.24E-01	13.86	13.86				
UN	TC3	0.50	1	3.03	1.36	2.91E-03	1.34	0.01	2.88E-03	1.61E-05	4.77E-04	
UN	TC3	0.50	2	3.01	1.55	3.35E-03						
UN	TC3	0.50	3	3.01	1.11	2.39E-03						
UN	TC3	0.50	4	3.02	3.81	8.19E-03						
SB	TC3	0.50	1	3.00	1.49	3.22E-03	1.33	1.33	2.87E-03	2.87E-03		
SB	TC3	0.50	2	3.03	1.11	2.38E-03						
SB	TC3	0.50	3	3.00	1.24	2.68E-03						
SB	TC3	0.50	4	3.00	1.49	3.22E-03						
UN	TC3	1.00	1	3.01	0.80	1.72E-03	0.83	-0.14	1.79E-03	-3.07E-04	7.45E-05	
UN	TC3	1.00	2	3.02	0.80	1.72E-03						

**Table B.5 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
SB	TC3	1.00	1	3.02	1.43	3.07E-03		0.97	0.97	2.09E-03	2.09E-03	
SB	TC3	1.00	2	3.01	1.05	2.27E-03						
SB	TC3	1.00	3	3.01	0.80	1.72E-03						
SB	TC3	1.00	4	3.00	0.61	1.32E-03						
UN	TC3	1.75	1	3.02	0.67	1.44E-03		0.53	0.06	1.14E-03	1.35E-04	1.18E-03
UN	TC3	1.75	2	3.01	1.24	2.68E-03						
UN	TC3	1.75	3	3.00	0.13	2.81E-04						
UN	TC3	1.75	4	3.02	0.07	1.50E-04						
SPK (30 ppb)	TC3	1.75	1	3.02	27.80	5.98E-02		27.99	27.99			
SPK	TC3	1.75	2	3.01	29.87	6.45E-02						
SPK	TC3	1.75	3	3.02	25.13	5.40E-02						
SPK	TC3	1.75	4	3.03	29.16	6.25E-02						
SB	TC3	1.75	1	3.02	0.39	8.38E-04		0.47	0.47	1.00E-03	1.00E-03	
SB	TC3	1.75	2	3.02	0.46	9.87E-04						
SB	TC3	1.75	3	3.01	0.42	9.05E-04						
SB	TC3	1.75	4	3.01	0.59	1.27E-03						
UN	TC3	2.50	1	3.01	0.65	1.40E-03		0.67	0.34	1.44E-03	7.39E-04	3.48E-04
UN	TC3	2.50	2	3.01	0.85	1.83E-03						
UN	TC3	2.50	3	3.00	0.46	9.94E-04						
UN	TC3	2.50	4	3.03	0.72	1.54E-03						
SB	TC3	2.50	1	3.02	5.07	1.09E-02		0.33	0.33	3.25E-03	3.25E-03	
SB	TC3	2.50	2	3.00	0.39	8.42E-04						
SB	TC3	2.50	3	3.01	0.33	7.12E-04						
SB	TC3	2.50	4	3.00	0.26	5.61E-04						
UN	TC3	3.25	1	3.02	0.12	2.58E-04		0.18	0.18	3.82E-04	3.82E-04	1.42E-04
UN	TC3	3.25	2	3.02	0.13	2.80E-04						
UN	TC3	3.25	3	3.00	0.20	4.32E-04						
UN	TC3	3.25	4	3.01	0.26	5.61E-04						
STD			3	0.00	0.33	1.25E-02		0.33	0.33			
UN	TC4	0.50	1	3.01	1.30	2.80E-03		1.74	0.86	3.74E-03	1.84E-03	8.15E-04
UN	TC4	0.50	2	3.03	1.82	3.90E-03						
UN	TC4	0.50	3	3.02	2.21	4.75E-03						
UN	TC4	0.50	4	3.02	1.62	3.48E-03						
SB	TC4	0.50	1	3.02	1.04	2.24E-03		0.88	0.88	1.89E-03	1.89E-03	2.86E-04
SB	TC4	0.50	2	3.00	0.91	1.97E-03						
SB	TC4	0.50	3	3.03	0.85	1.82E-03						
SB	TC4	0.50	4	3.01	0.72	1.55E-03						
UN	TC4	1.00	1	3.04	2.73	5.83E-03		2.58	1.43	5.54E-03	3.06E-03	6.13E-04
UN	TC4	1.00	2	3.00	2.86	6.18E-03						
UN	TC4	1.00	3	3.03	2.53	5.43E-03						
UN	TC4	1.00	4	3.02	2.21	4.75E-03						
SB	TC4	1.00	1	3.01	1.04	2.24E-03		1.16	1.16	2.48E-03	2.48E-03	2.38E-04
SB	TC4	1.00	2	3.04	1.17	2.50E-03						
SB	TC4	1.00	3	3.02	1.11	2.39E-03						
SB	TC4	1.00	4	3.01	1.30	2.80E-03						
MB			1		0.26	7.38E-03		0.23	0.23		6.53E-03	
MB			2		0.20	5.68E-03						
MB			3		0.33	9.37E-03						
MB			4		0.13	3.69E-03						
UN	TC4	1.75	1	3.01	1.69	3.64E-03		2.05	0.38	4.41E-03	8.08E-04	8.81E-04
UN	TC4	1.75	2	3.00	2.40	5.19E-03						
UN	TC4	1.75	3	3.01	1.69	3.64E-03						
UN	TC4	1.75	4	3.03	2.40	5.15E-03						
SB	TC4	1.75	1	3.02	1.69	3.63E-03		1.67	1.67	3.60E-03	3.60E-03	1.32E-04
SB	TC4	1.75	2	3.01	1.75	3.77E-03						
SB	TC4	1.75	3	3.00	1.62	3.50E-03						
SB	TC4	1.75	4	3.01	1.62	3.49E-03						
UN	TC4	2.50	1	3.03	2.86	6.13E-03		2.76	1.07	5.93E-03	2.31E-03	3.60E-04
UN	TC4	2.50	2	3.02	2.53	5.44E-03						
UN	TC4	2.50	3	3.02	2.92	6.26E-03						
UN	TC4	2.50	4	3.00	2.73	5.90E-03						

**Table B.5 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)			(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
SB	TC4	2.50	1	3.02	2.14	4.60E-03	1.69	1.69	3.62E-03	3.62E-03		
SB	TC4	2.50	2	3.01	1.43	3.08E-03						
SB	TC4	2.50	3	3.03	1.56	3.35E-03						
SB	TC4	2.50	4	3.03	1.62	3.47E-03						
UN	TC4	3.25	1	3.06	0.26	5.51E-04	0.31	0.31	6.64E-04	6.64E-04	2.14E-04	
UN	TC4	3.25	2	3.01	0.26	5.60E-04						
UN	TC4	3.25	3	3.02	0.26	5.59E-04						
UN	TC4	3.25	4	3.03	0.46	9.85E-04						
UN	TC5	0.50	1	3.00	0.98	2.12E-03	1.11	1.62	2.38E-03	3.49E-03	4.82E-04	
UN	TC5	0.50	2	3.04	0.98	2.09E-03						
UN	TC5	0.50	3	3.04	1.11	2.37E-03						
UN	TC5	0.50	4	3.00	1.36	2.94E-03						
SB	TC5	0.50	1	3.00	0.52	1.12E-03	-0.52	-0.52	-1.11E-03	-1.11E-03	1.78E-03	
SB	TC5	0.50	2	3.01	-0.97	-2.09E-03						
SB	TC5	0.50	3	3.03	-0.78	-1.67E-03						
SB	TC5	0.50	4	3.03	-0.84	-1.80E-03						
UN	TC5	1.00	1	3.02	-0.52	-1.12E-03	-0.36	-0.36	-7.64E-04	-7.64E-04	6.13E-04	
UN	TC5	1.00	2	3.03	-0.52	-1.12E-03						
UN	TC5	1.00	3	3.01	-0.45	-9.71E-04						
UN	TC5	1.00	4	3.00	0.07	1.51E-04						
SB	TC5	1.00	1	3.03	-0.65	-1.39E-03	-0.55	-0.55	-1.18E-03	-1.18E-03	4.46E-04	
SB	TC5	1.00	2	3.00	-0.58	-1.25E-03						
SB	TC5	1.00	3	3.02	-0.71	-1.53E-03						
SB	TC5	1.00	4	3.01	-0.26	-5.61E-04						
STD			4		53.90	2.04E+00	53.90	53.90				
UN	TC5	1.75	1	3.03	3.05	6.53E-03	6.67	5.91	1.43E-02	1.27E-02	4.25E-03	
UN	TC5	1.75	2	3.04	9.42	2.01E-02						
UN	TC5	1.75	3	3.01	7.21	1.56E-02						
UN	TC5	1.75	4	3.04	7.86	1.68E-02						
UN	TC5	1.75	1	3.01	6.75	1.45E-02						
UN	TC5	1.75	2	3.02	7.53	1.62E-02						
UN	TC5	1.75	3	3.03	7.01	1.50E-02						
UN	TC5	1.75	4	3.01	4.55	9.79E-03						
DUP	TC5	1.75	1	3.02	0.26	5.58E-04	0.77	0.77	1.65E-03	1.65E-03		
DUP	TC5	1.75	2	3.01	0.65	1.40E-03						
DUP	TC5	1.75	3	3.02	1.30	2.80E-03						
DUP	TC5	1.75	4	3.01	0.85	1.83E-03						
UN	TC5	2.50	1	3.03	-0.45	-9.63E-04	-0.18	-0.18	-3.76E-04	-3.76E-04	4.60E-04	
UN	TC5	2.50	2	3.03	-0.13	-2.79E-04						
UN	TC5	2.50	3	3.00	0.07	1.51E-04						
UN	TC5	2.50	4	3.03	-0.19	-4.07E-04						
SB	TC5	2.50	1	3.00	-1.17	-2.53E-03	-1.09	-1.09	-2.34E-03	-2.34E-03	2.32E-04	
SB	TC5	2.50	2	3.04	-0.97	-2.07E-03						
SB	TC5	2.50	3	3.01	-1.17	-2.52E-03						
SB	TC5	2.50	4	3.02	-1.04	-2.24E-03						
UN	TC5	3.25	1	3.05	-1.23	-2.62E-03	-1.22	-1.22	-2.61E-03	-2.61E-03	1.84E-04	
UN	TC5	3.25	2	3.01	-1.23	-2.66E-03						
UN	TC5	3.25	3	3.02	-1.10	-2.36E-03						
UN	TC5	3.25	4	3.01	-1.30	-2.80E-03						
STD			5		-0.78	-2.95E-02	-0.78	-0.78				
MB			1		-0.58	-1.65E-05	-0.65				-1.84E-05	
MB			2		-0.65	-1.84E-05						
MB			3		-0.71	-2.02E-05						
MB			4		-0.65	-1.84E-05						
UN	TC6	0.50	1	3.05	0.07	1.49E-04	0.20	0.20	4.28E-04	4.28E-04	3.96E-04	
UN	TC6	0.50	2	3.03	0.20	4.28E-04						
UN	TC6	0.50	3	3.01	0.46	9.90E-04						
UN	TC6	0.50	4	3.03	0.07	1.50E-04						
DUP	TC6	0.50	1	3.01	0.91	1.96E-03	0.34	0.34	7.36E-04	7.38E-04		
DUP	TC6	0.50	2	3.00	0.20	4.32E-04						
DUP	TC6	0.50	3	3.04	0.26	5.55E-04						
DUP	TC6	0.50	4	3.02	0.00	0.00E+00						

**Table B.5 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC6	1.00	1	3.01	-0.58	-1.25E-03	-0.54	-0.54	-1.15E-03	-1.15E-03	2.37E-04	
UN	TC6	1.00	2	3.01	-0.39	-8.41E-04						
UN	TC6	1.00	3	3.01	-0.52	-1.12E-03						
UN	TC6	1.00	4	3.01	-0.65	-1.40E-03						
SB	TC6	1.00	1	3.03	-0.97	-2.08E-03	-0.91	-0.91	-1.94E-03	-1.94E-03		
SB	TC6	1.00	2	3.04	-0.91	-1.94E-03						
SB	TC6	1.00	3	3.02	-0.84	-1.81E-03						
SB	TC6	1.00	4	3.04	-0.91	-1.95E-03						
UN	TC6	1.75	1	3.03	-0.19	-4.07E-04	-0.21	-0.21	-4.45E-04	-4.45E-04	1.71E-04	
UN	TC6	1.75	2	3.02	-0.32	-6.86E-04						
UN	TC6	1.75	3	3.00	-0.13	-2.81E-04						
UN	TC6	1.75	4	3.04	-0.19	-4.06E-04						
SB	TC6	1.75	1	3.02	-0.71	-1.53E-03	-0.89	-0.89	-1.92E-03	-1.92E-03		
SB	TC6	1.75	2	3.01	-1.04	-2.24E-03						
SB	TC6	1.75	3	3.01	-0.91	-1.96E-03						
SB	TC6	1.75	4	3.02	-0.91	-1.95E-03						
UN	TC6	2.50	1	3.00	0.33	7.13E-04	3.15	3.15	6.78E-03	6.78E-03	3.34E-04	
UN	TC6	2.50	2	3.03	8.31	1.78E-02						
UN	TC6	2.50	3	3.01	3.25	7.01E-03						
UN	TC6	2.50	4	3.03	3.05	6.54E-03						
SB	TC6	2.50	1	3.02	2.08	4.47E-03	1.75	1.75	3.76E-03	3.76E-03		
SB	TC6	2.50	2	3.04	1.95	4.16E-03						
SB	TC6	2.50	3	3.02	1.36	2.93E-03						
SB	TC6	2.50	4	3.01	1.62	3.49E-03						
STD			6		0.46	1.74E-02	0.46	0.46				
UN	TC6	3.25	1	3.00	-1.62	-3.50E-03	-1.38	-1.38	-2.97E-03	-2.97E-03	6.90E-04	
UN	TC6	3.25	2	3.04	-1.56	-3.33E-03						
UN	TC6	3.25	3	3.03	-1.43	-3.06E-03						
UN	TC6	3.25	4	3.00	-0.91	-1.97E-03						
UN	TC7	0.50	1	3.00	6.62	1.43E-02	5.68	5.50	1.22E-02	1.18E-02	1.63E-03	
UN	TC7	0.50	2	3.04	5.07	1.08E-02						
UN	TC7	0.50	3	3.02	5.13	1.10E-02						
UN	TC7	0.50	4	3.02	5.91	1.27E-02						
SB	TC7	0.50	1	3.03	-0.06	-1.29E-04	0.18	0.18	3.91E-04	3.91E-04		
SB	TC7	0.50	2	3.02	0.59	1.27E-03						
SB	TC7	0.50	3	3.03	-0.13	-2.79E-04						
SB	TC7	0.50	4	3.04	0.33	7.05E-04						
MB			1		-1.62	-4.60E-02	-1.57	-1.57				
MB			2		-1.62	-4.60E-02						
MB			3		-1.56	-4.43E-02						
MB			4		-1.49	-4.23E-02						
UN	TC7	1.00	1	3.01	0.46	9.92E-04	1.45	1.45	3.12E-03	3.12E-03	1.72E-03	
UN	TC7	1.00	2	3.01	1.17	2.52E-03						
UN	TC7	1.00	3	3.00	1.88	4.06E-03						
UN	TC7	1.00	4	3.01	2.27	4.89E-03						
DUP	TC7	1.00	1	3.01	1.82	3.92E-03	2.28	2.28	4.91E-03	4.91E-03		
DUP	TC7	1.00	2	3.02	5.78	1.24E-02						
DUP	TC7	1.00	3	3.00	0.98	2.12E-03						
DUP	TC7	1.00	4	3.00	0.52	1.12E-03						
SB	TC7	1.00	1	3.02	-0.19	-4.08E-04	-0.09	-0.09	-1.98E-04	-1.98E-04		
SB	TC7	1.00	2	3.04	-0.19	-4.06E-04						
SB	TC7	1.00	3	3.01	-0.06	-1.29E-04						
SB	TC7	1.00	4	3.02	0.07	1.51E-04						
UN	TC7	1.75	1	3.02	17.53	3.76E-02	28.36	28.36	6.10E-02	6.10E-02	1.96E-02	
UN	TC7	1.75	2	3.02	37.60	8.07E-02						
UN	TC7	1.75	3	3.01	33.83	7.30E-02						
UN	TC7	1.75	4	3.01	24.48	5.27E-02						
SB	TC7	1.75	1	3.04	-0.58	-1.24E-03	-0.54	-0.54	-1.15E-03	-1.15E-03		
SB	TC7	1.75	2	3.01	-0.39	-8.42E-04						
SB	TC7	1.75	3	3.01	-0.52	-1.12E-03						
SB	TC7	1.75	4	3.01	-0.65	-1.40E-03						
STD	TC7		7		34.03	1.29E+00	34.03	34.03				

**Table B.5 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )				
UN	TC7	2.50	1	3.00	21.69	4.69E-02	22.83	22.83	4.93E-02	4.93E-02	5.05E-03	
UN	TC7	2.50	2	3.01	25.98	5.60E-02						
UN	TC7	2.50	3	3.01	23.12	4.99E-02						
UN	TC7	2.50	4	3.00	20.52	4.43E-02						
UN	TC7	3.25	1	3.01	-1.23	-2.66E-03	-1.22	-1.22	-2.61E-03	-2.61E-03	6.65E-05	
UN	TC7	3.25	2	3.04	-1.23	-2.62E-03						
UN	TC7	3.25	3	3.02	-1.23	-2.64E-03						
UN	TC7	3.25	4	3.03	-1.17	-2.51E-03						

**Table B.6** Raw data for endo 1,4- $\beta$ -glucanase activity in 2009

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)					
UN	TC1	0.50	1	3.01	1.10	4.74E-03	1.51	0.79	6.50E-03	3.38E-03	3.88E-03	
UN	TC1	0.50	2	3.02	1.10	4.72E-03						
UN	TC1	0.50	3	3.02	0.98	4.22E-03						
UN	TC1	0.50	4	3.03	2.87	1.23E-02						
SPK	TC1	0.50	5	3.02	8.99	3.87E-02	7.18	6.46	3.09E-02	2.78E-02	1.54E+00	
SPK	TC1	0.50	6	3.01	7.86	3.39E-02						
SPK	TC1	0.50	7	3.01	5.59	2.41E-02						
SPK	TC1	0.50	8	3.03	6.28	2.69E-02						
SB	TC1	0.50	9	3.00	0.60	1.30E-03	0.73	0.73	1.56E-03	1.56E-03		
SB	TC1	0.50	10	3.01	0.85	1.83E-03						
SB	TC1	0.50	11	3.01	0.66	1.42E-03						
SB	TC1	0.50	12	3.00	0.79	1.71E-03						
UN	TC1	1.00	1	3.01	1.29	5.57E-03	1.25	0.52	5.36E-03	2.24E-03	3.87E-04	
UN	TC1	1.00	2	3.05	1.36	5.79E-03						
UN	TC1	1.00	3	3.02	1.17	5.03E-03						
UN	TC1	1.00	4	3.02	1.17	5.02E-03						
UN	TC1	1.75	1	3.03	1.10	4.71E-03	1.07	0.35	4.61E-03	1.49E-03	3.25E-04	
UN	TC1	1.75	2	3.04	1.17	5.00E-03						
UN	TC1	1.75	3	3.00	0.98	4.23E-03						
UN	TC1	1.75	4	3.01	1.04	4.49E-03						
UN	TC1	2.50	1	3.01	1.10	4.75E-03	1.13	0.41	4.87E-03	1.75E-03	2.86E-04	
UN	TC1	2.50	2	3.01	1.23	5.30E-03						
UN	TC1	2.50	3	3.03	1.10	4.71E-03						
UN	TC1	2.50	4	3.01	1.10	4.74E-03						
STD	TC1		1		11.08	1.44E-01	11.08			1.44E-01		
UN	TC1	3.25	1	3.02	1.17	5.03E-03	1.20	0.47	5.16E-03	2.04E-03	3.66E-04	
UN	TC1	3.25	2	3.02	1.10	4.73E-03						
UN	TC1	3.25	3	3.01	1.23	5.30E-03						
UN	TC1	3.25	4	3.00	1.29	5.58E-03						
UN	TC2	0.50	1	3.01	1.29	5.57E-03	1.23	0.12	5.30E-03	4.95E-04	6.85E-04	
UN	TC2	0.50	2	3.00	1.17	5.05E-03						
UN	TC2	0.50	3	3.03	1.42	6.08E-03						
UN	TC2	0.50	4	3.01	1.04	4.48E-03						
UN	TC2	1.00	1	3.00	1.04	4.49E-03	1.03	-0.09	4.42E-03	-3.88E-04	4.78E-04	
UN	TC2	1.00	2	3.02	0.91	3.91E-03						
UN	TC2	1.00	3	3.00	0.98	4.24E-03						
UN	TC2	1.00	4	3.01	1.17	5.04E-03						
DUP	TC2	1.00	5	3.01	1.92	8.27E-03	1.44	0.32	6.18E-03	1.38E-03		
DUP	TC2	1.00	6	3.00	1.17	5.05E-03						
DUP	TC2	1.00	7	3.02	1.29	5.54E-03						
DUP	TC2	1.00	8	3.01	1.36	5.86E-03						
SB	TC2	1.00	9	3.03	0.98	4.20E-03	1.12	1.12	4.79E-03	4.79E-03		
SB	TC2	1.00	10	3.03	1.29	5.53E-03						
SB	TC2	1.00	11	3.02	1.28	5.50E-03						
SB	TC2	1.00	12	3.00	0.91	3.94E-03						
MB			1			2.18	2.10			2.72E-02		
MB			2			2.05						
MB			3			2.05						
MB			4			2.11						
UN	TC2	1.75	1	3.01	1.48	6.37E-03	1.48	0.37	6.37E-03	1.58E-03	5.57E-04	
UN	TC2	1.75	2	3.03	1.67	7.14E-03						
UN	TC2	1.75	3	3.02	1.36	5.84E-03						
UN	TC2	1.75	4	3.01	1.42	6.13E-03						
UN	TC2	2.50	1	3.00	1.29	5.57E-03	1.20	0.09	5.15E-03	3.65E-04	2.81E-04	
UN	TC2	2.50	2	3.04	1.17	5.00E-03						
UN	TC2	2.50	3	3.03	1.17	5.01E-03						
UN	TC2	2.50	4	3.03	1.17	5.01E-03						
UN	TC2	3.25	1	3.00	1.23	5.32E-03	1.20	0.09	5.15E-03	3.65E-04	1.65E-04	
UN	TC2	3.25	2	3.02	1.17	5.02E-03						
UN	TC2	3.25	3	3.03	1.23	5.27E-03						
UN	TC2	3.25	4	3.04	1.17	5.00E-03						
STD			2		43.47	5.64E-01	43.47			5.64E-01		



**Table B.6 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC3	0.50	1	3.01	2.81	1.21E-02	2.75	0.24	1.18E-02	1.02E-03	6.73E-04	
UN	TC3	0.50	2	3.03	2.62	1.12E-02						
UN	TC3	0.50	3	3.02	2.62	1.13E-02						
UN	TC3	0.50	4	3.02	2.93	1.26E-02						
UN	TC3	1.00	1	3.01		0.00E+00	2.05	0.46	8.84E-03	1.98E-03	4.43E-03	
UN	TC3	1.00	2	3.02		0.00E+00						
UN	TC3	1.00	3	3.01		0.00E+00						
UN	TC3	1.00	4	3.00	2.05	8.85E-03						
SB	TC3	1.00	5	3.01	1.73	7.45E-03	1.59	1.59	6.85E-03	6.85E-03		
SB	TC3	1.00	6	3.02	1.48	6.37E-03						
SB	TC3	1.00	7	3.01	1.48	6.37E-03						
SB	TC3	1.00	8	3.00	1.67	7.22E-03						
UN	TC3	1.75	1	3.01	2.37	1.02E-02	2.12	0.65	9.12E-03	2.80E-03	7.36E-04	
UN	TC3	1.75	2	3.00	2.05	8.86E-03						
UN	TC3	1.75	3	3.01	1.99	8.58E-03						
UN	TC3	1.75	4	3.01	2.05	8.84E-03						
SPK	TC3	1.75	5	3.01	41.83	1.80E-01	37.71	36.24	1.62E-01	1.56E-01		
SPK	TC3	1.75	6	3.03	31.60	1.35E-01						
SPK	TC3	1.75	7	3.01	38.79	1.67E-01						
SPK	TC3	1.75	8	3.00	38.61	1.67E-01						
SB	TC3	1.75	9	3.01	1.23	5.30E-03	1.47	1.47	6.32E-03	6.32E-03		
SB	TC3	1.75	10	3.01	1.36	5.85E-03						
SB	TC3	1.75	11	3.01	1.54	6.64E-03						
SB	TC3	1.75	12	3.01	1.73	7.46E-03						
UN	TC3	2.50	1	3.01	1.99	8.57E-03	1.99	0.23	8.57E-03	9.70E-04	2.13E-04	
UN	TC3	2.50	2	3.01	1.99	8.59E-03						
UN	TC3	2.50	3	3.02	2.05	8.81E-03						
UN	TC3	2.50	4	3.01	1.92	8.29E-03						
SB	TC3	2.50	5	3.03	1.61	6.90E-03	1.76	1.76	7.57E-03	7.57E-03		
SB	TC3	2.50	6	3.01	2.10	9.05E-03						
SB	TC3	2.50	7	3.03	1.67	7.16E-03						
SB	TC3	2.50	8	3.01	1.67	7.20E-03						
UN	TC3	3.25	1	3.02		0.00E+00	1.63	1.63	7.02E-03	7.02E-03	3.55E-03	
UN	TC3	3.25	2	3.00	1.67	7.22E-03						
UN	TC3	3.25	3	3.00	1.73	7.48E-03						
UN	TC3	3.25	4	3.01	1.48	6.39E-03						
STD					11.52	1.49E-01	11.52			1.49E-01		
UN	TC4	0.50	1	3.01	2.49	1.07E-02	2.54	0.62	1.09E-02	2.65E-03	6.09E-04	
UN	TC4	0.50	2	3.01	2.74	1.18E-02						
UN	TC4	0.50	3	3.01	2.43	1.05E-02						
UN	TC4	0.50	4	3.03	2.49	1.07E-02						
SB	TC4	0.50	5	3.01	1.86	8.02E-03	1.92	1.92	8.27E-03	8.27E-03	3.77E-04	
SB	TC4	0.50	6	3.01	1.86	8.01E-03						
SB	TC4	0.50	7	3.02	2.05	8.81E-03						
SB	TC4	0.50	8	3.02	1.92	8.24E-03						
UN	TC4	1.00	1	3.00	3.63	1.57E-02	3.41	1.07	1.47E-02	4.61E-03	9.66E-04	
UN	TC4	1.00	2	3.02	3.50	1.50E-02						
UN	TC4	1.00	3	3.02	3.38	1.45E-02						
UN	TC4	1.00	4	3.02	3.12	1.34E-02						
SB	TC4	1.00	5	3.02	2.43	1.04E-02	2.34	2.34	1.00E-02	1.00E-02	3.65E-04	
SB	TC4	1.00	6	3.04	2.37	1.01E-02						
SB	TC4	1.00	7	3.02	2.30	9.89E-03						
SB	TC4	1.00	8	3.03	2.24	9.58E-03						
MB	TC4		1		2.49	3.23E-02	2.51			3.25E-02		
MB	TC4		2		2.49	3.23E-02						
MB	TC4		3		2.49	3.23E-02						
MB	TC4		4		2.56	3.32E-02						
UN	TC4	1.75	1	3.01	3.63	1.56E-02	3.63	0.83	1.56E-02	3.56E-03	1.89E-04	
UN	TC4	1.75	2	3.02	3.69	1.59E-02						
UN	TC4	1.75	3	3.01	3.57	1.54E-02						
UN	TC4	1.75	4	3.00	3.63	1.57E-02						
SB	TC4	1.75	5	3.01	2.87	1.24E-02	2.81	2.81	1.21E-02	1.21E-02	5.04E-04	

**Table B.6 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
		(m.b.g.s)		(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
UN	TC4	2.50	1	3.03	2.35	1.01E-02	3.21	0.64	1.38E-02	2.76E-03	2.58E-03
UN	TC4	2.50	2	3.03	3.31	1.42E-02					
UN	TC4	2.50	3	3.01	3.50	1.51E-02					
UN	TC4	2.50	4	3.02	3.69	1.59E-02					
DUP	TC4	2.50	5	3.02	3.63	1.56E-02	2.93	0.36	1.26E-02	1.56E-03	
DUP	TC4	2.50	6	3.01	3.44	1.48E-02					
DUP	TC4	2.50	7	3.02	3.75	1.61E-02					
DUP	TC4	2.50	8	3.04	0.91	3.89E-03					
SB	TC4	2.50	9	3.00	2.56	1.11E-02	2.57	2.57	1.11E-02	1.11E-02	
SB	TC4	2.50	10	3.02	2.49	1.07E-02					
SB	TC4	2.50	11	3.02	2.49	1.07E-02					
SB	TC4	2.50	12	3.00	2.74	1.19E-02					
UN	TC4	3.25	1	3.01	-0.73	-3.15E-03	-0.73	-0.73	-3.13E-03	-3.13E-03	1.15E-03
UN	TC4	3.25	2	3.04	-0.92	-3.93E-03					
UN	TC4	3.25	3	3.03	-0.92	-3.94E-03					
UN	TC4	3.25	4	3.02	-0.35	-1.50E-03					
UN	TC5	0.50	1	3.03	-0.41	-1.75E-03	-0.39	-0.39	-1.67E-03	-1.67E-03	1.46E-04
UN	TC5	0.50	2	3.02	-0.35	-1.50E-03					
UN	TC5	0.50	3	3.01	-0.35	-1.51E-03					
UN	TC5	0.50	4	3.03	-0.41	-1.76E-03					
SB	TC5	0.50	5	3.03	-0.73	-3.12E-03	-0.70	-0.70	-2.98E-03	-2.98E-03	1.62E-04
SB	TC5	0.50	6	3.02	-0.66	-2.84E-03					
SB	TC5	0.50	7	3.03	-0.66	-2.83E-03					
SB	TC5	0.50	8	3.04	-0.73	-3.12E-03					
UN	TC5	1.00	1	3.02	0.16	6.87E-04	0.17	0.17	7.41E-04	7.41E-04	3.37E-04
UN	TC5	1.00	2	3.03	0.28	1.20E-03					
UN	TC5	1.00	3	3.02	0.09	3.86E-04					
UN	TC5	1.00	4	3.01	0.16	6.90E-04					
SB	TC5	1.00	5	3.04	-0.22	-9.40E-04	-0.22	-0.22	-9.52E-04	-9.52E-04	2.77E-04
SB	TC5	1.00	6	3.04	-0.29	-1.24E-03					
SB	TC5	1.00	7	3.03	-0.22	-9.43E-04					
SB	TC5	1.00	8	3.03	-0.16	-6.86E-04					
STD	TC5		4		44.92	5.83E-01					
UN	TC5	1.75	1	3.01	2.68	1.16E-02	1.89	0.55	8.15E-03	2.38E-03	2.50E-03
UN	TC5	1.75	2	3.01	1.86	8.01E-03					
UN	TC5	1.75	3	3.01	1.73	7.45E-03					
UN	TC5	1.75	4	3.00	1.29	5.58E-03					
SPK	TC5	1.75	5	3.01	33.74	1.45E-01	34.04	32.71	1.46E-01	1.41E-01	
SPK	TC5	1.75	6	3.03	30.02	1.29E-01					
SPK	TC5	1.75	7	3.02	34.63	1.49E-01					
SPK	TC5	1.75	8	3.02	37.78	1.63E-01					
SB	TC5	1.75	9	3.03	1.48	6.35E-03	1.34	1.34	5.74E-03	5.74E-03	2.47E-03
SB	TC5	1.75	10	3.04	1.86	7.94E-03					
SB	TC5	1.75	11	3.02	1.29	5.55E-03					
SB	TC5	1.75	12	3.02	0.72	3.09E-03					
UN	TC5	2.50	1	3.04	0.60	2.56E-03	0.59	0.54	2.51E-03	2.32E-03	1.22E-03
UN	TC5	2.50	2	3.02	0.41	1.76E-03					
UN	TC5	2.50	3	3.01	0.98	4.22E-03					
UN	TC5	2.50	4	3.01	0.35	1.51E-03					
SB	TC5	2.50	5	3.03	-0.35	-1.50E-03	0.05	0.05	1.94E-04	1.94E-04	1.50E-03
SB	TC5	2.50	6	3.01	0.22	9.50E-04					
SB	TC5	2.50	7	3.01	0.03	1.29E-04					
SB	TC5	2.50	8	3.00	0.28	1.21E-03					
UN	TC5	3.25	1	3.04	-0.60	-2.56E-03	-0.65	-0.65	-2.77E-03	-2.77E-03	2.63E-04
UN	TC5	3.25	2	3.01	-0.66	-2.84E-03					
UN	TC5	3.25	3	3.04	-0.73	-3.12E-03					
UN	TC5	3.25	4	3.03	-0.60	-2.57E-03					
STD			5		46.31	6.01E-01	46.31			6.01E-01	
MB			1		0.03	3.89E-04	0.13			1.62E-03	
MB			2		0.35	4.54E-03					
MB			3		0.09	1.17E-03					
MB			4		0.03	3.89E-04					

**Table B.6 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight	Concentration			Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
					(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )		
UN	TC6	0.50	1	3.05	0.06	2.56E-04	0.10	0.10	4.28E-04	4.28E-04	3.59E-04	
UN	TC6	0.50	2	3.03	0.09	3.86E-04						
UN	TC6	0.50	3	3.01	0.03	1.29E-04						
UN	TC6	0.50	4	3.03	0.22	9.43E-04						
SB	TC6	0.50	9	3.03	-0.09	-3.86E-04	-0.29	-0.29	-1.23E-03	-1.23E-03		
SB	TC6	0.50	10	3.03	-0.22	-9.42E-04						
SB	TC6	0.50	11	3.01	-0.48	-2.07E-03						
SB	TC6	0.50	12	3.01	-0.35	-1.51E-03						
UN	TC6	1.00	1	3.03	0.28	1.20E-03	0.22	0.22	9.48E-04	9.48E-04	2.98E-04	
UN	TC6	1.00	2	3.01	0.16	6.90E-04						
UN	TC6	1.00	3	3.00	0.28	1.21E-03						
UN	TC6	1.00	4	3.01	0.16	6.89E-04						
SB	TC6	1.00	5	3.01	-0.16	-6.89E-04	-0.23	-0.23	-9.64E-04	-9.64E-04		
SB	TC6	1.00	6	3.03	-0.29	-1.24E-03						
SB	TC6	1.00	7	3.04	-0.16	-6.83E-04						
SB	TC6	1.00	8	3.04	-0.29	-1.24E-03						
UN	TC6	1.75	1	3.00	0.22	9.50E-04	0.19	0.19	8.08E-04	8.08E-04	3.51E-04	
UN	TC6	1.75	2	3.01	0.16	6.89E-04						
UN	TC6	1.75	3	3.02	0.28	1.20E-03						
UN	TC6	1.75	4	3.02	0.09	3.87E-04						
SB	TC6	1.75	5	3.01	-0.10	-4.30E-04	-0.11	-0.11	-4.83E-04	-4.83E-04		
SB	TC6	1.75	6	3.02	-0.03	-1.29E-04						
SB	TC6	1.75	7	3.01	-0.22	-9.48E-04						
SB	TC6	1.75	8	3.04	-0.10	-4.27E-04						
UN	TC6	2.50	1	3.01	4.07	1.75E-02	4.23	1.19	1.82E-02	5.10E-03	1.11E-03	
UN	TC6	2.50	2	3.02	4.58	1.97E-02						
UN	TC6	2.50	3	3.03	4.01	1.72E-02						
UN	TC6	2.50	4	3.01	4.26	1.84E-02						
SB	TC6	2.50	5	3.02	2.87	1.23E-02	3.05	3.05	1.31E-02	1.31E-02		
SB	TC6	2.50	6	3.04	2.56	1.09E-02						
SB	TC6	2.50	7	3.01	3.69	1.59E-02						
SB	TC6	2.50	8	3.03	3.06	1.31E-02						
STD			6		11.08	1.44E-01	11.08			1.44E-01		
UN	TC6	3.25	1	3.02	-0.48	-2.07E-03	-0.48	-0.48	-2.05E-03	-2.05E-03	2.29E-04	
UN	TC6	3.25	2	3.03	-0.41	-1.76E-03						
UN	TC6	3.25	3	3.03	-0.54	-2.32E-03						
UN	TC6	3.25	4	3.02	-0.48	-2.06E-03						
UN	TC7	0.50	1	3.02	1.92	8.25E-03	2.05	0.93	8.80E-03	4.00E-03	1.29E-03	
UN	TC7	0.50	2	3.03	2.49	1.06E-02						
UN	TC7	0.50	3	3.01	1.99	8.59E-03						
UN	TC7	0.50	4	3.03	1.80	7.70E-03						
SB	TC7	0.50	5	3.01	0.72	3.11E-03	1.12	1.12	4.82E-03	4.82E-03		
SB	TC7	0.50	6	3.00	1.10	4.75E-03						
SB	TC7	0.50	7	3.02	1.29	5.55E-03						
SB	TC7	0.50	8	3.01	1.36	5.86E-03						
MB			1		0.22	2.85E-03	0.17			2.24E-03		
MB			2		0.16	2.08E-03						
MB			3		0.28	3.63E-03						
MB			4		0.03	3.89E-04						
UN	TC7	1.00	1	3.00	0.91	3.93E-03	0.84	0.21	3.59E-03	8.93E-04	2.57E-04	
UN	TC7	1.00	2	3.01	0.79	3.40E-03						
UN	TC7	1.00	3	3.02	0.85	3.66E-03						
UN	TC7	1.00	4	3.03	0.79	3.39E-03						
SPK	TC7	1.00	5	3.02	10.70	4.60E-02	9.72	9.72	4.18E-02	4.18E-02		
SPK	TC7	1.00	6	3.01	10.38	4.47E-02						
SPK	TC7	1.00	7	3.03	8.10	3.46E-02						
SPK	TC7	1.00	8	3.01	9.69	4.17E-02						
SB	TC7	1.00	9	3.04	0.53	2.26E-03	0.63	0.63	2.69E-03	2.69E-03		
SB	TC7	1.00	10	3.02	0.60	2.57E-03						
SB	TC7	1.00	11	3.00	0.72	3.11E-03						
SB	TC7	1.00	12	3.03	0.66	2.82E-03						
UN	TC7	1.75	1	3.02	2.11	9.05E-03	1.83	1.50	7.84E-03	6.42E-03	2.52E-03	

**Table B.6 Continued**

Code ID	Test Cell	Depth	Rep	Soil Weight		Concentration		Mean Concentration	Blank Subtracted Mean	Mean Concentration	Blank Subtracted Mean	Std Dev
				(m.b.g.s)	(g)	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )	(ppb)	(nmol 4-MU g <sup>-1</sup> hr <sup>-1</sup> )			
SB	TC7	1.75	5	3.01	0.28	1.21E-03	0.33	0.33	1.42E-03	1.42E-03		
SB	TC7	1.75	6	3.02	0.66	2.83E-03						
SB	TC7	1.75	7	3.01	0.22	9.47E-04						
SB	TC7	1.75	8	3.03	0.16	6.86E-04						
STD			7			0.00E+00	0.00				0.00E+00	
UN	TC7	2.50	1	3.02	2.37	1.02E-02	2.45	1.98	1.05E-02	8.51E-03	7.75E-04	
UN	TC7	2.50	2	3.01	2.56	1.10E-02						
UN	TC7	2.50	3	3.01	2.62	1.13E-02						
UN	TC7	2.50	4	3.02	2.24	9.62E-03						
SB	TC7	2.50	5	3.01	0.41	1.77E-03	0.47	0.47	2.02E-03	2.02E-03		
SB	TC7	2.50	6	3.02	0.53	2.27E-03						
SB	TC7	2.50	7	3.01	0.47	2.02E-03						
SB	TC7	2.50	8	3.00	0.47	2.03E-03						
UN	TC7	3.25	1	3.02	-0.22	-9.47E-04	-0.38	-0.38	-1.63E-03	-1.63E-03	6.32E-04	
UN	TC7	3.25	2	3.04	-0.29	-1.24E-03						
UN	TC7	3.25	3	3.04	-0.53	-2.26E-03						
UN	TC7	3.25	4	3.03	-0.48	-2.05E-03						

**Table B.7** Acid Volatile Sulfide Content

Sample ID	Vessel	Soil Weight (g)	KIO3 Titration (mL)		Titration Volume (mL)	S%	S umol/g	S ppm	Mean S%
			Start	Stop					
TC2 0.30 m 2009	A	3.03	0.0	1.9	1.90	1.40E-01	4.37E+01	1.40E+03	1.43E-01
	B	3.00	1.9	3.6	1.65	1.23E-01	3.84E+01	1.23E+03	
	C	3.01	3.6	5.8	2.25	1.67E-01	5.22E+01	1.67E+03	
TC2 1.15 m 2009	A	3.00	13.9	15.3	1.40	1.04E-01	3.26E+01	1.04E+03	9.15E-02
	B	3.03	17.6	19.1	1.50	1.11E-01	3.45E+01	1.11E+03	
	C	3.02	20.8	21.6	0.80	5.93E-02	1.85E+01	5.93E+02	
TC2 1.50 m 2009	A	3.01	6.5	7.4	0.90	6.69E-02	2.09E+01	6.69E+02	8.42E-02
	B	2.99	9.9	11.1	1.20	8.98E-02	2.80E+01	8.98E+02	
	C	3.03	11.1	12.4	1.30	9.60E-02	2.99E+01	9.60E+02	
TC2 2.90 m 2009	A	3.01	5.5	6.5	1.00	7.43E-02	2.32E+01	7.43E+02	8.40E-02
	B	3.03	4.2	5.5	1.30	9.60E-02	2.99E+01	9.60E+02	
	C	3.01	2.0	3.1	1.10	8.17E-02	2.55E+01	8.17E+02	
TC5 0.30 m 2009	A	3.01	5.8	7.0	1.20	8.92E-02	2.78E+01	8.92E+02	1.03E-01
	B	3.07	7.0	8.5	1.50	1.09E-01	3.41E+01	1.09E+03	
	C	3.00	8.5	10.0	1.50	1.12E-01	3.49E+01	1.12E+03	
TC5 1.15 m 2009	A	3.01	10.0	11.9	1.90	1.41E-01	4.40E+01	1.41E+03	1.44E-01
	B	3.00	11.9	13.8	1.90	1.42E-01	4.42E+01	1.42E+03	
	C	3.00	13.8	15.8	2.00	1.49E-01	4.65E+01	1.49E+03	
TC5 1.50 m 2009	A	3.03	15.8	16.9	1.10	8.12E-02	2.53E+01	8.12E+02	9.42E-02
	B	3.00	16.9	18.0	1.10	8.20E-02	2.56E+01	8.20E+02	
	C	3.00	18.0	19.6	1.60	1.19E-01	3.72E+01	1.19E+03	
TC5 2.90 m 2009	A	3.01	19.6	21.4	1.80	1.34E-01	4.17E+01	1.34E+03	1.56E-01
	B	3.01	21.4	23.8	2.40	1.78E-01	5.56E+01	1.78E+03	
	C	3.01	1.0	3.1	2.10	1.56E-01	4.87E+01	1.56E+03	
TC7 0.30 m 2009	A	2.80	18.1	18.4	0.30	2.40E-02	7.48E+00	2.40E+02	2.23E-02
	B	2.81	18.4	18.6	0.20	1.59E-02	4.97E+00	1.59E+02	
	C	2.89	18.6	19.0	0.35	2.71E-02	8.45E+00	2.71E+02	
TC7 1.15 m 2009	A	3.03	16.6	18.1	1.50	1.11E-01	3.45E+01	1.11E+03	9.46E-02
	B	2.99	15.6	16.6	1.00	7.48E-02	2.33E+01	7.48E+02	
	C	3.07	14.3	15.6	1.35	9.84E-02	3.07E+01	9.84E+02	
TC7 1.50 m 2009	A	2.98	11.4	14.3	2.85	2.14E-01	6.67E+01	2.14E+03	1.94E-01
	B	3.09	9.0	11.4	2.40	1.74E-01	5.42E+01	1.74E+03	
	C	3.07	6.9	9.0	2.10	1.53E-01	4.77E+01	1.53E+03	
TC7 2.90 m 2009	A	3.09	5.6	6.9	1.30	9.41E-02	2.94E+01	9.41E+02	9.94E-02
	B	2.99	4.2	5.6	1.40	1.05E-01	3.27E+01	1.05E+03	
	C	2.91	3.2	4.2	1.00	7.69E-02	2.40E+01	7.69E+02	

**Table B.8** Moisture Content of Carbon amended Tailings Samples

Test Cell	Depth (m.b.g.s.)	Year	Dish (g)	Wet Tailings + Dish (g)	Wet Tailings (g)	Dry Tailings + Dish (g)	Dry Tailings (g)	Moisture Content (%)
TC1	0.50	2005	1.01	6.91	5.90	6.28	5.28	10.6
TC1	1.00	2005	1.00	6.45	5.45	5.66	4.66	14.3
TC1	1.75	2005	1.00	6.96	5.96	6.35	5.35	10.2
TC1	2.50	2005	1.02	6.96	5.95	6.21	5.19	12.7
TC1	3.25	2005	1.02	6.98	5.95	6.28	5.25	11.7
TC2	0.50	2005	1.02	6.97	5.95	6.32	5.31	10.8
TC2	1.00	2005	1.02	6.91	5.90	6.25	5.23	11.3
TC2	1.75	2005	1.01	6.88	5.87	6.27	5.26	10.4
TC2	2.50	2005	1.01	6.96	5.95	6.41	5.40	9.2
TC2	3.25	2005	1.02	6.87	5.85	6.17	5.14	12.0
TC3	0.50	2005	1.00	7.04	6.04	5.40	4.40	27.2
TC3	1.00	2005	1.00	7.50	6.50	5.80	4.80	26.2
TC3	1.75	2005	1.00	8.42	7.42	6.62	5.62	24.3
TC3	2.50	2005	1.00	7.10	6.10	5.44	4.44	27.2
TC3	3.25	2005	1.00	7.16	6.16	5.50	4.50	26.9
TC4	0.50	2005	1.00	7.49	6.49	5.88	4.88	24.8
TC4	1.00	2005	1.00	7.49	6.49	5.92	4.92	24.2
TC4	1.75	2005	1.00	7.18	6.18	5.51	4.51	27.0
TC4	2.50	2005	1.00	7.70	6.70	6.06	5.06	24.5
TC4	3.25	2005	1.00	7.07	6.07	5.49	4.49	26.0
TC5	0.50	2005	1.00	7.42	6.42	5.82	4.82	24.9
TC5	1.00	2005	1.00	7.17	6.17	5.52	4.52	26.7
TC5	1.75	2005	1.00	7.11	6.11	5.41	4.41	27.8
TC5	2.50	2005	1.00	8.79	7.79	6.98	5.98	23.2
TC5	3.25	2005	1.00	7.65	6.65	5.96	4.96	25.4
TC6	0.50	2005	1.00	5.57	4.57	4.34	3.34	26.9
TC6	1.00	2005	1.00	7.16	6.16	5.50	4.50	26.9
TC6	1.75	2005	1.00	7.92	6.92	6.14	5.14	25.7
TC6	2.50	2005	1.00	7.08	6.08	5.48	4.48	26.3
TC7	0.50	2005	1.00	8.67	7.67	6.66	5.66	26.2
TC7	1.00	2005	1.00	8.28	7.28	6.39	5.39	26.0
TC7	1.75	2005	1.00	8.41	7.41	6.52	5.52	25.5
TC7	2.50	2005	1.00	8.52	7.52	6.61	5.61	25.4
TC7	3.25	2005	1.00	8.48	7.48	6.74	5.74	23.3

**Table B.8** Continued

Test Cell	Depth (m.b.g.s.)	Year	Dish (g)	Wet Tailings + Dish (g)	Wet Tailings (g)	Dry Tailings + Dish (g)	Dry Tailings (g)	Moisture Content (%)
TC1	0.50	2007	1.04	5.80	4.76	5.33	4.29	9.9
TC1	1.00	2007	0.99	5.52	4.53	5.09	4.1	9.5
TC1	1.75	2007	1.04	5.22	4.18	4.8	3.76	10.0
TC1	2.50	2007	1.03	5.64	4.61	5.2	4.17	9.5
TC1	3.25	2007	1.03	5.26	4.23	4.87	3.84	9.2
TC2	0.50	2007	1.05	6.17	5.12	5.75	4.7	8.2
TC2	1.00	2007	1.03	3.98	2.95	3.67	2.64	10.5
TC2	1.75	2007	1.04	4.97	3.93	4.55	3.51	10.7
TC2	2.50	2007	1.00	5.52	4.52	5.08	4.08	9.7
TC2	3.25	2007	1.03	5.31	4.28	4.85	3.82	10.7
TC3	0.50	2007	1.03	4.33	3.3	4.04	3.01	8.8
TC3	1.00	2007	1.03	5.87	4.84	5.44	4.41	8.9
TC3	1.75	2007	1.04	5.32	4.28	4.73	3.69	13.8
TC3	2.50	2007	1.03	4.55	3.52	4.23	3.2	9.1
TC4	0.50	2007	1.03	4.40	3.37	4.2	3.17	5.9
TC4	1.00	2007	1.01	3.43	2.42	3.22	2.21	8.7
TC4	1.75	2007	1.03	4.49	3.46	4.12	3.09	10.7
TC4	2.50	2007	1.00	3.26	2.26	3.05	2.05	9.3
TC4	3.25	2007	1.03	4.44	3.41	4.1	3.07	10.0
TC5	0.50	2007	1.00	6.26	5.26	5.79	4.79	8.9
TC5	1.00	2007	1.02	5.78	4.76	5.24	4.22	11.3
TC5	1.75	2007	1.03	5.19	4.16	4.8	3.77	9.4
TC5	2.50	2007	1.01	5.95	4.94	5.44	4.43	10.3
TC5	3.25	2007	1.00	5.23	4.23	4.77	3.77	10.9
TC6	0.50	2007	1.02	5.63	4.61	5.18	4.16	9.8
TC6	1.00	2007	1.02	6.08	5.06	5.57	4.55	10.1
TC6	1.75	2007	1.01	6.31	5.3	5.81	4.8	9.4
TC6	2.50	2007	1.03	6.70	5.67	6.06	5.03	11.3
TC6	3.25	2007	1.01	5.68	4.67	5.21	4.2	10.1
TC7	0.50	2007	0.99	5.34	4.35	5.04	4.05	6.9
TC7	1.00	2007	0.98	5.64	4.66	5.18	4.2	9.9
TC7	1.75	2007	0.99	6.40	5.41	5.85	4.86	10.2
TC7	2.50	2007	1.00	5.40	4.4	4.92	3.92	10.9
TC7	3.25	2007	1.00	4.84	3.84	4.4	3.4	11.5

**Table B.8** Continued

<b>Test Cell</b>	<b>Depth (m.b.g.s.)</b>	<b>Year</b>	<b>Dish (g)</b>	<b>Wet Tailings + Dish (g)</b>	<b>Wet Tailings (g)</b>	<b>Dry Tailings + Dish (g)</b>	<b>Dry Tailings (g)</b>	<b>Moisture Content (%)</b>
TC1	0.50	2009	1.03	5.76	4.73	5.23	4.20	11.2
TC1	1.00	2009	1.02	5.77	4.75	5.23	4.21	11.3
TC1	1.75	2009	0.99	5.76	4.77	5.27	4.28	10.3
TC1	2.50	2009	1.00	5.74	4.74	5.09	4.09	13.8
TC1	3.25	2009	0.98	6.89	5.91	6.28	5.30	10.4
TC2	0.50	2009	1.02	7.57	6.55	6.89	5.87	10.3
TC2	1.00	2009	1.00	6.09	5.09	5.55	4.55	10.6
TC2	1.75	2009	1.00	6.26	5.27	5.76	4.76	9.5
TC2	2.50	2009	1.00	6.77	5.77	6.02	5.02	13.0
TC2	3.25	2009	1.02	5.62	4.60	5.15	4.13	10.2
TC3	0.50	2009	1.00	8.83	7.83	8.08	7.08	9.6
TC3	1.00	2009	1.00	9.21	8.20	8.41	7.41	9.7
TC3	1.75	2009	1.01	6.97	5.96	6.40	5.39	9.5
TC3	2.50	2009	0.99	7.83	6.84	7.03	6.04	11.7
TC3	3.25	2009	0.99	8.57	7.59	7.69	6.70	11.6
TC4	0.50	2009	0.99	7.34	6.35	6.79	5.80	8.6
TC4	1.00	2009	1.03	7.14	6.11	6.56	5.53	9.5
TC4	1.75	2009	1.01	7.45	6.44	6.82	5.81	9.8
TC4	2.50	2009	1.01	6.75	5.74	6.20	5.19	9.6
TC4	3.25	2009	1.01	6.12	5.10	5.68	4.67	8.5
TC5	0.50	2009	1.03	5.94	4.90	5.48	4.45	9.3
TC5	1.00	2009	1.00	5.98	4.99	5.48	4.48	10.1
TC5	1.75	2009	1.00	7.81	6.81	7.10	6.10	10.4
TC5	2.50	2009	1.00	6.94	5.94	6.40	5.40	9.1
TC5	3.25	2009	1.02	8.10	7.08	7.31	6.30	11.1
TC6	0.50	2009	1.00	6.82	5.82	6.31	5.31	8.7
TC6	1.00	2009	1.02	5.90	4.87	5.42	4.40	9.8
TC6	1.75	2009	1.04	5.90	4.86	5.36	4.32	11.1
TC6	2.50	2009	1.03	6.68	5.64	6.02	4.99	11.7
TC6	3.25	2009	1.03	7.90	6.87	7.11	6.08	11.5
TC7	0.50	2009	0.99	7.59	6.60	6.98	5.99	9.3
TC7	1.00	2009	0.99	8.77	7.78	8.05	7.06	9.2
TC7	1.75	2009	1.01	7.72	6.71	6.99	5.99	10.9
TC7	2.50	2009	1.01	8.98	7.98	8.37	7.36	7.7
TC7	3.25	2009	1.01	7.41	6.39	6.82	5.81	9.1



**Table B.9** Summary of Acid Digestion of Inorganic Carbon in Carbon amended Tailings

Test Cell	Depth (m.b.g.s.)	Year	Vial Weight (mg)	Weight of Amended Tailings (mg)	Volume of 3M HCl (mL)	Weight after Digestion (mg)	Weight of Tailings after Digestion (mg)	Fraction of Non-Acid and Acid Digested Sample Weights
TC2	0.60	2005	37671.8	1003.1	2	38887.5	1215.7	1.21
TC2	1.00	2005	38017.7	1009.5	2	39239.7	1222.0	1.21
TC2	1.75	2005	37708.3	1015.1	2	38934.5	1226.2	1.21
TC2	2.50	2005	37668.6	1011.3	2	38936.8	1268.2	1.25
TC2	3.23	2005	37640.5	1014.0	2	38911.6	1271.1	1.25
TC3	0.60	2005	37721.0	1006.6	2	38952.9	1231.9	1.22
TC3	1.00	2005	37647.6	1003.1	2	38864.3	1216.7	1.21
TC3	1.75	2005	37941.3	1022.3	2	39197.4	1256.1	1.23
TC3	2.50	2005	37715.6	1023.3	2	38945.8	1230.2	1.20
TC3	3.23	2005	37588.7	1010.4	2	38810.6	1221.9	1.21
TC4	0.60	2005	38002.6	1003.7	2	39215.9	1213.3	1.21
TC4	1.00	2005	37477.1	1006.6	2	38910.3	1433.2	1.42
TC4	1.75	2005	37881.0	1013.1	2	39109.4	1228.4	1.21
TC4	2.50	2005	37653.6	1003.1	2	38869.3	1215.7	1.21
TC4	3.23	2005	37933.8	1017.5	2	39160.2	1226.4	1.21
TC5	0.60	2005	37697.8	1002.8	2	38915.3	1217.5	1.21
TC5	1.00	2005	37678.0	1002.6	2	38887.5	1209.5	1.21
TC5	1.75	2005	37593.1	1010.5	2	38809.4	1216.3	1.20
TC5	2.50	2005	37706.0	1007.9	2	38924.2	1218.2	1.21
TC5	3.23	2005	37977.1	1016.0	2	39223.8	1246.7	1.23
TC6	0.60	2005	38001.7	1012.5	2	39227.7	1226.0	1.21
TC6	1.00	2005	37850.3	1002.7	2	39062.1	1211.8	1.21
TC6	1.75	2005	38044.9	1009.5	2	39266.5	1221.6	1.21
TC6	2.50	2005	37624.9	1006.8	2	38841.6	1216.7	1.21
TC7	0.60	2005	37857.4	1010.0	2	39079.2	1221.8	1.21
TC7	1.00	2005	37590.7	1011.4	2	38811.0	1220.3	1.21
TC7	1.75	2005	37640.4	1010.4	2	38858.3	1217.9	1.21
TC7	2.50	2005	37720.1	1019.0	2	38951.0	1230.9	1.21
TC7	3.23	2005	37727.4	1010.9	2	38955.6	1228.2	1.21

**Table B.9** Continued

Test Cell	Depth (m.b.g.s.)	Year	Vial Weight (mg)	Weight of Amended Tailings (mg)	Volume of 3M HCl (mL)	Weight after Digestion (mg)	Weight of Tailings after Digestion (mg)	Fraction of Non-Acid and Acid Digested Sample Weights
TC2	0.50	2007	37678.1	1005.1	2	38915.7	1237.6	1.23
TC2	1.00	2007	37639.1	1006.7	2	38888.2	1249.1	1.24
TC2	1.75	2007	37902.4	1016.7	2	39173.8	1271.4	1.25
TC2	2.50	2007	37996.7	1007.8	2	39269.2	1272.5	1.26
TC2	3.23	2007	37709.2	1020.9	2	38924.2	1215.0	1.19
TC3	0.50	2007	37741.0	1011.3	2	38981.2	1240.2	1.23
TC3	1.00	2007	37599.6	1015.3	2	38873.9	1274.3	1.26
TC3	1.75	2007	37440.7	1016.0	2	38907.6	1466.9	1.44
TC3	2.50	2007	37544.1	1034.4	2	38816.7	1272.6	1.23
TC4	0.50	2007	37989.4	1019.0	2	39260.2	1270.8	1.25
TC4	1.00	2007	38066.9	1010.3	2	39331.4	1264.5	1.25
TC4	1.75	2007	37861.5	1004.2	2	39075.2	1213.7	1.21
TC4	2.50	2007	38002.5	1008.0	2	39236.6	1234.1	1.22
TC4	3.23	2007	37999.5	1005.4	2	39176.7	1177.2	1.17
TC5	0.50	2007	37646.6	1002.4	2	38861.2	1214.6	1.21
TC5	1.00	2007	37660.5	1001.8	2	38883.5	1223.0	1.22
TC5	1.75	2007	37990.6	1009.1	2	39207.0	1216.4	1.21
TC5	2.50	2007	37744.8	1013.3	2	39015.3	1270.5	1.25
TC5	3.23	2007	37696.9	1012.9	2	38926.7	1229.8	1.21
TC6	0.50	2007	37618.2	1014.1	2	38899.2	1281.0	1.26
TC6	1.00	2007	37631.8	1013.5	2	38876.2	1244.4	1.23
TC6	1.75	2007	37862.2	1009.9	2	39092.3	1230.1	1.22
TC6	2.50	2007	37970.6	1004.2	2	39220.2	1249.6	1.24
TC6	3.23	2007	37709.1	1006.7	2	38952.8	1243.7	1.24
TC7	0.50	2007	37889.2	1019.9	2	39155.1	1265.9	1.24
TC7	1.00	2007	37635.4	1012.8	2	38969.0	1333.6	1.32
TC7	1.75	2007	37907.2	1010.1	2	39129.3	1222.1	1.21
TC7	2.50	2007	37973.0	1005.1	2	39273.6	1300.6	1.29
TC7	3.23	2007	38087.6	1021.6	2	39328.1	1240.5	1.21

**Table B.9** Continued

Test Cell	Depth (m.b.g.s.)	Year	Vial Weight (mg)	Weight of Amended Tailings (mg)	Volume of 3M HCl (mL)	Weight after Digestion (mg)	Weight of Tailings after Digestion (mg)	Fraction of Non-Acid and Acid Digested Sample Weights
TC2	0.50	2009	37628.7	1001.7	2	38862.4	1233.7	1.23
TC2	1.00	2009	37635.5	1006.0	2	38844.4	1208.9	1.20
TC2	1.75	2009	37630.5	1008.4	2	38839.6	1209.1	1.20
TC2	2.50	2009	37692.1	1018.8	2	38879.9	1187.8	1.17
TC2	3.23	2009	37965.3	1007.2	2	39212.1	1246.8	1.24
TC3	0.50	2009	37727.9	1002.1	2	38952.6	1224.7	1.22
TC3	1.00	2009	37607.8	1005.5	2	38788.8	1181.0	1.17
TC3	1.75	2009	37694.5	1004.3	2	38879.0	1184.5	1.18
TC3	2.50	2009	37619.0	1003.7	2	38766.8	1147.8	1.14
TC3	3.23	2009	37764.4	1005.5	2	38917.4	1153.0	1.15
TC4	0.50	2009	37889.9	1007.6	2	39048.9	1159.0	1.15
TC4	1.00	2009	37710.6	1018.1	2	38905.7	1195.1	1.17
TC4	1.75	2009	37754.3	1005.0	2	38963.1	1208.8	1.20
TC4	2.50	2009	38054.9	1008.1	2	39235.4	1180.5	1.17
TC4	3.23	2009	37693.3	1007.5	2	39235.4	1542.1	1.53
TC5	0.50	2009	37712.2	1004.3	2	38925.3	1213.1	1.21
TC5	1.00	2009	38027.3	1016.4	2	39271.9	1244.6	1.22
TC5	1.75	2009	37968.5	1007.2	2	39184.6	1216.1	1.21
TC5	2.50	2009	37665.0	1021.1	2	38893.5	1228.5	1.20
TC5	3.23	2009	37994.6	1005.4	2	39240.9	1246.3	1.24
TC6	0.50	2009	38049.6	1008.6	2	39285.9	1236.3	1.23
TC6	1.00	2009	37669.4	1011.9	2	38889.4	1220.0	1.21
TC6	1.75	2009	37687.1	1002.0	2	38913.6	1226.5	1.22
TC6	2.50	2009	37924.0	1004.0	2	39140.4	1216.4	1.21
TC6	3.23	2009	37748.6	1016.0	2	38964.3	1215.7	1.20
TC7	0.50	2009	37909.6	1004.6	2	39126.4	1216.8	1.21
TC7	1.00	2009	37977.9	1015.0	2	39203.8	1225.9	1.21
TC7	1.75	2009	37730.9	1013.8	2	38953.9	1223.0	1.21
TC7	2.50	2009	38007.9	1009.5	2	39229.4	1221.5	1.21
TC7	3.23	2009	38040.5	1003.5	2	39273.4	1232.9	1.23

**Table B.10** Total Mean Weight % Carbon from Induction Furnace

<b>Test Cell</b>	<b>Depth (m.b.g.s)</b>	<b>Year</b>	<b>Sample Mass (mg)</b>	<b>Analysis Time (sec)</b>	<b>Mean wt% Carbon</b>	<b>Standard Deviation</b>
TC2	0.50	2005	68	62	3.7821	0.0067
TC2	1.00	2005	53	54	3.7182	0.0240
TC2	1.75	2005	58	58	3.6188	0.0335
TC2	2.50	2005	66	56	3.7773	0.0140
TC2	3.25	2005	55	55	3.7290	0.0846
TC3	0.50	2005	65	60	3.4537	0.0512
TC3	1.00	2005	88	58	3.8071	0.0934
TC3	1.75	2005	56	54	3.6956	0.1467
TC3	2.50	2005	78	55	3.7509	0.0991
TC3	3.25	2005	60	58	3.6999	0.0353
TC4	0.50	2005	56	59	3.5266	0.0372
TC4	1.00	2005	55	56	3.7207	0.0558
TC4	1.75	2005	64	57	3.7169	0.0713
TC4	2.50	2005	64	60	3.2178	0.0227
TC4	3.25	2005	55	61	3.1693	0.0429
TC5	0.50	2005	62	59	3.5990	0.0479
TC5	1.00	2005	53	52	3.6807	0.0449
TC5	1.75	2005	60	57	3.5429	0.1144
TC5	2.50	2005	70	55	3.5344	0.0683
TC5	3.25	2005	61	56	3.7540	0.0703
TC6	0.50	2005	57	55	3.4489	0.0150
TC6	1.00	2005	57	59	3.5673	0.1003
TC6	1.75	2005	66	56	3.8845	0.0176
TC6	2.50	2005	57	59	3.6588	0.0528
TC7	0.50	2005	56	57	4.1596	0.0621
TC7	1.00	2005	57	55	3.9987	0.0128
TC7	1.75	2005	51	61	3.7412	0.0165
TC7	2.50	2005	67	64	4.1878	0.0833
TC7	3.25	2005	59	61	4.1406	0.0078

**Table B.10** Continued

<b>Test Cell</b>	<b>Depth (m.b.g.s)</b>	<b>Year</b>	<b>Sample Mass (mg)</b>	<b>Analysis Time (sec)</b>	<b>Mean wt% Carbon</b>	<b>Standard Deviation</b>
TC2	0.50	2007	69	55	3.6498	0.5773
TC2	1.00	2007	54	56	3.9973	0.0751
TC2	1.75	2007	54	55	3.9521	0.0195
TC2	2.50	2007	56	56	3.7942	0.0456
TC2	3.25	2007	56	57	3.7699	0.0314
TC3	0.50	2007	55	56	3.8644	0.0458
TC3	1.00	2007	70	61	3.9157	0.0085
TC3	1.75	2007	56	60	4.0666	0.0743
TC3	2.50	2007	75	60	4.1033	0.0535
TC4	0.50	2007	56	56	3.5852	0.0209
TC4	1.00	2007	60	59	3.9621	0.0387
TC4	1.75	2007	65	62	4.0176	0.0090
TC4	2.50	2007	53	59	3.9298	0.0654
TC4	3.25	2007	55	56	3.5109	0.0399
TC5	0.50	2007	65	54	3.8189	0.0658
TC5	1.00	2007	64	57	3.9450	0.0523
TC5	1.75	2007	51	68	4.0047	0.0252
TC5	2.50	2007	59	56	3.8715	0.0537
TC5	3.25	2007	52	58	4.4169	0.0400
TC6	0.50	2007	54	61	3.7501	0.0293
TC6	1.00	2007	50	54	3.8629	0.0834
TC6	1.75	2007	60	56	4.0682	0.0917
TC6	2.50	2007	62	59	3.8580	0.0678
TC6	3.25	2007	77	61	4.8297	0.1185
TC7	0.50	2007	51	58	3.7853	0.1040
TC7	1.00	2007	56	56	3.8864	0.0175
TC7	1.75	2007	68	58	3.9180	0.0856
TC7	2.50	2007	70	60	4.0235	0.0949
TC7	3.25	2007	76	61	4.3117	0.0396

**Table B.10** Continued

<b>Test Cell</b>	<b>Depth (m.b.g.s)</b>	<b>Year</b>	<b>Sample Mass (mg)</b>	<b>Analysis Time (sec)</b>	<b>Mean wt% Carbon</b>	<b>Standard Deviation</b>
TC2	0.50	2009	52	55	3.9207	0.0224
TC2	1.00	2009	52	52	4.0190	0.1051
TC2	1.75	2009	76	60	4.2748	0.0819
TC2	2.50	2009	52	51	3.6268	0.0494
TC2	3.25	2009	53	54	3.7304	0.0208
TC3	0.50	2009	65	57	3.8558	0.1277
TC3	1.00	2009	62	60	3.9836	0.0997
TC3	1.75	2009	63	54	3.8570	0.0700
TC3	2.50	2009	57	54	3.8376	0.0867
TC3	3.25	2009	59	52	3.8979	0.0731
TC4	0.50	2009	59	55	3.5634	0.2111
TC4	1.00	2009	62	56	3.8393	0.0303
TC4	1.75	2009	52	54	3.7900	0.0424
TC4	2.50	2009	72	58	3.7903	0.0838
TC4	3.25	2009	66	54	3.1700	0.0192
TC5	0.50	2009	53	54	3.4753	0.0513
TC5	1.00	2009	64	59	3.5225	0.0715
TC5	1.75	2009	77	66	3.8390	0.0929
TC5	2.50	2009	71	62	3.6377	0.0616
TC5	3.25	2009	75	58	3.6243	0.0539
TC6	0.50	2009	55	55	3.3612	0.0412
TC6	1.00	2009	57	54	3.4416	0.0633
TC6	1.75	2009	63	56	3.9887	0.0682
TC6	2.50	2009	57	60	4.2026	0.1029
TC7	0.50	2009	53	55	3.6656	0.0598
TC7	1.00	2009	66	55	3.4859	0.0760
TC7	1.75	2009	59	58	3.8167	0.0708
TC7	2.50	2009	54	56	3.7934	0.0471
TC7	3.25	2009	63	60	3.9174	0.0299

**Table B.11** Organic Carbon Content from Acid Digested Samples (No Inorganic Matter)

Test Cell	Depth	Year	Rep	Furnace Temp (oC)	Crucible Weight (mg)	Total Sample Weight (mg)	Sample Weight After Combustion (mg)	Fraction of Non-Acid and Acid Digested Sample Weight	Organic Carbon wt%	Corrected Organic Carbon wt %	Mean Organic Carbon wt %
TC2	0.50	2005	1	1350	35864.0	87.5	54.1	1.21	0.300	0.364	0.354
TC2	0.50	2005	2	1350	36809.5	83.8	53.6	1.21	0.292	0.354	
TC2	0.50	2005	3	1350	28934.5	84.8	53.3	1.21	0.284	0.344	
TC2	1.00	2005	1	1350	36475.1	84.4	53.3	1.21	0.339	0.411	0.425
TC2	1.00	2005	2	1350	30537.5	84.9	53.0	1.21	0.323	0.391	
TC2	1.00	2005	3	1350	35068.6	82.1	52.9	1.21	0.390	0.472	
TC2	1.75	2005	1	1350	29437.9	88.0	56.5	1.21	0.286	0.345	0.368
TC2	1.75	2005	2	1350	29365.4	88.7	57.9	1.21	0.274	0.331	
TC2	1.75	2005	3	1350	35586.4	88.8	57.4	1.21	0.355	0.429	
TC2	2.50	2005	1	1350	34914.6	81.6	50.2	1.25	0.440	0.552	0.524
TC2	2.50	2005	2	1350	36796.1	88.8	56.8	1.25	0.381	0.478	
TC2	2.50	2005	3	1350	35869.0	85.0	53.3	1.25	0.434	0.544	
TC2	3.25	2005	1	1350	28731.2	87.0	52.8	1.25	0.338	0.424	0.416
TC2	3.25	2005	2	1350	29424.2	83.4	50.8	1.25	0.353	0.443	
TC2	3.25	2005	3	1350	29192.0	85.4	52.1	1.25	0.303	0.380	
TC3	0.50	2005	1	1350	35970.2	87.4	54.9	1.22	0.183	0.224	0.223
TC3	0.50	2005	2	1350	29147.2	87.8	52.5	1.22	0.186	0.227	
TC3	0.50	2005	3	1350	29216.6	83.2	50.0	1.22	0.178	0.218	
TC3	1.00	2005	1	1350	36285.2	84.9	52.9	1.21	0.337	0.409	0.382
TC3	1.00	2005	2	1350	36188.6	86.7	54.3	1.21	0.312	0.378	
TC3	1.00	2005	3	1350	36675.8	84.6	52.8	1.21	0.295	0.358	
TC3	1.75	2005	1	1350	35499.6	85.5	54.3	1.23	0.331	0.406	0.426
TC3	1.75	2005	2	1350	35874.1	83.0	51.8	1.23	0.348	0.428	
TC3	1.75	2005	3	1350	35400.2	83.2	53.4	1.23	0.362	0.444	
TC3	2.50	2005	1	1350	36323.2	82.8	50.0	1.20	0.367	0.441	0.404
TC3	2.50	2005	2	1350	36309.1	85.4	53.5	1.20	0.295	0.355	
TC3	2.50	2005	3	1350	35253.8	86.9	53.7	1.20	0.346	0.416	
TC3	3.25	2005	1	1350	35778.5	83.3	52.1	1.21	0.370	0.447	0.442
TC3	3.25	2005	2	1350	35726.3	84.8	51.8	1.21	0.357	0.432	
TC3	3.25	2005	3	1350	36032.5	89.3	54.8	1.21	0.368	0.445	
TC4	0.50	2005	1	1350	36202.6	81.4	49.0	1.21	0.248	0.300	0.281
TC4	0.50	2005	2	1350	35800.8	81.9	49.7	1.21	0.247	0.299	
TC4	0.50	2005	3	1350	36176.0	87.7	53.1	1.21	0.202	0.244	
TC4	1.00	2005	1	1350	36174.4	81.7	52.6	1.42	0.519	0.739	0.769
TC4	1.00	2005	2	1350	29131.4	81.0	51.7	1.42	0.514	0.732	
TC4	1.00	2005	3	1350	36232.3	87.3	54.1	1.42	0.587	0.835	
TC4	1.75	2005	1	1350	36911.6	84.2	52.8	1.21	0.420	0.509	0.597
TC4	1.75	2005	2	1350	36022.7	83.4	50.4	1.21	0.596	0.722	
TC4	1.75	2005	3	1350	35942.3	87.8	54.1	1.21	0.462	0.560	
TC4	2.50	2005	1	1350	36548.5	88.8	56.0	1.21	0.231	0.280	0.303
TC4	2.50	2005	2	1350	36171.7	88.7	56.8	1.21	0.277	0.336	
TC4	2.50	2005	3	1350	36334.4	87.0	56.5	1.21	0.242	0.293	
TC4	3.25	2005	1	1350	36367.3	86.8	55.4	1.21	0.240	0.289	0.263
TC4	3.25	2005	2	1350	36491.1	81.9	50.1	1.21	0.193	0.233	
TC4	3.25	2005	3	1350	36753.4	83.6	53.8	1.21	0.222	0.268	
TC5	0.50	2005	1	1350	36498.6	88.7	55.7	1.21	0.220	0.267	0.302
TC5	0.50	2005	2	1350	36172.8	87.9	55.4	1.21	0.253	0.308	
TC5	0.50	2005	3	1350	36912.7	82.2	51.1	1.21	0.272	0.331	
TC5	1.00	2005	1	1350	36366.2	83.3	51.1	1.21	0.468	0.564	0.529
TC5	1.00	2005	2	1350	36022.4	84.4	51.3	1.21	0.424	0.512	
TC5	1.00	2005	3	1350	36548.3	87.1	53.4	1.21	0.424	0.511	
TC5	1.75	2005	1	1350	36751.2	84.0	52.1	1.20	0.194	0.234	0.247
TC5	1.75	2005	2	1350	36174.4	82.9	50.6	1.20	0.194	0.234	
TC5	1.75	2005	3	1350	36333.6	85.4	52.4	1.20	0.227	0.273	
TC5	2.50	2005	1	1350	36175.3	87.1	53.7	1.21	0.272	0.329	0.306
TC5	2.50	2005	2	1350	29130.6	87.3	52.5	1.21	0.232	0.281	
TC5	2.50	2005	3	1350	35944.4	83.9	52.5	1.21	0.254	0.307	
TC5	3.25	2005	1	1350	35804.5	85.1	53.1	1.23	0.351	0.431	0.438
TC5	3.25	2005	2	1350	36204.2	84.0	53.3	1.23	0.306	0.376	
TC5	3.25	2005	3	1350	36239.1	86.7	53.4	1.23	0.414	0.508	

**Table B.11 Continued**

Test Cell	Depth	Year	Rep	Furnace Temp (oC)	Crucible Weight (mg)	Total Sample Weight (mg)	Sample Weight After Combustion (mg)	Fraction of Non-Acid and Acid Digested Sample Weight	Organic Carbon wt%	Corrected Organic Carbon wt %	Mean Organic Carbon wt %
TC6	0.50	2005	1	1350	36286.9	81.5	49.2	1.21	0.221	0.268	0.252
TC6	0.50	2005	2	1350	36189.8	88.6	54.7	1.21	0.197	0.238	
TC6	0.50	2005	3	1350	36676.8	86.2	52.1	1.21	0.206	0.250	
TC6	1.00	2005	1	1350	35503.4	87.0	53.6	1.21	0.338	0.409	0.417
TC6	1.00	2005	2	1350	35875.8	84.8	51.7	1.21	0.336	0.407	
TC6	1.00	2005	3	1350	35401.2	82.3	50.6	1.21	0.360	0.434	
TC6	1.75	2005	1	1350	36324.1	86.2	53.8	1.21	0.395	0.478	0.469
TC6	1.75	2005	2	1350	36310.2	84.8	51.2	1.21	0.392	0.474	
TC6	1.75	2005	3	1350	35254.5	83.6	50.3	1.21	0.377	0.456	
TC6	2.50	2005	1	1350	35806.6	84.2	na	1.21	0.263	0.318	0.317
TC6	2.50	2005	2	1350	35730.6	82.3	51.6	1.21	0.250	0.302	
TC6	2.50	2005	3	1350	36035.3	85.6	51.1	1.21	0.275	0.333	
TC7	0.50	2005	1	1350	35973.7	83.2	50.2	1.21	0.882	1.067	1.079
TC7	0.50	2005	2	1350	29147.7	87.8	53.3	1.21	0.864	1.046	
TC7	0.50	2005	3	1350	29217.8	82.7	49.9	1.21	0.931	1.126	
TC7	1.00	2005	1	1350	34916.2	84.9	51.1	1.21	0.684	0.825	0.858
TC7	1.00	2005	2	1350	36797.8	83.2	50.0	1.21	0.787	0.949	
TC7	1.00	2005	3	1350	35870.5	81.5	47.7	1.21	0.663	0.800	
TC7	1.75	2005	1	1350	29439.7	85.6	53.2	1.21	0.390	0.470	0.472
TC7	1.75	2005	2	1350	29365.8	84.4	53.1	1.21	0.388	0.468	
TC7	1.75	2005	3	1350	35586.7	87.6	55.9	1.21	0.397	0.478	
TC7	2.50	2005	1	1350	36476.6	87.1	53.4	1.21	0.466	0.563	0.572
TC7	2.50	2005	2	1350	30538.4	83.0	50.1	1.21	0.465	0.562	
TC7	2.50	2005	3	1350	35070.9	84.9	50.9	1.21	0.490	0.592	
TC7	3.25	2005	1	1350	35871.1	87.1	53.1	1.21	0.510	0.620	0.597
TC7	3.25	2005	2	1350	36811.6	80.7	50.3	1.21	0.498	0.604	
TC7	3.25	2005	3	1350	28935.2	81.5	51.2	1.21	0.467	0.568	
TC2	0.50	2007	1	1350	35870.4	84.3	52.7	1.23	0.652	0.803	0.586
TC2	0.50	2007	2	1350	35973.5	88.4	56.5	1.23	0.393	0.484	
TC2	0.50	2007	3	1350	29145.7	88.3	54.5	1.23	0.382	0.470	
TC2	1.00	2007	1	1350	35401.0	86.5	54.6	1.24	0.506	0.628	0.606
TC2	1.00	2007	2	1350	36287.3	81.9	52.1	1.24	0.497	0.616	
TC2	1.00	2007	3	1350	36190.9	88.6	57.1	1.24	0.462	0.573	
TC2	1.75	2007	1	1350	35586.6	83.7	52.9	1.25	0.447	0.558	0.544
TC2	1.75	2007	2	1350	34918.9	89.2	55.9	1.25	0.422	0.528	
TC2	1.75	2007	3	1350	36800.0	83.1	52.3	1.25	0.436	0.546	
TC2	2.50	2007	1	1350	35070.5	86.5	56.0	1.26	0.304	0.383	0.368
TC2	2.50	2007	2	1350	29438.2	84.8	54.0	1.26	0.296	0.373	
TC2	2.50	2007	3	1350	29363.9	83.9	53.3	1.26	0.276	0.348	
TC2	3.25	2007	1	1350	28934.0	86.4	54.5	1.19	0.368	0.438	0.450
TC2	3.25	2007	2	1350	36475.9	89.5	56.2	1.19	0.387	0.460	
TC2	3.25	2007	3	1350	30538.0	86.1	53.9	1.19	0.381	0.454	
TC3	0.50	2007	1	1350	35266.1	82.4	48.6	1.23	0.365	0.447	0.468
TC3	0.50	2007	2	1350	35520.2	86.8	52.0	1.23	0.422	0.517	
TC3	0.50	2007	3	1350	35888.8	81.6	49.2	1.23	0.358	0.439	
TC3	1.00	2007	1	1350	36044.8	84.7	51.5	1.26	0.343	0.430	0.417
TC3	1.00	2007	2	1350	36335.5	88.0	53.4	1.26	0.321	0.403	
TC3	1.00	2007	3	1350	36321.0	84.1	51.2	1.26	0.332	0.417	
TC3	1.75	2007	1	1350	36926.2	87.4	53.5	1.44	0.716	1.034	1.088
TC3	1.75	2007	2	1350	35822.4	82.7	44.8	1.44	0.757	1.093	
TC3	1.75	2007	3	1350	35746.4	85.2	51.7	1.44	0.788	1.138	
TC3	2.50	2007	1	1350	36344.7	85.3	54.3	1.23	0.525	0.646	0.644
TC3	2.50	2007	2	1350	36516.3	87.6	52.9	1.23	0.487	0.599	
TC3	2.50	2007	3	1350	36184.0	82.5	49.5	1.23	0.559	0.687	
TC4	0.50	2007	1	1350	36375.9	87.9	56.2	1.25	0.247	0.307	0.379
TC4	0.50	2007	2	1350	36039.2	84.4	51.9	1.25	0.349	0.435	
TC4	0.50	2007	3	1350	36558.9	81.7	50.2	1.25	0.317	0.395	
TC4	1.00	2007	1	1350	35818.9	88.8	55.4	1.25	0.432	0.541	0.604
TC4	1.00	2007	2	1350	36214.9	84.1	53.7	1.25	0.507	0.634	
TC4	1.00	2007	3	1350	36252.4	82.6	50.9	1.25	0.510	0.638	



**Table B.11** Continued

Test Cell	Depth	Year	Rep	Furnace Temp (oC)	Crucible Weight (mg)	Total Sample Weight (mg)	Sample Weight After Combustion (mg)	Fraction of Non-Acid and Acid Digested Sample Weight	Organic Carbon wt%	Corrected Organic Carbon wt %	Mean Organic Carbon wt %
TC4	1.75	2007	1	1350	35586.1	86.8	54.1	1.21	0.541	0.654	0.746
TC4	1.75	2007	2	1350	34840.6	83.0	49.9	1.21	0.606	0.732	
TC4	1.75	2007	3	1350	36039.7	83.9	48.3	1.21	0.705	0.853	
TC4	2.50	2007	1	1350	36599.0	84.5	51.6	1.22	0.545	0.668	0.645
TC4	2.50	2007	2	1350	35876.3	86.8	52.4	1.22	0.521	0.638	
TC4	2.50	2007	3	1350	36117.9	85.2	50.8	1.22	0.514	0.629	
TC4	3.25	2007	1	1350	36687.4	87.2	52.5	1.17	0.262	0.307	0.317
TC4	3.25	2007	2	1350	35904.7	89.8	53.5	1.17	0.272	0.319	
TC4	3.25	2007	3	1350	36822.6	89.2	53.8	1.17	0.278	0.326	
TC5	0.50	2007	1	1350	35975.9	76.7	48.3	1.21	0.515	0.624	0.593
TC5	0.50	2007	2	1350	36287.9	83.8	52.1	1.21	0.502	0.608	
TC5	0.50	2007	3	1350	34921.6	86.2	55.0	1.21	0.450	0.546	
TC5	1.00	2007	1	1350	35870.3	89.7	59.2	1.22	0.408	0.498	0.553
TC5	1.00	2007	2	1350	35402.2	88.6	58.1	1.22	0.447	0.546	
TC5	1.00	2007	3	1350	35588.4	84.8	53.9	1.22	0.505	0.616	
TC5	1.75	2007	1	1350	35946.2	82.7	53.6	1.21	0.488	0.588	0.618
TC5	1.75	2007	2	1350	36753.9	84.8	54.7	1.21	0.534	0.643	
TC5	1.75	2007	3	1350	36178.3	84.4	55.0	1.21	0.516	0.622	
TC5	2.50	2007	1	1350	36179.9	83.4	55.3	1.25	0.317	0.397	0.393
TC5	2.50	2007	2	1350	29339.2	86.1	55.1	1.25	0.323	0.405	
TC5	2.50	2007	3	1350	29131.2	89.0	57.9	1.25	0.301	0.377	
TC5	3.25	2007	1	1350	28733.3	87.3	55.9	1.21	0.862	1.046	1.014
TC5	3.25	2007	2	1350	29425.4	86.8	52.0	1.21	0.895	1.087	
TC5	3.25	2007	3	1350	29193.7	86.1	52.2	1.21	0.749	0.910	
TC6	0.50	2007	1	1350	36232.3	100.7	65.6	1.26	0.589	0.744	0.599
TC6	0.50	2007	2	1350	35062.1	78.1	50.8	1.26	0.350	0.442	
TC6	0.50	2007	3	1350	35242.7	84.0	56.0	1.26	0.484	0.611	
TC6	1.00	2007	1	1350	29216.3	90.4	57.7	1.23	0.375	0.461	0.508
TC6	1.00	2007	2	1350	35611.7	93.3	62.7	1.23	0.370	0.454	
TC6	1.00	2007	3	1350	36581.3	86.4	57.5	1.23	0.497	0.610	
TC6	1.75	2007	1	1350	28934.5	85.4	54.7	1.22	0.412	0.502	0.512
TC6	1.75	2007	2	1350	36476.8	84.4	52.1	1.22	0.479	0.583	
TC6	1.75	2007	3	1350	30537.4	83.6	54.4	1.22	0.371	0.452	
TC6	2.50	2007	1	1350	35071.5	89.0	59.7	1.24	0.400	0.498	0.479
TC6	2.50	2007	2	1350	29438.4	85.4	55.2	1.24	0.373	0.464	
TC6	2.50	2007	3	1350	29364.3	82.3	53.3	1.24	0.383	0.477	
TC6	3.25	2007	1	1350	29144.9	82.4	51.7	1.24	0.932	1.152	1.226
TC6	3.25	2007	2	1350	36191.9	82.8	51.9	1.24	1.016	1.255	
TC6	3.25	2007	3	1350	36803.2	84.7	54.5	1.24	1.028	1.270	
TC7	0.50	2007	1	1350	na	75.3	na	1.24	0.653	0.811	0.772
TC7	0.50	2007	2	1350	na	75.8	na	1.24	0.591	0.733	
TC7	0.50	2007	3	1350	36785.3	75.7	38.6	1.24	0.623	0.773	
TC7	1.00	2007	1	1350	36290.1	76.2	46.2	1.32	0.577	0.760	0.717
TC7	1.00	2007	2	1350	36193.5	75.4	47.2	1.32	0.535	0.705	
TC7	1.00	2007	3	1350	30537.1	76.8	45.4	1.32	0.520	0.685	
TC7	1.75	2007	1	1350	34928.8	75.9	42.7	1.21	0.628	0.760	0.740
TC7	1.75	2007	2	1350	29145.6	74.8	44.6	1.21	0.557	0.674	
TC7	1.75	2007	3	1350	28936.1	76.5	46.5	1.21	0.650	0.786	
TC7	2.50	2007	1	1350	35074.4	75.8	na	1.29	0.636	0.822	0.818
TC7	2.50	2007	2	1350	36476.8	75.6	46.5	1.29	0.681	0.881	
TC7	2.50	2007	3	1350	29217.4	75.8	45.5	1.29	0.581	0.751	
TC7	3.25	2007	1	1350	29439.2	75.2	47.5	1.21	0.795	0.965	0.967
TC7	3.25	2007	2	1350	29362.7	74.7	47.1	1.21	0.778	0.945	
TC7	3.25	2007	3	1350	35612.5	74.9	47.3	1.21	0.816	0.991	
TC2	0.50	2009	1	1350	35609.8	81.7	48.7	1.23	0.488	0.600	0.458
TC2	0.50	2009	2	1350	36580.4	82.4	45.7	1.23	0.344	0.423	
TC2	0.50	2009	3	1350	36232.8	86.1	50.0	1.23	0.284	0.349	
TC2	1.00	2009	1	1350	34833.3	87.8	50.3	1.20	0.295	0.354	0.329
TC2	1.00	2009	2	1350	36024.7	87.3	52.0	1.20	0.270	0.324	
TC2	1.00	2009	3	1350	36593.7	81.1	49.0	1.20	0.258	0.310	

**Table B.11 Continued**

Test Cell	Depth	Year	Rep	Furnace Temp (oC)	Crucible Weight (mg)	Total Sample Weight (mg)	Sample Weight After Combustion (mg)	Fraction of Non-Acid and Acid Digested Sample Weight	Organic Carbon wt%	Corrected Organic Carbon wt %	Mean Organic Carbon wt %
TC2	1.75	2009	1	1350	35065.1	81.3	48.9	1.20	0.264	0.317	0.321
TC2	1.75	2009	2	1350	35240.9	83.9	50.3	1.20	0.273	0.327	
TC2	1.75	2009	3	1350	35575.6	88.4	52.6	1.20	0.265	0.318	
TC2	2.50	2009	1	1350	35853.7	82.1	49.5	1.17	0.293	0.342	0.345
TC2	2.50	2009	2	1350	36105.1	86.5	53.9	1.17	0.296	0.345	
TC2	2.50	2009	3	1350	35932.8	82.8	51.2	1.17	0.298	0.348	
TC2	3.25	2009	1	1350	35265.8	83.3	49.0	1.24	0.240	0.297	0.302
TC2	3.25	2009	2	1350	36102.0	84.7	49.8	1.24	0.240	0.297	
TC2	3.25	2009	3	1350	35552.3	84.5	49.6	1.24	0.253	0.313	
TC3	0.50	2009	1	1350	35610.8	86.3	50.7	1.22	0.359	0.439	0.432
TC3	0.50	2009	2	1350	36581.2	84.5	51.2	1.22	0.360	0.439	
TC3	0.50	2009	3	1350	36233.6	88.3	50.5	1.22	0.343	0.419	
TC3	1.00	2009	1	1350	35061.6	80.6	48.8	1.17	0.386	0.453	0.456
TC3	1.00	2009	2	1350	35240.7	86.6	52.9	1.17	0.371	0.436	
TC3	1.00	2009	3	1350	35575.1	86.6	52.2	1.17	0.407	0.478	
TC3	1.75	2009	1	1350	34833.8	83.5	51.7	1.18	0.306	0.361	0.377
TC3	1.75	2009	2	1350	36028.2	86.6	52.8	1.18	0.336	0.397	
TC3	1.75	2009	3	1350	36592.4	87.2	54.2	1.18	0.317	0.373	
TC3	2.50	2009	1	1350	35855.8	58.0	35.3	1.14	0.328	0.375	0.402
TC3	2.50	2009	2	1350	36107.1	54.7	32.7	1.14	0.373	0.426	
TC3	2.50	2009	3	1350	35944.4	58.7	33.0	1.14	0.354	0.404	
TC3	3.25	2009	1	1350	35270.8	81.3	49.0	1.15	0.402	0.461	0.456
TC3	3.25	2009	2	1350	36108.0	81.8	48.2	1.15	0.387	0.444	
TC3	3.25	2009	3	1350	35567.3	86.7	50.9	1.15	0.404	0.463	
TC4	0.50	2009	1	1350	35878.6	86.8	57.4	1.15	0.251	0.288	0.286
TC4	0.50	2009	2	1350	36812.1	83.0	53.6	1.15	0.274	0.316	
TC4	0.50	2009	3	1350	28934.6	85.5	54.8	1.15	0.222	0.255	
TC4	1.00	2009	1	1350	36475.4	83.5	53.5	1.17	0.360	0.422	0.452
TC4	1.00	2009	2	1350	30538.4	83.5	50.5	1.17	0.384	0.451	
TC4	1.00	2009	3	1350	35071.4	85.5	51.9	1.17	0.412	0.483	
TC4	1.75	2009	1	1350	29438.7	86.2	51.2	1.20	0.291	0.350	0.404
TC4	1.75	2009	2	1350	29365.8	82.1	48.1	1.20	0.344	0.414	
TC4	1.75	2009	3	1350	35586.5	85.0	51.1	1.20	0.371	0.446	
TC4	2.50	2009	1	1350	34917.2	89.5	56.7	1.17	0.405	0.475	0.478
TC4	2.50	2009	2	1350	36799.1	84.5	53.5	1.17	0.446	0.522	
TC4	2.50	2009	3	1350	35870.1	86.9	53.9	1.17	0.374	0.438	
TC4	3.25	2009	1	1350	35972.9	89.0	57.0	1.53	0.214	0.327	0.315
TC4	3.25	2009	2	1350	29146.5	80.4	50.5	1.53	0.205	0.314	
TC4	3.25	2009	3	1350	29217.9	89.3	56.8	1.53	0.199	0.304	
TC5	0.50	2009	1	1350	36504.0	83.4	51.1	1.21	0.214	0.258	0.291
TC5	0.50	2009	2	1350	36176.5	84.3	52.1	1.21	0.253	0.306	
TC5	0.50	2009	3	1350	36916.5	84.9	50.6	1.21	0.256	0.310	
TC5	1.00	2009	1	1350	35810.0	88.8	56.0	1.22	0.292	0.357	0.373
TC5	1.00	2009	2	1350	35736.6	87.3	54.4	1.22	0.295	0.362	
TC5	1.00	2009	3	1350	36037.2	84.5	52.4	1.22	0.327	0.400	
TC5	1.75	2009	1	1350	36326.0	83.5	50.5	1.21	0.415	0.500	0.543
TC5	1.75	2009	2	1350	36311.5	83.9	51.4	1.21	0.446	0.539	
TC5	1.75	2009	3	1350	35256.2	86.1	51.9	1.21	0.488	0.590	
TC5	2.50	2009	1	1350	35509.2	89.0	52.0	1.20	0.305	0.367	0.386
TC5	2.50	2009	2	1350	35878.0	83.2	48.5	1.20	0.372	0.447	
TC5	2.50	2009	3	1350	35401.0	83.4	49.9	1.20	0.286	0.344	
TC5	3.25	2009	1	1350	36286.8	88.2	53.5	1.24	0.282	0.349	0.321
TC5	3.25	2009	2	1350	36190.3	83.4	51.1	1.24	0.220	0.272	
TC5	3.25	2009	3	1350	36678.5	84.9	51.9	1.24	0.276	0.342	
TC6	0.50	2009	1	1350	35807.7	81.9	50.5	1.23	0.494	0.606	
TC6	0.50	2009	2	1350	36207.8	88.1	54.5	1.23	0.238	0.292	0.288
TC6	0.50	2009	3	1350	36243.3	84.1	51.3	1.23	0.255	0.313	
TC6	0.50	2009	4	1350	36368.8	85.0	52.2	1.23	0.212	0.260	

**Table B.11** Continued

Test Cell	Depth	Year	Rep	Furnace Temp (oC)	Crucible Weight (mg)	Total Sample Weight (mg)	Sample Weight After Combustion (mg)	Fraction of Non-Acid and Acid Digested Sample Weight	Organic Carbon wt%	Corrected Organic Carbon wt %	Mean Organic Carbon wt %
TC6	1.00	2009	1	1350	36025.5	86.0	50.8	1.21	0.170	0.204	0.230
TC6	1.00	2009	2	1350	36550.1	84.1	5036.0	1.21	0.189	0.228	
TC6	1.00	2009	3	1350	28733.8	84.9	49.4	1.21	0.214	0.258	
TC6	1.75	2009	1	1350	29425.4	86.8	52.1	1.22	0.169	0.207	0.216
TC6	1.75	2009	2	1350	29192.9	87.4	54.1	1.22	0.163	0.200	
TC6	1.75	2009	3	1350	36177.5	88.1	53.8	1.22	0.197	0.241	
TC6	2.50	2009	1	1350	29339.4	82.9	49.8	1.21	0.501	0.607	0.662
TC6	2.50	2009	2	1350	29131.1	81.9	47.7	1.21	0.592	0.717	
TC6	2.50	2009	3	1350	35946.0	83.2	49.6	1.21	0.628	0.761	
TC6	3.25	2009	1	1350	36752.9	83.2	49.0	1.20	0.411	0.492	0.487
TC6	3.25	2009	2	1350	36177.3	85.5	50.2	1.20	0.399	0.477	
TC6	3.25	2009	3	1350	36336.2	83.2	48.2	1.20	0.410	0.491	
TC7	0.50	2009	1	1350	29217.0	85.7	53.7	1.21	0.464	0.562	0.593
TC7	0.50	2009	2	1350	35610.8	85.9	53.0	1.21	0.474	0.574	
TC7	0.50	2009	3	1350	36580.7	88.7	55.3	1.21	0.530	0.641	
TC7	1.00	2009	1	1350	36231.8	89.4	55.4	1.21	0.295	0.356	0.371
TC7	1.00	2009	2	1350	35060.6	86.2	53.1	1.21	0.324	0.392	
TC7	1.00	2009	3	1350	35240.8	84.9	52.7	1.21	0.302	0.365	
TC7	1.75	2009	1	1350	36679.1	85.1	51.7	1.21	0.518	0.625	0.581
TC7	1.75	2009	2	1350	35886.9	83.9	51.2	1.21	0.431	0.519	
TC7	1.75	2009	3	1350	36813.1	86.1	52.1	1.21	0.497	0.599	
TC7	2.50	2009	1	1350	36592.0	84.2	50.3	1.21	0.573	0.694	0.678
TC7	2.50	2009	2	1350	35859.5	87.5	52.4	1.21	0.522	0.632	
TC7	2.50	2009	3	1350	36109.0	85.0	49.5	1.21	0.586	0.709	
TC7	3.25	2009	1	1350	35576.1	89.0	53.1	1.23	0.393	0.483	0.490
TC7	3.25	2009	2	1350	34833.7	86.9	53.1	1.23	0.410	0.504	
TC7	3.25	2009	3	1350	36028.7	83.4	51.3	1.23	0.392	0.482	

**Table B.12** Summary of Organic, Inorganic and Total Carbon

Test Cell	Depth (m.b.g.s.)	Year	Number of Replicates	Mean	Total	Mean	Organic	Mean
				Total C %	C Std Dev	Organic C %	C Std Dev	Inorganic C %
				Induction Furnace	Resistance Furnace		Calculated Value	
TC2	0.50	2005	3	3.782	0.007	0.354	0.010	3.428
TC2	1.00	2005	3	3.718	0.024	0.425	0.042	3.293
TC2	1.75	2005	3	3.619	0.033	0.368	0.053	3.250
TC2	2.50	2005	3	3.777	0.014	0.524	0.041	3.253
TC2	3.25	2005	3	3.729	0.085	0.416	0.032	3.313
TC3	0.50	2005	3	3.454	0.051	0.223	0.005	3.231
TC3	1.00	2005	3	3.807	0.093	0.382	0.026	3.425
TC3	1.75	2005	3	3.696	0.147	0.426	0.019	3.269
TC3	2.50	2005	3	3.751	0.099	0.404	0.044	3.347
TC3	3.25	2005	3	3.700	0.035	0.442	0.009	3.258
TC4	0.50	2005	3	3.527	0.037	0.281	0.032	3.246
TC4	1.00	2005	3	3.721	0.056	0.769	0.058	2.952
TC4	1.75	2005	3	3.717	0.071	0.597	0.112	3.120
TC4	2.50	2005	3	3.218	0.023	0.303	0.029	2.915
TC4	3.25	2005	3	3.169	0.043	0.263	0.028	2.906
TC5	0.50	2005	3	3.599	0.048	0.302	0.032	3.297
TC5	1.00	2005	3	3.681	0.045	0.529	0.031	3.152
TC5	1.75	2005	3	3.543	0.114	0.247	0.023	3.296
TC5	2.50	2005	3	3.534	0.068	0.306	0.024	3.229
TC5	3.25	2005	3	3.754	0.070	0.438	0.066	3.316
TC6	0.50	2005	3	3.449	0.015	0.252	0.015	3.197
TC6	1.00	2005	3	3.567	0.100	0.417	0.015	3.151
TC6	1.75	2005	3	3.884	0.018	0.469	0.012	3.415
TC6	2.50	2005	3	3.659	0.053	0.317	0.015	3.341
TC7	0.50	2005	3	4.160	0.062	1.079	0.042	3.080
TC7	1.00	2005	3	3.999	0.013	0.858	0.080	3.140
TC7	1.75	2005	3	3.741	0.017	0.472	0.005	3.269
TC7	2.50	2005	3	4.188	0.083	0.572	0.017	3.616
TC7	3.25	2005	3	4.141	0.008	0.597	0.027	3.543

**Table B.12** Continued

Test Cell	Depth (m.b.g.s.)	Year	Number of Replicates	Mean Total C %	Total C Std Dev	Mean Organic C %	Organic C Std Dev	Mean Inorganic C %
				Induction Furnace	Resistance Furnace		Calculated Value	
TC2	0.50	2007	3	3.650	0.577	0.586	0.188	3.064
TC2	1.00	2007	3	3.997	0.075	0.606	0.029	3.392
TC2	1.75	2007	3	3.952	0.019	0.544	0.016	3.408
TC2	2.50	2007	3	3.794	0.046	0.368	0.018	3.426
TC2	3.25	2007	3	3.770	0.031	0.450	0.012	3.319
TC3	0.50	2007	3	3.864	0.046	0.468	0.043	3.397
TC3	1.00	2007	3	3.916	0.008	0.417	0.014	3.499
TC3	1.75	2007	3	4.067	0.074	1.088	0.052	2.978
TC3	2.50	2007	3	4.103	0.054	0.644	0.044	3.459
TC4	0.50	2007	3	3.585	0.021	0.379	0.065	3.206
TC4	1.00	2007	3	3.962	0.039	0.604	0.055	3.358
TC4	1.75	2007	3	4.018	0.009	0.746	0.100	3.272
TC4	2.50	2007	3	3.930	0.065	0.645	0.020	3.285
TC4	3.25	2007	3	3.511	0.040	0.317	0.009	3.194
TC5	0.50	2007	3	3.819	0.066	0.593	0.042	3.226
TC5	1.00	2007	3	3.945	0.052	0.553	0.059	3.392
TC5	1.75	2007	3	4.005	0.025	0.618	0.028	3.387
TC5	2.50	2007	3	3.871	0.054	0.393	0.015	3.478
TC5	3.25	2007	3	4.417	0.040	1.014	0.093	3.403
TC6	0.50	2007	3	3.750	0.029	0.599	0.152	3.151
TC6	1.00	2007	3	3.863	0.083	0.508	0.088	3.355
TC6	1.75	2007	3	4.068	0.092	0.512	0.066	3.556
TC6	2.50	2007	3	3.858	0.068	0.479	0.017	3.379
TC6	3.25	2007	3	4.830	0.119	1.226	0.064	3.604
TC7	0.50	2007	3	3.785	0.104	0.772	0.039	3.013
TC7	1.00	2007	3	3.886	0.018	0.717	0.039	3.170
TC7	1.75	2007	3	3.918	0.086	0.740	0.059	3.178
TC7	2.50	2007	3	4.024	0.095	0.818	0.065	3.205
TC7	3.25	2007	3	4.312	0.040	0.967	0.023	3.345

**Table B.12** Continued

Test Cell	Depth (m.b.g.s.)	Year	Number of Replicates	Mean Total C %	Total C Std Dev	Mean Organic C %	Organic C Std Dev	Mean Inorganic C %
				Induction Furnace	Resistance Furnace		Calculated Value	
TC2	0.50	2009	3	3.921	0.022	0.458	0.129	3.463
TC2	1.00	2009	3	4.019	0.105	0.329	0.023	3.690
TC2	1.75	2009	3	4.275	0.082	0.321	0.006	3.954
TC2	2.50	2009	3	3.627	0.049	0.345	0.003	3.282
TC2	3.25	2009	3	3.730	0.021	0.302	0.009	3.428
TC3	0.50	2009	3	3.856	0.128	0.432	0.012	3.423
TC3	1.00	2009	3	3.984	0.100	0.456	0.021	3.528
TC3	1.75	2009	3	3.857	0.070	0.377	0.018	3.480
TC3	2.50	2009	3	3.838	0.087	0.402	0.026	3.436
TC3	3.25	2009	3	3.898	0.073	0.456	0.011	3.442
TC4	0.50	2009	3	3.563	0.211	0.286	0.030	3.277
TC4	1.00	2009	3	3.839	0.030	0.452	0.030	3.387
TC4	1.75	2009	3	3.790	0.042	0.404	0.049	3.386
TC4	2.50	2009	3	3.790	0.084	0.478	0.042	3.312
TC4	3.25	2009	3	3.170	0.019	0.315	0.012	2.855
TC5	0.50	2009	3	3.475	0.051	0.291	0.029	3.184
TC5	1.00	2009	3	3.522	0.071	0.373	0.024	3.149
TC5	1.75	2009	3	3.839	0.093	0.543	0.045	3.296
TC5	2.50	2009	3	3.638	0.062	0.386	0.054	3.251
TC5	3.25	2009	3	3.624	0.054	0.321	0.043	3.303
TC6	0.50	2009	3	3.361	0.041	0.288	0.027	3.073
TC6	1.00	2009	3	3.364	0.086	0.230	0.027	3.134
TC6	1.75	2009	3	3.442	0.063	0.216	0.022	3.226
TC6	2.50	2009	3	3.989	0.068	0.662	0.078	3.327
TC6	3.25	2009	3	4.203	0.103	0.487	0.008	3.716
TC7	0.50	2009	3	3.666	0.060	0.593	0.043	3.073
TC7	1.00	2009	3	3.486	0.076	0.371	0.018	3.115
TC7	1.75	2009	3	3.817	0.071	0.581	0.055	3.236
TC7	2.50	2009	3	3.793	0.047	0.678	0.041	3.115
TC7	3.25	2009	3	3.917	0.030	0.490	0.012	3.428