Evaluating BMPs for Temporary Stockpiling of Poultry Litter

FINAL REPORT

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Executive Summary

Most poultry farms lack adequate on-farm capacity to store total cleanout litter in their manure storage sheds. As a result, storing poultry litter in the field after removal from the poultry production facility prior to spreading as a fertilizer during the production of crops is a common practice in the Delmarva region. There is a lack of research, however, on the potential losses of nutrients during this period of field storage. The objectives of this project were to quantify the types and amounts of nutrients being lost from these piles during storage and to evaluate techniques that can be used to minimize these nutrient losses. Production-size piles were utilized for this project, because all previous research used small research-size piles that may not adequately compare to actual practices used in production agriculture. Two methods were used to monitor nutrient losses from poultry litter piles. One method used runoff pans to collect runoff/leachate from the edges of poultry litter piles. With this method, a total of six replications of runoff/leachate were collected from three different piles during a three-year period. Assuming a pile size of 100 tons of poultry litter, the results showed that the average amounts of inorganic N, total P, potassium, and sulfur in the runoff/leachate were 17, 3, 113, and 32 pounds, respectively. The other method of measuring nutrient losses from poultry litter piles involved taking soil samples from either the surface 36- or 48-inch soil layer. In this project, a total of 33 different site-treatment combinations were sampled where litter had been stored for at least 90 days. Assuming a stockpile size of 100 tons of litter, the amounts of inorganic N (i.e., ammonium-N + nitrate-N) found in the soil ranged from 2 to 29 pounds with a mean of 12 pounds. This project also evaluated various covers and bases (i.e., something under the litter). None of the covers or bases resulted in a significant reduction in nutrient losses from the poultry litter piles. During the three years of this project, there were four direct comparisons of using a polyethylene cover versus using no cover. The results showed that on average the no-cover treatments lost 16 pounds of inorganic N, while the polyethylene cover was not significantly different and lost an average of 13 pounds of inorganic N. Soluble salt levels in the surface layer of the soil following poultry litter storage usually prevented establishment of crops in the area were the litter was piled. Covering the pile with polyethylene did not reduce the amounts of soluble salts found in the soil. The nutrient lost in the greatest amounts from poultry litter piles was potassium followed by sulfur. Regression analysis showed that these two nutrients were the main contributors to high levels of soluble salts, and inorganic N levels had nearly zero impact on soluble salt concentrations. The poultry litter piles had only minimal impacts on soil test phosphorus concentrations. Overall, the results from this project showed that amounts of N lost from temporary piles of poultry litter were quite small and represented about 0.2% of the amount of N in the litter pile. These findings suggest that properly shaped poultry litter piles have less potential for nutrient losses than poultry litter spread on the soil at the wrong time of the year (i.e., in the fall or early winter prior to crop establishment). In other words, poultry litter storage requirements should not promote litter applications at inappropriate times of the year. Finally, Delaware regulations on temporary in-field storage of poultry litter should be considered best management practices (BMPs) and should be followed.

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Background and Justification

The poultry industry on Delmarva is facing unprecedented challenges. Environmental issues related to water and air quality are a high priority. The challenge to the industry is the adoption of sound, practical and cost-effective technologies that protect the environment. These technologies must be phased-in to meet both current and future issues in a manner that does not jeopardize the industry's competitiveness in national and international markets. Using best available management practices for temporary storage of poultry litter is a challenge that is currently facing the poultry industry. In fact, temporary storage of poultry litter has been identified by the Delaware Nutrient Management Commission (DNMC) as a priority initiative for nutrient management research and education needs within the state of Delaware (DNMC Annual Report, 2004). At a DNMC meeting on November 9, 2004 at the Delaware Department of Agriculture, temporary storage of poultry litter was identified as one of the most pressing issues facing agriculture in Delaware, and there was unanimous agreement that research using production-size stockpiles was needed for implementing best management practices (BMPs) that minimize nutrient loss potential. This meeting included individuals from the poultry industry, farmers, consultants, University of Delaware research and extension personnel, the director of DNREC's Water Resources Division, NRCS personnel, DDA personnel, and other citizens concerned with water quality/nutrient management issues in Delaware.

There has been considerable research done with temporary storage of poultry litter in relatively small piles; however, we can find no work that has evaluated or demonstrated the impact of stockpiling BMPs when poultry litter is stored in piles the size that are used in production agriculture. A typical stockpile on Delmarva from a whole-house cleanout typically will contain from 75 to 200 tons of litter. During the summer of 2004, Bud Malone organized a "meeting of the minds" of individuals throughout all of North America who had conducted research and demonstration projects. The bottom-line finding from this workshop was that most research and demonstration work has been done on piles with eight to ten tons of litter and that no projects have ever evaluated BMPs and nutrient losses from poultry litter that is temporarily stored in stockpiles the size of those used in production agriculture.

New EPA standards indicate that stockpiles of litter that remain in the field for more than 14 days should be covered. Covering a pile with polyethylene is a recommended practice for litter that is stored outside beyond 14 days. However, farmers who have tried covering litter piles in polyethylene suggest that this practice is not practical. Their experiences indicate that piles covered in polyethylene require almost constant upkeep and monitoring and are costly to maintain. In addition, there is evidence that nutrient loading may not be reduced by covering poultry litter piles with polyethylene. Farmers have also reported that a wet, offensive layer of litter sometimes occurs on the surface of the covered pile.

Discussions with many of those involved in production agriculture who use poultry litter as a fertilizer have stated that it will be nearly impossible for them to store litter for less than 14 days in the field. Therefore, they will be forced to stop using litter, thereby creating a greater surplus of litter that will need to be exported from the area. Another major concern of this 14-day limit on stockpiling is that some growers will likely spread the litter on their fields regardless of the time

of year. Obviously, spreading the litter without regard to the time of year (i.e., winter) is a practice that greatly increases the risk of nutrient losses to the environment.

Objectives

The main objective of this project was to determine best management practices for minimizing nutrient losses during temporary outdoor storage of poultry litter. The primary tasks were:

1) To evaluate duration of poultry litter temporary storage

2) To evaluate type of cover during temporary storage of litter

3) To evaluate type of base (i.e., treatment applied under the litter pile) for use during temporary storage of litter

Methodology

Time of Removal:

This project began in the fall of 2005 by creating a large pile (approximately 350 tons) of poultry litter at a farm in Sussex County, DE. The pile was defined as Site TR1 and was setup as shown in Diagram 1 below:

B	Trt 1	**B**	Trt 2	**B**	Trt 3	**B**	Trt 4	**B**	Trt 5	**B**	Trt 6	**B**

Diagram 1. An 8-ft wide buffer (**B**) area was placed between treatments to eliminate possible treatments impacting each other.

Each buffer area was eight feet in length, while each treatment area was 16 feet in length. The width of the pile was about 20 feet and the height was about 6.5 feet. There were six planned treatments that were to remove the litter at 15 days, 30 days, 45 days, 90 days, 135 days, and 180 days after the pile was created. The pile required 14 tractor-trailer loads (each load contained about 25 tons) of litter, and this litter was dumped at the site from October 28 to October 31. The pile was pushed up into an “A” shape on 1 November 2005. The pile was positioned in a north-south orientation. The poultry litter was removed on the following dates: 17 Nov 2005, 2 Dec 2005, 14 Dec 2005, 2 Feb 2006, 20 Mar 2006, and 5 May 5 2006. These removal dates corresponding to the following number of days from initiation of the pile: 16, 31, 43, 93, 139, and 185 days, respectively.

This time of removal study was repeated by putting out another large pile in the fall of 2006 on a different farm in Sussex County; this site was defined as Site TR2. This pile was pushed up and started on 25 Oct 2006. Because of weather challenges and schedule conflicts with the cooperator, the removal dates did not coincide with those used in the first year at Site TR1. At Site TR2, the six removal dates were: 29 Nov 2006, 12 Dec 2006, 20 Feb 2007, 15 Mar 2007, 2 Apr 2007, and 8 May 2007. These removal dates corresponded to the following number of days from initiation of the pile: 35, 48, 118, 141, 159, and 195 days, respectively. Because the number of days from initiation of the pile to removal of the litter is different between the two sites, the treatments will be designated as R1, R2, R3, R4, R5, and R6 throughout this report.

Covers and Bases:

In the fall of 2005, a large litter pile was constructed on a different farm from Site TR1. The pile was defined as Site CB and was created as shown in Diagram 1; however, this pile contained seven treatments that were: 1) no cover, 2) polyethylene cover, 3) bentonite clay base, 4) spray-on carbon material at single rate, 5) spray-on carbon material at double rate, 6) sawdust base, and 7) Poultry Guard®, a litter treatment for ammonia control, spread on the soil as a base before piling the litter. This pile was created by dumping about 16 tractor-trailer loads of poultry litter on October 25 and October 26. On 27 October 2005, this pile was pushed up into an “A” shape that was nearly seven feet high (see Picture 1 for an image of the pile at Site CB).

Picture 1. Site CB showing the no-cover treatment in the front, then the poly cover, then the bentonite base, then the two spray-on carbon treatments, then the sawdust treatment, and the Poultry Guard®-base treatment at the far end of the pile.

At Site CB, the base treatments were applied the morning of October 26 before the first load of litter was hauled in. The sawdust treatment was applied onto the soil surface to a depth of about

four inches, while 100 pounds of bentonite clay was applied to an area that was 14 ft by 16 ft. The Poultry Guard was applied in a granular form at a rate of 50 pounds to an area that was 14 ft by 16 ft. Poultry Guard® is granulated clay impregnated with sulfuric acid that is used in poultry production houses for ammonia control. Unfortunately, the bentonite clay, Poultry Guard, and sawdust did not completely cover the area under the pile because the width of the pile was about 18 feet. All soil samples that were taken "under" the pile were collected from a treated area but the "edge" samples were not from a treated area. The spray-on carbon material was from a company in North Carolina that used this material as a bedding in poultry houses. The spray-on carbon material was applied on November 11. The two treatment areas where the carbon material was applied were covered with polyethylene from 27 Oct through 11 Nov. The material was sprayed on by employees of this North Carolina company. The contact person from this company was Timothy Cathey. The rates were applied as recommended by Mr. Cathey, which involved putting on his recommended rate for both treatment areas. On the "double" treatment area, a second layer of the material was applied so that it had double the thickness of the single rate treatment. This pile was positioned in a north-south orientation. The litter from all seven treatments was removed on March 27, 2006.

In the second year of this project, the cover and base study was changed based on the results from the first year. At one site (Site HM), four treatments were established in the same manner as in the first year. The four treatments were: 1) no cover, 2) polyethylene cover, 3) Soiltac® at 110 sq ft/gal, and 4) Soiltac at 220 sq ft/gal. Soiltac® is a product marketed by company called Soilworks® that is located in Gilbert, AZ (their web site is http://www.soiltac.com/default.aspx). Soiltac is polymer-based emulsion that is used to stabilize soil banks to prevent erosion. This material was sprayed on as a cover over the litter using a hand-held sprayer. The same four treatments were replicated at an additional site (Site GT), which was located in Sussex County near the Georgetown airport. A different set of four treatments were used at another site (Site LS) in western Sussex County; the four treatments were: 1) no cover or base, 2) spray-on as a cover of the Illinois Silage material, 3) Soiltac sprayed on the soil as a base at a rate of 220 sq ft/gal, and 4) sawdust applied as a base. The Illinois silage cover is a recipe developed by Dr. Larry Berger at the University of Illinois using primarily ground wheat and salt. This product was developed to spray on silage to protect it during storage that can then be fed directly to animals when the silage is fed. The Soiltac and the sawdust treatments were both applied so that the entire area under the pile was treated, including the edges of the pile. The sawdust was applied so that it was about four inches thick on the surface of the soil before the litter was applied on top of it.

At Site HM, the litter was piled and pushed into a conical shape on November 20, 2006 and the covers were applied on November 21; the litter was removed on March 23, 2007. At Site GT, the pile was created on December 14, 2006, the poly cover was applied on December 15, and the Soiltac covers were applied on December 19; the litter was removed May 11, 2007. At Site LS, the litter was piled and pushed into a conical shape on January 22, 2007, and the pile was removed on May 18, 2007.

In the third year of this project, an additional study was conducted to evaluate the effect of covering and to be sure that the methods used with the poly covers in the first two years were

appropriate methodology. In the first two years of this study, the poly cover was only applied to a portion of a large pile due to the way the study was designed (see Diagram 1 and Picture 1). In a production agriculture field, the entire pile would be covered. Therefore, in the third year, three large piles were created in one field on a farm in Sussex County. One pile was left uncovered, one was covered with black poly, and the third pile was covered with a material called Compostex®, which is a breathable cover that is designed to keep water out but air can move through the material and it is used for composting various materials. The two piles that were covered were completely covered (see Picture 2 for an example). These piles were created on 10 November 2007 and each pile contained about 150 tons of poultry litter. The piles were removed on 19 March 2008.

Picture 2. This is the poly-covered pile in 2008.

Soil Sampling

For all studies in all years, soil samples were taken from each treatment area within one day of the litter being removed from the soil. For most piles, soil samples were taken again about 30 to 45 days later, and then samples were taken again about 70 to 90 days after the litter was removed. The reason for taking these additional samples was to determine if there was additional loading of nutrients from the litter that was not completely removed from each treatment area. In the first year of the project, soil samples were taken from the following depths: 0 to 6, 6 to 12, 12 to 24, and 24 to 36 inches. During the second year of the project, the same depths were sampled plus the 36- to 48-inch depth was sampled. In the third year of the project, the sampling depths were the same as the second year but the 0- to 6- and 6- to 12-inch depths were taken as one sample (i.e., 0 to 12 inches).

During the first year of the project, soil samples were taken by taking five cores from each sample area and compositing these into one sample for each depth. A 1-inch diameter soil probe was used for the surface 24 inches of soil, while a 0.5-inch probe was used for the 24- to 36-inch layer. The spring of 2006 was quite dry and it became nearly impossible to push the soil probe into the soil so beginning with the 180-day removal treatment and for Site CB, a three-inch diameter bucket auger was used for taking the samples. The bucket auger was used in the second and third year studies. With the bucket auger, only one core was taken per sampling area due to the large volume of the soil that was collected and the length of time required for taking the samples. To prevent water and soil from washing into the soil sampling holes, all holes were filled with bentonite clay immediately after the soil samples were taken.

For the first-year studies, nine separate areas were sampled within each treatment area. The sampling locations were the following: 15 and 30 feet outside the pile on both the east and west side (four sample locations), the edge of the pile on both the east and west side (two sample locations), directly under the peak of the pile (one sample), three feet to the east of the peak (one sample), and three feet to the west of the peak (one sample).

For the second year of the project, based on the first year's results, the sampling pattern was changed. The second-year pattern involved taking ten sampling points from each treatment in the following way: 20 feet outside the pile on both sides of the pile (two sampling points), two feet outside from the edge of the pile on both sides (two sampling points), both edges of the pile (two sampling points), two feet inside from the edge of the pile on both sides (i.e., two sampling points that were both under the pile), and then two feet on either side of the center peak of the pile (i.e., two sampling points that were both under the pile).

In the third year, the soil samples were taken from 13 points where the pile was located. The 13 sampling points were sampled in the following way: 20 feet outside the pile on both sides of the pile (two sampling points), four feet outside from the edge of the pile on both sides (two sampling points), two feet outside from the edge of the pile on both sides (two sampling points), both edges of the pile (two sampling points), two feet inside from the edge of the pile on both sides (i.e., two sampling points that were both under the pile), four feet inside from the edge of the pile on both sides (i.e., two sampling points that were both under the pile),and then one sample from directly under the peak of the pile (one sample point). This sampling pattern was done twice across line transects perpendicular to the line of the pile, so there were a total of 26 sampling points.

For each year of the study, all soil samples were immediately and rapidly air-dried in a greenhouse. The samples were then ground to pass a 2-mm sieve and sent to the laboratory for analyses. Mehlich III (M3) analyses were performed as follows: 1 g of soil was mixed with 10 ml of the extracting solution (0.2 M CH_3COOH + 0.25 M NH_4NO_3 + 0.015 M NH_4F + 0.013 M HNO_3 + 0.001 M EDTA) for 5 min. and filtered through Whatman #42 filter paper (Mehlich, 1984). The M3 extracts were analyzed by inductively coupled plasma atomic emission spectroscopy (ICP-AES). Soluble salts were determined as described by Sims and Heckendorn, 1991. Nitrate and ammonium were determined using the 2M KCl procedure as described by Sims and Heckentorn, 1991. Mehlich III and soluble salts were measured only on soil samples from the

surface twelve inches, while nitrate and ammonium were determined on all soil samples. For the 2008 studies (i.e., Year 3), the soil samples were only analyzed for nitrate and ammonium. All soil analyses were performed by the University of Delaware Soil Testing Laboratory. The following estimated soil bulk densities were used for each of the sampling depths (0-6", 6-12", 12-24", 24-36", and 36-48") when calculating total amounts of nutrient in the soil: 1.30, 1.32, 1.34, 1.36, and 1.38 grams per cubic centimeter of soil, respectively.

Poultry Litter Sampling and Analyses

The poultry litter that was used for all piles was sampled when the pile was created and when the pile was removed by taking several small grab samples using a shovel. At the time of litter removal, separate samples were taken from the wet layer on the outside of the litter and the dry litter in the middle of the pile (see Picture 3 for view of the "wet" layer). The grab samples were placed in a bucket and mixed thoroughly. A subsample was taken and placed in a sealed plastic Ziploc® bag and immediately placed in a refrigerated room until analyzed by the laboratory. Each treatment area within each pile had at least three separate samples taken. All manure samples were analyzed by the Delaware Department of Agriculture Manure Testing Laboratory. All litter samples were analyzed for total N, ammonia N, calcium, magnesium, sulfur, copper, zinc, manganese, boron, ash content, and moisture content. This laboratory is certified through the Manure Analysis Proficiency (MAP) Program that is administered through the Minnesota Department of Agriculture.

Runoff Collection System

For all three years of this study, a runoff collection system was built that was designed to catch any runoff and leachate coming out of the pile. The runoff system was installed when the pile was pushed up and left in place for about 185 days at Site TR1 and 195 days at Site TR2. For the third year, manure was pushed up on January 12, 2008 and the pile was removed on March 23, 2008; the runoff system was in place this entire time and this pile was defined as Site T3. It is assumed that when piles are pushed up into an "A" shape that water will run off the edges of the pile and then move into the underlying soil along these edges of the pile. Visual observations suggest that approximately the outside three feet of the pile (see Picture 3 for an example) will become saturated after enough rainfall has occurred and then this runoff and leachate will leach into the soil. The runoff system was designed with the goal of capturing all of this runoff and leachate.

Stainless steel pans were built six feet in length and four feet in width with a four-inch tall edge around the pan. The pan was inserted about three feet and three inches into the pile, so the pan was collecting runoff from a six-foot length along the edge of the pile. A hole was drilled into the corner of the pan with a drainage tube that drained via gravity into a tank that was placed in a large hole that was dug next to the pile. A slanted roof was built over the portion of the pan that was not inserted into the pile to prevent rainfall from getting into the pan. A runoff system was

installed on both the east and west side of the pile so that data were collected from two places in the pile for each year. After each runoff event, the total leachate volume was measured and subsamples were taken from the leachate and immediately frozen. The frozen samples were transported to the University of Delaware Soil Testing Laboratory. Once at the laboratory, the samples were thawed and immediately analyzed for total nutrient (N, P, and K) content.

Site Descriptions

All piles in this study were located on soils with less than 1% slope. The soil texture at Sites LS and NPS were sandy loam, while the texture for all other sites was loamy sand.

Weather Information

Several automatic weather stations in the area were used to collect weather data and rain gauges were used at the runoff sites to collect rainfall amounts. Also, the temperature of some piles was monitored with automatic data loggers, however, much of the temperature data were lost due to system malfunctions. In some cases, temperature data were collected and recorded.

Picture 3. This illustrates how the wet layer forms on top of the pile and along the edges of the pile. This image was taken on 2 Feb 2006 from a pile that was created on 1 Nov 2005; this pile had received 9.8 inches of rain since 1 Nov 2005.

Results and Discussion

Rainfall amounts during the three years of this study are shown in Figure 1a. The rainfall patterns were near normal for Sussex County with the exception of the period from February 13 through April 1 of year 1, which was extremely dry. The average daily temperatures followed similar patterns each year of this study (Figure 1b). Rainfall amounts were collected with manual rain gauges at each site where the runoff-collection systems were installed and these amounts are shown in Tables 1, 2, and 3. The total amount of runoff collected for each runoff event is also presented in Tables 1, 2, and 3.

The poultry litter for all projects came directly from local poultry houses and was from total cleanouts. The litter used in these projects came from different houses. In fact, for the very large piles, the litter within the piles was sometimes from more than one house. The nutrient concentrations tended to vary within the same pile (Tables 4 through 11). For example, for the time of removal study in year 1, the total N concentration was 36 lb N/ton of litter in the Day 15 treatment but was 62 lb N/ton of litter in the Day 90 treatment (Table 5). This variability probably represents variability within the house or possibly different houses rather than variability within the immediate position within the pile because each value in Tables 4 through 11 represents a mean of at least three separate samples that came from the same part of the large pile. The variability among samples taken from the same point is much less than the variability among the treatment areas within the large pile. The concentrations of boron, manganese, copper, and zinc for all manure samples are presented in Tables 12 through 19.

Runoff Study

The concentration of nutrients in the runoff samples was always highest for the first runoff event in all three years (Figures 2, 3, and 4). After the first one to two runoff events, the concentration of ammonium, P, and K tended to be somewhat consistent. Although the concentrations seemed rather high, it is important to evaluate the total amounts of nutrient being lost from the piles. The total ammonium-N lost each year ranged from about 0.3 to 0.5 pounds of N (Figure 5). This represents a six-foot length of the pile. In order to convert these values to pounds of nutrient per area of land, a specific pile size is needed. Therefore, for this calculation and for all similar calculations throughout this report, a pile size of 100 feet in length and 18 feet in width will be used. A pile with this size footprint that was 6.5 feet tall should contain a little over 100 tons of poultry litter. Based on the observed concentrations of N in the leachate and this assumed pile size, the average amount of ammonium-N lost from the six replications over the three years of this study was 16.3 lbs. (Figure 8). Minimal amounts of nitrate-N were found in the leachate, in fact, for most leaching/runoff events the amount of nitrate-N that was lost was near zero. The average amount of nitrate-N lost from the litter over the three years of this study was 0.8 lbs (Figure 8).

The average amount of total P for the three years of this study that was found in the leachate was 3.5 lbs, while the amounts of dissolved P averaged 0.8 lbs (Figure 9). The nutrient that was lost in the greatest amounts from all six replications was K, and the average amount of K in the

leachate was 113 lbs (Figure 10). Sulfur was also an important nutrient in terms of amounts found in the leachate. Although the amounts of S lost from the piles were much less than the amounts of K, the amounts of S were about double the amounts of N lost from the piles. The average amount of S lost in the leachate was 32 lbs (Figure 10).

Cover and Base Study: Nitrogen in Soil

In Year 1 at Site CB, the concentration of inorganic N (ammonium-N PLUS nitrate-N) tended to be higher along the edge of the pile than directly under the middle of the pile (Table 20). These data also show that inorganic N did leave the poultry litter and entered into the soil (i.e., compare 30 feet outside the pile to the edge and under the pile). An observation that was surprising was the concentration of inorganic N in the soil under the poly-covered treatment. Not only did nitrogen leave the litter from the pile that was covered with poly, but these data suggest that more N was lost from the poly-covered treatment than was lost from the treatment that had no cover. Soil samples were taken again from each of these treatment areas 51 days after the piles were removed (Table 21). These samples taken 51 days later show the same trends as the initial samples suggesting that the poly-covered treatment lost more N than the no-cover treatment. It is important, however, to remember that these data represent only one replication. The other five treatments in this project (i.e., bentonite-clay base, spray-on carbon at two rates, sawdust base, and the Poultry Guard base appeared to provide no significant reduction in nutrient loading to the soil when compared to the no-cover treatment.

There were several important observations that should be documented from these various treatments. First of all, the bentonite clay was applied at a rate that seemed economically practical. After it was applied, it was assumed that the material would swell and the rate would be adequate. Our observations suggest that the rate should probably be doubled from what we used. A bigger problem, however, with the bentonite clay was that once applied to the ground it became very sticky. Because growers typically drive a large truck across the soil as they are dumping the litter into the pile, the tires from the truck tend to destroy the bentonite clay layer and the bentonite sticks to the truck tires. The spray-on carbon material sealed up well after it was sprayed onto the piles, however, after a few weeks the material began to crack. After five months, the material had an extreme number of cracks and parts of the material had even blown off in the wind. The litter under the spray-on cover smelled worse and was harder to work with than the treatment that had no cover. An interesting observation from the sawdust treatment was that the sawdust under the pile had the same appearance and feel as it did the day it was placed at the site. It was not soggy and felt as if the moisture content was nearly the same as when it was first placed at the site. There were no visual signs of decomposition. This observation suggests that little, if any, water moved out of the pile and that the concentration of oxygen was limiting under the pile because the sawdust had not started to decompose. Nothing unusual or important was noted about the Poultry Guard treatment.

In the second year of this project, the covers and bases were evaluated at more locations with a smaller pile size (in terms of length, not height or width) because it was difficult to find growers who wanted to create such a large pile. Also, this allowed more replication of some of the

treatments. The poly cover treatment was applied at two sites in the second year of the project (Site HM and Site GT). At these two sites, the poly cover treatments did have elevated concentrations of inorganic N relative to the area that was outside the pile (i.e., 20 ft out); however, the N levels under the poly cover treatments were not higher than the no-cover treatments as observed in the Year 1 study (Tables 22 and 23). Nonetheless, these data, along with the data from Year 1 of the study, suggest that using a poly cover provides no advantage in reducing N losses from the pile when compared to applying no cover. The data from these poly covered treatments suggest that the N could be entering into the soil as ammonia gas. The temperature of the litter under the poly cover is typically hotter than when no cover is used, which may convert more of the N in the litter to ammonia. This could explain why the inorganic N levels were higher under the poly in the first year of the study. For example, in the first-year study at Site CB, the temperature at two feet down in the pile on 20 Mar 2006 was 63.9°F under the no-cover treatment and 109.2°F under the poly cover treatment.

As mentioned previously, there was concern that the design of the project was different than how a pile would be covered in a production field. Therefore, in 2008, an additional study was done where the entire piles were covered. The results indicate that the inorganic N levels where the entire pile was covered show no trend for the poly cover to have higher inorganic N levels in the soil than the no-cover treatment (Table 24). These data, however, are similar to the previous data that suggest there is no environmental benefit to covering the pile. In addition, the breathable cover (i.e., Compostex) appears to be similar as the poly cover in that losses of inorganic N from the litter pile into the underlying soil did occur. In this 2008 project, a second set of soil samples were taken on June 3rd, however, the flags that were used to mark the pile locations were dislocated by the farming equipment for all three piles. In most cases the location of a previous poultry litter pile can still be located several weeks after the litter has been removed because of limited, if any, crop growth; however, there was an excellent stand of corn where all three piles had been located at Site NPC. This excellent stand of corn occurred most likely because of the aggressive tillage by the farmer after the piles were removed, thereby, thoroughly mixing the salts into the soil and allowing the corn seed to geminate and the seedlings to grow. As a result, it is possible that the samples were not taken from the exact locations intended, so the results in Table 24a should be used with caution. For the results shown in Table 24a, all soil samples were taken from within the cornfield, and these samples were taken when PSNT samples would be taken (i.e., 12-inch tall corn).

During the second year of this project, several other options were evaluated as possible alternatives that may reduce nutrient losses from a poultry litter pile. Our observations suggest that the Soiltac does not provide a benefit because the inorganic N levels were similar to the no-cover treatment regardless of the Soiltac treatment (Tables 22, 23, and 25). This finding is not surprising because the Soiltac tended to crack after a few weeks of spraying it onto either the poultry litter or the soil. The Illinois Silage treatment was also not a good alternative, in fact, this treatment didn't work at all (Table 25). The treatment completely fell apart and cracked. One of the challenges with the Illinois Silage treatment is that when this is used on silage piles a tractor is used to pack down the material. This packing process is really not an option for a poultry litter pile because the sides of the pile are too steep. Based on the observations that have been found with the poly cover for the three years of this project and assuming that much of the N is

moving into the soil as ammonia gas, it seems unlikely that any cover could be used to prevent inorganic N from leaving the pile and getting into the underlying soil.

During the second year of this project, three additional piles were sampled on three different farms that were piled in an “A” shape and were at least six feet tall. In fact, the pile at Site WI was about 14 feet tall, was piled onto heavy cornstalk residue, and contained 245 tons of litter. The inorganic N concentrations in the soil indicate that N moved from these piles into the underlying soil, however, it is important to note the concentrations of inorganic N found 20 feet outside the pile (Table 26) because these concentrations were not influenced by the pile. Even though it is apparent that N did move out of these three piles into the underlying soil, the amounts of N that moved out of the piles were quite small.

Time of Removal Studies: Nitrogen in Soil

In Year 1, Site TB1 showed that some inorganic N had entered into the soil within 15 days (Table 27). In Year 2, Site TB2 did not have a 15-day treatment, but the first removal date (i.e, 35 days) showed again that some inorganic N had entered into the soil within 35 days (Table 28). Interestingly, at Site TB1, there was little rain on the litter pile prior to the 15-day treatment being removed. Because inorganic N was present in the soil after this treatment was removed, this supports the idea that ammonia gas may be the primary pathway for N movement from the litter into the underlying soil. These data at Site TB1 show that the inorganic N levels in the soil were higher for the 30-day removal treatment than for the 15-day removal. There was significant movement of inorganic N to the lower soil depths for some treatments. In most cases, the primary form of inorganic N present in the soil under the piles was ammonium (see Tables 29 through 32 for examples).

To put these concentrations into perspective, the concentrations were converted to pounds of N. To make this conversion, the same land area was assumed as with the runoff data: 100 feet wide and 18 feet long. The assumed bulk densities used for converting concentrations to pounds of nutrient were provided above. Using these assumptions at Site TB1, the amounts of inorganic N ranged from a low of 4 lbs for the 16-day removal treatment to a high of 12 pounds for the 31-day treatment, while the 185-day removal treatment had 10 lbs of inorganic N in the soil (Figure 11). For Site TB2, the first removal was the 35-day treatment and there were 4 lbs of inorganic N found in this treatment, while the 195-day treatment contained 16 lbs of inorganic N in the underlying soil (Figure 11). The most surprising observation from these two replications of data for the time-of-removal study was the relatively small amounts of inorganic N found in the soil after 180-days of litter storage (Figure 11).

Summary of Soil Nitrogen Data from all Samplings

During the time period of this study, there were 33 separate site-treatment combinations where litter was piled for at least 90 days. All 33 site-treatment combinations had soil samples taken following litter removal. In all cases, soil samples were taken from the area affected by the litter

and an area outside the pile that was not affected by the litter so that a total loading from the litter could be calculated. Using the assumed pile size provided above, the amount of inorganic N that moved out of the litter and was found in the underlying soil ranged from 2 to 29 lbs with a mean of 12 lbs (Figure 12). It is interesting to note that there was no significant correlation between the amounts of N found in the soil under the piles and the concentrations of N found in the poultry litter that was piled at the site (Figure 13).

A poultry litter pile that is 6.5 tall, 100 feet long, and 18 feet wide would contain at least 100 tons of litter, which would correspond to about 5,500 pounds of N (assuming 55 lb N/ton) in that pile. As a result, the data from these 33 site-treatment combinations suggest that about 0.2% of the N in a properly shaped pile will be lost from the pile to the environment. This amount of N is insignificant compared to the amount of N that could potentially be lost to the environment from 5,500 pounds of N spread as poultry litter during the wrong time of the year. In other words, the results of this research demonstrate that relatively small amounts of N are lost from properly-shaped piles, and therefore, if poultry litter must be kept in temporary field storage piles, it should be kept in the pile until the recommended time of spreading for the crop to be grown regardless of how many days the poultry litter pile has been in place. These results, however, do not support storing poultry litter in temporary piles from one growing season to the next.

Within these 33 site-treatments, there were four side-by-side comparisons of a polyethylene covered pile next to a pile with no cover. The average amount of inorganic N in the soil under the four poly covered piles was 13 lbs, while the average under the no-cover pile was 16 lbs. Because there was no significant difference in amounts of N found in the underlying soil between the poly covered and no-cover piles, this suggests that N is moving from the litter into the soil as ammonia. Regardless of the method of movement, covering poultry litter piles with polyethylene does little to reduce the amounts of N leaving the litter and moving into the soil.

The overall average increases in inorganic N throughout soil profile under the litter piles for all 33 site-treatment combinations were 39.1, 19.4, 15.2, and 6.7 mg N/kg for the depths of 0-12, 12-24, 24-36, and 36-48 inches, respectively. When converted to pounds and assuming a 100 ft by 18 ft pile size, these values were 5.8, 2.9, 2.3, and 1.0 pounds for the 0-12, 12-24, 24-36, and 36-48 inch depths, respectively. This shows that about 75% of the N in the soil under the pile was in the top 24 inches of soil. Therefore, if a crop could be established in the area where the pile was located, it is likely that a significant portion of this N could be utilized by the growing crop and not lost to the environment.

Phosphorus in Soil

All sites used for this study tended to have high concentrations of Mehlich 3-P in the soil, which is not surprising because these farms all have long-term histories of using poultry litter. In general, the soil test P data from these sites suggest that the poultry litter piles are not having much of an impact on soil test P (Tables 33 through 39). There were instances where the soil test P concentration where the litter was piled were higher than the concentration of soil test P where no litter was piled (e.g., Table 33) , but at most locations it is difficult to see an affect of

the litter pile on soil test P. At one site (Table 36), the soil test P levels in the soil where the pile was located appear to be greater than outside the pile area; however, it should be noted that the samples taken 20 feet outside where the pile was located were actually taken in a grassy area outside the field. Therefore, the high P concentrations where the pile was located may or may not be a result of the litter pile. It's possible that the higher concentrations may simply be a result of past management in this area.

Potassium, Sulfur, and Soluble Salts in Soil

The soil test data show that large amounts of potassium are entering into the soil where the poultry litter was piled (Table 40 through 46). These results show great variability in the magnitude of the increase in soil test K in the area under the pile relative to the area outside where the pile was located, but it is clear from these soil analyses that the nutrient that is being lost in the greatest quantities by several orders of magnitude is potassium. This finding is similar to what was found in the runoff that was collected from the poultry litter piles.

The soluble salt concentrations in the surface layer of the soil where the litter was piled were often significantly above the level considered safe for growing crops, which is about 1 mmhos/cm (Tables 47 through 53). These high levels of soluble salts explain why farmers often are unable to establish a crop in these areas. The high soluble salts either prevent the seed from germinating or kill the young plant after it germinates because the roots are destroyed from the high concentrations of salts (see Picture 4).

The high concentrations of potassium in the soil where poultry litter has been piled appear to be one of the main contributors to the soluble salt concentrations in the soil. The relationship between soil potassium concentration and soluble salts shows that soil K accounts for 92% and 82% of the variability in soluble salts for the two years of this study, while soil S accounts for 93% and 82% (Figure 8). The relationships between soil ammonium and soil nitrate concentrations with soluble salt concentrations suggest that these two nutrient forms had little effect on the observed soluble salt concentrations (Figure 9). The concentrations of Mehlich-3 sulfur for each site are presented in Tables 54 through 60.

Other Nutrients in Soil

Because the Mehlich-3 procedure was used to measure concentrations of P and K in the soil, several other nutrients were automatically included in the analyses so these concentrations are being presented in this report for informational purposes. These other nutrients included calcium {(Ca) Tables 61 through 67}, magnesium {(Mg) Tables 68 through 74}, copper {(Cu) Tables 75 through 81}, manganese {(Mn) Tables 82 through 88}, and zinc {(Zn) Tables 89 through 95}. It appears that the poultry litter had only slight, if any, influence on the concentrations of these nutrients in the underlying soil.

Picture 4. Image taken on 26 Sept 2006 from a site where poultry litter was piled during the winter of 2005/2006 that shows the lack of soybeans growing in the area.

Summary and Conclusions

1) Using a poly cover did not reduce nutrient losses from field-size poultry litter piles to the underlying soil.

2) Potassium was the nutrient lost in the largest amounts from the piles to the environment.

3) Potassium and sulfur were the two nutrients that caused the high soluble salt concentrations in the soil where the piles were located.

4) Phosphorus losses from poultry litter piles were small.

5) Potassium losses from poultry litter piles were about eight times greater than N losses.

6) On average, a 100-ton pile of poultry litter lost 12 pounds of nitrogen, which is a relatively small amount of N.

7) About 75% of the N that moved into the underlying soil from the poultry litter was in the surface 24 inches of soil, so establishment of a crop in the area of the pile would remove a significant portion of this N from the soil.

8) Sawdust, Poultry Guard®, bentonite clay, Soiltac®, and spray-on carbon materials provided no benefit in terms of reducing nutrient losses from the pile to the environment.

9) The amount of N leaving properly-shaped poultry litter piles and moving into the underlying soil was only about 0.2% of the amount of N in the poultry litter.

10) Litter spread at the wrong time of the year would have a much greater risk of nutrient loss than litter kept in a pile.

11) If litter must be stored in the field, it should be kept in a pile until the appropriate spreading time for the crop to be grown.

12) Recommendations that promote spreading litter sooner than is optimal for crop production practices should be discouraged, because litter spread too early will have much greater risk of nutrient losses than litter kept in a properly-shaped litter pile.

13) In-field storage of poultry litter facilitates the transport of poultry litter from areas with high concentrations of poultry litter to areas where there is a low concentration of poultry litter available for use during crop production.

14) Current Delaware regulations on temporary stockpiling of poultry litter should be considered best management practices (BMPs) and should be followed.

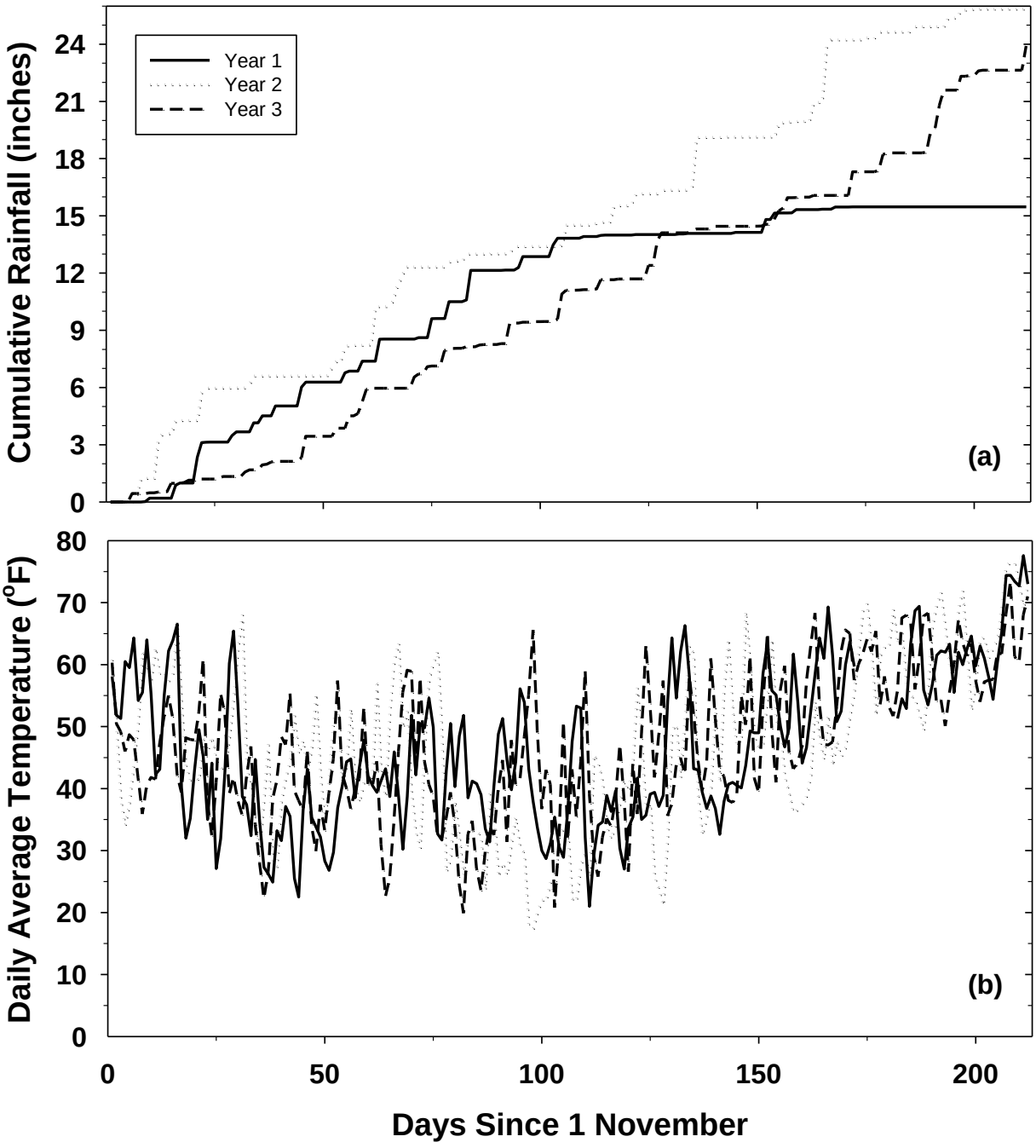

Figure 1. Cumulative rainfall (a) and average daily temperature (b) from November 1 to May 31 at the airport in Laurel, Delaware; project started in November 2005 and ended in May 2008.

Table 1. Rainfall amounts and runoff/leachate amounts collected in each tank during the 1st year of the study at Site TR1.

		Runoff Amount	
Date	**Rainfall**	**East**	**West**
	- inches -	-------- ounces--------	
9-Nov-05	0.04	0	0
10-Nov-05	0.10	0	0
17-Nov-05	0.80	0	0
29-Nov-05	0.80	0	0
3-Dec-05	0.55	533	754
7-Dec-05	0.23	0	0
12-Dec-05	0.60	466	273
18-Dec-05	0.80	1512	1053
26-Dec-05	0.40	153	170
30-Dec-05	0.43	217	179
3-Jan-06	1.00	904	987
16-Jan-06	0.80	1381	1224
19-Jan-06	0.70	526	438
24-Jan-06	1.40	2377	2511
1-Feb-06	0.08	63	49
12-Feb-06	1.20	3110	2290
4-Apr-06	0.35	0	0
24-Apr-06	2.10	806	589

Table 2. Rainfall amounts and runoff/leachate amounts collected in each tank during the 2nd year of the study at Site TR2.

		Runoff Amount†	
Date	**Rainfall**	**East**	**West**
	- inches -	-------- ounces--------	
28-Oct-06	2.60	0	0
8-Nov-06	1.20	0	0
13-Nov-06	2.20	922	TC
25-Nov-06	1.30	1722	1438
4-Dec-06	0.40	0	0
6-Dec-06	0.25	0	0
22-Dec-06	0.60	TC	TC
25-Dec-06	0.75	1371	1576
2-Jan-07	2.53	2714	2427
7-Jan-07	1.18	1550	1897
22-Jan-07	0.30	730	554
2-Feb-07	0.25	0	0
14-Feb-07	1.35	0	0
26-Feb-07	0.85	1180	1103
2-Mar-07	0.38	0	0
16-Mar-07	2.85	0	0
4-Apr-07	0.90	914	1261
12-Apr-07	0.30	0	0
16-Apr-07	0.80	0	0
17-Apr-07	0.45	998	833

†TC = tank collapsed and sample lost

Table 3. Rainfall amounts and runoff/leachate amounts collected in each tank during the 3rd year of the study at Site T3.

		Runoff Amount	
Date	**Rainfall**	**East**	**West**
	- inches -	-------- ounces--------	
18-Jan-08	0.73	0	70
2-Feb-08	1.00	614	507
15-Feb-08	1.25	1946	1178
23-Feb-08	0.40	46	0
7-Mar-08	0.75	781	166
11-Mar-08	1.35	1126	1011
13-Mar-08	0.03	0	39
17-Mar-08	0.25	14	0

Table 4. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 1st year of this study at Site CB.

Trmt†	Total N	NH_4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
Initial Samples Taken the Day the Pile was Created								
No Cover	40.7	10.5	32.0	47.6	30.2	8.4	10.4	26.4
Poly Cover	44.3	11.1	37.0	47.2	34.9	8.9	15.1	24.4
Bentonite	45.5	11.3	39.7	50.9	36.4	9.3	15.8	26.2
Carbon 1	51.6	11.5	36.6	56.2	39.7	9.9	12.6	28.6
Carbon 2	47.2	11.8	35.9	51.7	37.4	9.3	14.0	26.6
Sawdust	54.9	14.3	40.5	55.1	37.9	10.0	15.5	28.6
P. Guard	58.5	16.3	40.2	53.9	37.6	10.1	16.4	31.7
MEAN	49.0	12.4	37.4	51.8	36.3	9.4	14.2	27.5
Samples Taken on Day of Removal from the "Dry" Litter								
No Cover	70.0	21.1	51.3	60.0	41.0	11.2	18.8	30.3
Poly Cover	43.3	12.7	41.7	53.7	36.7	9.6	16.1	22.8
Bentonite	55.9	15.7	43.3	57.3	37.6	10.0	17.6	31.0
Carbon 1	51.0	14.3	45.4	56.6	38.6	10.4	15.5	38.3
Carbon 2	49.4	13.8	42.0	54.5	37.9	10.1	17.2	34.6
Sawdust	47.6	11.9	40.7	53.0	33.5	9.5	14.1	38.6
P. Guard	50.3	14.9	41.9	54.8	37.9	10.1	14.7	39.2
MEAN	52.5	14.9	43.7	55.7	37.6	10.1	16.3	33.5
Samples Taken on Day of Removal from the "Wet" Litter								
No Cover	25.1	4.9	24.8	29.5	24.2	6.9	6.5	51.3
Poly Cover	41.2	12.8	39.7	51.8	35.9	9.3	15.7	24.0
Bentonite	29.9	5.9	30.2	38.9	29.2	7.4	10.6	50.9
Carbon 1	30.0	5.0	28.5	40.5	30.2	7.7	9.9	52.3
Carbon 2	34.1	7.6	31.2	47.6	29.8	7.6	13.8	48.5
Sawdust	32.7	7.0	29.0	46.0	30.0	7.5	12.4	54.3
P. Guard	36.5	7.7	38.1	45.4	35.7	9.2	12.0	51.0
MEAN	32.8	7.3	31.7	42.8	30.7	8.0	11.6	47.5

†P. Guard = Poultry Guard®

Table 5. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the time of removal study at Site TR1.

Trmt†	Total N	NH_4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
	Initial Samples Taken the Day the Pile was Created							
R1	35.7	8.5	22.4	30.3	24.7	5.9	9.9	12.5
R2	49.4	13.0	38.2	51.4	37.1	9.6	12.8	21.9
R3	58.8	12.4	42.1	54.0	39.7	10.3	13.8	20.6
R4	61.6	12.9	42.8	52.7	42.7	10.5	14.8	20.6
R5	59.1	14.4	42.4	55.1	36.5	9.9	14.8	18.8
R6	57.3	12.8	44.3	56.0	41.1	10.3	15.3	17.9
MEAN	53.7	12.3	38.7	49.9	37.0	9.4	13.5	18.7
	Sample Taken on Day of Removal from the "Dry" Litter							
R1	45.1	13.6	28.9	35.9	29.0	6.9	12.7	18.5
R2	53.5	14.5	36.3	45.6	34.8	8.9	12.2	24.6
R3	47.1	13.2	31.6	41.7	32.2	8.0	13.1	21.2
R4	48.0	12.0	41.0	53.6	34.9	9.4	14.2	31.2
R5	57.8	15.9	44.6	52.9	41.5	9.9	16.2	18.5
R6	55.5	15.5	40.7	52.8	35.8	9.3	13.9	23.3
MEAN	51.2	14.1	37.2	47.1	34.7	8.7	13.7	22.9
	Sample Taken on Day of Removal from the "Wet" Litter							
R1	21.7	4.9	18.6	17.2	18.3	4.4	5.8	49.9
R2	20.8	3.4	21.6	12.2	22.5	5.3	3.2	57.3
R3	22.7	4.2	23.4	22.3	23.2	5.5	6.3	53.8
R4	19.3	4.2	25.3	7.5	25.7	5.5	3.3	45.7
R5	28.7	6.7	27.3	30.9	24.2	6.1	9.0	57.9
R6	27.4	6.8	31.3	33.9	27.0	7.0	8.7	53.3
MEAN	23.4	5.0	24.6	20.7	23.5	5.6	6.0	53.0

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 6. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site GT.

Trmt	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
Initial Samples Taken the Day the Pile was Created								
No Cover	53.9	13.6	40.0	53.4	33.9	9.0	11.0	35.8
Poly Cover	59.1	12.3	46.9	54.7	40.8	9.9	12.1	30.1
Soiltac R1	57.4	11.3	48.5	59.3	41.1	10.3	15.1	30.6
Soiltac R2	59.7	11.7	54.6	60.0	50.2	11.1	19.9	27.4
MEAN	57.5	12.2	47.5	56.8	41.5	10.1	14.5	31.0
Samples Taken on Day of Removal from the "Dry" Litter								
No Cover	57.5	12.0	45.2	48.9	35.2	8.9	12.3	34.0
Poly Cover	62.6	11.2	52.2	54.3	42.5	9.8	15.2	28.3
Soiltac R1	58.3	13.1	50.4	48.5	44.3	9.4	17.5	32.9
Soiltac R2	57.2	11.6	43.4	49.2	35.4	8.6	13.0	32.3
MEAN	58.9	12.0	47.8	50.2	39.3	9.2	14.5	31.9
Samples Taken on Day of Removal from the "Wet" Litter								
No Cover	25.0	2.6	29.3	34.8	22.8	6.0	7.0	66.2
Poly Cover	46.3	9.6	46.4	50.1	38.2	8.8	14.1	41.2
Soiltac R1	25.9	3.5	32.2	24.4	27.9	5.9	8.3	66.6
Soiltac R2	25.0	3.0	29.1	21.4	23.6	5.9	5.1	67.5
MEAN	30.5	4.7	34.2	32.7	28.1	6.7	8.6	60.4

Table 7. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site HM.

Trmt	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
Initial Samples Taken the Day the Pile was Created								
No Cover	48.1	8.9	35.2	49.1	27.8	7.8	11.3	35.9
Poly Cover	57.4	13.4	46.9	57.5	37.4	10.0	17.3	32.7
Soiltac R1	54.4	13.5	40.6	55.1	37.0	8.6	15.9	38.8
Soiltac R2	45.1	13.7	43.6	58.4	44.4	10.3	13.2	37.5
MEAN	51.2	12.4	41.6	55.0	36.7	9.2	14.4	36.2
Samples Taken on Day of Removal from the "Dry" Litter								
No Cover	38.6	9.7	35.5	35.6	30.7	7.7	9.5	48.6
Poly Cover	57.7	8.9	43.8	53.8	35.2	9.6	14.2	30.1
Soiltac R1	ND	ND	ND	ND	ND	ND	ND	ND
Soiltac R2	48.3	11.0	41.7	49.1	34.5	8.8	14.1	34.7
MEAN	48.2	9.9	40.3	46.2	33.4	8.7	12.6	37.8
Samples Taken on Day of Removal from the "Wet" Litter								
No Cover	32.0	6.7	34.4	32.1	29.7	7.6	8.4	56.2
Poly Cover	30.1	4.7	60.1	69.1	50.3	12.5	21.2	58.6
Soiltac R1	ND	ND	ND	ND	ND	ND	ND	ND
Soiltac R2	21.4	2.7	28.0	20.4	23.6	5.9	6.5	63.0
MEAN	27.8	4.7	40.8	40.5	34.5	8.7	12.0	59.3

Table 8. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site LS.

Trmt	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
	Initial Samples Taken the Day the Pile was Created							
No Cover	63.7	12.1	63.3	62.2	46.0	11.5	13.2	29.0
Illinois	57.7	13.4	54.4	54.7	41.3	10.4	11.8	29.4
Soiltac Base	57.6	13.0	56.7	61.0	43.5	11.5	13.0	26.7
Sawdust Base	57.6	13.0	56.7	61.0	43.5	11.5	13.0	26.7
MEAN	59.2	12.9	57.8	59.7	43.6	11.3	12.8	28.0
	Samples Taken on Day of Removal from the "Dry" Litter							
No Cover	64.9	10.2	60.0	57.8	40.9	10.2	12.7	30.2
Illinois	53.8	7.0	45.8	48.2	32.8	8.0	10.4	40.6
Soiltac Base	60.0	10.7	59.0	55.9	42.6	10.6	12.7	30.6
Sawdust Base	62.6	12.3	58.6	57.4	41.7	10.2	12.7	32.2
MEAN	60.3	10.0	55.8	54.8	39.5	9.7	12.1	33.4
	Samples Taken on Day of Removal from the "Wet" Litter							
No Cover	40.0	6.0	47.2	63.3	30.8	7.9	13.3	52.4
Illinois	32.7	5.6	40.9	32.0	43.9	8.4	6.7	60.9
Soiltac Base	36.3	5.2	55.9	65.4	38.9	9.9	14.6	52.3
Sawdust Base	43.5	9.5	40.5	50.0	26.5	6.8	10.1	56.1
MEAN	38.1	6.6	46.1	52.7	35.0	8.3	11.2	55.4

Table 9. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at three sites where no treatments were applied (i.e., these would be “no cover” piles).

Trmt	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
	Samples Taken on Day of Removal from the "Dry" Litter							
Site KM	52.5	11.8	39.8	51.5	36.7	9.2	13.1	34.3
Site WI	53.3	15.1	41.4	53.1	35.5	9.9	17.0	31.4
Site KW	ND†	ND	ND	ND	ND	ND	ND	ND
	Samples Taken on Day of Removal from the "Wet" Litter							
Site KM	24.1	3.5	32.0	30.0	24.9	6.4	7.4	65.8
Site WI	26.1	4.4	27.6	33.4	26.0	6.8	10.2	61.4
Site KW	ND	ND	ND	ND	ND	ND	ND	ND

†ND = no data

Table 10. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 3rd year of this study at Site NPC.

Trmt	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
	Initial Samples Taken the Day the Pile was Created							
No Cover	61.7	10.2	44.7	52.4	33.7	9.5	15.0	25.9
Poly Cover	48.9	9.2	38.7	45.1	30.3	8.3	13.5	21.9
Compostex	64.2	10.4	46.5	56.1	32.8	9.9	12.6	22.0
MEAN	58.2	9.9	43.3	51.2	32.3	9.2	13.7	23.3
	Samples Taken on Day of Removal from the "Dry" Litter							
No Cover	65.6	5.6	40.7	50.8	29.8	8.7	14.6	28.1
Poly Cover	63.2	7.4	46.6	56.4	36.5	10.2	16.0	23.3
Compostex	63.0	8.3	49.0	58.7	38.8	10.6	13.9	24.0
MEAN	64.0	7.1	45.5	55.3	35.0	9.8	14.8	25.1
	Samples Taken on Day of Removal from the "Wet" Litter							
No Cover	22.7	2.6	27.6	20.0	23.9	5.9	5.1	66.9
Poly Cover	22.0	3.6	23.5	29.2	18.9	5.2	8.4	57.9
Compostex	26.3	3.4	34.0	36.9	26.5	7.6	8.6	61.9
MEAN	23.7	3.2	28.4	28.7	23.1	6.2	7.4	62.2

Table 11. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the time-of-removal study at Site TR2.

Trmt†	Total N	NH4-N	P	K	Ca	Mg	S	Moisture
	---------- lb of nutrient per ton of poultry manure ----------							-- % --
	Initial Samples Taken the Day the Pile was Created							
R1	62.4	8.0	49.4	54.5	37.8	10.5	16.9	33.5
R2	66.0	13.6	44.5	53.3	32.6	10.3	13.7	28.4
R3	50.5	12.8	46.3	51.2	38.9	9.9	14.7	33.8
R4	57.2	13.3	45.0	54.6	35.8	9.8	14.1	36.3
R5	52.6	14.0	45.8	50.1	39.0	10.0	13.1	35.9
R6	63.3	11.0	44.6	51.5	41.4	11.1	12.8	26.4
MEAN	58.7	12.1	45.9	52.5	37.6	10.2	14.2	32.4
	Sample Taken on Day of Removal from the "Dry" Litter							
R1	54.6	8.6	42.4	54.7	33.0	10.1	12.8	24.6
R2	54.2	12.0	47.6	53.4	39.7	10.2	14.2	36.0
R3	56.1	12.3	44.4	51.9	35.3	9.6	13.1	39.9
R4	ND‡	ND	ND	ND	ND	ND	ND	ND
R5	61.0	11.7	51.1	50.9	43.8	9.9	13.4	31.9
R6	ND	ND	ND	ND	ND	ND	ND	ND
MEAN	56.5	11.2	46.4	52.7	37.9	9.9	13.4	33.1
	Sample Taken on Day of Removal from the "Wet" Litter							
R1	20.9	3.6	27.5	12.7	21.5	6.1	3.6	68.8
R2	26.9	3.9	38.1	24.9	31.0	7.7	6.6	66.8
R3	27.6	4.3	33.5	26.7	27.6	6.6	6.9	64.2
R4	ND	ND	ND	ND	ND	ND	ND	ND
R5	27.6	3.6	30.8	30.2	23.9	6.4	7.8	63.3
R6	ND	ND	ND	ND	ND	ND	ND	ND
MEAN	25.7	3.8	32.5	23.6	26.0	6.7	6.2	65.8

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

‡ND = No data

Table 12. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 1st year of this study at Site CB.

Trmt†	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Initial Samples Taken the Day the Pile was Created				
No Cover	0.07	0.60	0.64	0.63	37.5
Poly Cover	0.08	0.70	0.74	0.73	36.7
Bentonite	0.08	0.72	0.72	0.77	32.5
Carbon 1	0.10	0.69	0.72	0.74	25.7
Carbon 2	0.07	0.70	0.73	0.72	31.9
Sawdust	0.16	1.09	0.78	0.89	26.1
P. Guard	0.11	0.81	0.77	0.88	22.2
MEAN	0.10	0.76	0.73	0.77	30.4
	Samples Taken on Day of Removal from the "Dry" Litter				
No Cover	0.08	0.79	0.83	0.93	20.6
Poly Cover	0.07	0.69	0.72	0.77	37.0
Bentonite	0.08	0.77	0.74	0.82	23.6
Carbon 1	0.08	0.74	0.76	0.87	20.8
Carbon 2	0.07	0.74	0.73	0.81	24.6
Sawdust	0.07	0.70	0.67	0.81	19.4
P. Guard	0.08	0.72	0.71	0.83	19.9
MEAN	0.08	0.74	0.74	0.84	23.7
	Samples Taken on Day of Removal from the "Wet" Litter				
No Cover	0.04	0.45	0.48	0.52	27.7
Poly Cover	0.07	0.68	0.70	0.75	40.9
Bentonite	0.05	0.54	0.54	0.60	23.1
Carbon 1	0.06	0.55	0.54	0.63	21.4
Carbon 2	0.06	0.57	0.57	0.62	21.9
Sawdust	0.06	0.60	0.53	0.65	18.8
P. Guard	0.07	0.77	0.63	0.77	19.5
MEAN	0.06	0.59	0.57	0.65	24.8

†P. Guard = Poultry Guard®

Table 13. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the time of removal study during year 1 at Site TR1.

Trmt†	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				-- % --
	Initial Samples Taken the Day the Pile was Created				
R1	0.06	0.42	0.54	0.47	63.9
R2	0.09	0.70	0.73	0.77	39.7
R3	0.08	0.87	0.83	0.89	28.0
R4	0.08	0.80	0.75	0.83	25.5
R5	0.12	0.76	0.73	0.85	35.1
R6	0.08	0.88	0.89	1.00	29.7
MEAN	0.08	0.74	0.75	0.80	37.0
	Sample Taken on Day of Removal from the "Dry" Litter				
R1	0.06	0.54	0.57	0.58	50.6
R2	0.07	0.70	0.66	0.71	37.3
R3	0.06	0.64	0.68	0.63	45.2
R4	0.07	0.79	0.71	0.79	28.8
R5	0.07	0.76	0.75	0.80	37.6
R6	0.07	0.74	0.69	0.76	25.8
MEAN	0.07	0.69	0.68	0.71	37.5
	Sample Taken on Day of Removal from the "Wet" Litter				
R1	0.03	0.34	0.37	0.37	30.5
R2	0.03	0.34	0.41	0.40	23.8
R3	0.08	0.42	0.43	0.47	26.0
R4	0.02	0.36	0.50	0.47	37.6
R5	0.04	0.47	0.51	0.53	17.3
R6	0.05	0.54	0.51	0.56	23.6
MEAN	0.04	0.41	0.46	0.47	26.5

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 14. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site GT.

Trmt	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Initial Samples Taken the Day the Pile was Created				
No Cover	0.07	0.49	0.67	0.93	16.40
Poly Cover	0.08	0.58	0.75	0.96	16.57
Soiltac R1	0.08	0.57	0.76	1.02	16.67
Soiltac R2	0.08	0.66	0.84	1.05	18.77
MEAN	0.08	0.58	0.76	0.99	17.1
	Samples Taken on Day of Removal from the "Dry" Litter				
No Cover	0.08	0.49	0.65	0.72	14.90
Poly Cover	0.07	0.60	0.77	0.85	17.03
Soiltac R1	0.08	0.61	0.74	0.82	16.43
Soiltac R2	0.07	0.45	0.63	0.69	15.80
MEAN	0.07	0.54	0.70	0.77	16.0
	Samples Taken on Day of Removal from the "Wet" Litter				
No Cover	0.05	0.36	0.43	0.50	11.23
Poly Cover	0.06	0.54	0.71	0.77	14.73
Soiltac R1	0.04	0.37	0.46	0.48	9.77
Soiltac R2	0.04	0.32	0.43	0.47	9.17
MEAN	0.05	0.39	0.51	0.55	11.2

Table 15. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site HM.

Trmt	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Initial Samples Taken the Day the Pile was Created				
No Cover	0.07	0.58	0.55	0.59	19.93
Poly Cover	0.08	0.77	0.67	0.73	18.23
Soiltac R1	0.08	0.77	0.62	0.85	15.47
Soiltac R2	0.09	0.84	0.74	0.86	21.17
MEAN	0.08	0.74	0.65	0.76	18.7
	Samples Taken on Day of Removal from the "Dry" Litter				
No Cover	0.05	0.55	0.52	0.56	19.43
Poly Cover	0.08	0.69	0.65	0.74	18.70
Soiltac R1	ND	ND	ND	ND	ND
Soiltac R2	0.06	0.67	0.59	0.67	22.53
MEAN	0.06	0.64	0.59	0.66	20.2
	Samples Taken on Day of Removal from the "Wet" Litter				
No Cover	0.05	0.53	0.51	0.55	15.90
Poly Cover	0.10	0.96	0.86	0.98	14.10
Soiltac R1	ND	ND	ND	ND	ND
Soiltac R2	0.04	0.42	0.40	0.42	17.85
MEAN	0.06	0.64	0.59	0.65	16.0

Table 16. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for each treatment during the 2nd year of this study at Site LS.

Trmt	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Initial Samples Taken the Day the Pile was Created				
No Cover	0.08	0.51	0.92	1.09	16.90
Illinois	0.07	0.45	0.81	1.42	20.60
Soiltac Base	0.09	0.50	0.90	0.95	19.77
Sawdust Base	0.09	0.50	0.90	0.95	19.77
MEAN	0.08	0.49	0.88	1.10	19.3
	Samples Taken on Day of Removal from the "Dry" Litter				
No Cover	0.08	0.47	0.82	0.79	16.17
Illinois	0.06	0.41	0.66	0.62	16.87
Soiltac Base	0.08	0.50	0.84	0.80	18.67
Sawdust Base	0.08	0.46	0.81	0.77	15.87
MEAN	0.08	0.46	0.78	0.74	16.9
	Samples Taken on Day of Removal from the "Wet" Litter				
No Cover	0.07	0.40	0.61	0.66	14.40
Illinois	0.05	0.30	0.60	0.53	16.30
Soiltac Base	0.08	0.48	0.78	0.75	18.30
Sawdust Base	0.06	0.36	0.53	0.55	11.57
MEAN	0.07	0.39	0.63	0.62	15.1

Table 17. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the each treatment during the 2nd year of this study at three sites where no treatments were applied (i.e., these would be “no cover” piles).

Trmt	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Samples Taken on Day of Removal from the "Dry" Litter				
Site KM	0.08	0.72	0.64	0.69	20.03
Site WI	0.07	0.45	0.54	0.61	25.70
Site KW	ND	ND	ND	ND	ND
	Samples Taken on Day of Removal from the "Wet" Litter				
Site KM	0.05	0.52	0.44	0.46	12.53
Site WI	0.04	0.32	0.39	0.42	16.67
Site KW	ND	ND	ND	ND	ND

Table 18. Micronutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the each treatment during the 3rd year of this study at Site NPC.

Trmt	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				- % -
	Initial Samples Taken the Day the Pile was Created				
No Cover	0.07	0.50	0.65	0.80	26.40
Poly Cover	0.06	0.45	0.56	0.69	37.83
Compotex	0.07	0.52	0.67	0.83	23.57
MEAN	0.07	0.49	0.63	0.77	29.27
	Samples Taken on Day of Removal from the "Dry" Litter				
No Cover	0.07	0.51	0.59	0.73	21.27
Poly Cover	0.08	0.57	0.67	0.83	23.03
Compotex	0.07	0.55	0.68	0.89	20.40
MEAN	0.07	0.55	0.65	0.81	21.57
	Samples Taken on Day of Removal from the "Wet" Litter				
No Cover	0.03	0.26	0.40	0.46	12.40
Poly Cover	0.04	0.27	0.36	0.42	21.13
Compotex	0.05	0.37	0.51	0.61	17.85
MEAN	0.04	0.30	0.42	0.50	17.13

Table 19. Nutrient concentrations in the poultry litter on the day the pile was initiated and the day the pile was removed for the time-of-removal study during year 2 at Site TR2 (i.e., 2006 to 2007).

Trmt†	B	Cu	Mn	Zn	Ash
	- lb of nutrient per ton of poultry manure -				-- % --
	Initial Samples Taken the Day the Pile was Created				
R1	0.21	0.71	0.78	0.72	18.57
R2	0.10	0.63	0.68	0.83	16.57
R3	0.09	0.79	0.76	0.83	24.67
R4	0.10	0.79	0.75	0.89	19.00
R5	0.07	0.74	0.75	0.85	21.97
R6	0.05	0.63	0.68	0.77	18.87
MEAN	0.10	0.71	0.73	0.81	19.9
	Sample Taken on Day of Removal from the "Dry" Litter				
R1	0.08	0.51	0.56	0.80	25.00
R2	0.08	0.76	0.76	0.85	17.90
R3	0.07	0.65	0.67	0.75	18.80
R4	ND	ND	ND	ND	ND
R5	0.08	0.61	0.67	0.74	19.87
R6	ND	ND	ND	ND	ND
MEAN	0.08	0.63	0.66	0.78	20.4
	Sample Taken on Day of Removal from the "Wet" Litter				
R1	0.03	0.31	0.39	0.36	11.90
R2	0.05	0.50	0.55	0.56	13.93
R3	0.04	0.47	0.48	0.52	14.53
R4	ND	ND	ND	ND	ND
R5	0.05	0.39	0.42	0.45	13.57
R6	ND	ND	ND	ND	ND
MEAN	0.04	0.42	0.46	0.47	13.5

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

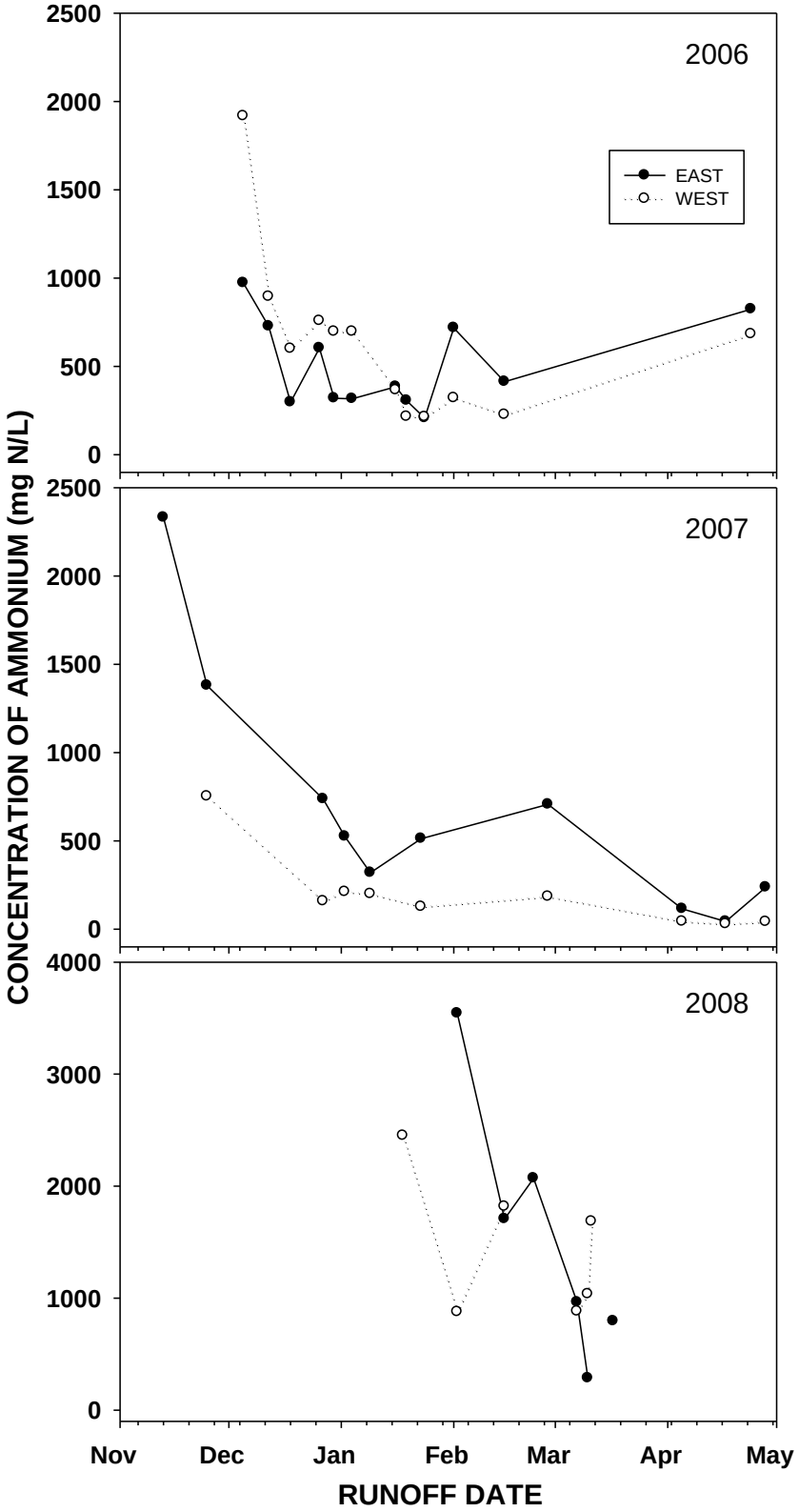

Figure 2. Concentration of ammonium-N in the runoff/leachate for each year of the study.

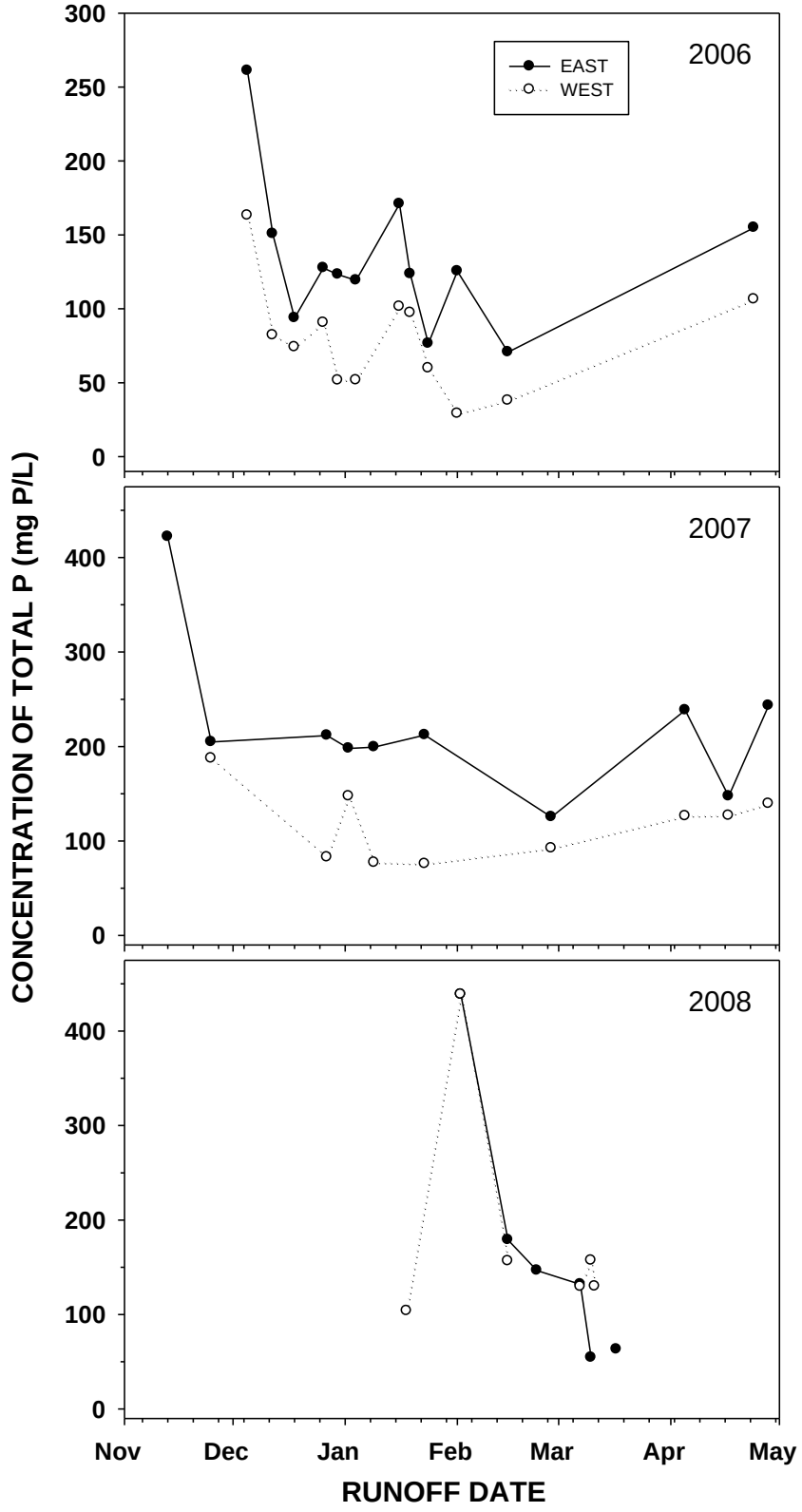

Figure 3. Concentration of total P in the runoff/leachate for each year of the study.

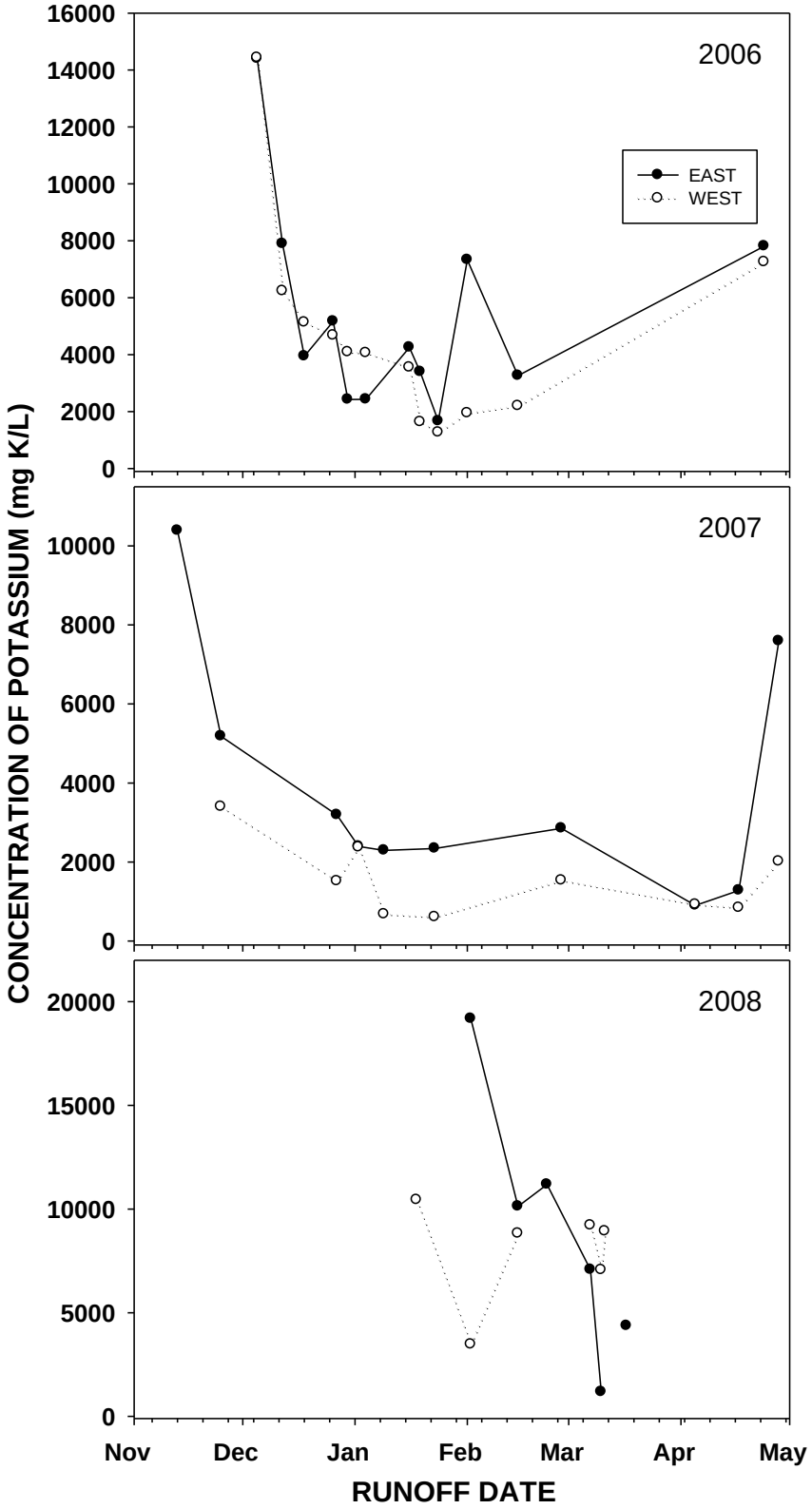

Figure 4. Concentration of potassium in the runoff/leachate for each year of the study.

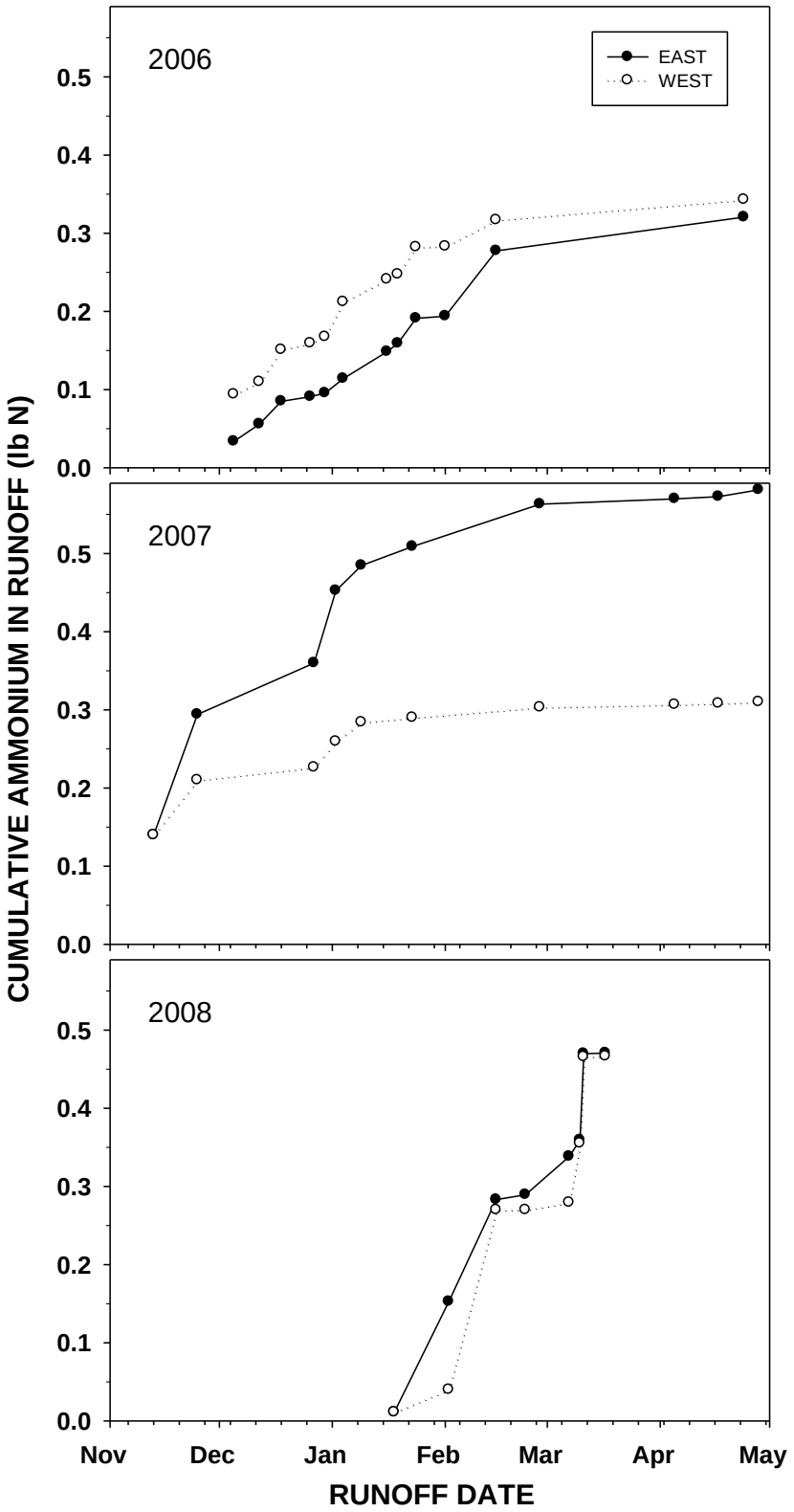

Figure 5. Cumulative amount of ammonium-N in the runoff/leachate for each year in a 6-ft length of the poultry litter pile.

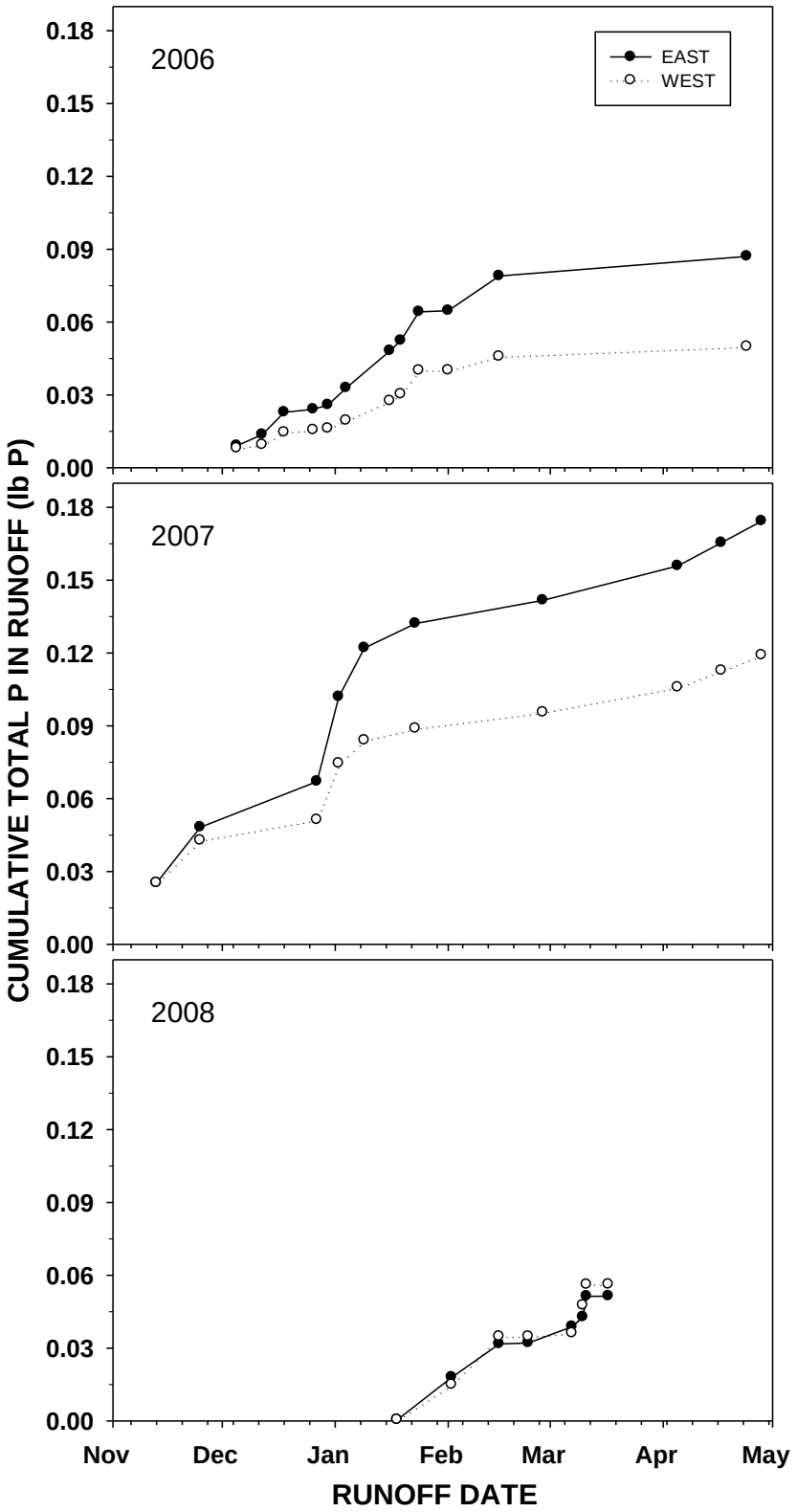

Figure 6. Cumulative amount of total P in the runoff/leachate for each year in a 6-ft length of the poultry litter pile.

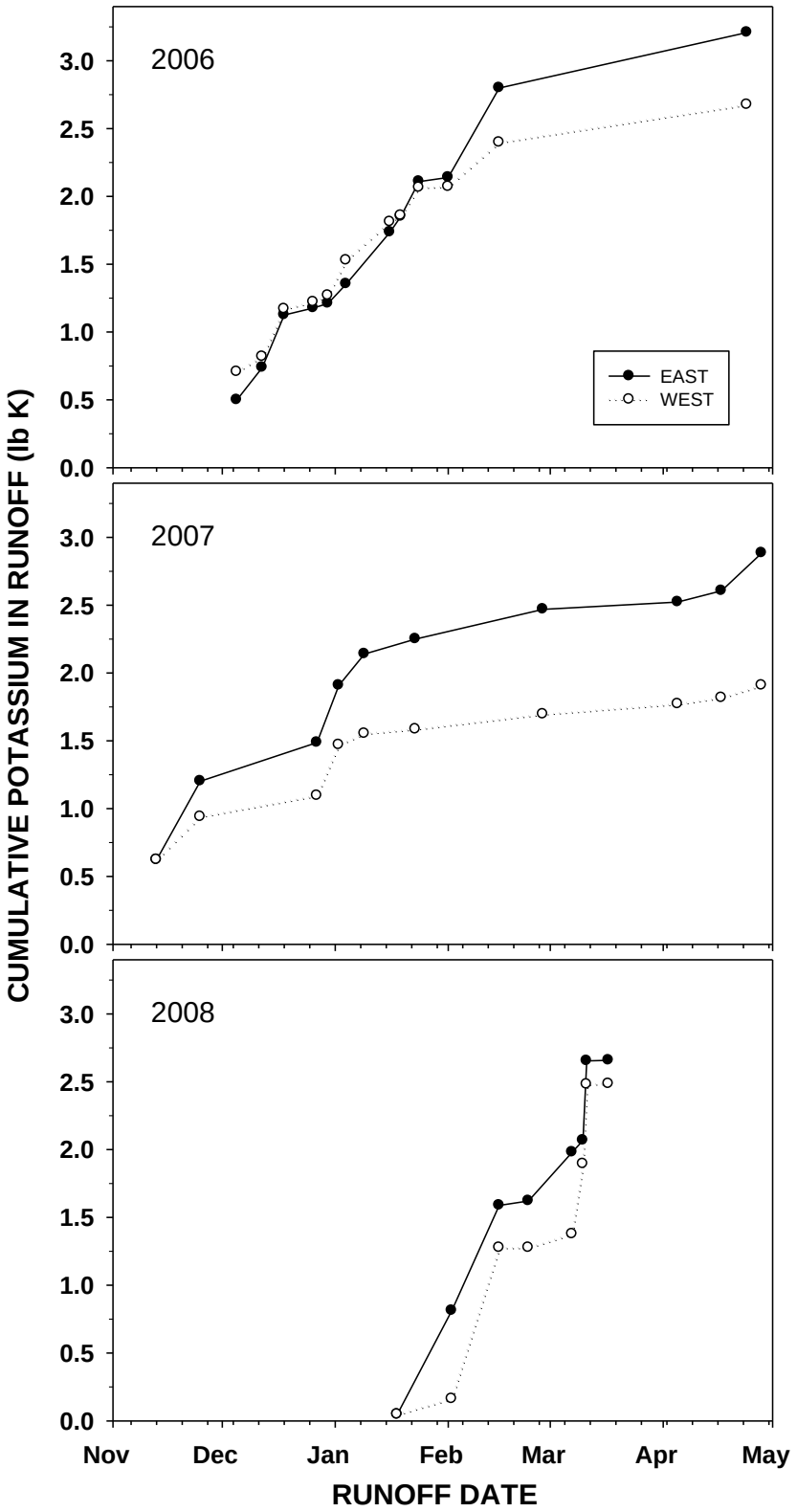

Figure 7. Cumulative amount of potassium in the runoff/leachate for each year in a 6-ft length of the poultry litter pile.

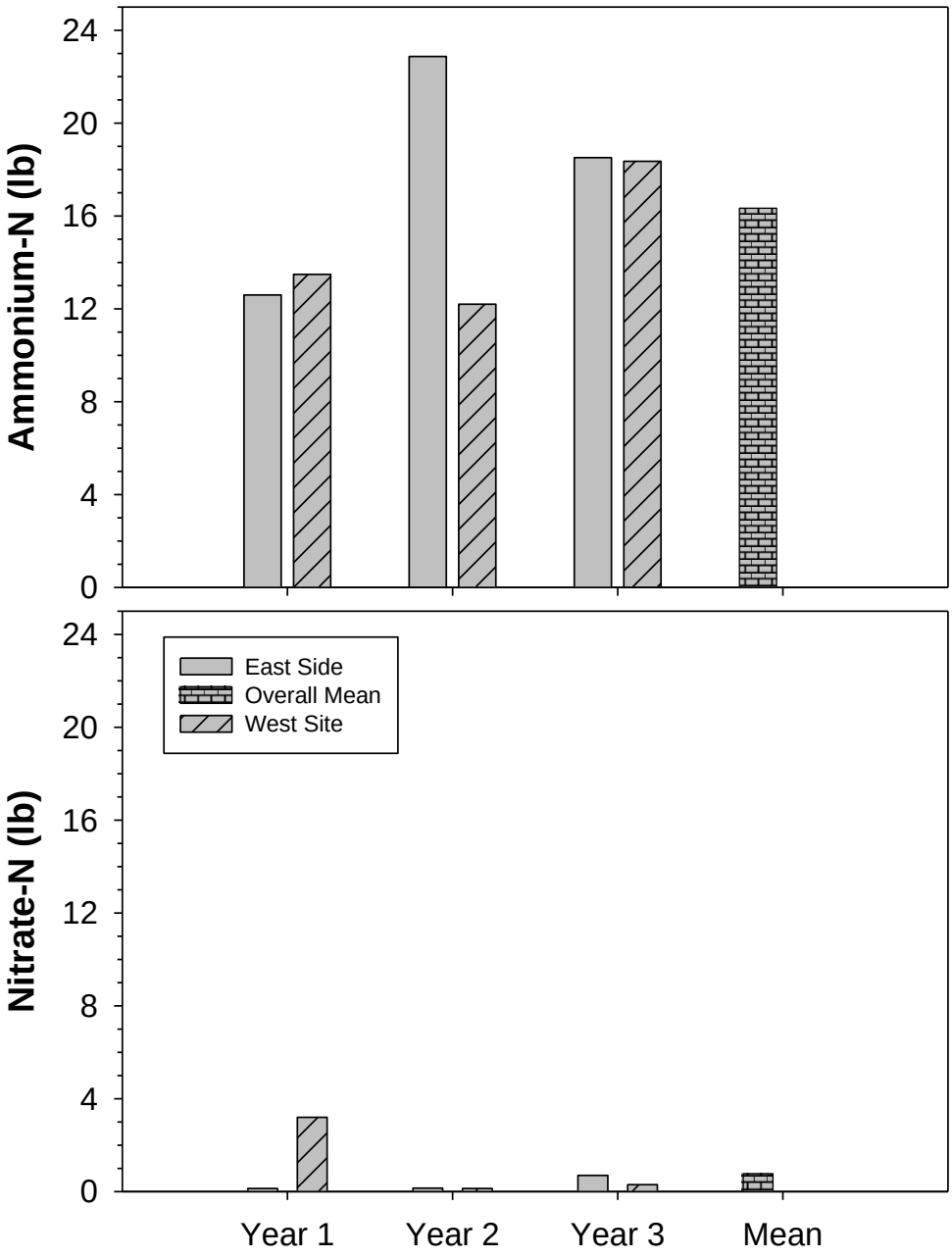

Figure 8. Total amounts of ammonium-N and nitrate-N in the runoff for each side of the pile in each year and the mean across all three years; total amounts are based on a pile size of 100 feet long and 18 feet wide.

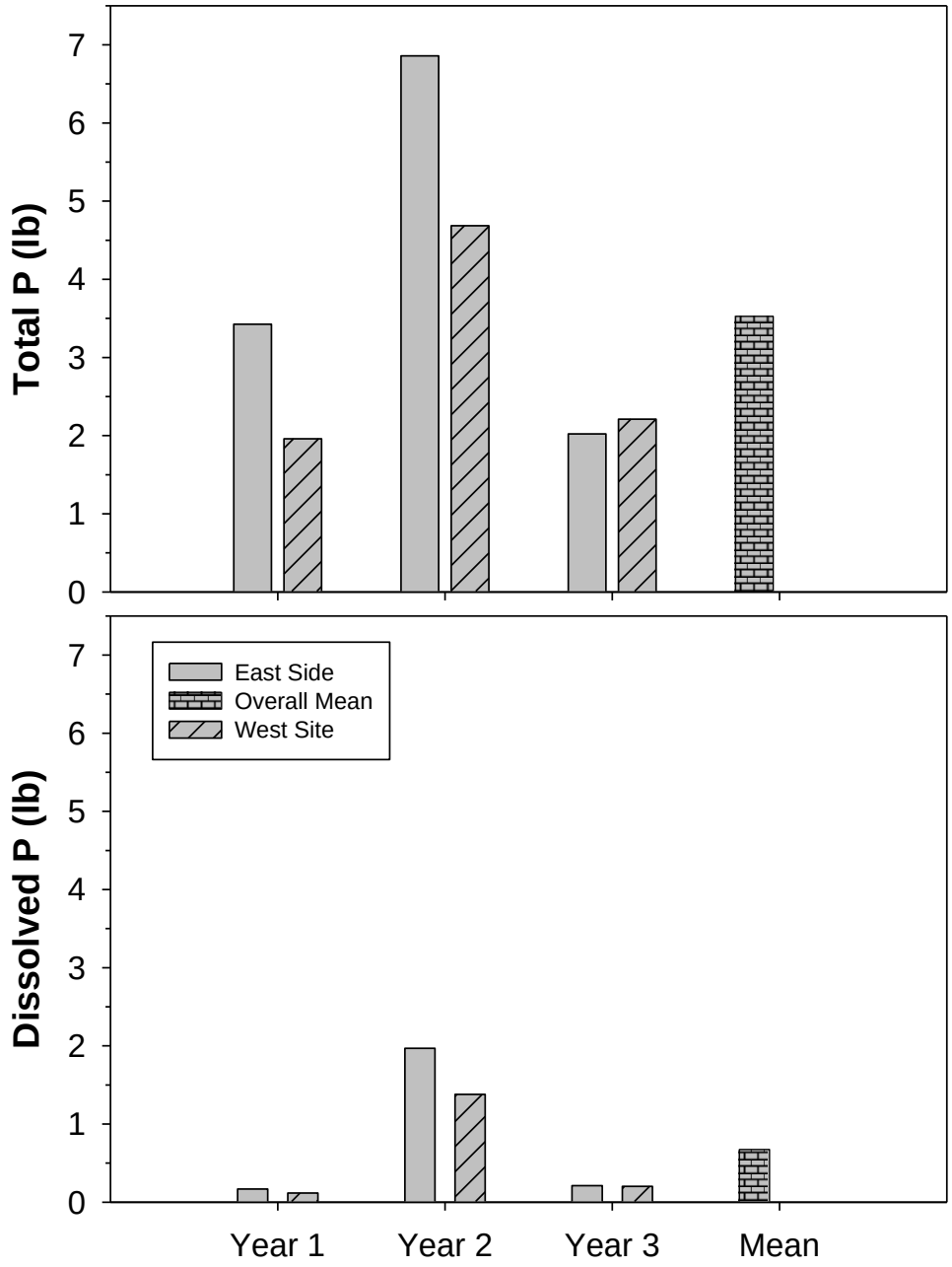

Figure 9. Total amounts of total P and dissolved P in the runoff for each side of the pile in each year and the mean across all three years; total amounts are based on a pile size of 100 feet long and 18 feet wide

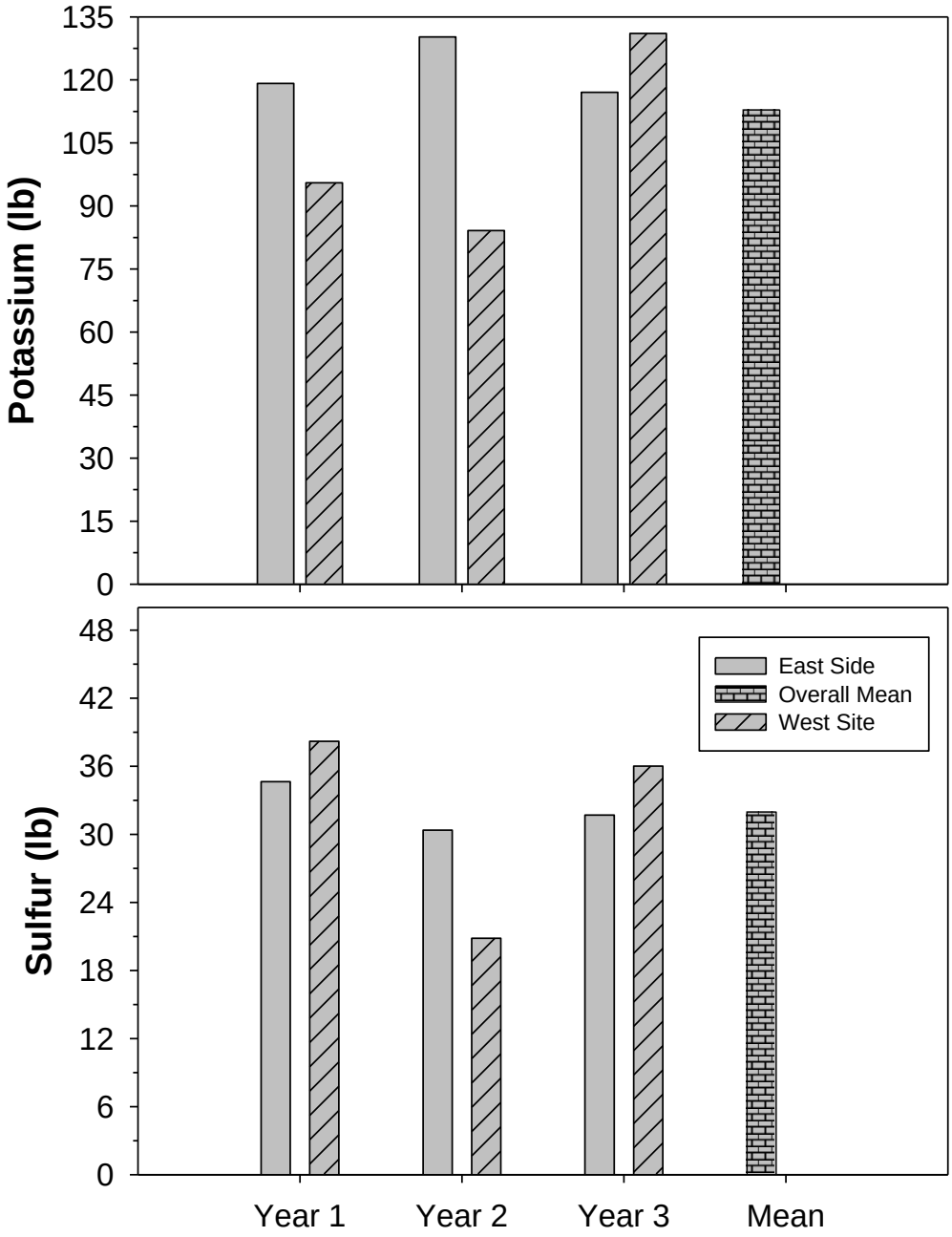

Figure 10. Total amounts of potassium and sulfur in the runoff for each side of the pile in each year and the mean across all three years; total amounts are based on a pile size of 100 feet long and 18 feet wide.

Table 20. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on a Delaware farm in 2006 on the day after poultry litter was removed from Site CB.

		Concentration of Inorganic N in Soil		
Treatment	**Depth**	**30 ft out**	**edge**	**under**
	inches	---------- mg N/kg ----------		
No Cover	0-6	10	41	68
	6-12	8	121	48
	12-24	8	47	23
	24-36	5	45	30
Poly Cover	0-6	10	308	21
	6-12	8	100	47
	12-24	9	49	22
	24-36	2	33	24
Bentonite	0-6	13	45	51
Under	6-12	5	114	36
	12-24	5	75	16
	24-36	13	17	37
Spray-On	0-6	12	23	54
Rate 1	6-12	6	103	41
	12-24	7	65	22
	24-36	9	50	41
Spray-On	0-6	11	20	44
Rate 2	6-12	9	121	51
	12-24	7	60	18
	24-36	7	55	48
Sawdust	0-6	11	30	63
Under	6-12	9	122	45
	12-24	12	42	27
	24-36	8	45	23
Poultry	0-6	14	27	57
Guard	6-12	10	103	36
Under	12-24	11	47	29
	24-36	12	38	30

Table 21. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on a Delaware farm in 2006 fifty-one days after poultry litter was removed from Site CB.

		Concentration of Inorganic N in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	---------- mg N/kg ----------		
No Cover	0-6	25	10	44
	6-12	13	110	36
	12-24	6	79	9
	24-36	9	14	7
Poly Cover	0-6	31	225	11
	6-12	13	153	55
	12-24	7	50	10
	24-36	5	10	9
Bentonite	0-6	19	33	43
Under	6-12	10	76	28
	12-24	5	76	10
	24-36	7	11	11
Spray-On	0-6	19	16	49
Rate 1	6-12	11	62	21
	12-24	5	109	10
	24-36	7	17	10
Spray-On	0-6	12	13	22
Rate 2	6-12	12	100	26
	12-24	6	88	9
	24-36	7	16	10
Sawdust	0-6	16	19	42
Under	6-12	14	98	16
	12-24	15	43	13
	24-36	10	13	12
Poultry	0-6	14	19	62
Guard	6-12	17	55	41
Under	12-24	15	37	16
	24-36	14	20	17

Table 22. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on a Delaware farm in 2007 on the day after poultry litter was removed from Site GT.

		Concentration of Inorganic N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	---------- mg N/kg ----------				
No	0-6	24	33	47	105	107
Cover	6-12	11	11	12	61	29
	12-24	11	11	14	57	19
	24-36	10	13	14	22	20
	36-48	10	11	9	16	30
Poly	0-6	17	20	60	63	93
Cover	6-12	8	11	27	23	40
	12-24	8	10	17	20	22
	24-36	9	13	11	36	12
	36-48	8	8	12	18	28
Soil Tac	0-6	26	49	74	93	104
Rate 1	6-12	11	16	31	93	54
	12-24	9	24	39	33	27
	24-36	16	12	28	26	31
	36-48	13	13	18	15	23
Soil Tac	0-6	26	77	61	56	86
Rate 2	6-12	11	11	25	45	28
	12-24	10	10	15	55	15
	24-36	13	11	15	34	11
	36-48	10	9	15	36	12

Table 23. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on a Delaware farm in 2007 on the day after poultry litter was removed from Site HM.

		Concentration of Inorganic N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	---------- mg N/kg ----------				
No	0-6	48	54	48	26	38
Cover	6-12	5	29	16	9	18
	12-24	8	7	13	7	10
	24-36	8	8	19	30	69
	36-48	16	8	13	9	9
Poly	0-6	40	55	44	49	33
Cover	6-12	4	12	9	9	21
	12-24	8	11	15	13	7
	24-36	8	10	10	9	9
	36-48	9	10	10	12	11
Soil Tac	0-6	30	37	30	29	45
Rate 1	6-12	6	6	16	22	25
	12-24	7	7	3	15	6
	24-36	7	10	12	15	10
	36-48	8	10	9	12	9
Soil Tac	0-6	24	39	25	51	24
Rate 2	6-12	7	17	60	46	38
	12-24	6	4	18	34	11
	24-36	6	14	16	12	9
	36-48	12	13	11	16	11

Table 24. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 90 days on a Delaware farm in 2008 on the day after poultry litter was removed from Site NPC.

		Concentration of Inorganic N in Soil						
Trmt	**Depth**	**20 ft out**	**4 ft out**	**2 ft out**	**edge**	**2 ft in**	**4 ft in**	**center**
	inches	---------- mg N/kg ----------						
No	0-12	7	13	40	142	196	235	101
Cover	12-24	9	12	17	23	40	23	8
	24-36	15	14	24	30	37	25	31
	36-48	15	19	17	21	19	17	12
Poly	0-12	6	7	13	18	136	213	102
Cover	12-24	4	5	4	9	20	16	9
	24-36	5	7	5	13	10	12	11
	36-48	12	11	12	15	16	15	9
Compostex	0-12	14	13	22	58	154	135	102
Cover	12-24	6	4	18	8	15	16	9
	24-36	19	19	49	29	19	17	12
	36-48	12	13	15	11	12	19	11

Table 24a. Concentration of inorganic-N (nitrate-N +ammonium-N) after poultry litter was piled for 90 days on a Delaware farm in 2008; samples were taken when corn was 12-in tall (i.e., June 3, 2008) at Site NPC.

Trmt	**Depth**	**90 ft out**	**Edge**	**Under**
	inches			
No	0-12	23	74	69
Cover	12-24	15	31	28
	24-36	16	31	23
	36-48	18	22	21
Poly	0-12	13	47	59
Cover	12-24	15	65	65
	24-36	11	32	20
	36-48	14	23	17
Compostex	0-12	25	35	17
Cover	12-24	14	23	13
	24-36	12	16	16
	36-48	12	15	14

Table 25. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on a Delaware farm in 2007 on the day after poultry litter was removed from Site LS.

		Concentration of Inorganic N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	---------- mg N/kg ----------				
No	0-6	20	27	51	11	34
Cover	6-12	14	15	14	14	14
	12-24	5	11	20	27	5
	24-36	7	10	17	16	4
	36-48	3	8	12	11	11
Illinois	0-6	20	35	44	80	50
Cover	6-12	13	13	13	13	14
	12-24	4	18	27	41	17
	24-36	13	22	33	12	18
	36-48	5	14	18	19	15
Soil Tac	0-6	11	15	19	53	41
Under	6-12	14	14	14	14	14
the Pile	12-24	4	6	19	19	13
	24-36	9	6	15	33	16
	36-48	5	11	9	14	13
Sawdust	0-6	26	18	17	35	39
Under	6-12	14	14	14	14	14
the Pile	12-24	5	5	12	15	16
	24-36	8	7	11	68	14
	36-48	8	6	10	27	13

Table 26. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 150 days on three Delaware farms in 2007 on the day after poultry litter was removed (sites had no treatments).

		Concentration of Inorganic N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	---------- mg N/kg ----------				
Site KM	0-6	39	43	40	43	33
No Cover	6-12	6	3	13	40	17
	12-24	5	7	10	23	13
	24-36	8	11	15	12	11
	36-48	7	13	13	15	10
Site WI	0-6	69	90	105	128	37
No Cover	6-12	8	12	21	5	22
	12-24	10	6	33	13	7
	24-36	12	12	13	8	10
	36-48	11	8	10	12	13
Site KW	0-6	34	20	45	55	96
No Cover	6-12	16	12	30	49	32
	12-24	8	14	20	85	26
	24-36	7	6	8	14	43
	36-48	11	8	10	14	12

Table 27. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 15 to 180 days on a Delaware farm in 2006 at Site TR1; samples were taken shortly after litter was removed.

		Concentration of Inorganic N in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg N/kg ----------		
R1	0-6	14	43	41
	6-12	14	24	18
	12-24	4	14	8
	24-36	6	11	7
R2	0-6	20	97	100
	6-12	11	64	36
	12-24	7	43	7
	24-36	6	14	6
R3	0-6	12	75	59
	6-12	14	49	22
	12-24	6	16	9
	24-36	5	17	6
R4	0-6	18	36	96
	6-12	10	48	34
	12-24	5	33	7
	24-36	8	23	8
R5	0-6	13	45	56
	6-12	12	60	26
	12-24	6	54	10
	24-36	5	39	9
R6	0-6	13	39	80
	6-12	9	42	20
	12-24	7	38	11
	24-36	7	34	14

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 28. Concentration of inorganic-N (nitrate-N + ammonium-N) after poultry litter was piled for 15 to 180 days on a Delaware farm in 2007 at Site TR2; samples were taken immediately after litter was removed.

		Concentration of Inorganic N in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg N/kg ----------			
R1	0-6	13	29	77	54	42
	6-12	7	10	5	6	7
	12-24	6	8	12	14	8
	24-36	7	6	9	8	7
	36-48	11	8	12	10	9
R2	0-6	13	40	86	65	53
	6-12	7	18	52	93	34
	12-24	7	11	14	15	10
	24-36	8	10	10	16	11
	36-48	ND‡	ND	ND	ND	ND
R3	0-6	Lost	53	51	95	69
	6-12	17	14	20	54	7
	12-24	6	80	28	29	17
	24-36	6	24	19	15	16
	36-48	5	15	21	16	13
R4	0-6	12	49	89	63	66
	6-12	16	23	78	73	46
	12-24	7	39	84	11	50
	24-36	16	19	27	25	15
	36-48	9	11	9	9	7
R5	0-6	29	33	68	25	107
	6-12	10	27	97	83	33
	12-24	13	25	56	52	17
	24-36	8	18	12	16	14
	36-48	10	22	19	17	18
R6	0-6	18	25	48	58	115
	6-12	13	20	42	43	25
	12-24	11	19	42	34	23
	24-36	13	16	63	25	57
	36-48	14	16	40	24	21

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

‡ND = No data because samples were not taken from this depth.

Table 29. Concentration of ammonium-N after poultry litter was piled for 150 days on a Delaware farm in 2006 on the day after poultry litter was removed from Site CB.

		Concentration of Inorganic N in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg NH_4^+-N/kg ----------		
No Cover	0-6	8	37	66
	6-12	5	111	45
	12-24	5	39	18
	24-36	5	42	30
Poly Cover	0-6	7	173	18
	6-12	6	60	42
	12-24	7	33	16
	24-36	3	27	24
Bentonite	0-6	10	42	50
Under	6-12	2	108	34
	12-24	3	66	13
	24-36	12	13	34
Spray-On	0-6	10	21	53
Rate 1	6-12	3	100	38
	12-24	5	57	18
	24-36	6	48	39
Spray-On	0-6	10	18	43
Rate 2	6-12	6	118	48
	12-24	4	54	13
	24-36	7	49	44
Sawdust	0-6	9	28	60
Under	6-12	9	115	39
	12-24	7	30	19
	24-36	5	42	19
Poultry	0-6	13	25	54
Guard	6-12	8	99	33
Under	12-24	4	38	22
	24-36	5	28	19

Table 30. Concentration of ammonium-N in 2006 after poultry litter was piled for 150 days on a Delaware farm; samples taken 51 days after poultry litter was removed from Site CB.

		Concentration of Inorganic N in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg N/kg ----------		
No Cover	0-6	12	6	41
	6-12	9	98	31
	12-24	3	65	5
	24-36	7	7	3
Poly Cover	0-6	17	86	5
	6-12	8	76	42
	12-24	4	17	5
	24-36	2	2	3
Bentonite	0-6	7	11	36
Under	6-12	6	69	22
	12-24	3	70	6
	24-36	4	3	4
Spray-On	0-6	11	14	33
Rate 1	6-12	7	56	15
	12-24	3	98	6
	24-36	3	9	4
Spray-On	0-6	9	10	19
Rate 2	6-12	5	96	22
	12-24	4	81	4
	24-36	4	8	4
Sawdust	0-6	7	16	10
Under	6-12	9	94	8
	12-24	4	30	4
	24-36	12	6	4
Poultry	0-6	7	11	51
Guard	6-12	14	50	33
Under	12-24	12	26	10
	24-36	9	8	10

Table 31. Concentration of ammonium-N after poultry litter was piled for 150 days on a Delaware farm in 2007 on the day after poultry litter was removed from Site GT.

		Concentration of Ammonium-N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg N/kg ----------			
No	0-6	17	25	43	73	105
Cover	6-12	6	7	8	48	26
	12-24	5	6	7	51	16
	24-36	4	8	7	18	16
	36-48	5	7	4	10	26
Poly	0-6	13	14	56	55	89
Cover	6-12	5	7	24	17	37
	12-24	4	6	14	13	18
	24-36	4	7	7	29	9
	36-48	4	3	8	11	24
Soil Tac	0-6	20	41	49	91	100
Rate 1	6-12	6	9	17	90	50
	12-24	4	21	35	29	26
	24-36	11	6	20	22	26
	36-48	8	5	9	9	18
Soil Tac	0-6	23	61	58	53	76
Rate 2	6-12	7	7	13	42	26
	12-24	4	6	8	52	13
	24-36	6	5	6	30	8
	36-48	4	3	5	32	7

Table 32. Concentration of ammonium-N after poultry litter was piled for 150 days on a Delaware farm in 2007 on the day after poultry litter was removed from Site HM.

		Concentration of Ammonium-N in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg N/kg ----------			
No	0-6	42	47	41	22	36
Cover	6-12	2	27	14	7	15
	12-24	5	5	11	5	7
	24-36	3	4	7	6	20
	36-48	8	5	10	6	7
Poly	0-6	35	46	37	45	30
Cover	6-12	1	6	6	6	19
	12-24	4	5	11	10	3
	24-36	3	3	6	6	5
	36-48	5	4	6	8	6
Soil Tac	0-6	24	27	27	25	41
Rate 1	6-12	2	3	12	18	22
	12-24	3	3	1	13	4
	24-36	2	2	10	11	6
	36-48	5	3	6	9	6
Soil Tac	0-6	19	28	20	47	20
Rate 2	6-12	4	14	55	41	33
	12-24	2	2	12	30	7
	24-36	2	4	5	9	5
	36-48	6	5	5	12	6

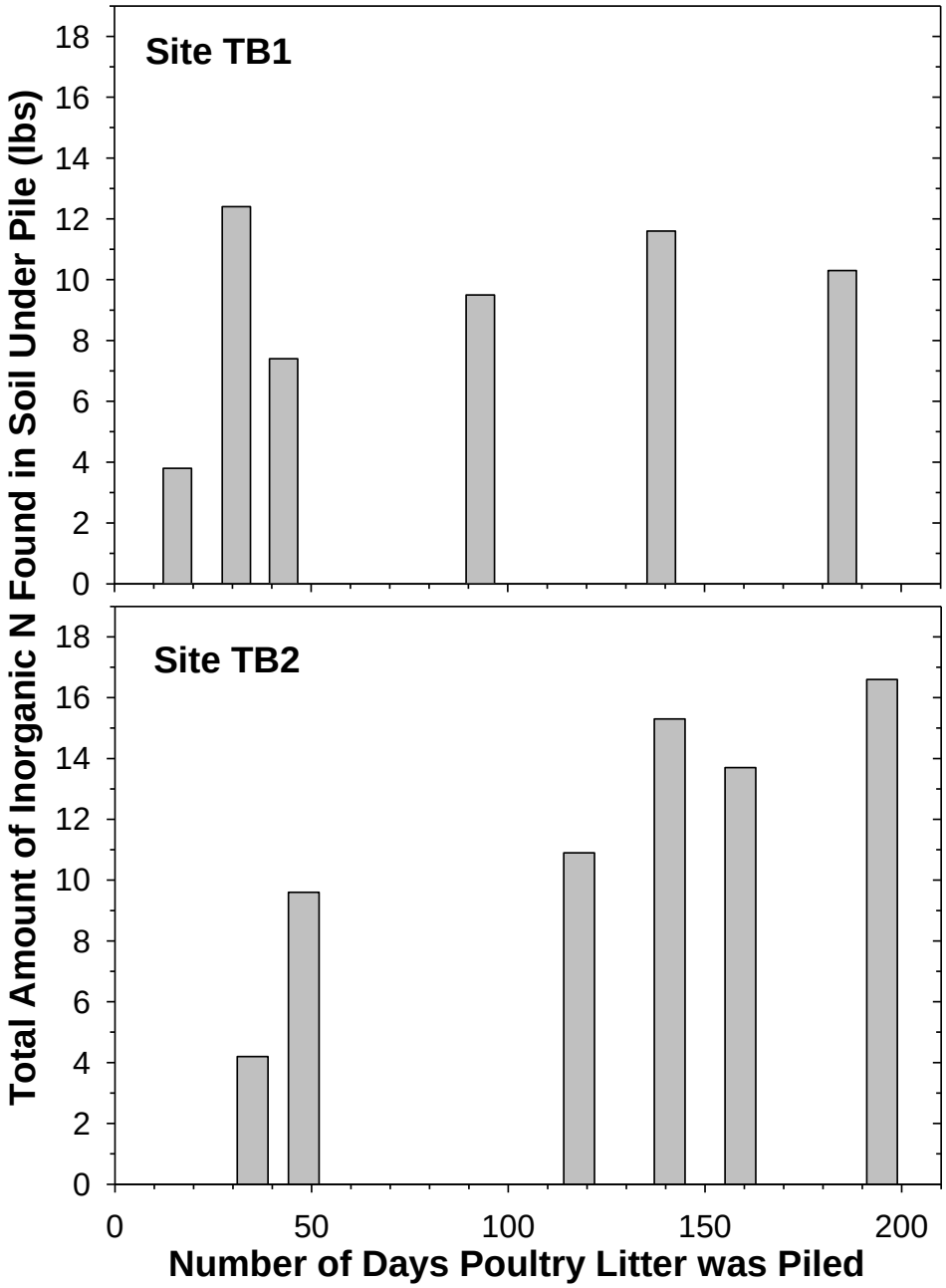

Figure 11. Total amounts of inorganic N (nitrate-N + ammonium-N) found in the underlying soil after poultry litter was removed from Sites TB1 and TB2; number of days refers to the number of days the litter was in place before it was removed from the site. The total inorganic N amounts were based on a land area of 100 ft long and 18 ft wide.

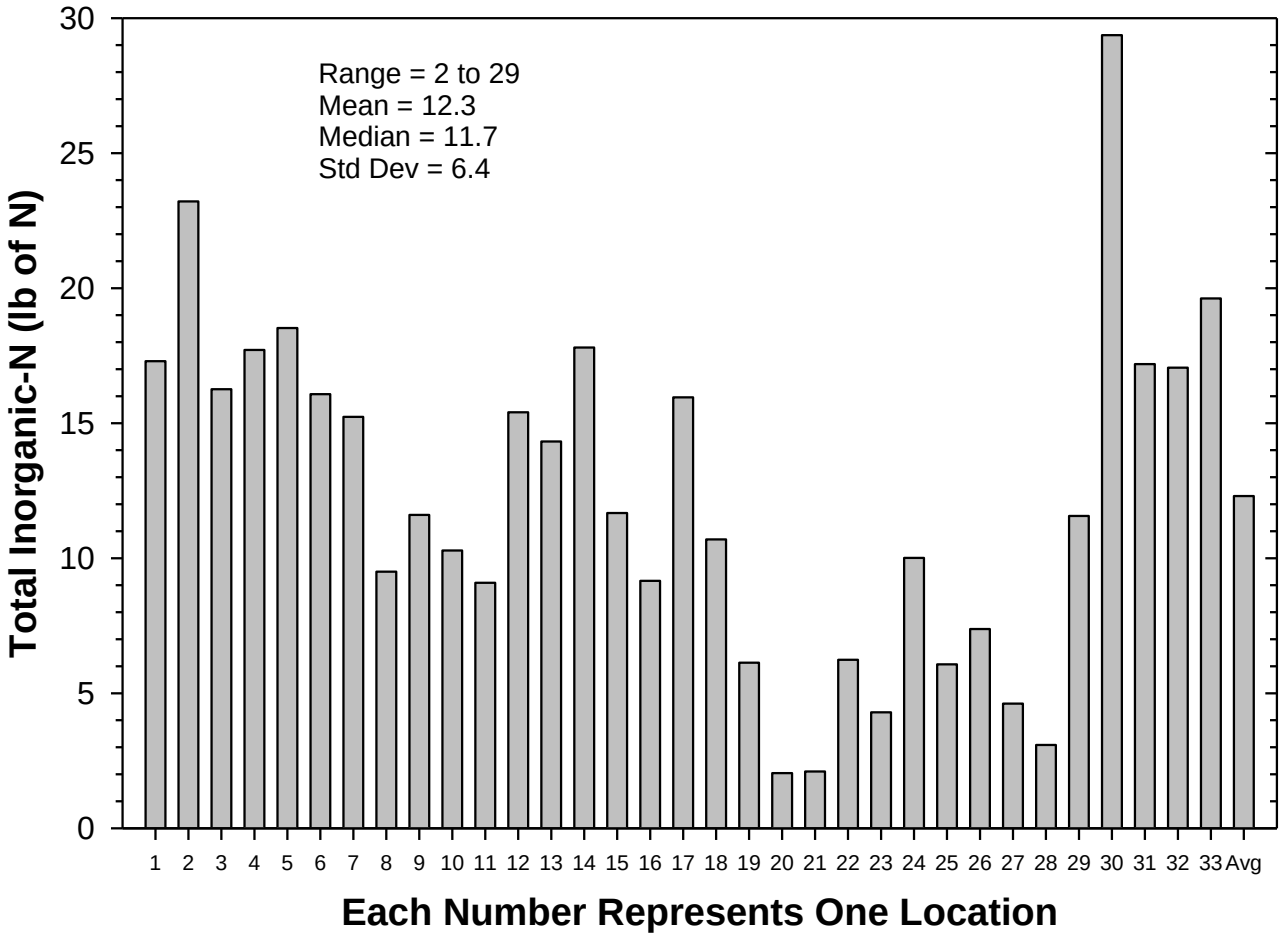

Figure 12. Total amounts of inorganic N (nitrate-N + ammonium-N) found in the underlying soil after poultry litter was removed for 33 different site-treatment combinations that all had poultry litter piled for at least 90 days during the three years of this project. The total inorganic N amounts were based on a land area of 100 ft long and 18 ft wide.

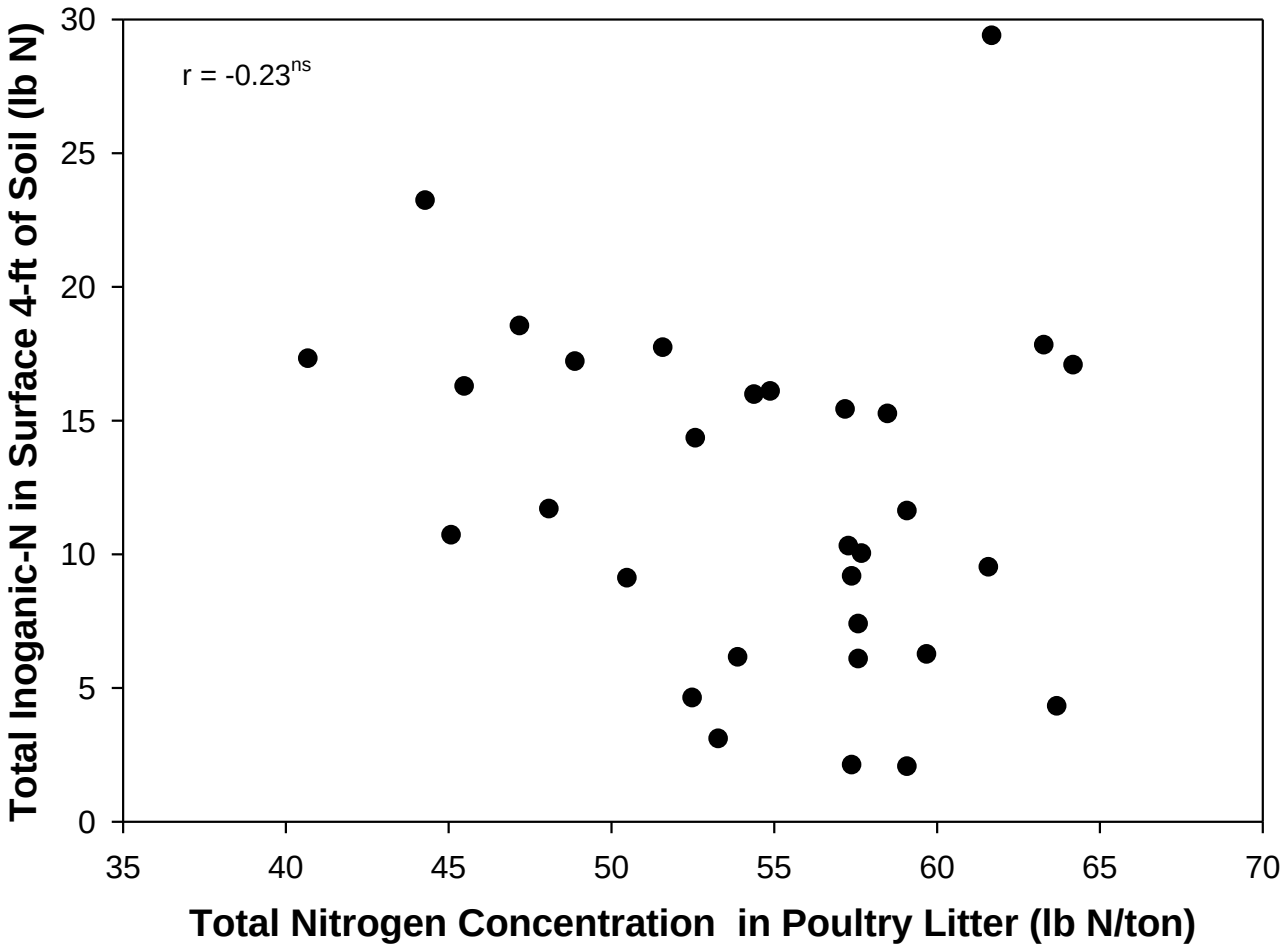

Figure 13. Relationship between total amounts of inorganic N found in the underlying soil and amounts of N present in the poultry litter that was piled on the site; these data represent 33 site-treatment combinations that all had poultry litter piled for at least 90 days during the three years of this project. The total inorganic N amounts in the soil were based on a land area of 100 ft long and 18 ft wide.

Table 33. Concentration of Mehlich 3-P after poultry litter was piled for 150 days in 2006 on a Delaware farm; soil samples were taken 86 days after poultry litter was removed from Site CB.

		Concentration of Phosphorus in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-P/kg ----------		
No Cover	0-6	408	495	359
	6-12	186	155	317
Poly Cover	0-6	403	441	382
	6-12	348	298	289
Bentonite	0-6	385	492	393
	6-12	294	259	231
Spray-on 1	0-6	370	537	528
	6-12	304	255	255
Spray-on 2	0-6	386	483	411
	6-12	310	343	384
Sawdust	0-6	362	462	394
	6-12	293	364	405
Poultry	0-6	478	651	492
Guard	6-12	309	416	430

Table 34. Concentration of Mehlich 3-P after poultry litter was piled for 150 days on a Delaware farm in 2007 immediately after poultry litter was removed from Site GT.

		Concentration of Phosphorus in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-P/kg ----------				
No Cover	0-6	185	181	163	218	198
	6-12	80	44	39	55	29
Poly Cover	0-6	180	125	182	178	194
	6-12	52	29	36	41	60
Soil Tac (R1)	0-6	176	178	161	167	299
	6-12	76	45	32	30	73
Soil Tac (R2)	0-6	198	165	148	185	256
	6-12	75	48	43	31	37

Table 35. Concentration of Mehlich 3-P after poultry litter was piled for 150 days on a Delaware farm in 2007 immediately after poultry litter was removed from Site HM.

		Concentration of Phosphorus in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-P/kg ----------				
No Cover	0-6	425	482	528	520	521
	6-12	250	261	173	202	243
Poly Cover	0-6	414	452	463	463	421
	6-12	182	186	192	172	204
Soil Tac (R1)	0-6	428	405	499	455	356
	6-12	242	159	216	204	146
Soil Tac (R2)	0-6	511	451	419	452	401
	6-12	219	242	263	283	358

Table 36. Concentration of Mehlich 3-P after poultry litter was piled for 150 days on a Delaware farm in 2007 immediately after poultry litter was removed from Site LS.

		Concentration of Phosphorus in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-P/kg ----------				
No Cover	0-6	205	436	245	414	259
	6-12	171	382	206	235	173
Illinois Cover	0-6	199	453	296	317	408
	6-12	180	318	214	164	198
Soil Tac	0-6	173	343	317	363	447
	6-12	209	308	272	261	237
Sawdust	0-6	192	419	420	465	531
	6-12	133	405	307	303	272

Table 37. Concentration of Mehlich 3-P after poultry litter was piled for 150 days on three Delaware farm in 2007 immediately after poultry litter was removed (sites had no treatments).

		Concentration of Phosphorus in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-P/kg ----------				
Site KM	0-6	451	518	467	475	514
	6-12	258	238	264	114	314
Site WI	0-6	382	383	388	374	361
	6-12	261	330	321	350	330
Site KW	0-6	782	641	639	690	687
	6-12	444	467	353	492	401

Table 38. Concentration of Mehlich 3-P in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day the poultry litter was removed.

		Concentration of Phosphorus in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-P/kg ----------		
R1	0-6	270	209	247
	6-12	137	83	112
R2	0-6	241	267	293
	6-12	149	93	99
R3	0-6	231	297	260
	6-12	171	142	134
R4	0-6	250	265	252
	6-12	159	139	147
R5	0-6	242	271	230
	6-12	141	144	75
R6	0-6	275	308	259
	6-12	200	183	145

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 39. Concentration of Mehlich 3-P in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day the poultry litter was removed.

		Concentration of Phosphorus in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-P/kg ----------				
R1	0-6	580	541	539	556	579
	6-12	356	318	310	272	231
R2	0-6	545	537	594	530	539
	6-12	372	335	370	272	233
R3	0-6	608	713	726	631	640
	6-12	366	342	316	304	338
R4	0-6	715	721	668	592	588
	6-12	392	318	295	234	143
R5	0-6	747	827	798	735	758
	6-12	406	316	564	327	357
R6	0-6	744	695	743	723	704
	6-12	377	276	280	223	199

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 40. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken one day after poultry litter was removed from the site.

		Concentration of Potassium in Soil		
Trmt	**Depth**	**20 ft out**	**edge**	**under**
	inches	--------- mg M3-K/kg ----------		
No Cover	0-6	46	2118	593
	6-12	36	1039	66
Poly Cover	0-6	49	677	705
	6-12	52	160	121
Bentonite	0-6	59	1640	555
	6-12	52	1110	70
Spray-on 1	0-6	48	2361	647
	6-12	36	1147	83
Spray-on 2	0-6	66	2106	886
	6-12	59	1114	159
Sawdust	0-6	191	2139	222
	6-12	190	949	144
Poultry	0-6	297	2035	655
Guard	6-12	275	702	144

Table 41. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 150 days in 2007 at Site GT ; soil samples were taken one day after poultry litter was removed from the site.

		Concentration of Potassium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-K/kg ----------				
No Cover	0-6	172	334	546	951	831
	6-12	132	120	147	383	163
Poly Cover	0-6	141	169	669	629	921
	6-12	96	105	151	147	194
Soil Tac (R1)	0-6	168	415	807	1560	1214
	6-12	90	112	204	486	299
Soil Tac (R2)	0-6	155	352	628	1537	1210
	6-12	68	109	202	402	168

Table 42. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 150 days in 2007 at Site HM; soil samples were taken one day after poultry litter was removed from the site.

		Concentration of Potassium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-K/kg ----------				
No Cover	0-6	178	347	752	1605	653
	6-12	117	271	180	179	140
Poly Cover	0-6	218	275	500	783	573
	6-12	129	170	221	194	97
Soil Tac (R1)	0-6	148	640	1032	1019	459
	6-12	138	169	195	293	98
Soil Tac (R2)	0-6	389	441	1046	1983	652
	6-12	108	178	353	475	160

Table 43. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Potassium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-K/kg ----------				
No Cover	0-6	151	536	351	1224	393
	6-12	157	490	325	630	103
Illinois Cover	0-6	268	208	346	812	1081
	6-12	117	191	313	526	174
Soil Tac	0-6	68	104	278	677	1087
	6-12	85	115	291	504	302
Sawdust	0-6	187	157	319	1017	1018
	6-12	112	130	231	835	340

Table 44. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Potassium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-K/kg ----------				
Site KM	0-6	205	252	763	1767	652
	6-12	126	131	218	192	211
Site WI	0-6	246	485	1116	615	649
	6-12	149	217	201	86	127
Site KW	0-6	215	166	230	656	669
	6-12	183	79	112	693	126

Table 45. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 15 to 180 days in 2006 as Site TR1; soil samples were taken the same day the poultry litter was removed.

		Concentration of Potassium in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-K/kg ----------		
R1	0-6	134	210	220
	6-12	50	60	52
R2	0-6	136	890	431
	6-12	73	110	81
R3	0-6	101	721	239
	6-12	63	269	84
R4	0-6	94	530	424
	6-12	60	347	60
R5	0-6	74	359	379
	6-12	49	305	90
R6	0-6	122	439	446
	6-12	85	312	65

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 46. Concentration of Mehlich 3-K in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day the poultry litter was removed.

		Concentration of Potassium in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-K/kg ----------				
R1	0-6	153	251	791	1100	418
	6-12	77	105	306	371	149
R2	0-6	103	251	737	1137	706
	6-12	83	83	265	350	177
R3	0-6	145	668	1741	1539	931
	6-12	133	478	813	690	203
R4	0-6	175	404	957	1183	1603
	6-12	121	281	579	844	212
R5	0-6	193	529	986	1812	998
	6-12	132	294	767	1047	234
R6	0-6	177	400	1327	1232	750
	6-12	116	167	426	443	232

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 47. Concentration of soluble salts in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 1 day after poultry litter was removed from the site.

		Concentration of Soluble Salts in Soil		
Trmt	**Depth**	**20 ft out**	**edge**	**under**
	inches	--------- mmhos/cm ----------		
No Cover	0-6	0.2	5.5	1.6
	6-12	0.1	3.4	0.3
Poly Cover	0-6	0.2	2.8	1.8
	6-12	0.1	0.8	0.4
Bentonite	0-6	0.1	4.8	1.8
	6-12	0.1	3.0	0.3
Spray-on 1	0-6	0.2	5.8	1.6
	6-12	0.2	3.3	0.3
Spray-on 2	0-6	0.1	4.5	2.1
	6-12	0.2	2.8	0.4
Sawdust	0-6	0.2	5.9	0.5
	6-12	0.2	2.6	0.2
Poultry	0-6	0.2	4.7	1.7
Guard	6-12	0.2	2.3	0.3

Table 48. Concentration of soluble salts in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Soluble Salts in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mmhos/cm ----------			
No Cover	0-6	0.2	0.5	0.8	1.4	1.3
	6-12	0.1	0.2	0.3	0.7	0.3
Poly Cover	0-6	0.2	0.2	0.9	0.8	1.7
	6-12	0.1	0.1	0.3	0.2	0.4
Soil Tac (R1)	0-6	0.2	0.6	1.1	2.6	1.6
	6-12	0.1	0.2	0.5	1.9	0.7
Soil Tac (R2)	0-6	0.1	0.5	1.0	2.1	1.7
	6-12	0.1	0.2	0.4	0.5	0.3

Table 49. Concentration of soluble salts in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Soluble Salts in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mmhos/cm ----------			
No Cover	0-6	0.2	0.5	1.3	3.6	1.2
	6-12	0.3	0.5	0.3	0.3	0.2
Poly Cover	0-6	0.2	0.4	0.9	1.5	1.0
	6-12	0.1	0.2	0.2	0.3	0.1
Soil Tac (R1)	0-6	0.2	0.9	2.6	3.8	1.0
	6-12	0.2	0.3	0.4	0.8	0.3
Soil Tac (R2)	0-6	0.2	0.7	1.9	4.8	1.4
	6-12	0.1	0.2	1.3	1.7	0.6

Table 50. Concentration of soluble salts in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Soluble Salts in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mmhos/cm ----------			
No Cover	0-6	0.3	0.8	0.7	1.7	0.8
	6-12	0.3	0.8	0.6	1.3	0.2
Illinois Cover	0-6	0.3	0.7	0.9	2.0	2.0
	6-12	0.1	0.6	1.0	1.1	0.4
Soil Tac	0-6	0.1	0.2	0.5	1.2	2.1
	6-12	0.1	0.1	0.4	0.8	0.5
Sawdust	0-6	0.3	0.2	0.4	1.7	2.0
	6-12	0.2	0.2	0.4	1.2	0.7

Table 51. Concentration of soluble salts in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Soluble Salts in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mmhos/cm ----------			
Site KM	0-6	0.3	0.3	1.1	2.4	1.3
	6-12	0.5	0.4	0.8	0.7	0.3
Site WI	0-6	0.5	1.2	2.9	1.8	1.3
	6-12	0.2	0.4	0.5	0.1	0.3
Site KW	0-6	0.3	0.3	0.4	0.7	1.3
	6-12	0.1	0.1	0.2	0.7	0.1

Table 52. Concentration of soluble salts in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Soluble Salts in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mmhos/cm ----------		
R1	0-6	0.4	1.0	0.6
	6-12	0.0	0.0	0.0
R2	0-6	0.2	3.2	1.0
	6-12	0.0	0.0	0.0
R3	0-6	0.2	1.5	0.7
	6-12	0.0	0.0	0.0
R4	0-6	0.2	0.9	1.2
	6-12	0.1	0.6	0.2
R5	0-6	0.2	0.5	1.1
	6-12	0.1	0.6	0.3
R6	0-6	0.2	1.0	1.2
	6-12	0.2	0.6	0.2

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 53. Concentration of soluble salts in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day the poultry litter was removed.

		Concentration of Soluble Salts in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mmhos/cm ----------			
R1	0-6	0.2	0.3	1.4	1.9	0.6
	6-12	0.1	0.2	0.9	1.0	0.1
R2	0-6	0.1	0.3	0.9	1.8	1.2
	6-12	0.1	0.2	0.7	1.1	0.5
R3	0-6	0.3	0.9	3.0	3.5	1.8
	6-12	0.3	0.6	1.8	1.7	0.3
R4	0-6	0.2	0.5	1.2	2.0	3.1
	6-12	0.2	0.4	0.8	1.5	0.3
R5	0-6	0.2	0.6	1.0	2.3	1.6
	6-12	0.1	0.3	0.8	1.5	0.3
R6	0-6	0.3	0.6	1.6	1.8	1.3
	6-12	0.2	0.3	0.6	0.7	0.3

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

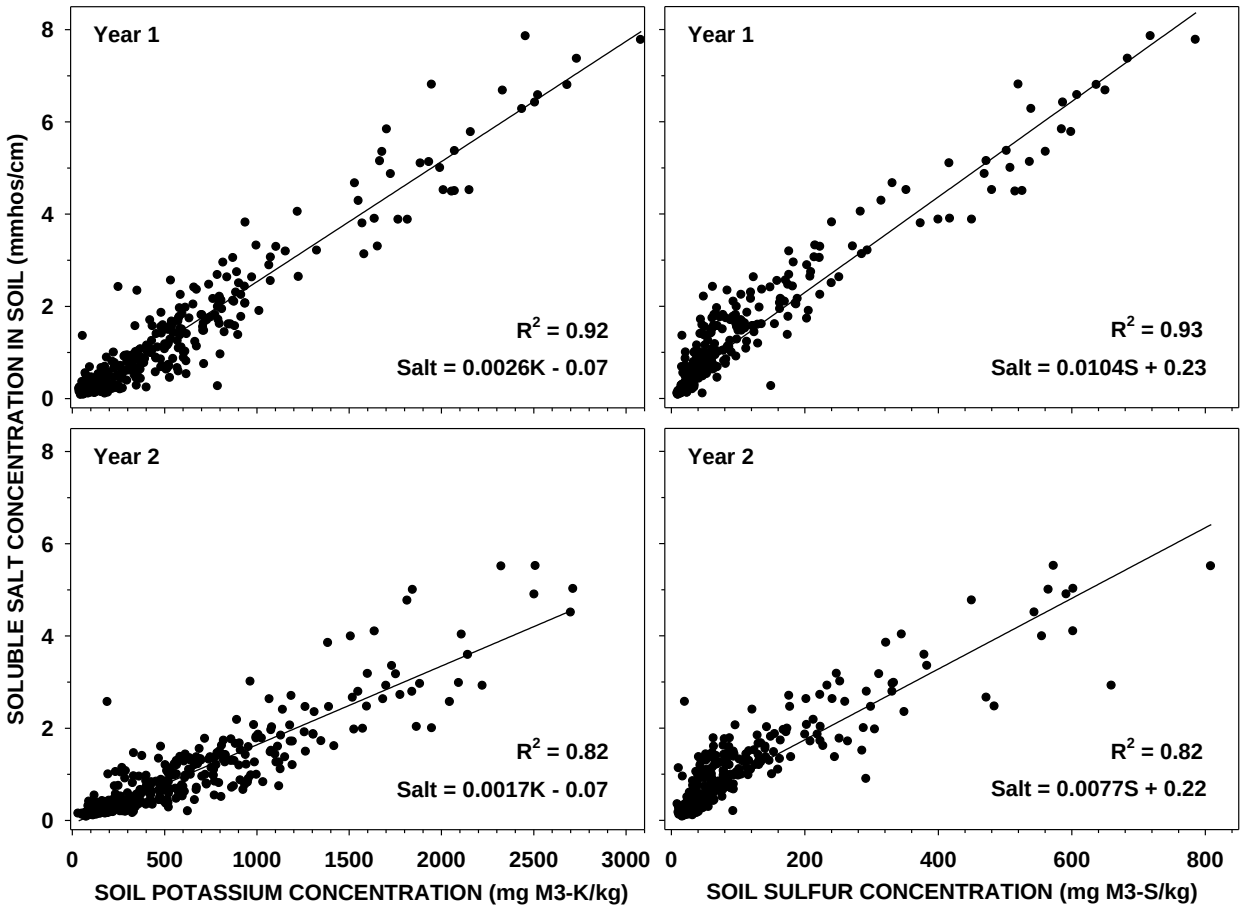

Figure 8. Relationships between concentrations of soluble salts and soil potassium and soil sulfur in the surface six-inch soil layer during the first two years of this study.

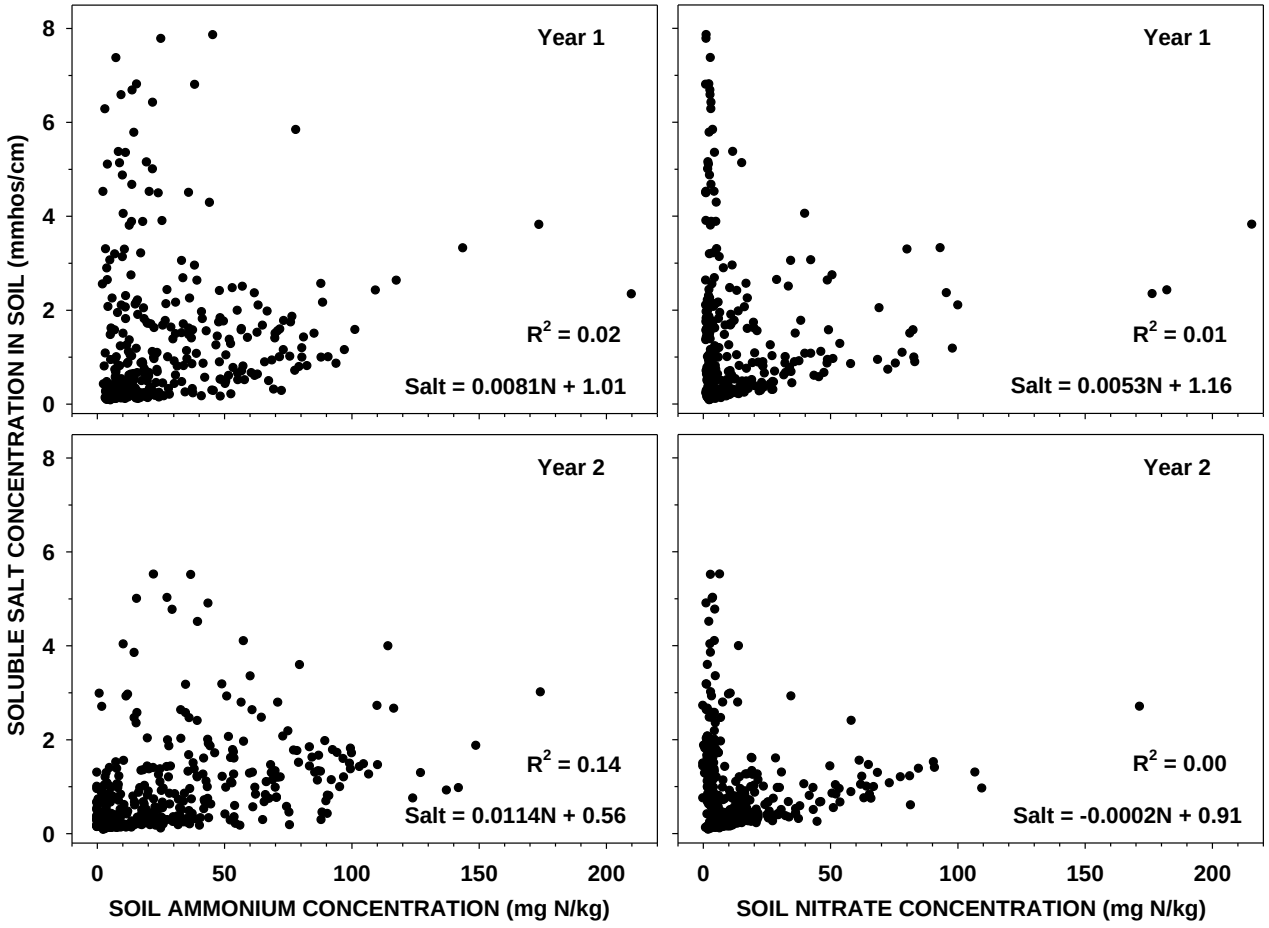

Figure 9. Relationships between concentrations of soluble salts and soil ammonium and soil nitrate in the surface six-inch soil layer during the first two years of this study.

Table 54. Concentration of sulfur in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 51 days after poultry litter was removed from the site.

		Concentration of Sulfur in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-S/kg ----------		
No Cover	0-6	17	476	61
	6-12	14	327	15
Poly Cover	0-6	19	150	51
	6-12	14	52	20
Bentonite	0-6	17	480	62
	6-12	14	395	15
Spray-on 1	0-6	18	602	63
	6-12	16	393	13
Spray-on 2	0-6	18	498	96
	6-12	15	341	17
Sawdust	0-6	25	585	42
	6-12	26	364	15
Poultry	0-6	32	518	86
Guard	6-12	25	258	18

Table 55. Concentration of sulfur in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Sulfur in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-S/kg ----------				
No Cover	0-6	31	49	78	86	77
	6-12	27	27	32	58	30
Poly Cover	0-6	31	37	146	137	83
	6-12	26	23	38	28	30
Soil Tac (R1)	0-6	34	101	190	479	189
	6-12	25	39	66	289	53
Soil Tac (R2)	0-6	35	69	103	229	189
	6-12	24	34	44	50	32

Table 56. Concentration of sulfur in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Sulfur in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-S/kg ----------				
No Cover	0-6	21	49	149	375	42
	6-12	20	47	69	37	21
Poly Cover	0-6	23	32	73	134	43
	6-12	20	29	36	47	17
Soil Tac (R1)	0-6	25	97	251	293	60
	6-12	31	54	55	92	29
Soil Tac (R2)	0-6	58	73	246	706	66
	6-12	19	26	125	199	27

Table 57. Concentration of sulfur in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Sulfur in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-S/kg ----------				
No Cover	0-6	37	77	46	189	66
	6-12	33	70	43	176	26
Illinois Cover	0-6	43	35	52	93	156
	6-12	22	33	49	73	41
Soil Tac	0-6	20	26	43	87	157
	6-12	22	24	46	69	51
Sawdust	0-6	43	28	47	141	167
	6-12	25	24	39	119	68

Table 58. Concentration of sulfur in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Sulfur in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-S/kg ----------				
Site KM	0-6	27	36	188	431	61
	6-12	23	43	69	60	34
Site WI	0-6	57	138	404	149	59
	6-12	57	63	60	19	26
Site KW	0-6	44	43	49	72	100
	6-12	24	24	28	87	24

Table 59. Concentration of sulfur in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Sulfur in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-S/kg ----------		
R1	0-6	40	74	50
	6-12	11	12	12
R2	0-6	19	247	44
	6-12	10	34	11
R3	0-6	14	153	22
	6-12	11	89	14
R4	0-6	15	69	45
	6-12	12	67	16
R5	0-6	16	42	60
	6-12	11	50	28
R6	0-6	16	57	46
	6-12	14	45	15

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 60. Concentration of sulfur in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Sulfur in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-S/kg ----------			
R1	0-6	29	24	136	152	38
	6-12	19	25	102	97	16
R2	0-6	23	30	82	173	61
	6-12	18	21	66	105	40
R3	0-6	26	69	349	300	72
	6-12	55	56	220	145	29
R4	0-6	30	45	113	145	323
	6-12	21	36	87	117	20
R5	0-6	29	59	103	218	88
	6-12	21	46	115	178	31
R6	0-6	35	68	185	205	96
	6-12	25	28	59	64	27

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 61. Concentration of calcium in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 51 days after poultry litter was removed from the site.

		Concentration of Calcium in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg Ca/kg ----------		
No Cover	0-6	510	469	397
	6-12	216	204	186
Poly Cover	0-6	484	458	530
	6-12	208	562	239
Bentonite	0-6	513	485	449
	6-12	280	251	217
Spray-on 1	0-6	496	506	514
	6-12	195	302	191
Spray-on 2	0-6	475	472	590
	6-12	311	273	280
Sawdust	0-6	623	584	579
	6-12	246	228	173
Poultry	0-6	538	650	566
Guard	6-12	351	302	382

Table 62. Concentration of calcium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Calcium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Ca/kg ----------			
No Cover	0-6	538	564	532	559	470
	6-12	312	469	515	371	348
Poly Cover	0-6	596	485	528	477	447
	6-12	325	356	356	321	250
Soil Tac (R1)	0-6	529	530	469	487	635
	6-12	295	286	267	373	324
Soil Tac (R2)	0-6	633	456	404	532	601
	6-12	195	252	284	276	312

Table 63. Concentration of calcium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Calcium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Ca/kg ----------			
No Cover	0-6	602	649	690	751	834
	6-12	334	426	370	272	292
Poly Cover	0-6	645	670	676	694	655
	6-12	343	353	286	316	374
Soil Tac (R1)	0-6	675	596	684	740	452
	6-12	359	270	287	250	238
Soil Tac (R2)	0-6	799	528	539	599	565
	6-12	291	206	250	297	487

Table 64. Concentration of calcium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Calcium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Ca/kg ----------				
No Cover	0-6	475	689	396	517	471
	6-12	333	582	312	387	368
Illinois Cover	0-6	339	805	462	427	495
	6-12	311	542	407	268	326
Soil Tac	0-6	301	613	475	487	554
	6-12	379	476	392	346	393
Sawdust	0-6	379	837	712	563	665
	6-12	271	712	596	414	464

Table 65. Concentration of calcium in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Calcium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Ca/kg ----------				
Site KM	0-6	710	671	632	597	860
	6-12	339	344	329	753	316
Site WI	0-6	431	513	494	550	645
	6-12	259	411	445	450	464
Site KW	0-6	835	540	455	611	652
	6-12	530	240	191	239	196

Table 66. Concentration of calcium in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Calcium in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Ca/kg ----------		
R1	0-6	440	374	380
	6-12	272	236	244
R2	0-6	415	603	610
	6-12	334	357	374
R3	0-6	361	476	445
	6-12	323	413	334
R4	0-6	440	366	370
	6-12	343	248	293
R5	0-6	346	285	307
	6-12	250	179	178
R6	0-6	373	331	321
	6-12	255	211	199

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 67. Concentration of calcium in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Calcium in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Ca/kg ----------			
R1	0-6	488	493	373	421	525
	6-12	320	269	289	309	290
R2	0-6	510	433	567	405	452
	6-12	346	318	327	251	261
R3	0-6	610	692	733	639	668
	6-12	411	318	338	408	436
R4	0-6	665	654	580	579	582
	6-12	357	383	302	337	378
R5	0-6	743	604	587	569	654
	6-12	405	274	338	274	365
R6	0-6	572	532	595	524	559
	6-12	320	333	357	406	393

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 68. Concentration of magnesium in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 1 day after poultry litter was removed from the site.

		Concentration of Magnesium in Soil		
Trmt[†]	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Mg/kg ----------		
No Cover	0-6	101	91	71
	6-12	74	52	70
Poly Cover	0-6	77	102	83
	6-12	94	63	71
Bentonite	0-6	84	86	86
	6-12	33	46	38
Spray-on 1	0-6	74	84	149
	6-12	49	57	76
Spray-on 2	0-6	81	75	97
	6-12	95	73	55
Sawdust	0-6	77	82	87
	6-12	71	53	44
Poultry	0-6	85	187	156
Guard	6-12	51	52	101

Table 69. Concentration of magnesium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Magnesium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mg/kg ----------			
No Cover	0-6	75	89	80	90	88
	6-12	52	101	100	61	59
Poly Cover	0-6	79	62	75	71	84
	6-12	47	64	61	51	41
Soil Tac (R1)	0-6	74	94	75	76	150
	6-12	42	47	48	61	53
Soil Tac (R2)	0-6	88	75	68	94	132
	6-12	28	42	48	43	46

Table 70. Concentration of magnesium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Magnesium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mg/kg ----------			
No Cover	0-6	79	84	92	75	111
	6-12	67	88	93	58	58
Poly Cover	0-6	77	88	84	83	86
	6-12	68	66	58	65	57
Soil Tac (R1)	0-6	81	80	87	105	61
	6-12	66	65	58	58	42
Soil Tac (R2)	0-6	96	91	63	69	75
	6-12	56	36	40	51	79

Table 71. Concentration of magnesium in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Magnesium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Mg/kg ----------				
No Cover	0-6	80	153	81	60	65
	6-12	59	136	57	45	57
Illinois Cover	0-6	69	61	61	77	119
	6-12	46	50	52	30	42
Soil Tac	0-6	45	50	55	75	108
	6-12	41	44	39	38	58
Sawdust	0-6	67	86	99	113	177
	6-12	49	64	72	51	76

Table 72. Concentration of magnesium in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Magnesium in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Mg/kg ----------				
Site KM	0-6	82	78	79	84	107
	6-12	65	71	71	229	59
Site WI	0-6	92	88	102	121	131
	6-12	50	72	71	61	73
Site KW	0-6	74	51	57	88	92
	6-12	54	32	31	39	42

Table 73. Concentration of magnesium in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Magnesium in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Mg/kg ----------		
R1	0-6	62	53	52
	6-12	35	38	29
R2	0-6	54	88	87
	6-12	42	65	69
R3	0-6	48	66	50
	6-12	38	63	53
R4	0-6	57	55	45
	6-12	45	29	36
R5	0-6	48	52	34
	6-12	29	22	24
R6	0-6	51	67	40
	6-12	32	33	29

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 74. Concentration of magnesium in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Magnesium in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mg/kg ----------			
R1	0-6	46	54	39	58	55
	6-12	33	30	35	38	45
R2	0-6	53	50	78	44	46
	6-12	37	28	32	25	28
R3	0-6	69	100	117	85	79
	6-12	58	35	42	48	51
R4	0-6	77	82	91	64	59
	6-12	47	50	39	47	73
R5	0-6	85	73	75	56	68
	6-12	48	34	28	26	43
R6	0-6	68	55	115	108	63
	6-12	46	57	79	81	74

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 75. Concentration of copper in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 1 day after poultry litter was removed from the site.

		Concentration of Copper in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg Cu/kg ----------		
No Cover	0-6	9	12	8
	6-12	4	8	4
Poly Cover	0-6	8	7	8
	6-12	5	4	4
Bentonite	0-6	6	13	8
	6-12	4	9	4
Spray-on 1	0-6	8	13	9
	6-12	5	7	3
Spray-on 2	0-6	7	11	10
	6-12	3	8	3
Sawdust	0-6	11	16	10
	6-12	5	7	3
Poultry	0-6	12	17	9
Guard	6-12	6	5	3

Table 76. Concentration of copper in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Copper in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Cu/kg ----------				
No Cover	0-6	5	5	5	5	5
	6-12	2	2	2	2	2
Poly Cover	0-6	5	4	4	4	4
	6-12	1	1	2	1	2
Soil Tac (R1)	0-6	5	5	5	7	6
	6-12	2	2	1	2	2
Soil Tac (R2)	0-6	5	4	4	6	6
	6-12	2	2	2	2	2

Table 77. Concentration of copper in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Copper in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Cu/kg ----------				
No Cover	0-6	8	10	13	14	13
	6-12	4	5	3	3	4
Poly Cover	0-6	10	10	10	11	11
	6-12	3	3	3	3	4
Soil Tac (R1)	0-6	10	10	13	10	8
	6-12	4	3	3	3	3
Soil Tac (R2)	0-6	11	9	13	17	10
	6-12	4	4	5	6	7

Table 78. Concentration of copper in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Copper in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Cu/kg ----------				
No Cover	0-6	5	8	4	11	6
	6-12	4	7	3	6	3
Illinois Cover	0-6	4	10	6	6	7
	6-12	4	6	5	4	3
Soil Tac	0-6	4	10	6	7	8
	6-12	4	6	6	5	4
Sawdust	0-6	5	13	10	9	9
	6-12	3	10	6	6	6

Table 79. Concentration of copper in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Copper in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches	--------- mg M3-Cu/kg ----------				
Site KM	0-6	10	11	11	15	13
	6-12	5	4	4	3	5
Site WI	0-6	7	10	11	9	10
	6-12	3	6	7	8	6
Site KW	0-6	14	12	10	11	15
	6-12	5	4	3	6	4

Table 80. Concentration of copper in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Copper in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	---------- mg M3-Cu/kg ----------		
R1	0-6	4	3	3
	6-12	1	1	1
R2	0-6	3	5	4
	6-12	1	1	1
R3	0-6	3	6	3
	6-12	1	2	1
R4	0-6	4	5	3
	6-12	2	3	1
R5	0-6	3	4	3
	6-12	1	3	1
R6	0-6	4	5	3
	6-12	1	2	1

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 81. Concentration of copper in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Copper in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Cu/kg ----------			
R1	0-6	8	8	11	8	8
	6-12	4	5	5	5	3
R2	0-6	8	7	9	5	8
	6-12	5	5	10	7	3
R3	0-6	9	11	17	11	11
	6-12	5	6	11	7	4
R4	0-6	11	11	12	9	13
	6-12	4	4	6	3	2
R5	0-6	11	12	11	9	11
	6-12	5	4	13	9	6
R6	0-6	10	10	10	7	10
	6-12	4	4	3	3	2

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 82. Concentration of manganese in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 1 day after poultry litter was removed from the site.

		Concentration of Manganese in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Mn/kg ----------		
No Cover	0-6	20	28	27
	6-12	12	16	15
Poly Cover	0-6	17	25	30
	6-12	17	15	15
Bentonite	0-6	16	27	29
	6-12	17	16	14
Spray-on 1	0-6	22	32	29
	6-12	17	12	13
Spray-on 2	0-6	20	33	30
	6-12	11	10	11
Sawdust	0-6	28	28	27
	6-12	17	9	8
Poultry	0-6	32	28	27
Guard	6-12	16	9	11

Table 83. Concentration of manganese in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Manganese in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mn/kg ----------			
No Cover	0-6	14	18	18	22	21
	6-12	8	6	7	10	6
Poly Cover	0-6	15	13	16	18	21
	6-12	7	5	9	6	9
Soil Tac (R1)	0-6	17	21	20	24	29
	6-12	9	7	7	11	13
Soil Tac (R2)	0-6	21	22	21	25	32
	6-12	7	8	8	8	11

Table 84. Concentration of manganese in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Manganese in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mn/kg ----------			
No Cover	0-6	28	34	35	37	39
	6-12	12	16	9	12	12
Poly Cover	0-6	30	32	33	36	34
	6-12	7	10	9	8	14
Soil Tac (R1)	0-6	27	27	32	31	26
	6-12	11	10	11	8	12
Soil Tac (R2)	0-6	35	25	28	29	28
	6-12	10	10	15	14	20

Table 85. Concentration of manganese in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Manganese in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mn/kg ----------			
No Cover	0-6	23	27	19	30	30
	6-12	15	24	9	15	21
Illinois Cover	0-6	21	28	23	26	30
	6-12	13	15	17	16	17
Soil Tac	0-6	15	23	21	25	36
	6-12	13	16	18	20	20
Sawdust	0-6	20	32	34	30	38
	6-12	12	22	20	20	26

Table 86. Concentration of manganese in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Manganese in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mn/kg ----------			
Site KM	0-6	32	31	31	28	37
	6-12	16	16	10	21	16
Site WI	0-6	18	27	31	29	33
	6-12	13	20	20	25	27
Site KW	0-6	23	18	15	22	22
	6-12	12	8	9	9	6

Table 87. Concentration of manganese in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Manganese in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Mn/kg ----------		
R1	0-6	14	11	18
	6-12	6	5	7
R2	0-6	12	16	30
	6-12	6	5	9
R3	0-6	12	20	26
	6-12	7	8	9
R4	0-6	16	19	26
	6-12	9	9	11
R5	0-6	16	20	21
	6-12	8	10	7
R6	0-6	17	20	23
	6-12	8	10	6

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 88. Concentration of manganese in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Manganese in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Mn/kg ----------			
R1	0-6	21	27	24	24	31
	6-12	17	16	15	14	8
R2	0-6	24	21	30	21	20
	6-12	17	15	21	13	16
R3	0-6	25	38	31	32	41
	6-12	20	19	23	20	20
R4	0-6	35	31	27	29	33
	6-12	18	19	18	12	7
R5	0-6	31	29	30	26	35
	6-12	17	14	20	12	16
R6	0-6	18	25	24	22	28
	6-12	16	19	13	11	7

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.

Table 89. Concentration of zinc in the soil after poultry litter was piled for 150 days in 2006 at Site CB; soil samples were taken 1 day after poultry litter was removed from the site.

		Concentration of Zinc in Soil		
Trmt	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Zn/kg ----------		
No Cover	0-6	12	19	11
	6-12	4	7	5
Poly Cover	0-6	10	12	12
	6-12	5	6	5
Bentonite	0-6	8	17	13
	6-12	4	6	4
Spray-on 1	0-6	12	22	11
	6-12	5	4	3
Spray-on 2	0-6	9	23	16
	6-12	3	5	3
Sawdust	0-6	14	24	13
	6-12	3	4	3
Poultry	0-6	14	23	14
Guard	6-12	5	4	4

Table 90. Concentration of zinc in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site GT.

		Concentration of Zinc in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Zn/kg ----------			
No Cover	0-6	8	6	6	7	6
	6-12	4	2	2	2	1
Poly Cover	0-6	6	3	5	5	6
	6-12	2	1	1	1	2
Soil Tac (R1)	0-6	6	7	6	7	11
	6-12	2	2	1	2	3
Soil Tac (R2)	0-6	7	5	5	8	11
	6-12	2	2	1	1	2

Table 91. Concentration of zinc in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site HM.

		Concentration of Zinc in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Zn/kg ----------			
No Cover	0-6	13	15	17	20	16
	6-12	4	5	3	4	3
Poly Cover	0-6	15	16	15	17	15
	6-12	3	3	3	2	5
Soil Tac (R1)	0-6	16	15	17	17	9
	6-12	4	3	4	3	3
Soil Tac (R2)	0-6	19	13	14	18	13
	6-12	3	4	4	6	6

Table 92. Concentration of zinc in the soil after poultry litter was piled for 150 days in 2007 on a Delaware farm; soil samples were taken 1 day after poultry litter was removed from Site LS.

		Concentration of Zinc in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Zn/kg ----------			
No Cover	0-6	11	17	10	17	10
	6-12	6	14	4	6	4
Illinois Cover	0-6	10	27	12	13	15
	6-12	7	12	8	5	4
Soil Tac	0-6	7	20	12	15	16
	6-12	7	9	10	7	6
Sawdust	0-6	10	32	25	21	19
	6-12	4	20	12	10	9

Table 93. Concentration of zinc in the soil after poultry litter was piled for 150 days in 2007 on three Delaware farms; soil samples were taken 1 day after poultry litter was removed from each site (sites had no treatments).

		Concentration of Zinc in Soil				
Trmt	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Zn/kg ----------			
Site KM	0-6	16	17	15	18	18
	6-12	5	6	4	2	4
Site WI	0-6	11	14	15	13	12
	6-12	3	8	10	13	8
Site KW	0-6	28	18	13	20	21
	6-12	9	5	4	6	4

Table 94. Concentration of zinc in the soil after poultry litter was piled for 15 to 180 days in 2006 at Site TR1; soil samples were taken the same day poultry litter was removed.

		Concentration of Zinc in Soil		
Trmt†	**Depth**	**30 ft out**	**edge**	**under**
	inches	--------- mg M3-Zn/kg ----------		
R1	0-6	7	4	5
	6-12	1	1	1
R2	0-6	5	7	6
	6-12	1	1	1
R3	0-6	6	8	5
	6-12	2	1	1
R4	0-6	7	7	5
	6-12	2	2	1
R5	0-6	6	8	5
	6-12	2	3	1
R6	0-6	7	9	5
	6-12	2	2	1

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=16 days, R2=31 days, R3=43 days, R4=93 days, R5=139 days, and R6=185 days.

Table 95. Concentration of zinc in the soil after poultry litter was piled for 15 to 180 days in 2007 at Site TR2; soil samples were taken the same day poultry litter was removed.

		Concentration of Zinc in Soil				
Trmt†	**Depth**	**20 ft out**	**2 ft out**	**edge**	**2 ft in**	**under**
	inches		--------- mg M3-Zn/kg ----------			
R1	0-6	14	15	13	16	15
	6-12	8	7	8	8	4
R2	0-6	14	13	18	15	14
	6-12	8	9	11	7	6
R3	0-6	17	23	29	19	20
	6-12	9	8	11	9	8
R4	0-6	20	20	20	16	22
	6-12	9	7	8	5	2
R5	0-6	22	20	19	18	19
	6-12	11	7	15	10	9
R6	0-6	18	18	22	16	19
	6-12	7	8	7	6	4

† Number of days between formation of the poultry litter pile and removal of the pile:

R1=35 days, R2=48 days, R3=118 days, R4=141 days, R5=159 days, and R6=195 days.