Appendix F. Diflubenzuron Exposure through Use on Fly Breeding Areas in Livestock Operations.

This appendix describes the ecological exposure to diflubenzuron for fly control at livestock operations and estimates aquatic exposure from this use. This is a non-standard exposure scenario and requires more explanation and justification than would typically be presented in the main body of the CRLF risk assessment document.

There are several very different methods that use diflubenzuron to control fly larvae in manure and other fly-breeding sites around livestock facilities. First, the diflubenzuron can be administered to the livestock through food. In this way the diflubenzuron is incorporated into the livestock manure as the livestock defecate. Similarly a second method uses a “bolus gun” to directly place a time release formulation (bolus) into the digestive system of the livestock so that diflubenzuron will again be directly incorporated into the manure as the bolus is digested. EFED has little information available concerning the concentration in the manure produced and, therefore, limited ability to assess these uses.

A third method is a direct spray on manure (produced by un-treated livestock) and other fly-breeding areas. Because EFED has sufficient information to assess this method of diflubenzuron application for this use, the direct spray application is used to assess all of the previously described methods of application for this use. If the direct spray method of application results in lower EECs than either of the other methods, the risk posed to the CRLF may be underestimated.

Exposure Assessment

EFED does not have standardized scenarios for assessing this type of use, therefore, several assumptions were made for this assessment[1]. Most important was the assumption that diflubenzuron’s degradation behavior in manure is similar to degradation behavior in soil. For example, the environmental fate data indicates that diflubenzuron will be relatively persistent in soil. Therefore, diflubenzuron is assumed to be equally persistent in manure. Similarly because diflubenzuron tends to adsorb to soils (and therefore probably manure), it may contaminate surface water through erosion and to a lesser extent dissolved in runoff.

According to the label for the direct spray method the direct spray is applied to manure, stale/wasted feed, feed muck/spoilage, manure/straw mixtures, spoiled organic refuse, and moisture collecting areas. Applications would begin when flies first appear. Repeat treatments would be made as needed when adult fly numbers begin to increase, typically at 3-4 week intervals. Assuming the minimum proposed 21-day reapplication interval (3 weeks) in an area where flies are a year-round problem, up to 17 applications per year could be made. As part of the ecological exposure assessment for this use, aquatic and terrestrial exposures are estimated from both the application to livestock operations and through application of the livestock manure containing residual diflubenzuron to agricultural fields.

The amount of diflubenzuron applied through this use, however, is difficult to quantify because the proposed application method does not appear to allow for well-quantified applications. The label indicates a rate of 5 fl. ozs./10 gals with 1 qt. of spray solution as a spot treatment for 10 ft^2

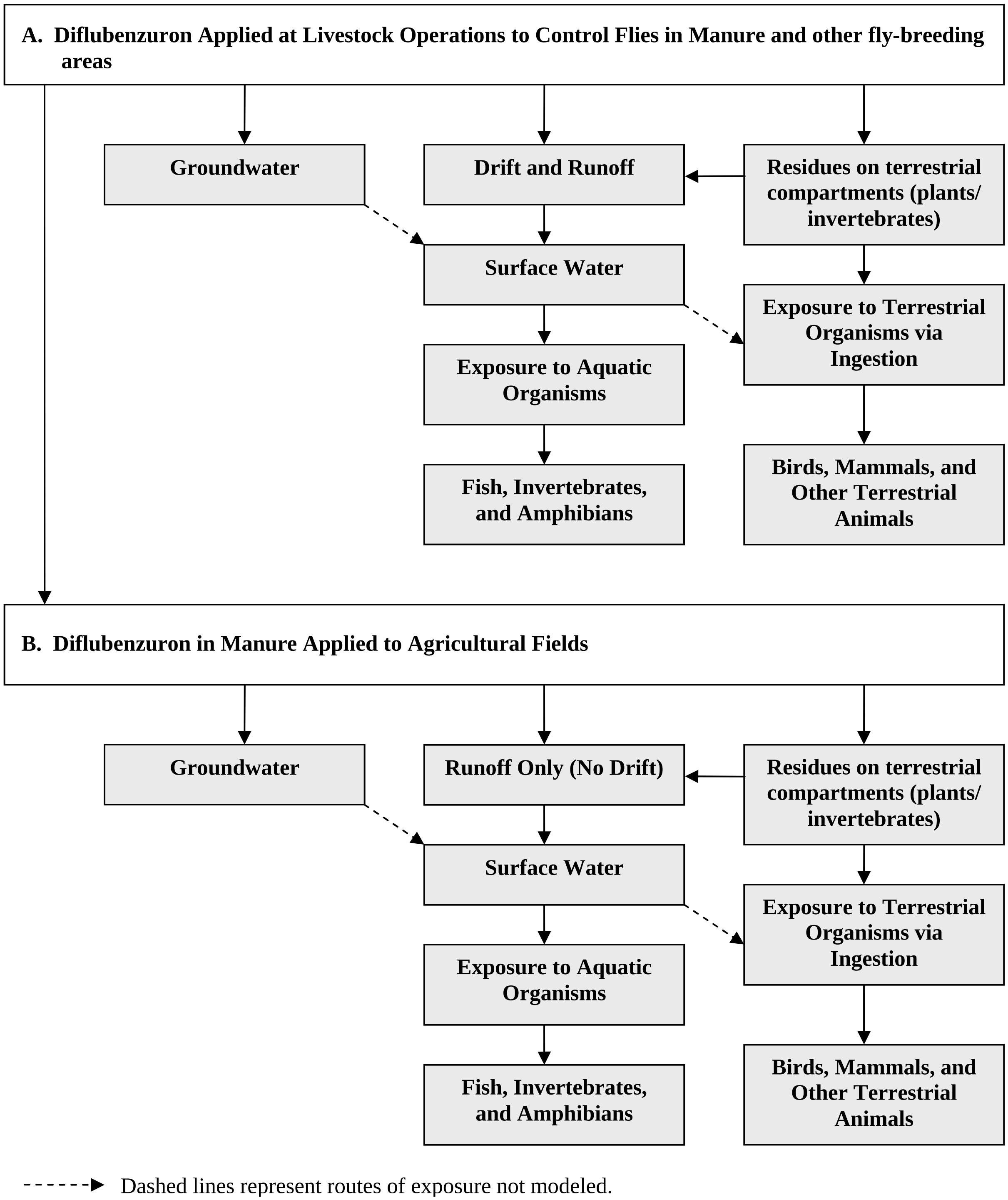
[1] For consistency purposes, this assessment follows the assessment procedures used to assess a similar use for an insecticide, cyromazine, with a similar mode of action (Wolf 2006; DP317886).

of fly breeding areas (8.508 lbs. ai/A) and a reapplication interval of 21 days. However, the extent of use within an area (the proportion of area treated) is unknown. For example, the original area treated would consist of pens and “feeder-waterer” facilities that would have a definite area, but whether 10% or 90% of those areas are treated would likely vary from one livestock operation to another.

Furthermore the diflubenzuron concentration in the manure collected from treated facilities and spread on agricultural fields will also vary with the amount of manure produced between each diflubenzuron treatment. Therefore, operations with less manure produced per unit of surface area treated will produce manure with relatively high diflubenzuron concentrations, while operations with more manure produced per unit of surface area treated will produce manure with relatively lower diflubenzuron concentrations.

Conceptual Model

This assessment addresses potential risks from use of diflubenzuron to control flies when applied to manure and other fly-breeding sites in livestock facilities as well as potential risk resulting from this treated manure being applied to fields as a soil amendment. Movement offsite to adjacent water bodies is expected to occur via runoff and to a much lesser extent drift from manure spray operations (Appendix Figure F1a). Exposure to terrestrial animals is expected through application to seeds and invertebrates in treated manure and to other plants inadvertently treated when manure and other fly-breeding areas are treated.



Appendix Figure F1. Anticipated exposure to diflubenzuron from livestock operations (a) and from application of diflubenzuron treated manure to agricultural fields (b).

Aquatic exposure through runoff, but not drift, is also expected from spreading of manure across agricultural fields as a solid soil amendment (Appendix Figure F1b). Terrestrial exposure is also expected when manure containing seeds and invertebrates with diflubenzuron residues is spread onto fields.

Measures of Exposure

Magnitude of residues in or on selected potential dietary sources for mammals and birds (*e.g.*, vegetation, insects) that could be ingested by these organisms will be estimated using the conceptual approach given in the Tier 1 model TREX (v 1.2.3, 2005). Risks to aquatic species will be based on diflubenzuron EECs in surface water calculated using GENEEC.

Use Characterization

A copy of the relevant language from the Dimilin 2L label is provided in Appendix Figure F2. Assuming diflubenzuron is applied to the entire treatment area (all area within the pens and feeder-waterer facilities in livestock operations), the suggested application rate converts to 8.508 lbs. ai/A:

$$\frac{5\text{ fl. ozs./10 gals.} \times 1\text{ qt./10 ft}^2 \times 43{,}560\text{ ft}^2\text{ / A} \times 2\text{ lbs ai/gal.}}{128\text{ ozs./gal.} \times 4\text{ qt./gal.}} = 8.508\text{ lbs. ai/A or } 9.529\text{ kg ai/ha}$$

Using 3 weeks (21 days) as the retreatment interval and assuming that flies are a year-round problem results in the potential for diflubenzuron to be applied 17 times during a year.

<table>
<tr><th>Target Sites</th><th>Pests</th><th>Application Rate</th><th>Application Timing</th></tr>
<tr><td rowspan="2">Fly Breeding areas in livestock operations include:
• Manure
• Stale/wasted feed
• Feed muck/spoilage
• Manure/straw mixtures
• Spoiled organic refuse
• Moisture collecting areas</td><td>House fly
Stable fly
Face fly
Horn fly</td><td>5 fl. ozs./
10 gals. Water</td><td>Apply as a directed spray in spot treatments at a volume of 1 quart of spray solution to 10 sq. ft. of surface area. 100 gallons of spray solution will treat 4000 sq. ft. Begin applications when flies first appear. Repeat applications should be made as needed when adult fly numbers begin to increase, typically at 3-4 week intervals.

Dimilin 2L will not control fly adults or pupae, but does provide extended control of the developing larvae. If a large adult fly population already exists, application of a knock down insecticide may be desirable to achieve rapid reduction of the adult population.</td></tr>
<tr><td colspan="3">Livestock operations include feedlots, dairies, farms, barns, farm buildings, and equine facilities. Application sites within these operations include wall footings, fence lines of holding pens, areas where moisture collects surrounding feed and water troughs, feed bunks, hay bale feeders, and marginal areas of waste treatment ponds. For optimal control around hay feeding sites, be sure to treat the entire area where manure and waste hay are mixed at the soil surface by livestock activity.</td></tr>
</table>

Appendix Figure F2. Section of Dimilin 2L label pertaining to fly control in livestock operations.

Nationally, the potential for diflubenzuron use on livestock operations is summarized in Appendix Table F1 using the number and size of farms with confined systems for beef cattle and pig (swine) production as an indication of potential number of use sites and magnitude of use at those sites.

Appendix Table F1. National figures for farms, animal units, and land base by confined livestock facility size class.[1]

Animal Type	Farm Size[2]				
	Very Small (<50 AU) Number (%)[3]	**Small (50 -299 AU) Number (%)**	**Medium (300 -999 AU) Number (%)**	**Large (>1,000 AU) Number (%)**	**Total Number**
Beef Cattle					
Farms	37,975 (81)	7,082 (15)	1,226 (3)	871 (2)	47,154
AU[4] (1,000)	487 (5)	734 (8)	635 (7)	7463 (80)	9,318
Land base (1,000 acres)	16,627 (66)	6,295 (25)	1,483 (6)	938 (4)	25,343
Swine (Pig)					
Farms	35,646 (56)	22,932 (36)	4,134 (6)	1,011 (2)	63,723
AU (1,000)	612 (7)	2,656 (32)	2,113 (26)	2,852 (35)	8,233
Land base (1,000 acres)	11,696 (43)	12,118 (45)	2,525 (9)	566 (2)	26,905

[1] From Gollehon et al, 2001.
[2] Size classes are based on the total numbers of animals on the farm. Data are for confined operations only.
[3] Percent total farms, no percent over all animal types.
[4] One AU = 1 animal unit = 1,000 lbs. live animal weight.

Wilson and Wall (2003) reported in a Technical Memorandum prepared for the Minnesota Pollution Control Agency that out of 29,122 feedlots (beef, dairy, and swine), 14,367 indicated that they had an open lot and 3,181 indicated that they had no open lots. Another 11,574 feedlots responded with a question mark. With additional information, Wilson and Wall (2003) estimated that 22,387 feedlots have open lots. Although this is only for Minnesota, the EPA assumes that many of the livestock production areas in other states also have a significant percentage of open lots.

Estimated Diflubenzuron Concentrations in Manure from Confined Cattle and Pig Production

The proposed diflubenzuron use controls flies associated with confined or partially confined livestock production systems ("livestock" is assumed to mean cattle and pigs but no poultry). The confined livestock production system descriptions in this section were obtained from a variety of sources to provide a conceptual understanding of these production practices (*e.g.*, size and number of animals and pens). Considerable local variation would be expected. The basic housing concepts are universal, and the descriptions which follow serve to illustrate the significance of the production system to fly control. This section is concerned with the control of the fly species listed on the label (house, stable, face, and horn flies) in and around confined-animal facilities. Those flies which are primarily pests of cattle on pastures and rangeland are not included.

This assessment also considers the removal and application of diflubenzuron treated manure to agricultural fields as a soil amendment. Often the manure also includes straw or hay that has been provided as a bedding material for the animals. Only manure is considered in this assessment.

Pig Production

Pig production may be classified as: 1) sow-herd which includes feeder pig production and farrow to finish and 2) feeder pig finishing. In either case, housing facilities (*e.g.*, hoop houses) vary from simple to specialized, high-density confinement. The simplest is a pasture system usually operating to yield only two litters per year from one group of sows in a farrow to finish system. Feeders and waterers are provided and fly breeding may occur around them. This type of production is rapidly disappearing. Whole herd and year-around continuous pig production in confined, high-density, controlled environment systems are becoming the most common production system [http://www.flycontrol.novartis.com/systems/en/index.shtml].

Most pig production occurs in either low-intensity or high-intensity confinement systems. Low intensity involves the use of simple buildings (sometimes converted from other uses) with concrete floors (with or without bedding) and partially open fronts. There may also be an outside run or pen area for feeding and watering.

In a sow-herd system, a separate building or partitioned portions of a building are used for gestation and breeding, farrowing, nursery, and growing-finishing. Growing-finishing is either to feeder pig selling weight (40-62 lbs.) or to market weight (about 220 lbs.). Buildings are either totally or partially enclosed and may be equipped with fans and heaters. In mild climates, partial curtain sides may be used. Feeders and waterers are automatic. The trend in pig production is towards totally enclosed, environmentally-controlled facilities. These allow the greatest production efficiency during all seasons of the year.

Pig Manure Management

Manure removal and management with modern pig production facilities is accomplished with various arrangements of slotted floors made of wire mesh, concrete slats, or expanded metal. The floor may be totally or partially slotted. In the partial slotted arrangement, the pens are about one-half concrete floor and one-half slotted. Feeders and waterers are usually in the solid floor area, which slopes toward the slotted portion.

The manure falls through and is flushed through the slotted floor to a concrete pit area beneath. However, the supports along the margins of the slotted floor have no openings, and provide an area for manure accumulation and fly breeding. The concrete pit is relatively shallow if it is frequently flushed to an outside holding pond.

An alternative is to use a deep pit beneath the slotted floor, to allow long-term storage of the manure slurry. Periodically, the slurry is pumped out or allowed to flow by gravity, either to a lagoon or into a spreader for distribution on cropland. The manure pit needs to be well ventilated (usually plenum and fans) to reduce odors and prevent the accumulation of gases which are detrimental to the swine and corrode equipment.

The trend to larger pig production units and the use of specialized high-density confinement facilities has increased the problem of manure management and fly control. Pockets of manure may accumulate along the edges of pens and may not be forced through the slotted floors. Flushing out the manure beneath the slotted floor requires large volumes of water and may not result in complete removal of the manure. If there is insufficient water in the deep pit, crusts and piles of partially dry manure may develop, which can allow fly breeding.

Flushing manure into an anaerobic lagoon is a common method which is also used for dairy manure disposal. If the lagoon is too small, islands of solids will accumulate and provide a habitat for fly breeding.

In mild climates, partially slotted floors and manure flushing systems are also used in less sophisticated partially open-front buildings with curtain sides. In simpler open-front buildings with outside pens, floors and pens are solid, and manure is either flushed out with hoses, or removed with scrapers. In both of these housing systems there are many areas along the pen walls, beneath railings and fences, and in corners where manure can accumulate and provide a habitat for fly breeding.

A typical swine farm in the U.S. consists of a number of houses (2 to 10). Waste storage and treatment consists of an anaerobic lagoon and a spray field. Pig houses are flanked by feeding bins. Most farms are feeder-to-finish or farrow-to-finish. Pigs come in weighing between 22 and 44 lbs and are kept for about 180 days until they reach about 250 lbs. (USEPA, 2002). Estimates of manure production for swine (pigs and hogs) are presented in Appendix Table F2.

Appendix Table F2. Manure production estimates for pigs.

Animal Type	Weight/day (lb/d)	Vol/day (ft^3/d)	Dry Weight (lb/d)	Source
Swine (400 lb/sow, 40-220 lb/grower)				Risse and Cheadle, 1996
Sow (lactating) Sow (gestating)	60.0 27.2	0.96 0.44	6.0 2.5	Risse and Cheadle, 1996
Grower	63.4	1.00	6.3	Risse and Cheadle, 1996
Boar	20.5	0.33	1.9	Risse and Cheadle, 1996
Farrow (per S&L cap.) Nursery (per pig cap.) Finishing (per pig cap.) Gestating (per sow cap.)	13.15 1.50 5.75 5.80	0.21 0.02 0.09 0.09		http://www.ces.purdue.edu/pork/manure/mannut.htm. A. Sutton and D. Jones Last Updated on 6/19/97
Nursery (25 lbs.) Grow-Finish (150 lbs.) Gestating (275 lbs.) Lactating (375 lbs.) Boar (350 lbs.)	2.7 9.5 7.5 22.5 7.2	0.04 0.15 0.12 0.36 0.12	0.27 1.0 0.69 2.25 0.66	Fulhage et al. 2002 Lorimor et al. 2000 Density = 62 to 63 lb/ft^3 (Percent water = 89 to 91)

These pig houses are approximately 230 ft by 50 ft (11,500 ft^2) (USEPA, 2002). They have 40 to 50 pens with an average size of between 140 and 172 ft^2 which contain 20 to 25 pigs each (Appendix Table F3). The average space per pig is about 6.5 to 8.1 ft^2. The floors are made of concrete and slatted so that waste products fall through into an underlying 1.6 ft deep compartment (lagoon) that is filled with about 1 ft of water.

Appendix Table F3. Pen size and stocking densities for Pigs.

Weight or number of head	Earthen Lot (ft^2)	Paved Lot (ft^2)	Source
Nursery Pig (30 -75) Finishing Pig (75-275) Gestating Sow Boar	75 150 200 200	8 15 20 40	Murphy and Harner, 2006
Hoop structures (pigs) 2.5 groups of pigs/yr; 180 to 200 head	30 x 72 = 2160 ft^2 160 to 170 pigs	13 ft^2/pig	Moulton and Moulton, 1998
		75 to 250 head per shelter 12 - 16 ft^2/pig	Gegner, 2004
House		230 ft × 50 ft = 11,500 ft^2	USEPA, 2002
	40 -50 pens	140 - 170 ft^2	
	20 -25 pigs per pen	6.5 - 8 ft^2	

Beef Cattle Production

Beef cattle operations fall into three basic categories: cow-calf operations, stocker operations, and feedlots. The cow-calf operations put brood cows to pasture, with generally one cow-calf pair to every 3 acres. A cow produces one calf every year. The gestation period is about 285 days, followed by a 60-90 day resting period (USEPA, 2002). Calving is usually in early spring or early fall. Calves are weaned at 7 months and weigh between 450 to 650 pounds. Beef cattle production is based on the cow-calf operation. There are diverse methods used. In some operations, cows and calves are kept on open pasture and rangeland. In others, cows and their calves spend most of their time in a confined area for feeding and shelter, while having limited access to pasture. The latter type of partially-confined operation creates filth fly problems which are discussed in this section [http://www.flycontrol.novartis.com/systems/beef/en/beef.shtml].

Stocker operations are similar to cow-calf operations except that the calves are weaned when they weigh between 450 and 800 pounds. They are confined to pens, typically about 100 head to a pen. The pens are uncovered. The cattle range in weight from 650 to 1500 lbs. Cattle are fed with a bunk feeder. The bunk feeder has a slotted bar structure so only the head can reach the food. The floor is typically earthen. The feedlot pens are cleaned yearly and refreshed with fresh soil.

The categories of cattle in a cow-calf operation are: 1) dry, mature pregnant cow, 2) cows nursing calves, 3) weanling replacement heifers, 4) bred yearling heifers, 5) growing steers and heifers, and 6) herd bulls.

Stalls and areas for feed and water are sites for fly breeding. Feeding is often accomplished with hay racks which may be covered or open. Racks may be fixed on a paved apron or movable. As an alternative to a hay rack, a solid-bottom bunk for hay and silage may be used. Bunks are also needed to feed grain and minerals. Since calves require a different nutrient composition in their diet, they are fed in a facility which excludes the brood cows. Such a facility is called a creep. A creep in the fence line restricts grazing. Movable grain creep feeders (usually on skids) may be used. Although arrangements vary, the creep feeder basically consists of some kind of fenced area or structure with openings of about 1 m by 40 cm wide which allow access only by calves. In the creep feeder, calves have access to high nutrient feeds, including feed grain, molasses, and protein supplements. Spillage from these feeders and wet feed in the feeders can provide prolific fly-breeding areas.

Feedlot Finishing

Calves produced in the cow-calf operation may be kept for various lengths of time according to the need for replacement and market conditions. Calves are fed on pasture and hay, grain and pasture, or corn silage, for long enough to bring them up to 270-380 kg each (about 6 months). This is known as back grounding or growing, after which calves are assembled into reasonably uniform groups and sold to feedlots. Calves may be kept longer (1 year) and sold to feedlots at 320-360 kg each. On feedlots, the cattle are finished, or, brought up to market weight on a diet of silage and protein supplements. Alternatively, finishing may be on grain and pasture. The finishing of cattle on feedlots is a very high-density confined-animal system. Cattle are grouped by type, age, sex, and weight in outdoor pens and provided with feed and water. Many pens are grouped together into a single feedlot operation, and conditions are ideal for fly breeding: large accumulations of manure, ample moisture from urine, rain, and watering devices, and nutrient-rich feed which is often spilled around the feed bunkers.

Major problem areas for fly breeding are spilled feed mixed with manure under the feed bunkers, and runoff areas where water and manure drains into depressions. Pens for housing sick animals have bedding and also provide a habitat for the development of flies, especially house flies and stable flies.

Silage

Cow-calf and feedlot operations usually use silage as part of the animal feed. Silage (chopped corn) is stored in either tower silos (which may be gas tight or stave types), or in horizontal trenches or bunkers. Horizontal storage bunkers may be concrete-lined, but are often just trenches in the ground. The silage is packed and covered with plastic sheeting. The margins of improperly packed and covered silage provide conditions favorable for fly breeding in horizontal storage systems.

Spillage around the base of tower storage facilities likewise provides a habitat for fly breeding. Sometimes the silage is piled above ground without proper compacting and covering to suppress fly breeding.

The use of hay can contribute to fly production. There has been an increased use of large round bales of hay which can be moved by tractor-mounted equipment. The margins of these bales, stored outdoors, provide a suitable habitat for fly breeding after rain, or after the bales have sat on moist ground for a long period of time. The pad of hay which is often left on the ground after moving the bales provides an excellent habitat for fly breeding. To prevent fly breeding, hay bales should be covered and stored on pallets to raise them above the ground.

Beef cow facilities vary in size (Appendix Table F4). Harner and Murphy (1998) report that a working facility will have an aerial extent between 1/8 and 1/2 acre (5445 and 21,780 ft^2). The amount of pen space per animal (stocking density) depends upon climate and whether the lots are paved (50 to 75 ft^2/animal) (Murphy and Harner 2006) or earthen (250 to 500 ft^2/animal). Others report stocking densities to range between 150 to 300 ft^2/animal.

Appendix Table F4. Pen size and stocking densities for Beef cattle.

Weight or number of head	Earthen Lot (ft^2)	Paved Lot (ft^2)	Source
Cow-calf (lbs.) Calf (600) Calf (600 – 1400)	500 250 350	75 50 60	Murphy and Harner, 2006
Beef Cattle	Typical Pen Size (ft2) - 300		Murphy and Harner, 2006
	Approximately 1 acre of land is required per 100 AUs for pen space, alleys, and feed roads		Murphy and Harner, 2006
	1 acre per 100 head	435 ft^2	Harner and Murphy, 1998
(80 to 160 head)		200 -300 ft^2	Harner and Murphy, 1998
	1/8 to 1/2 acre for facilities	5,445 to 21,780 ft^2	Harner and Murphy, 1998
	Pen sizes vary from 50 head to over 300 head	Most pens provide 200 ft^2/animal	http://www.winterfeedyard .com/pens.htm
100 - 2400 head	12 to 170 pens	50 to 300	Iowa Cattlemen Association, 2004
	75 to 150 ft^2/head		Lorimor, 2003
	150 to 300 ft^2/head		Davis, Stanton, Haren 2005

One AU = 1 animal unit = 1,000 lbs. live animal weight.

The Iowa Cattleman's Association (ICA) reports the number of head and pens and stocking density in units of animals/pen. The number of head ranged from less than 2000 to more than 12,000. The number of pens ranged from 12 to 151 (ICA 2004). The stocking density ranged from 40 to 300 animals per pen (ICA 2004).

Estimates of manure production for beef cattle are presented in Appendix Table F5.

Appendix Table F5. Manure production estimates for beef cattle.

Animal Type	Weight/day (lb/d)	Vol/day (ft^3/d)	Dry Weight (lb/d)	Source
Cow (800 lb/cow)	63.0	1.0	7.3	Risse and Cheadle, 1996
Cow 500 lbs 750 lbs 1000 lbs 1250 lbs Cow	30 45 60 75 63	0.51 0.75 1.00 1.26 1.06		Schmitt and Rehm, 2002 Livestock Waste Facilities Handbook, Midwest Plan Service, March 1985
Calf 450 lbs 750 Ibs 1100 1bs Cow 1000 lbs	26 62 92 63	0.42 1.00 1.40 1.00	3.4 5.8 8.5 7.7	Fulhage et al. 2002 Lorimor et al. 2000 (Percent water = 88 to 92)
Cow (avg. 1300 lbs.) confinement = 282 days (1 AU = 1000 lbs.) Cow (avg. 500 lbs.) confinement = 200 days (1 AU = 500 lbs.) [8.5 lbs. manure/day/1000 lbs. AU			9.6 lbs./day 5.6 lbs./day	Jokela et al. 1995

When accumulated manure is removed from livestock facilities, disposal often becomes a problem. Manure is seldom stored in piles, due to odors and fly breeding. Distribution of manure on cropland and pastures in a thin layer will not support fly breeding. However, improper spreading, leaving deep clumps, can result in some fly production in those fields.

Diflubenzuron Exposure from Livestock Operations

Exposure to diflubenzuron through this new use may occur through surface water and terrestrial exposure routes both where it is applied at the livestock operation and again when the diflubenzuron-treated manure is applied to agricultural fields as a soil amendment.

Exposure from the Livestock Operation

The aquatic and terrestrial exposures from the original site of application would depend upon the proportion of the area treated with diflubenzuron. The proposed use pattern indicates that while the entire area could be treated, the actual area treated is probably less than the total area. The highest exposure in accordance with the label (most conservative scenario) is used to asses this exposure route, which would occur if 100% of the area were treated with the maximum rate suggested on the proposed label. The maximum amount of diflubenzuron that can be applied is 5 fl. ozs./10 gals with 1 qt./10 ft^2 (1.95×10^4 lbs. ai/ft^2 or 8.508 lbs ai/acre).

Exposure from Manure-treated Fields

The aquatic and terrestrial exposures from the treated manure spread on agricultural fields are also based on the assumption that 100% of the livestock operation area is treated. However, these exposures are to a mixture of diflubenzuron and manure. Therefore, the amount of manure that accumulates between diflubenzuron applications will "dilute" the concentration of diflubenzuron to which organisms will be potentially exposed. If less manure accumulates between diflubenzuron applications, diflubenzuron concentrations in the manure will be high. Conversely, a greater manure accumulation between diflubenzuron applications will result in lower diflubenzuron concentrations in manure.

The amount of manure produced between applications will be related to the amount of manure produced per animal per day, the number of days between applications, and number of animals within the area treated. Since the label suggests the shortest reapplication period (most conservative scenario) is every 21 days, the number of days between applications is assumed to be at least 21.

A number of sources were consulted to obtain information concerning the size of facilities, number of animals (head), and the amount of manure produced (Appendix Tables F2 through 5). From this information, a range of values were selected over a range of conditions that could be evaluated (Appendix Table F6). The amount of manure (in lbs) was estimated by multiplying the lbs of manure per day per animal times the number of animals (or animals per pen times number of pens) times the number of days (Appendix Tables F2 and 5). The area of facility (ft^2) was obtained from a number of sources (Appendix Tables F3 and 4). The pig and cattle operations typically have pens in addition to the feeder-waterer facilities. The area (ft^2) for the pens was also determined by either obtaining values from literature or by multiplying stocking density (ft^2/animal) times the number of animals.

Appendix Table F6. Representative information of manure production, number and size of stock pens, stocking density, number of head, facility areas, diflubenzuron application and select properties of manure.

Animal	Manure Production (Ibs/day/animal)	Number of Pens (or houses)	Pen Area (ft^2)	Required Area Needed/Animal (ft^2/animal)	Number of Animals	Facilities Area (or houses) (ft^2)	Diflubenzuron Application [lbs ai/ft^2]	Manure Density (1b/ft2)	Manure Water Content (%)	
								wet	wet	At spreading
Pig	11.0	40 50	140 to 170	6.5 8.0	10 to 30	11,500	1.95×10^{-4}	61	91	
Pig	11.0 (2 to 4 eq352)			12 to 16	75 to 250	Hoop house 900 to 4000	1.95×10^{-4}			
Cattle	49	20 120	435 (1 ac per 100 head)	75 300	100 to 300	5445 to 21,780	1.95×10^{-4}	61	88 to 92	32
Cattle	55	20 120		75 300			1.95×10^{-4}	61	88 to 92	32
Cattle	61	20 120		75 300			1.95×10^{-4}	61	88 to 92	32

The amount of diflubenzuron applied to the pens was determined assuming that the entire area was treated (Appendix Table F7). The diflubenzuron concentration in manure in ppm (lb/lb basis) is calculated as:

$$\frac{Mass_{diflubenzuron}}{Mass_{manure}} \times 10^{6} = Concentration_{diflubenzuron} \text{ in ppm}$$

The concentrations presented in Appendix Table F7 are for any number of diflubenzuron applications because manure concentration is a ratio of two numbers that increase approximately proportionally over time. For example at the end of the n^{th} 21-day period, the mass of diflubenzuron in manure will be *n* times the mass of diflubenzuron in the first 21-day period. Similarly, the mass of manure will also be *n* times the mass of manure in the first 21-day period. Therefore, the manure concentration after *n* 21-day time periods will be:

$$\frac{n \times Mass_{diflubenzuron}}{n \times Mass_{manure}} \times 10^{6} = \frac{Mass_{diflubenzuron}}{Mass_{manure}} \times 10^{6} = Concentration_{diflubenzuron} \text{ in ppm}$$

Estimates of diflubenzuron applied to pig facilities indicate (based upon area treated) that approximately equal amounts of diflubenzuron would be applied in the facility area (0.18 to 2.24 lbs) and pen area (0.18 to 1.9 lbs). For cattle facilities, estimates of diflubenzuron applied indicate that the majority of the diflubenzuron would be applied in the pen area (39 to 2106 lbs) compared to the feeder-waterer facility area (4.25 lbs).

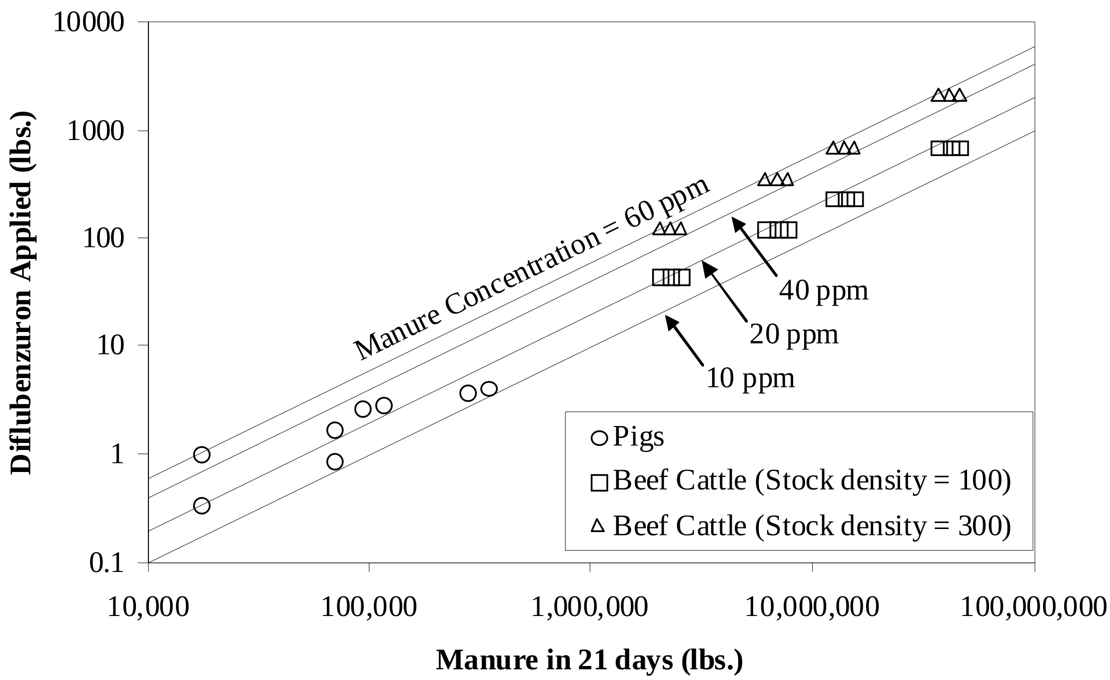
Appendix Table F7. Typical manure production, stock density, number of pens and animals, total manure produced and facility areas and treated facility and pen areas (Pig manure: 11 lbs./day/head; Cattle manure: 49, 55, and 61 lbs./day/animals).

								Facility Area		Pen Area		
Manure Scenario	Manure Produced (lbs./d/#)[a]	Stock-Density (ft^2/#)	# /pen	Num Pens[b]	Total #[c] (animals)	Manure per 21 days[d] (lbs.)	Maximum Appl. Rate[e] (lbs./ft^2)	Facility Area (ft^2)	Difluben-zuron Appl.[f] (lbs.)	Area[g] (ft^2)	Difluben-zuron Appl.[h] (lbs.)	Total Pen & Facility Manure Conc.[i] (ppm)
Pigs												
1	11	6.5	10	40	400	92,400	1.95×10^{-4}	11,500	2.24	2,600	0.51	29.8
2	11	6.5	30	40	1,200	277,200	1.95×10^{-4}	11,500	2.24	7,800	1.52	13.6
3	11	6.5	10	50	500	115,500	1.95×10^{-4}	11,500	2.24	3,250	0.63	24.9
4	11	6.5	30	50	1,500	346,500	1.95×10^{-4}	11,500	2.24	9,750	1.90	12.0
5	11	12	75	1	75	17,325	1.95×10^{-4}	900	0.18	900	0.18	20.3
6	11	12	300	1	300	69,300	1.95×10^{-4}	900	0.18	3,600	0.70	12.7
7	11	16	75	1	75	17,325	1.95×10^{-4}	4,000	0.78	1,200	0.23	58.5
8	11	16	300	1	300	69,300	1.95×10^{-4}	4,000	0.78	4,800	0.94	24.8
Beef Cattle (Stock density = 100)												
9	49	100	100	20	2,000	2,058,000	1.95×10^{-4}	21,780	4.25	200,000	39	21.0
10	49	100	300	20	6,000	6,174,000	1.95×10^{-4}	21,780	4.25	600,000	117	19.6
11	49	100	100	120	12,000	12,348,000	1.95×10^{-4}	21,780	4.25	1,200,000	234	19.3
12	49	100	300	120	36,000	37,044,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	19.1
13	55	100	100	20	2,000	2,310,000	1.95×10^{-4}	21,780	4.25	200,000	39	18.7
14	55	100	300	20	6,000	6,930,000	1.95×10^{-4}	21,780	4.25	600,000	117	17.5
15	55	100	100	120	12,000	13,860,000	1.95×10^{-4}	21,780	4.25	1,200,000	234	17.2
16	55	100	300	120	36,000	41,580,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	17.0
17	61	100	100	20	2,000	2,562,000	1.95×10^{-4}	21,780	4.25	200,000	39	16.9
18	61	100	300	20	6,000	7,686,000	1.95×10^{-4}	21,780	4.25	600,000	117	15.8
19	61	100	100	120	12,000	15,372,000	1.95×10^{-4}	21,780	4.25	1,200,000	234	15.5
20	61	100	300	120	36,000	46,116,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	15.3
Beef Cattle (Stock density = 300)												
21	49	300	100	20	2,000	2,058,000	1.95×10^{-4}	21,780	4.25	600,000	117	58.9
22	49	300	300	20	6,000	6,174,000	1.95×10^{-4}	21,780	4.25	1,800,000	351	57.5
23	49	300	100	120	12,000	12,348,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	57.2
24	49	300	300	120	36,000	37,044,000	1.95×10^{-4}	21,780	4.25	10,800,000	2106	57.0
25	55	300	100	20	2,000	2,310,000	1.95×10^{-4}	21,780	4.25	600,000	117	52.5
26	55	300	300	20	6,000	6,930,000	1.95×10^{-4}	21,780	4.25	1,800,000	351	51.3
27	55	300	100	120	12,000	13,860,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	51.0
28	55	300	300	120	36,000	41,580,000	1.95×10^{-4}	21,780	4.25	10,800,000	2106	50.8
29	61	300	100	20	2,000	2,562,000	1.95×10^{-4}	21,780	4.25	600,000	117	47.3

Manure Scenario	Manure Produced (lbs./d/#)[a]	Stock-Density (ft^2/#)	# /pen	Num Pens[b]	Total #[c] (animals)	Manure per 21 days[d] (lbs.)	Maximum Appl. Rate[e] (lbs./ft^2)	Facility Area: Facility Area (ft^2)	Facility Area: Difluben-zuron Appl.[f] (lbs.)	Pen Area: Area[g] (ft^2)	Pen Area: Difluben-zuron Appl.[h] (lbs.)	Total Pen & Facility Manure Conc.[i] (ppm)
30	61	300	300	20	6,000	7,686,000	1.95×10^{-4}	21,780	4.25	1,800,000	351	46.2
31	61	300	100	120	12,000	15,372,000	1.95×10^{-4}	21,780	4.25	3,600,000	702	45.9
32	61	300	300	120	36,000	46,116,000	1.95×10^{-4}	21,780	4.25	10,800,000	2106	45.8

[a] # is number of animals.
[b] NumPens is the number of pens per facility (house).
[c] Total# is the total number of animals per facility (house).
[d] Total manure (lbs.) produced in 21 days = manure × #/pen × NumPens × 21.
[e] Diflubenzuron in 1bs./ft^2 (single application) = 1.95×10^{-4} lbs./ft^2 $= \dfrac{5 \text{ fl. ozs.}/10 \text{ gals.} \times 1 \text{ qt.}/10 \text{ ft}^2 \times 2 \text{ lbs. ai/gal.}}{128 \text{ ozs./gal.} \times 4 \text{ qt./gal.}}$.
[f] Total diflubenzuron in facilities (lbs.) = diflubenzuron (lbs/ft^2) × Facility Area (ft^2) [treated area] .
[g] Pen area (ft^2) = stock density (ft^2/#) × #/pen (number/pen) × NumPens.
[h] Total diflubenzuron in pens (lbs.) = Diflubenzuron (lbs./ft^2) × Pen area (ft^2).
[i] Diflubenzuron concentration (ppm) in manure = Total Diflubenzuron (lbs.)/Total Manure (lbs.) × 10^6.

Appendix Figure F3 relates diflubenzuron concentrations in manure (read on the diagonal lines) as a function diflubenzuron applied to facilities and pens (y-axis) and manure produced by the animals housed in those facilities and pens (x-axis). The diflubenzuron applied is merely a function of the surface area of the pens and facilities. A greater surface area results in more diflubenzuron applied. The amount of manure produced within those pens and facilities is a function the stocking density (the number of animals per pen) and the amount of manure produced per animal (cattle produce more manure, while pigs produce less). Facility and pen configurations that provide more space relative to the amount of manure produced result in higher manure concentrations, while configurations that provide less space relative to the amount of manure produced result in lower manure concentrations.



Appendix Figure F3. Variation in manure concentration from cattle at 2 stocking densities and pigs based on the manure scenarios presented in Appendix Table 4.

The highest manure concentrations for pig and beef cattle (stock density = 300) were nearly equal (58.5 and 58.9 ppm, respectively), while beef cattle at a lower stock density (100) had much lower maximum concentrations (21 ppm). EFED believes that the 58.9 ppm concentration is a conservative (high) estimate of possible diflubenzuron concentration in manure. Although, higher or lower values may be possible for livestock held under different conditions.

This highest concentration (58.9 ppm) was used to estimate the amount of diflubenzuron present in a variety of manure application scenarios (Appendix Table F8). Both wet and dry manure is considered because manure may be applied in a wet or dry condition. Diflubenzuron concentrations in wet manure (90% water) are calculated as:

$$\frac{58.9\ \text{mg/kg} \times 10\ \text{tons/A} \times 2000\ \text{lbs/ton}}{10^6\ \text{mg/kg}} = 1.18\ \text{lbs/A}$$

Diflubenzuron concentrations in dry manure (35% water) are calculated as:

$$\frac{58.9\ \text{mg/kg} \times 5\ \text{tons/A} \times 2000\ \text{lbs/ton}}{10^6\ \text{mg/kg}} \times (100\% - (90\% - 35\%)) = 1.31\ \text{lbs/A}$$

EFED assumes that a manure application *above* 5 tons/A ("dry" weight) is unrealistic, due to other requirements associated with manure disposal (nitrogen and phosphorus) and difficulties involved with the process of spreading it.

Appendix Table F8. Diflubenzuron concentration per ton of wet and dry manure.

Wet Manure (Assumed to 90% water)		Dry Manure (Assumed to be 35% water)	
Manure (tons/A)	**Diflubenzuron (lbs./A)**	**Manure (tons/A)**	**Diflubenzuron (lbs./A)**
10	1.18	5	1.31
8	0.94	4	1.05
6	0.71	3	0.79
4	0.47	2	0.52
2	0.24	1	0.26

Water Assessment

The tier 1 screening model, GENEEC, was used for surface water exposure assessment. It should be noted that this model was not developed to be used for the application of diflubenzuron to manure or application of manure to agriculture soils as a soil amendment.

Potentially, the scenario used by GENEEC represents a "high-end" set of use conditions (*e.g.*, area treated, number of applications, interval length). There have been no Percent Crop Areas (PCAs) developed for livestock operations. Conservatively, the PCA is assumed to be 100%. The input parameters are given in Appendix Table F9. Because GENEEC was not developed to be used to estimate surface water concentrations from the application of manure to a soil, it is assumed that the binding of the diflubenzuron to the manure is similar to that of soil as represented by the soil Koc. However, assuming that 100 percent of the facility area is treated is likely a conservative (high) estimate.

Appendix Table F9. Input parameters for GENEEC modeling for diflubenzuron.

Parameter	Selected Values	Source
Application Rate(maximum)	8.508 lbs ai/A	EPA reg. No400-461
Interval between applications	21 days	EPA reg. No400-461
Type of Application and number of applications	Ground Spray Application with a maximum number of 17 applications per year	EPA reg. No400-461
K_{oc}	4609	MRID 00157842, 00039476, 00039477, 00040777, 46895401, 46888705, and 46888704
Solubility in H_2O	0.2 ppm	Product Chemistry
Molecular Weight	311	Product Chemistry
Henry's Constant	1.87×10^{-9} atm-m^3 mole^{-1}	Product Chemistry
Vapor Pressure	9.00×10^{-10}	Product Chemistry
Neutral Hydrolysis $t_{1/2}$	119 days	MRID 40859801 and 41087801
Aerobic Soil Metabolism $t_{1/2}$	4.7 days[1]	MRID 41722801 Combined Data Mean=3.44 days Std. Dev. = 1.92 days n=5 $t_{90, n-1}$ =1.476
Aqueous Photolysis $t_{1/2}$	80 days at pH 7-9	MRID 40816301 and 41087802
Aerobic Aquatic Metabolism $t_{1/2}$	23.4 days[1]	MRID 44895001 Combined Data Mean=11.70 days Std. Dev. = 12.41 days n=3 $t_{90, n-1}$ =1.638
Anaerobic Aquatic Metabolism $t_{1/2}$	102 days (34 days x 3)	MRID 448895002

[1] t_{input} = (mean of $t_{1/2}$) + ($t_{90,n-1}$* std. dev.)/$n^{0.5}$

The EFED GENEEC (GENeric Expected Environmental Concentration) model (version 1.2) is used to estimate pesticide concentrations in a 1 hectare by 2 meter deep pond with no outlet draining an adjacent 10 hectare field. It provides an upper-bound screening concentration value for most types of surface water for up to 56 days after runoff. GENEEC is a single runoff event but accounts for spray drift from single or multiple applications. The pond receives a pesticide load from spray drift for each application plus loading from a single-runoff event, in this case, two days after the last application. The runoff event transports a maximum of 10% of the pesticide remaining in the top 2.5 cm of soil. This amount can be reduced through soil adsorption. The amount of pesticide remaining on the field in the top 2.5 cm of soil depends on the application rate, number of applications, interval between applications, incorporation depth, and degradation rate in the soil. Spray drift is assumed to be 0 (insignificant) for this use.

In Appendix Table F9, the output of GENEEC model is presented based on 1, 9, and 17 applications, respectively, of diflubenzuron to the original feedlot site of application. Additionally, the last GENEEC output in this table presents a diflubenzuron-treated manure application to an agricultural field. The peak, 21-day average, and 60-day average EECs based on 17 diflubenzuron applications per year are 54.2, 42.0, and 27.3 µg/L, respectively, in Appendix Table F10. These values differ little from the peak, 21-day average, and 60-day average EECs based on 9 diflubenzuron applications per year are 53.9, 41.8, and 27.1 µg/L, respectively. The estimated diflubenzuron surface water concentrations based on 1.31 lb diflubenzuron/A manure applications to agricultural fields using manure that received a single or multiple applications of diflubenzuron are 7.29, 5.63, and 3.65 µg/L for peak, 21-day average, and 60-day average EECs, respectively.

Appendix Table F10. GENEEC surface water concentration estimates based on 1, 9, and 17 applications of diflubenzuron at the original feedlot site of application and a diflubenzuron-treated manure application to an agricultural field.

One Application at 8.508 lb ai/A to the Original Feedlot Application Site

```
    RUN No.   1 FOR Diflubenzuron    ON   Livestock     * INPUT VALUES *
    --------------------------------------------------------------------
     RATE (#/AC)   No.APPS &   SOIL  SOLUBIL   APPL TYPE NO-SPRAY INCORP
      ONE(MULT)    INTERVAL    Koc   (PPM )    (%DRIFT)   (FT)     (IN)
    --------------------------------------------------------------------
   8.508(  8.508)   1   1    4609.0  200.0   GRLOME(   .8)     .0    .0


    FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
    --------------------------------------------------------------------
    METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
     (FIELD)   RAIN/RUNOFF   (POND)     (POND-EFF)    (POND)     (POND)
    --------------------------------------------------------------------
       4.70        2          N/A     80.00- 9920.00    23.40     23.34


    GENERIC EECs (IN MICROGRAMS/LITER (PPB))     Version 2.0 Aug 1, 2001
    --------------------------------------------------------------------
        PEAK      MAX 4 DAY     MAX 21 DAY    MAX 60 DAY    MAX 90 DAY
        GEEC      AVG GEEC       AVG GEEC      AVG GEEC      AVG GEEC
    --------------------------------------------------------------------
        47.34       45.50         36.58         23.73         18.02
```

9 Applications at 8.508 lb ai/A to the Original Feedlot Application Site

```
   RUN No.   9 FOR Diflubenzuron    ON   Livestock     * INPUT VALUES *
    --------------------------------------------------------------------
     RATE (#/AC)   No.APPS &   SOIL  SOLUBIL   APPL TYPE NO-SPRAY INCORP
      ONE(MULT)    INTERVAL    Koc   (PPM )    (%DRIFT)   (FT)     (IN)
    --------------------------------------------------------------------
   8.508(  8.911)   9  21    4609.0  200.0   GRLOME(   .8)     .0    .0


    FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
    --------------------------------------------------------------------
    METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
     (FIELD)   RAIN/RUNOFF   (POND)     (POND-EFF)    (POND)     (POND)
    --------------------------------------------------------------------
       4.70        2          N/A     80.00- 9920.00    23.40     23.34


    GENERIC EECs (IN MICROGRAMS/LITER (PPB))     Version 2.0 Aug 1, 2001
    --------------------------------------------------------------------
        PEAK      MAX 4 DAY     MAX 21 DAY    MAX 60 DAY    MAX 90 DAY
        GEEC      AVG GEEC       AVG GEEC      AVG GEEC      AVG GEEC
    --------------------------------------------------------------------
        53.90       51.88         41.75         27.11         20.60
```

17 Applications at 8.508 lb ai/A to the Original Feedlot Application Site

```
RUN No.  17 FOR Diflubenzuron    ON   Livestock     * INPUT VALUES *
 --------------------------------------------------------------------
  RATE (#/AC)   No.APPS &   SOIL  SOLUBIL   APPL TYPE NO-SPRAY INCORP
   ONE(MULT)    INTERVAL    Koc   (PPM )    (%DRIFT)   (FT)     (IN)
 --------------------------------------------------------------------
8.508(  8.911)  17  21    4609.0  200.0   GRLOME(   .8)     .0    .0


 FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
 --------------------------------------------------------------------
 METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
  (FIELD)   RAIN/RUNOFF   (POND)     (POND-EFF)    (POND)     (POND)
 --------------------------------------------------------------------
    4.70        2           N/A     80.00- 9920.00    23.40     23.34


 GENERIC EECs (IN MICROGRAMS/LITER (PPB))     Version 2.0 Aug 1, 2001
 --------------------------------------------------------------------
     PEAK      MAX 4 DAY     MAX 21 DAY    MAX 60 DAY    MAX 90 DAY
     GEEC      AVG GEEC       AVG GEEC      AVG GEEC      AVG GEEC
 --------------------------------------------------------------------
     54.18       52.16         41.98         27.25         20.71
```

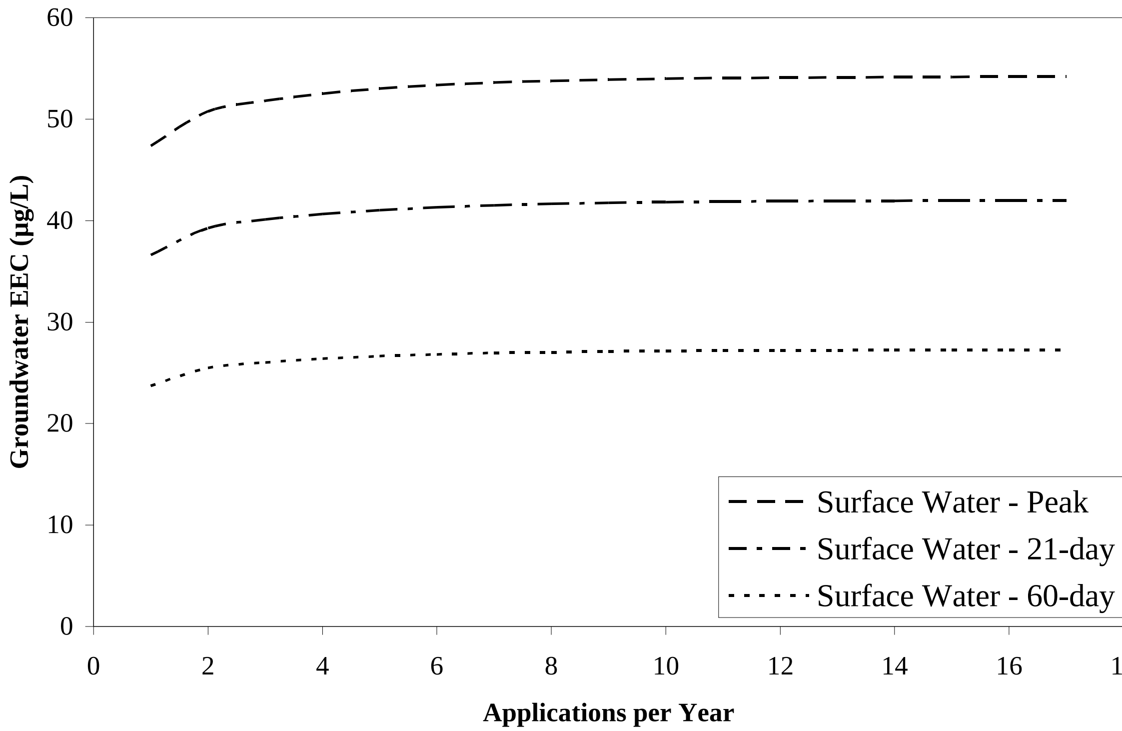
Diflubenzuron-treated Manure Application (1.31 lb ai/A) to Agricultural Field

```
RUN No.   1 FOR Diflubenzuron    ON   Manure        * INPUT VALUES *
 --------------------------------------------------------------------
  RATE (#/AC)   No.APPS &   SOIL  SOLUBIL   APPL TYPE NO-SPRAY INCORP
   ONE(MULT)    INTERVAL    Koc   (PPM )    (%DRIFT)   (FT)     (IN)
 --------------------------------------------------------------------
1.310(  1.310)   1   1    4609.0  200.0   GRLOME(   .8)     .0    .0


 FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
 --------------------------------------------------------------------
 METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
  (FIELD)   RAIN/RUNOFF   (POND)     (POND-EFF)    (POND)     (POND)
 --------------------------------------------------------------------
    4.70        2           N/A     80.00- 9920.00    23.40     23.34


 GENERIC EECs (IN MICROGRAMS/LITER (PPB))     Version 2.0 Aug 1, 2001
 --------------------------------------------------------------------
     PEAK      MAX 4 DAY     MAX 21 DAY    MAX 60 DAY    MAX 90 DAY
     GEEC      AVG GEEC       AVG GEEC      AVG GEEC      AVG GEEC
 --------------------------------------------------------------------
      7.29       7.01          5.63          3.65          2.78
```

In Appendix Figure F4, the GENEEC surface water EECs are shown to be relatively insensitive to the number of applications for more than 3 applications per year. This finding is important because the number of applications assumed should vary greatly with the climate with fewer applications in colder climates (where flies would only be a seasonal problem) and more applications in warmer climates (where flies would be a year-round problem). Because the EECs are relatively insensitive to the number of applications, using EECs based on the maximum number of applications does not represent an overly-conservative estimate of the EECs expected in colder climates. Therefore, the aquatic EECs based on 17 applications per year will be used to calculate risk quotients.



Appendix Figure F4. Variation in GENEEC surface water estimated environmental concentrations (EECs) with 1 to 17 diflubenzuron applications per year.

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