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OFFICE OF
PREVENTION, PESTICIDES AND
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MEMORANDUM

Subject: Drinking Water Exposure Assessment for Acetochlor (121601)

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Attached is our assessment of drinking water exposure to acetochlor. Emphasis in this assessment is placed on acetochlor parent because of its important in the dietary risk assessment; however, data on exposure to acetochlor degradates are also reviewed in this assessment.

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3. ABBREVIATIONS

AC	Acetochlor
Ac_ESA	Acetochlor ethanesulfonic acid
Ac_OXA	Acetochlor oxanilic acid
ARP	Acetochlor Registration Partnership
BEAD/OPP	Biological and Economic Analysis Division of OPP
CDF	Cumulative frequency distribution
CWS	Community water system
EFED/OPP	Environmental Fate and Effects Division of OPP
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act of 1996
GAC	Granular activated carbon treatment
NAWQA	National Water Quality Assessment Program of USGS
NCFAP	National Center for Food and Agricultural Policy (pesticide usage monitoring program)
OPP	Office of Pesticide Programs of USEPA
PAC	Powdered activated carbon treatment
PGW	Prospective ground water study (monitoring program)
SDWS	Surface drinking water supply (monitoring program)
SGW	State ground water (monitoring program)
SWM	Surface water monitoring
TWAM	Time-weighted annualized mean
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WARP	Watershed Regression for Pesticides – USGS Pesticide Concentration Model

4. EXECUTIVE SUMMARY

4.1. Purpose

In March of 1994, USEPA and ARP entered into a conditional registration agreement (USEPA, 1994) for the chemical acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), the active ingredient in a number of herbicides used on corn (*Zea maize*) crops to control annual grasses and certain broadleaf weeds (Hackett et al., 2004). Under the agreement, USEPA required ARP to conduct several acetochlor monitoring programs and specified a number of cancellation or mitigation endpoints aimed at protecting the environment and limiting potential risks to human health (USEPA, 1994). The purpose of this assessment is, therefore, to estimate exposure to acetochlor (in support of a human health dietary risk assessment) and to summarize the status of mitigation / cancellation endpoints encapsulated in the acetochlor conditional registration agreement.

The primary source data for both this exposure assessment and evaluation of the registration agreement compliance are the three major acetochlor data sets generated by the Acetochlor Registration Partnership (ARP). Two data sets are ground water source based and include the "State" Ground Water (SGW) monitoring program and the Prospective Ground Water studies (PGW) and one is surface water source based referred to as Surface Drinking Water Supplies (SDWS) monitoring program. The ARP provided a fourth acetochlor data set that consists of incident investigation of ground water primarily around pesticide dealer and storage facilities. The incident data are only indirectly related to impacts from registered uses of acetochlor therefore these data have not been explicitly included in the direct exposure assessment. When relevant to the exposure assessment, additional publicly available water monitoring data for acetochlor are discussed in this document.

4.2. Acetochlor Usage

Acetochlor is now registered in 42 states as well as the District of Columbia (Hackett et al., 2004). It is also used in corn growing areas of several countries including China, Europe, and Argentina. Presently, roughly 80% of the total use of acetochlor in the United States occurs in the Midwest. Detailed county-level sales maps for acetochlor from 1994 to 2003 are provided in Appendix section 12.3 **Acetochlor Usage – Detailed Summary**. These sales data have been provided separately by members of the acetochlor registration partnership (ARP) as confidential information and cannot be shared with unauthorized individuals.

These sales data are presented as a surrogate for the location of acetochlor usage. It should be noted that pesticide sales data may not be a consistent estimator of usage in any particular watershed because usage may not occur near the location of purchase. The maps of acetochlor sales data and surface water monitoring locations show that the largest fraction of the monitoring sites do not coincide well with the areas of highest sales. It is possible therefore that the drinking water intake locations that were monitored may not represent the sites where highest concentrations occurred.

4.3. Time Weighted Annualized Means and 95th Percentile Calculations

Time-weighted annualized means (TWAMs) were calculated for each site in the three major monitoring programs (SDWS, SGW, and PGW). Two separate weighting methods were implemented using a custom-built TWAM computer program to verify the TWAMs computed by the ARP. The weighting method used by the ARP (described later in this report) was cross-checked with a slightly different method implemented in the WARP beta model developed by the USGS (USGS 2004). Both weighting methods assign a weight to each discrete sample observation based upon the fraction of the time during a year that each sample represents. Weighted concentrations were then summed to provide an annualized mean.

4.4. Mitigation/Cancellation Endpoints

In addition to providing a drinking water exposure assessment for application to a dietary risk assessment for acetochlor, this document also addresses the endpoints or triggers for regulatory action incorporated into the acetochlor registration agreement are provided in Appendix 1 (see USEPA, 1994; for a full copy of the agreement). These endpoints are directly tied to each of the major monitoring programs required of the ARP in the Acetochlor Registration Agreement; the reader may need to refer to the Appendix for a complete understanding of the reasons for the way in which these endpoints are discussed in this document. The triggers varied between monitoring programs, the following is a comparison of the results to the triggers for each program. Discussion of both parent and degradate occurrence and their relation to the triggers is separately provided in this document, however, only parent residues are clearly classified as residues of concern for which the triggers for mitigation measures in the Registration Agreement apply.

4.4.1. ARP Surface Water Monitoring Endpoints

Acetochlor was detected above 8.0 ppb trigger for individual detections in 2 samples in the surface drinking water supply (SDWS) monitoring program. Two finished (treated water) samples were detected above 8.0 ppb, however the twelve month time-weighted annualized mean did not exceed the 2.0 ppb regulatory action trigger for these or any of the other water supply systems included in the SDWS. No raw (untreated) concentrations were detected above 8.0 ppb. For both raw and finished surface drinking water, roughly 99% of the time-weighted annualized means were below 0.5 ppb. Maximum acetochlor instantaneous concentrations, 95th percentiles, and time-weighted annualized means were observed in Illinois.

4.4.2. ARP Ground Water Monitoring Endpoints – PGW Study

For the PGW, the triggers for regulatory action were tied to both soil pore-water (lysimeter) and ground water detections. Acetochlor was detected above 0.1 ppb at only one site in nine foot lysimeters in the prospective ground water (PGW) studies. The maximum concentration of acetochlor in soil pore water was 3.2 ppb observed in the nine foot lysimeters in Iowa. The maximum residue detected in ground water wells was 0.06 ppb observed in Iowa. The acetochlor degradates ethanesulfonic acid (Ac_ESA) and oxanilic acid (Ac_OXA) were generally detected more frequently than parent acetochlor. In the PGW studies for example, Ac_ESA demonstrated a pattern of movement as defined by concentrations greater than or equal to 1.0 ppb at three, six, and nine foot lysimeter depths. In 293 instances Ac_ESA was detected above 1.0 ppb at all three lysimeter depths. These exceedences occurred in seven out of the eight states.

4.4.3. ARP Ground Water Monitoring Endpoints – SGW Study

For the SGW, the trigger for regulatory action was a pattern of detections in 20 or more wells at or above 0.10 ppb "followed by two subsequent detections of at least 0.10 ppb in monthly sampling of each of those wells, conducted over a period of six months" (this language did not anticipate the impact of a large number of missing samples as in the reduced sample collection regime resulting in a maximum of four samples per well per year being collected during the last two years of the monitoring program). See Appendix 12.2 for details. Parent acetochlor exhibited a pattern of detection in the required number of samples in seven wells, or thirteen wells short of the trigger for regulatory action based on SGW results. Residues of acetochlor degradates were much more widespread in the SGW wells, but these compounds have not been deemed residues of concern.

Approximately 10% of the instantaneous concentrations in the SGW wells were above 0.5 ppb and 15% of all time-weighted annualized means were greater than or equal to 0.03 ppb (i.e., the minimum detection limit). If the degradates are included in an exposure calculation, then the number of wells with a pattern of detections increases to approximately 36 (requires a modification of the "pattern of movement" definition to 2 of 3 consecutive detections greater than 0.1 ppb (0.2 ppb for Ac_ESA since the detection limit was 0.2 ppb) since sampling of degradates never occurred more frequently than a quarterly basis.

4.5. Exposure Summary

Acetochlor parent residue exposure is generally higher and more widespread through surface water sources than ground water (Table 1). Available data indicate that water treatment involving the use of activated carbon may reduce exposure by close to 50% on average; however limitations on the data preclude generalizing this as a predictable effect of water treatment. In particular, no data are available that match the same water in raw and finished water, the ARP SDWS dataset did not measure samples in intake water from those systems using other types of water treatment, and most of the highest concentrations observed in the SDWS study occurred in finished (not raw) samples.

Table 1. Summary presentation of chronic exposure to parent acetochlor: Time-weighted annualized mean concentrations (ppb) in surface and ground water from the ARP monitoring program (based on maximum TWAM values observed at each site by calendar year) along with WARP model predictions for streams and rivers.

Study	**N**	**Maximum**	**95th Percentile**	**Median**
Surface Water - SDWS raw	44	0.591	0.355	0.042
Surface Water - SDWS finished	189	1.428	0.347	0.032
Surface Water - WARP model (raw)[a]	*470*	*0.812*	*0.435*	*0.042*
Ground Water (shallow) - PGW site averages	8	<0.03	<0.03	<0.03
Ground Water (shallow) - PGW cluster maximums	8	<0.03	<0.03	<0.03
Ground Water - SGW	182	0.520	0.039	<0.03

[a] Includes TWAMs calculated by the WARP model. The WARP results are provided for comparison to the ARP monitoring results and include WARP results only for states where ARP also had surface water monitoring stations.
N = total number of sites included in the statistics.

Should a toxicological concern arise from exposure anywhere near these levels (up to 3x the levels reported in **Table 1**), a refined exposure assessment can be done adjusting the ARP exposure values for any disparity between usage intensity at the ARP monitoring sites and other watersheds with surface water serving as drinking water sources with higher use intensities. A requirement for this would be acquisition from the ARP or independent calculation by EPA of acetochlor usage by watershed based on the overlap of county and watershed boundaries (the best available data representing acetochlor spatially have all been reported at the county level).

5. INTRODUCTION

Pesticide substances in the United States are regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), later amended by the Food Quality Protection Act of 1996 (FQPA). Under FIFRA, any pesticide, be it a single active ingredient or a mixture, must be registered for use as a pesticide before a person may distribute or sell the product. Pesticides are also regulated at the state level (usually by U.S. Department of Agriculture); however, state regulations must be at least as stringent as federal regulations. In order to register a pesticide in the US, the USEPA must ensure that the pesticide, when used according to the product label, will not pose an unreasonable risk to human health or the environment. Under FQPA, regulators must also consider threats to human health through food residues and via pesticides in drinking water. The latter requirement has created a need to monitor and estimate pesticides in drinking water supplies, including both surface water and ground water sources.

In March of 1994, USEPA and ARP entered into a conditional registration agreement (USEPA, 1994) for the chemical acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), the active ingredient in a number of herbicides used on corn (Zea maize) crops to control annual grasses and certain broadleaf weeds (Hackett et al., 2004). Under the agreement, USEPA required ARP to conduct several acetochlor monitoring programs and specified a number of cancellation or mitigation endpoints aimed at limiting potential risks to human health and endangered species

5.1. Overview of ARP Monitoring Programs

As part of the conditional registration agreement, the USEPA mandated ARP to develop an "early warning" detection system that would alert health officials if acetochlor is found migrating toward surface or ground water resources or may have the potential to migrate to receiving waters. This early warning system consists of rigorous surface and ground water monitoring programs, specifically: (1) Surface Drinking Water Supplies (SDWS) as measured at water supply intakes for roughly 175 sites, (2) Prospective Ground Water (PGW) studies at eight sites in eight states that are geographically diverse and generally representative of U.S. corn production regions, and (3) State Ground Water (SGW) studies that included monitoring approximately 175 ground water wells located near treated cornfields. Appendices 0, 12.5, and 12.6 provide further details on the monitoring locations, site selection procedures and site descriptions, and the analytical methods used in the ARP programs.

5.1.1. Surface Water Monitoring (SDWS)

5.1.1.1. Scope of the SDWS

The surface drinking water supply (SDWS) program is intended to detect the presence of acetochlor or any of its degradates of toxicological concern in surface water bodies that may be used for community drinking water supplies. The program is funded by ARP and is focused on states that were anticipated to be major use areas (Figure 1). Specific details regarding the program are provided in Hackett et al. (2004). States involved in the surface water monitoring program are shown in Figure 1. In general, "finished" (or treated) water samples were collected from approximately 175 sampling stations each year at biweekly to monthly intervals (roughly 14 samples per year), although some sites were dropped and replaced by others in some years resulting in a total of 189 individual stations sampled over the seven year period (Table 2). "Raw" or untreated samples were also collected for a total of 44 stations and ranged from 26 to 38 individual stations per year (Table 2). Similar to finished water samples, some stations were dropped and others added throughout the seven year monitoring period. Specific details can be found in ARP annual reports as well as Hacket et al. (2005). Under the conditional registration agreement (USEPA 1994), the need for monitoring is reassessed every five years. Concentrations of acetochlor (and, potentially, acetochlor degradates, which were monitored for only from 1999 to 2001) from drinking water intakes are then compared to target levels to determine if mitigation or cancellation actions are required.

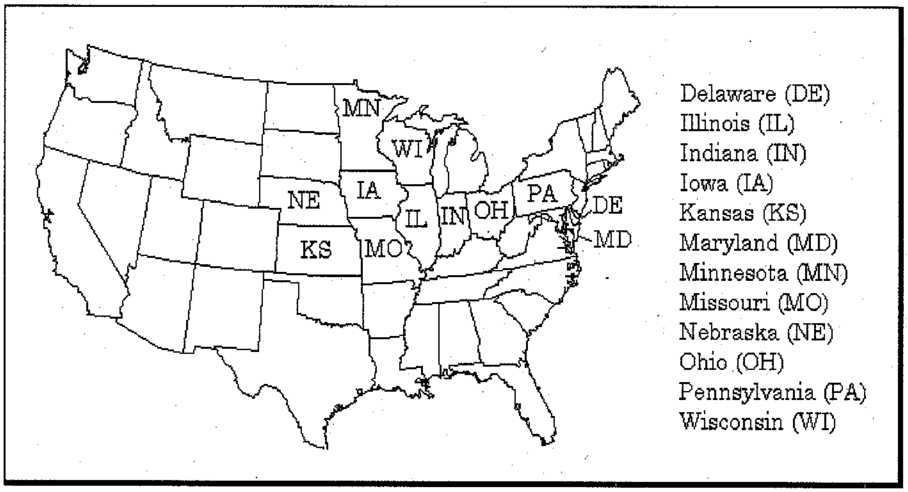


Figure 1. States involved in the Surface Water Monitoring Program for Acetochlor. (source: USEPA Office of Pesticide Programs).

Table 2. Number of community drinking water supply sites sampled for the parent acetochlor in each year.

YEAR	# Raw Water Sites	# Finished Water Sites
1995	26	175
1996	32	175
1997	35	175
1998	37	175
1999	38	175

2000	33	156
2001	37	152
TOTAL	44[a]	189[b]

[a] Total number of individual sites sampled. Raw water (untreated surface water) samples were collected from all community water systems (CWSs) that use granular activated carbon (GAC), and from several systems that use powdered activated carbon (PAC) (Hacket et al. 2005).

[b] Total number of individual sites sampled. Some sites were added in subsequent years while others were dropped. "The total number of CWSs was kept at 175 for the first five years with fewer than three sites requiring replacement in any year. Sites were always replaced by CWSs from the same or a higher vulnerability stratum. Several CWSs chose not to continue when the monitoring was extended for a final two years, dropping the number of sites to 156 in 2000, and to 152 in 2001" (Hacket et al, 2005).

Figure 1 shows the locations of ARP surface water monitoring locations overlaid on the maximum concentration observed by county based on NAWQA data. The blue circles represent locations of community water supply intakes where ARP sampled finished (treated) water and in some locations raw water samples were additionally sampled.

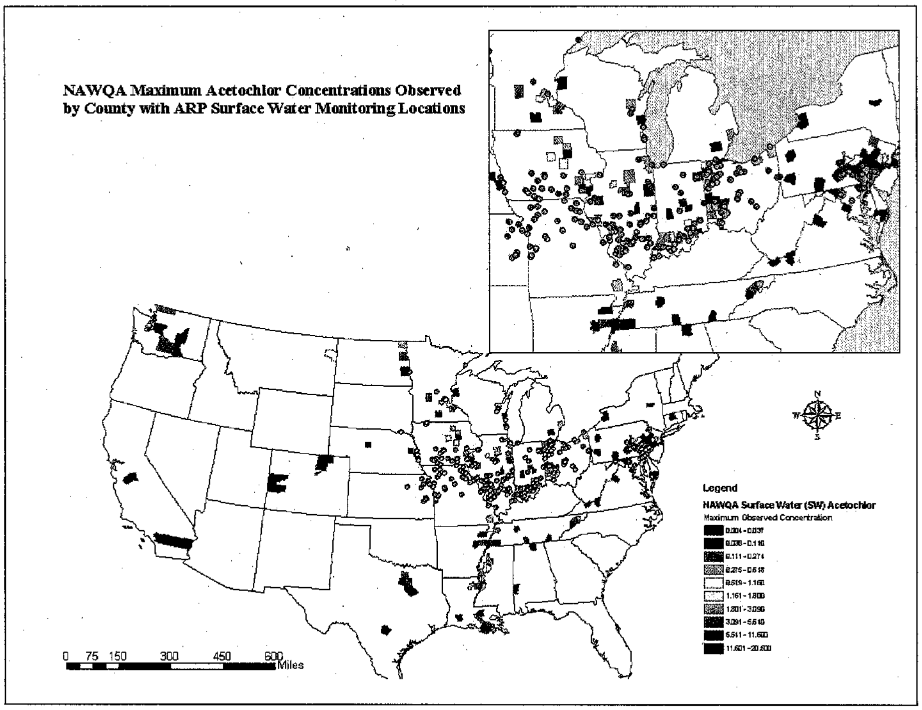


Figure 2. Locations of ARP surface water monitoring sites (blue circles) in relation to maximum observed concentrations of acetochlor in surface water (SW) by county based on available NAWQA data.

Figure 2 shows the locations of ARP surface water monitoring locations overlaid on the maximum concentration observed by county based on NAWQA data. The blue circles represent locations of community water supply intakes where ARP sampled finished (treated) water and in some locations raw water samples were additionally sampled.

5.1.1.2. *Site Selection for Surface Drinking Water Sites*

A particularly important issue in the assessment of exposure to parent acetochlor is how well the ARP SDWS study assesses the most vulnerable watersheds to acetochlor exposure (parent exposure levels in ground water sources were generally significantly lower). Included here is a summary of the SDWS site selection procedures, and, additionally, an excerpt from the ARP report describing the SDWS site selection process in more detail is provided in Appendix 12.5.

A site selection process was conducted to identify 175 CWSs in 12 states. Data regarding population and CWS source(s) were collected, and watershed areas and corn intensities were determined. Each of the 175 systems was visited, inspected, and data confirmed. Watersheds for the 175 systems were mapped. The selected CWSs represent a broad spectrum based on geographic diversity, general size and corn intensity of the watersheds. The data for the selected systems demonstrate the extensive diversity of the ARP surface water monitoring program. The watersheds are representative of the key acetochlor-use states, with a few extending into numerous states not included in the program. The CWSs are supplied by surface water from a variety of sources including small rivers and lakes, larger rivers and lakes, and reservoirs, and employ a wide variety of treatment methods. The selected watersheds span a large range of watershed area, and serve a large range of populations.

A total of 175 CWSs in nine mid-western and three mid-Atlantic states were selected for the program. The selection process was designed to include a wide array of CWSs with watersheds in areas of corn production, with an emphasis on including worst-case watersheds i.e., smaller watersheds (not on the Great Lakes and Continental Rivers) in areas of high corn production. These watersheds are expected to have higher concentrations of acetochlor after runoff events than larger watersheds which drain areas of both high and low corn production, because dilution would be greater for CWSs taking water from the Great Lakes and Continental Rivers. Data were collected to characterize each community water system included in the program.

The steps for the CWS selection and characterization process are summarized below:

1) Identification of all public CWSs that use surface water in the following 12 states: Illinois, Indiana, Iowa, Minnesota, Nebraska, Kansas, Wisconsin, Ohio, Missouri, Pennsylvania, Maryland, and Delaware.

2) Identification of all CWSs that belong to the target population.

Target Population - All CWSs in the 12 states that:

- use only surface water, or can discretely sample surface water,
- are willing to cooperate and
- have a corn intensity (for smaller watersheds that do not have an intake on a Great Lake or Continental River) greater than or equal to 5%, where corn intensity is the ratio of acreage of harvested corn to total acreage in the upstream watershed.

3) Separation of the target population of CWSs into disjoint (non-overlapping) strata based on the size of the watershed, the corn intensity (for smaller watersheds), and State that the system is in:

- State
- size of watershed (three major subdivisions)
    - Great Lakes
    - Continental Rivers (Missouri, Mississippi, Ohio Rivers)
    - Smaller Rivers and Lakes
- corn intensity (% corn planted in total area of watershed) (three major subdivisions)
    - 5-10% CI
    - 11-20% CI
    - >20% CI

4) Determination of the number of CWSs to be selected from each stratum. The focus was on strata containing CWS watersheds which are expected to have higher levels of acetochlor after runoff events, based on the size of the watershed and its corn intensity. A higher percentage of CWSs from these strata were chosen.

5) Random selection (using random number generation) of the appropriate number of CWSs from each stratum. All CWSs meeting the target population criteria were selected from the identified strata (for example, the >20% corn intensity, smaller watershed strata). A total of 175 CWSs were required for the study.

6) Collection of information for each selected CWS regarding intake location, sources of water, treatment, customer information, point of finished water sampling, soil types, and corn intensity of the watershed(s) for that system.

7) Removal of systems that did not meet target population criteria based on additional data collected. Systems were replaced in the same stratum and state, if possible, by additional random selection from the stratum. If there were no systems available in the same stratum, then a system was randomly selected from another stratum with available CWSs.

8) Generation of maps of watersheds for each CWS. Data entry into a Geographical Information System (GIS).

The highest percentage of CWSs, 100% of the available CWSs, was selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. Almost 50% of the sites were selected from smaller watersheds with >20% corn intensity, the watersheds expected to have the highest concentrations of acetochlor after runoff events. The focus on more vulnerable watersheds with higher corn intensity combined with the diversity of watersheds selected for this study will allow us to obtain both a worst-case and representative evaluation of the impact of acetochlor and other corn herbicide usage on surface drinking water in significant corn-growing areas of the United States.

5.1.2. Prospective Ground Water (PGW) Studies

ARP was also required to conduct eight Prospective Ground Water (PGW) studies according to the protocol approved for other herbicides in order to determine the potential for pesticide transport, or a "pattern of movement". Specific details regarding the program are provided by Newcombe et al. (2005). In general, sites were geographically located based on representative product label uses, or "in accordance with widespread and commonly recognized practice, including vulnerable and typical use situations," as outlined in the registration agreement. Sites were required to be located on a wide variety of soil textures as per the product label, and an effort was made to include a broad geographical representation. Test sites were located in the following states: Wisconsin, Ohio, Minnesota, Nebraska, Iowa, Indiana, Pennsylvania, and Delaware (Figure 3). Specifics of the study design are provided in Table 4. Newcombe et al., 2005 cites that these areas corresponded to areas of significant acetochlor use. Further details regarding the geographic distribution of acetochlor can be found in the "Acetochlor Usage" section of this report.

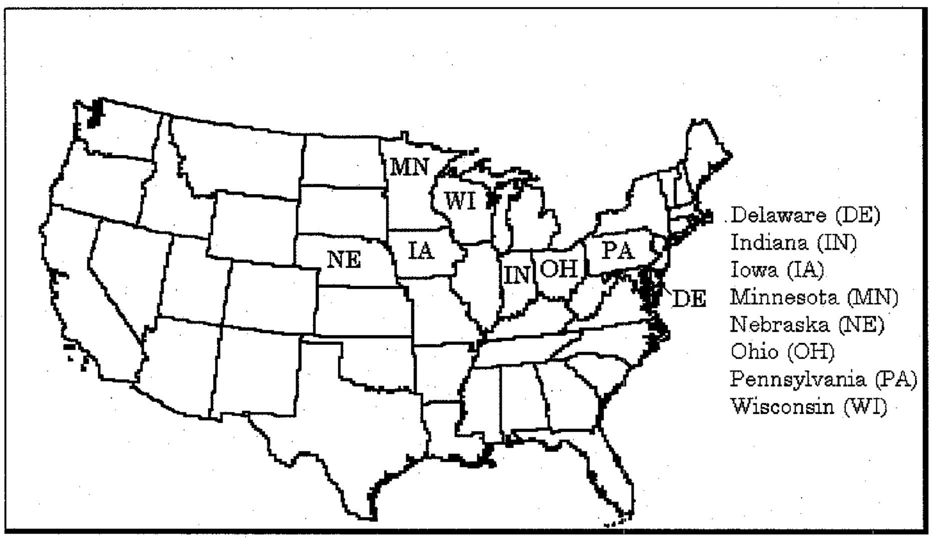


Figure 3. States with prospective ground water (PGW) studies for acetochlor.

Table 3. PGW sites: Selected soil and aquifer characteristics.

PGW Study Location	NRCS Soil Series; On-site surface soil % O.M. & pH	Subsoil Textures[1]	Avg. Hydraulic Conductivity[2] (mm/hr)		Aquifer soil textures determined[1]	Depth to ground water[3] (m)	Pore-water velocity (m/day)[4]
Wisconsin	Richford loamy sand OM = 1.6% pH = 6.4	Loamy Sand Sand Sandy loam	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	177 358 810 1482 776	Loamy sand Sandy loam Sand	7.6-10	1.9×10^{-3}
Ohio	Genessee silt loam	Clay loam	0-1.2 m 1.2-2.4 m	293 153	Sandy loam Loamy	0.6-5.2	0.8×10^{-1}

Table 3. PGW sites: Selected soil and aquifer characteristics.

PGW Study Location	NRCS Soil Series; On-site surface soil % O.M. & pH	Subsoil Textures[1]	Avg. Hydraulic Conductivity[2] (mm/hr)		Aquifer soil textures determined[1]	Depth to ground water[3] (m)	Pore-water velocity (m/day)[4]
	Fox silt loam OM = 2.9% pH = 7.7	Loam Sandy loam	2.4-3.6 m 3.6-4.8 m >4.8 m	NA NA NA	sand		
Minnesota	Estherville sandy loam OM = 3.5% pH = 6.3	Sandy loam Loamy sand Sand	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	180 331 NA NA NA	Sand Loamy sand Sandy loam	4.8-6.4	0.4×10^{-1}
Nebraska	Kenesaw silt loam Coly-Kenesaw silt loam OM = 1.8% pH = 5.7	Loam Silt loam	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	75 45 28 18 84	Silt loam Loam Sandy loam	7.0-9.7	0.4×10^{-2}
Iowa	Marshall silty clay loam Minden silty clay loam OM = 3.9% pH = 5.6	Silty clay loam Silt loam	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	207 84 172 87 1.0	Sand Silt loam Loam	1.2-8.5	0.9×10^{-1}
Indiana	Door loam Lydick loam OM = 3.0% pH = 6.7	Sandy clay loam Sandy loam Sand	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	64 190 244 742 978	Sand	7-9.1	0.6×10^{-1}
Pennsylvania	Clarksburg silt loam Duffield silt loam OM = 2.7% pH = 6.3	Loam Sandy loam	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m NA	382 138 95 19 NA	Sandy loam Loam	1.8– 7.3	0.4×10^{-1}
Delaware	Sassafras sandy loam OM = 2.9% pH = 5.8	Sandy loam Loamy sand Sand	0-1.2 m 1.2-2.4 m 2.4-3.6 m 3.6-4.8 m >4.8 m	30 86 30 129 NA	Sand Sandy loam Loamy sand	3.3-6.1	0.6×10^{-2}

[1] Soil texture determined by 3-fraction analysis (% sand, silt, and clay)
[2] Vertical saturated hydraulic conductivity determined by constant head permeability method
[3] Depth to ground water listed is below ground surface, and the minimum and maximum values are of all measurements made in the test plot piezometers during the course of the study
[4] Average value determined during the course of the study
This table is modified from a more extended version by the ARP found in Newcombe et al. (2005).

5.1.3. "State Ground Water" (SGW) Monitoring Program

In addition to PGW studies, the ARP, as part of the "State Ground Water" Monitoring program, was required to monitor 25 ground water wells in each of the expected seven high use states (WI, IL, IA, MN, IN, NE, KS) in Figure 4 all located adjacent to fields with contractually guaranteed use of acetochlor and located in areas representing a variety of use conditions based on soil characteristics, local hydrogeology, and climatic conditions. The monitoring data serve as an early indication that pesticide residues may be reaching ground water. Risk managers can then use this information to assess the potential threat to humans. Specific details regarding the program are provided in de Guzman et al., (2004), but a brief description of the program design follows here.

The SGW study was set up through the establishment of a network of 175 monitoring sites in regions of high corn production in each of the seven states chosen for this study. A site selection scheme for the SGW wells was set up using corn production data, soils database information, and consultations with state regulatory officials to obtain a set of wells representing a range of soil textures typical of corn agriculture in those regions. Soil classification was not a direct component of the site selection procedure. Soil survey data were collected for each site and are available in the documents submitted to the EPA by the ARP. The soil classification data are not available in a readily summarized form and are not presented here, but details can be found in the ARP Site Selection submission (MRID 43899601).

In general, ground water monitoring wells were to be located down gradient of acetochlor use areas at a distance agreed upon by the states. States participating in the SMP are shown in **Figure 4**. Where technically feasible, ARP is required to provide assistance to water system operators in monitoring for acetochlor residues at drinking water wells.

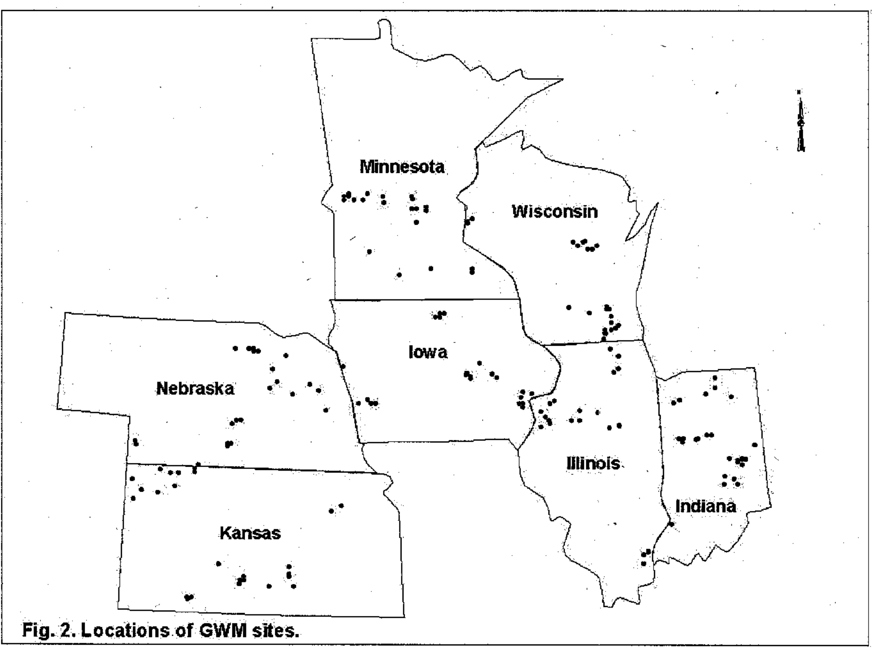


Fig. 2. Locations of GWM sites.

Figure 4. States involved in the ground water monitoring program for acetochlor and locations of wells. Source: De Guzman et al. (2005).

Table 4. Well characteristic summary for the GWM program. Values expressed in meters below ground surface (bgs).

State	Buffer distance[2]	Screen length	Depth to water	Screening Depth Interval[3]		
	-----------	-----------	-----meters-----	-----------	-----------	-----------
				Minimums	Maximums	Mean DTW – DTS
Illinois	9.1 - 45.7	4.6	3 - 22.8	2.7-4.6	7.3-9.1	2.5
Indiana	15.2 - 45.7	3	<7.6 - 22.8	5.8-23.5	8.8-26.5	3.1
Iowa	9.1 - 45.7	4.6	1.5 - 15.2	1.5-7.0	6.1-11.6	6.5
Kansas	9.1 - 30.5	3	4.6 - 22.8	4.0-22.9	7.0-25.9	1.2
Minnesota	15.2 - 45.7	3	7.6 - 22.8	4.9-21.3	7.9-24.4	3.4
Nebraska	15.2 - 45.7	4.6	3 - 22.8	4.6-20.4	9.1-25.0	1.8
Wisconsin	9.1	3	<7.6 - 15.2	1.2-14.9	4.3-18.0	1.4

[1] Table is adapted from Newcombe et al. (2005); state average difference between average screening interval (DTS) and average depth to ground water (DTW) has been added.

[2] Distance between wellhead and nearest point of the acetochlor treatment area.

[3] Screening depth interval data were extracted from master ground water database submitted by ARP. The screening interval represents the positions of the top and bottom of the screen measured during installation. The first pair is the minimum top of screen and the maximum top of screen, the second pair is the minimum bottom of screen and the maximum bottom of screen.

5.2. Design and Scope of Exposure Assessment

The purpose of this assessment is to review results from the three major acetochlor data sets generated by the ARP as described above (two ground water source based and one surface water source based). The assessment focuses on the status of acetochlor in ground and surface water with respect to specific endpoints triggering mandatory requirements for implementation of mitigation measures or cancellation of acetochlor uses (detailed in the conditional registration agreement, USEPA 1994) and to evaluate the impact of acetochlor on drinking water sources in support of human health risk assessments. ARP provided a fourth acetochlor data set that consists of incident investigation of ground water primarily around pesticide dealer and storage facilities. The incident data are only indirectly related to impacts from registered uses of acetochlor therefore these data have not been included in the direct exposure assessment.

Primary focus of this exposure assessment is on the parent acetochlor, with secondary emphasis on acetochlor degradates in water – widespread occurrence. This section deals with exposure to acetochlor parent residues in water and serves as the basis of the current Drinking Water Assessment. Conclusions made about exposure to the parent acetochlor apply to the parent chemical only. Although this assessment is focused on the parent acetochlor, exposure levels to degradates can be quite significant and has been characterized with secondary emphasis. Some of the ARP monitoring studies also contain data on the occurrence of other chloroacetanilide herbicides (alachlor and metolachlor and / or other corn herbicides (atrazine) – a limited discussion on these data and their utility for other exposure assessments will also follow this section. A portion of these data were reviewed for a previous drinking water assessment for another pesticide - atrazine (Environmental Fate and Effects Division, OPP, EPA, 2001). Highlighting the utility of the ARP data set for chloroacetanilide herbicide risk assessments.

5.3. Documents and Data

This assessment is based primarily on extensive surface water and ground water monitoring programs submitted in support of acetochlor registration and intended to provide a reasonably comprehensive portrait of exposure levels possible in ground and surface water. Discussion of the most relevant outside monitoring programs for acetochlor, most notably the NAWQA monitoring program by the USGS, is also provided. Since there were many hundreds of interim documents and reports submitted, only selected references (but including all final reports) are included in the bibliography.

5.4. Data Gaps

The ARP monitoring program was designed to assess exposure or exposure potential to acetochlor in the context of an evaluation of the compliance of the ongoing usage of acetochlor with exposure limits, and other regulatory requirements contained in the Acetochlor Registration Agreement (USEPA, 1994).

5.5. Uncertainties in the Drinking Water Assessment

A number of uncertainties must be recognized when interpreting this exposure assessment. These include the following:

- The surface drinking water supply (SDWS) and state ground water (SGW) monitoring programs were designed to focus on areas of high acetochlor use. The monitoring does not cover the entire geographic distribution of acetochlor use. Geographic analysis of the SDWS site locations and acetochlor use patterns seems to indicate that even a number of high acetochlor use areas were not monitored. Conclusions drawn in this report apply only to those areas monitored by the ARP and it may not be possible to generalize to all acetochlor usage areas. This is especially true for the SDWS where the lack of sampling of raw (pre-facility treatment) water at most locations makes it difficult to isolate the effects of site-specific usage and vulnerability factors and water treatment processes on the observed residue levels.

- County level sales data submitted separately by members of the ARP from 1994 -2003 is arguably some of the most extensive data available as a close approximation of acetochlor usage across the US. As such, it has been incorporated in this exposure assessment as a surrogate for acetochlor use in the mapping and statistical analyses. It is assumed that acetochlor sold in an individual county is, in general, also applied in the same county and in the same watershed. However, the exposure characterization recognizes that inter-county as well as inter-watershed transfer of acetochlor does occur in some cases.

- Acute exposure in this risk assessment is defined as the overall maximum observed concentration at a site. The actual peak concentration, however, may have occurred between sampling times. Thus, the maximum observed concentrations reported in this study may underestimate the true maximum acute exposure.

5.5.1. Degradation Pathways

Acetochlor persistence in a confined soil system appears to increase with coarser soil texture and increased application rate. The current label also specifies that acetochlor not be used on sand, sandy loam, and sandy loam soils with <6 % organic matter. The half-lives in aerobic soils for the 3, 4.5, 10.5, 41, and 50 ppm application rates were 8-12, 14, 110-245, 55, and 300 days, respectively. However, the most representative aerobic soil half-life is 8-14 days determined in the Monsanto study conducted in Ray silt loam (1.2 X OM), Drummer silty clay loam (3.4 % OM), and Spinks sandy loam (2.4 % OM) soils treated with 3 ppm (—2X label rate) of acetochlor. The 8-14 day half-life represents the labeled application rate and the soils to be treated with acetochlor. The longer half-lives were found only at exaggerated application rates (7.5-36X) labeled rates to coarse, low organic matter soils. The aerobic soil metabolism degradates oxanilic acid (oxamic acid), sulfonic acid, and thioacetic acid sulfoxide degradates of acetochlor. These degradates are rearrangement products of one amino moiety of the acetochlor molecule.

5.5.2. Soil Mobility

Parent acetochlor has a reported water solubility of 223 mg/l and K_d values of 0.4-2.7 ml/g in various soils texturally classified as sandy loam, loamy sand, silt loam and silty clay soils. Acetochlor also leached through soil columns.

The degradates are expected to have even higher mobility based on structural features. K_d values for the degradates were 0.15 to 0.97 for Ac_ESA, 0.13 to 0.86 for Ac_OXA, and 0.10 to 0.90 for a third degradate (acetochlor thioacetic acid sulphoxide) not included in this exposure assessment because of the low levels detected in environmental samples in previous studies. K_{oc} values were 21 to 68 in 9 of 10 soils tested and 430 in the other soil (median = 57) for Ac_ESA and 17 – 124 (median = 45) for Ac_OXA.

The results of studies submitted to support Subdivision N requirements for registration appear to be inconsistent with the laboratory data with respect to mobility. In at least one study, leaching of oxamic acid (oxanilic acid) and sulfonic acid and thioacetic acid sulfoxide was observed to a depth of 18 inches in a silt loam soil in Illinois containing 1.7% organic matter. No leaching was detected in another silt loam soil in Mississippi containing only 0.5% organic matter.

5.5.3. Dissipation Pathways

The major routes of dissipation for acetochlor appear to be microbially-mediated degradation, runoff, and leaching. Although acetochlor generally degrades rapidly when applied to soil, in some field situations it can be relatively persistent (e.g., field dissipation half-lives were up to 36 days) and it has been found in ground water at numerous locations. There is variable evidence as to the persistence of acetochlor in subsoil horizons (often persistence is increased substantially for organic pesticides that are subject to microbial degradation) with a published study by the registrant reporting only a modest increase in persistence from surface soils at two sites using *in situ* methods (Mills et al., 2001). Lavy et al. (1996) have reported a much more substantial increase in persistence at two sites (also *in situ* studies) for alachlor, a herbicide that is chemically related to acetochlor and tends to have a very similar environmental fate profile. Laboratory degradation data indicate that acetochlor does not degrade by abiotic processes (hydrolysis and photolysis); this may be to the higher application rates than used in the Mills et al. study. While acetochlor has relatively short half lives in fine-textured aerobic soil, it may be moderately persistent in coarser soils (this may be related to the lower rate of microbial activity in sandy, low organic matter soils).

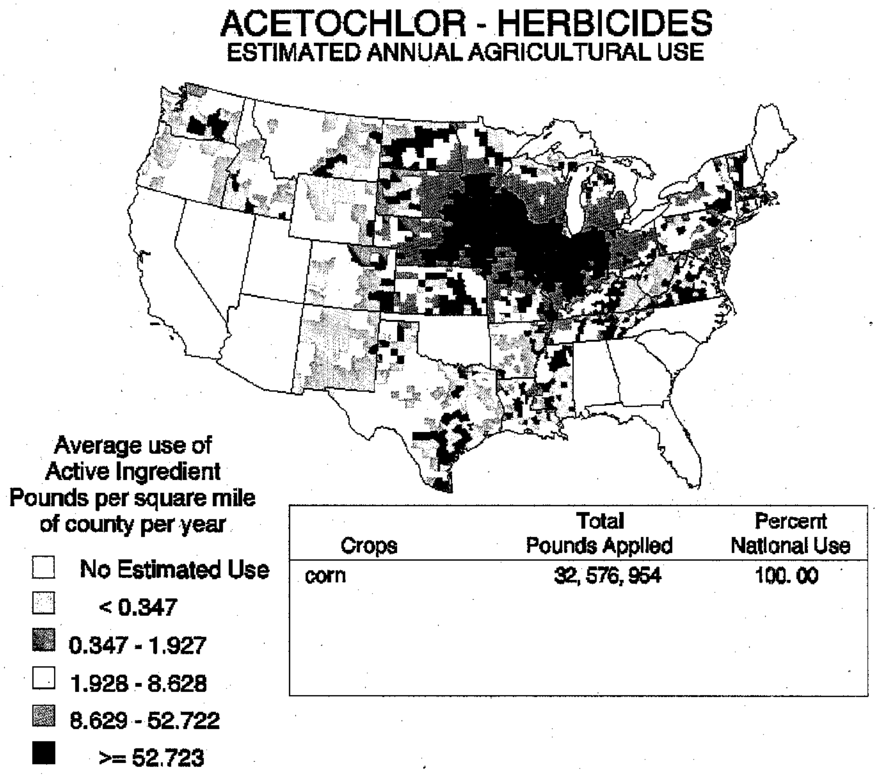
5.6. Acetochlor Usage

Acetochlor is registered for use on corn, pasture & rangeland, green peas, sorghum, soybeans, and sweet corn. Over 99% of the usage is on corn (includes field corn, production seed corn, corn silage, and popcorn; source: Screening Level Usage Analysis by Biological and Economic Analysis Division, OPP; delivered by an electronic mail message from Christina Scheltema, SRRD to Michael Barrett, EFED sent February 17, 2004). Acetochlor is now registered in 42 states as well as the District of Columbia (Hackett et al., 2004). It is also used in corn growing areas of several countries including China, Europe, and Argentina. Presently, roughly 80% of the total use of acetochlor in the United States occurs in the Midwest. The usage areas generally mirror the production areas for field corn (Figure 5 and Figure 6).

Figure 5. Corn production intensity (2002 Census of Agriculture data) and general locations of drinking water intakes sampled in the ARPs SDWS monitoring program (white = no reported corn acreage, green = lowest intensity category, red = highest corn intensity category).

Figure 5 shows corn production intensity and the generalized locations of the ARP SWDS monitoring locations (2002 Census of Agriculture data, see Appendix B for maps based on 1992 and 1997 Census of Agriculture data). Figure 6 provides the USGS estimate of acetochlor usage in the United States for 1997. Note that this map is a coarse estimate and should not be used for decision making at the county level. The USGS provides the following caveat with the data: "The pesticide use map shows regional-scale patterns of use intensity within the United States and [is] not intended for making local-scale estimates of pesticide use, such as for individual counties. The maps are based on state-level estimates of pesticide use rates for individual crops, which have been compiled by the National Center for Food and Agricultural Policy (NCFAP) for 1995-1998, and on 1997 Census of Agriculture county crop acreage. Key limitations include: (1) state use-coefficients represent an average for the entire state and consequently do not reflect the local variability of pesticide management practices found within many states and counties, and (2) the county-level acreage are based on the 1997 Census of Agriculture and may not represent all crop acreage due to Census non-disclosure rules. Please refer to Method for Estimating Pesticide Use for a detailed discussion of how the pesticide use data were developed."

Detailed sales maps for acetochlor from 1994 to 2003 are provided in the Appendix section "Acetochlor Usage – Detailed Summary". Acetochlor sales data have been provided separately by members of the Acetochlor Registration Partnership as confidential information and cannot be shared with unauthorized individuals.



Crops	Total Pounds Applied	Percent National Use
corn	32,576,954	100.00

Figure 6. USGS estimated acetochlor use for 1997.

Acetochlor is effective on a broad spectrum of weeds in corn fields and it therefore was expected that reductions in overall corn herbicides would occur. As such, the conditional registration agreement mandated a 33 percent reduction in the aggregate use of the selected corn herbicides (alachlor, metolachlor, atrazine, EPTC, butylate, and 2,4-D) over a five year period. Cancellation of the conditional registration agreement would be triggered if any one of the following usage target levels were not met:

1. At the end of 18 months from the date of registration, a net cumulative reduction of the six corn herbicides by 4 million pounds (4 M lbs) from 1992 levels, adjusted for planted acreage differences; or
2. At the end of three years from the date of registration, a net cumulative reduction of the six corn herbicides of 22.6 M lbs from 1992 levels, adjusted for planted acreage differences; or
3. At the end of five years from the date of registration, a net cumulative reduction of the six corn herbicides of 66.3 M lbs from 1992 levels, adjusted for planted acreage differences.

Based on OPPs Biological and Economic Analysis Division's analysis, it appears that increased use of acetochlor did result in a decrease in the combined use of the six selected herbicides. OPP/BEAD's review of the usage data submitted by ARP concluded that the 18 month, three year, and five year target reductions were achieved. The cumulative net reduction for the three year target (22.6 M lbs) was exceeded by 1996, and the five year target (66.3 M lbs) was exceeded by 4 M lbs in 1998. Overall, the proportion of acetochlor used relative to other pesticides steadily increased based on USDA and Doane Marketing Research surveys. These research surveys indicate that the percent of field corn treated specifically with acetochlor increased from 7 percent in 1994 to 24 percent in 1997. This increase amounted to an increase in total acetochlor use (based on surveys of 39 states) from 7.4 M lbs in 1994 to 31.8 M lbs by 1998.

At the time of its registration, the increase in acetochlor use was of particular concern since it was listed as a probable human carcinogen (a classification which it still maintains), and therefore exposure to acetochlor in drinking water contamination may pose a human health risk. In anticipation of its widespread use, several use restrictions were implemented as preventative measures. Specifically, acetochlor may only be applied by certified applicators. It may not be applied to coarse soils (e.g., sands with less than 3% organic matter) where depth to ground water is less than 30 feet. Acetochlor cannot be applied through any irrigation system (including flood irrigation), nor via aerial application. Acetochlor may not be applied directly to water or areas where surface water is present. In addition, acetochlor must not be mixed or loaded within 50 feet of surface water or wells, unless proper containment and disposal measures are in place. Each of these measures is intended to prevent acetochlor from migrating to ground water and/or surface water resources.

5.7. Overview of Exposure Assessment

This exposure assessment is based primarily on an extensive monitoring program submitted by the ARP as a requirement for registration of acetochlor. Other monitoring data and modeling results are also discussed in order to provide a more complete picture of exposure to acetochlor. Section 6 deals with parent acetochlor exposure, Section 7 evaluates exposure to degradates of acetochlor, and Section 8 provides an overview of the extensive body of monitoring data for other herbicides and herbicide degradates (including parent atrazine, and parent + degradates of alachlor and metolachlor) that the ARP compiled in the course of conducting some major surface water and ground water studies to support the acetochlor registration.

Uniquely relevant to OPP's exposure assessment for acetochlor is an evaluation of the detection rates and amounts in the ARP monitoring studies relevant to endpoints identified in the original Acetochlor Registration Agreement which could trigger requirements for mitigation or cancellation of uses should the endpoints be exceeded. There are unique endpoints identified for each of the three major ARP monitoring programs (SDWS, PGW, and SGW) as well as for outside monitoring; these are discussed separately for each of these monitoring programs. At this time, only acetochlor parent residues have been identified as relevant to the regulatory triggers.

Precedence in the review of the monitoring data is given to acetochlor parent based upon a presumption that the current risk assessment will focus on exposure to acetochlor parent. The Health Effects Division (HED) of the Office of Pesticide Programs has evaluated currently available toxicity and carcinogenicity data and determined that the dietary drinking water risk assessment should be based upon parent acetochlor alone (HED, 2004).

Although not anticipated to be included in the current drinking water risk assessment the degradate data are also included in this exposure assessment in a separate section of this document. The primary reason for this is to document the data submitted by the ARP which show exposure levels to acetochlor degradates that are frequently higher than acetochlor and many other pesticide residues and are widespread (Figure xxx; see below for a complete characterization). Some of the ARP monitoring studies also contain data on the occurrence of other chloroacetanilide herbicides (alachlor and metolachlor and / or other corn herbicides (atrazine) – a limited discussion on these data and their utility for other exposure assessments will also follow this section. A portion of these data were reviewed for a previous drinking water assessment for atrazine (Environmental Fate and Effects Division, OPP, EPA, 2001).

6. RESIDUES - ACETOCHLOR PARENT

The focus of the current risk assessment is on the parent acetochlor, with secondary emphasis on acetochlor degradates in water and their widespread occurrence. The assessment focuses on the status of acetochlor in ground and surface water with respect to specific endpoints triggering mandatory requirements for implementation of mitigation measures or cancellation of acetochlor uses (detailed in the conditional registration agreement, USEPA 1994) and to evaluate the impact of acetochlor on drinking water sources in support of human health risk assessments. The following sections present time-weighted annualized means an 95th percentile values, as well as the methodology implemented to compute these values. Assessments of acute and chronic exposure are also provided for each of the three surfaces and ground water monitoring programs.

6.1. Data Files Used

Table 5 lists the data files used for computing annualized means and summary statistics for each data set.

Table 5. Key data files submitted by the ARP used in this assessment

Data set	File Name	Modified
SDWS	Data: Surface water monitoring concentrations File Name: swm_conc.xls Datswm_anc.xls cws-population-served.xls	2/10/2003 2/10/2003 9/17/04
SGW	master gwm reporting dbase.mdb; Table "tblGWM_all"	6/25/2002
PGW	http://www.arpinfo.com/download/pgw/PGW_NUM_FINAL.TXT (All observed concentrations in the PGW studies)	4/22/04
	http://www.arpinfo.com/download/pgw/pgw_uncensored.xls (Uncensored data provided ARP for computation of TWAMs and Percentiles)	10/2/04

6.2. Time Weighted Annualized Means and 95th Percentile Calculations

Time-weighted annualized means (TWAMs) were calculated for each site in the three major monitoring programs (SDWS, SGW, and PGW). Two separate weighting methods were implemented using a custom-built TWAM computer program to verify the TWAMs computed by the ARP. The weighting method used by the ARP (described below) was cross-checked with a slightly different method implemented in the WARP beta model developed by the USGS (USGS 2004). Both weighting methods assign a weight to each discrete sample observation based upon the fraction of the time during a year that each sample represents. Weighted concentrations are then summed to provide an annualized mean.

6.2.1. ARP Weighting Methodology

The weighting method implemented by the ARP (equation 1) calculates annual means based on the calendar year. January 1 - December 31). Separate time-weighted annualized means are computed for each combination of analyte, site id, sample type, and year. Weighted concentrations are computed based on a two-step process. First, an average concentration is calculated as the sum of a value and the previous value divided by two. A weighting factor is then calculated as the time interval between a value and the previous value, divided by the time in 1 year. The final weighted concentration is the product of the average concentration and the corresponding weight factor.

Equation 1 :

$$\text{TWAM}= (c_1+c_0)\,(t_1-t_0)/2 + (c_2+c_1)\,(t_2-t_1)/2 + \ldots\ldots + (c_n+c_{n-1})\,(t_n-t_{n-1})/2 + (c_n)\,(t_f-t_n)\ \ \text{Days}_{yr}$$

Where "c" is the observed concentration, "t" is the sample date, "Daysyr" is the total number of days in the given year (accounts for leap years), and "n" is the total number of observations in the given year. The subscripts represent the observation number where "0" is Jan 1st at 0 hours, and "f" is December 31st at 2400 hrs, note that this is slightly different than ARP's code, which does not include the time from 0 hrs to 2400 hrs on December 31st. Each annualized mean begins January 1st Therefore, for each new year, a January 1st concentration must be calculated. This is done based on linear interpolation between the last record of the previous year and the first record of next consecutive year. For the first record in the set, there is no previous year for the first sample of a new site. The first concentration is used as the mean concentration from January 1st to the first observation at that site. Similarly, for the last year in record in a data set ("Cn" and "tf"), the last concentration is used as the mean concentration through the end of the year.

6.2.2. USGS WARP Beta Model Weighting Methodology

The USGS beta model weighting method (equation 2) also calculates time weighted annualized means based on the calendar year (January 1 - December 31). This method is different from the ARP method, as individual weights are computed as "the amount of time extending from one-half the time interval between a value and the preceding value and one-half the time interval extending from the value to the subsequent value, divided by the total time in 1 year....The annual mean concentration is simply the sum of the sample weight times the sample concentrations" (USGS 2004).

Equation 2:

$$\text{TWAM}= (c_1)\,[(t_1-t_0) + (t_2-t_1)/2] + (c_2)\,([(t_3-t_2) + (t_4-t_3)]\,/\,2) + \ldots\ldots + (c_n)\,[(t_n-t_{n-1})/2 + (t_f-t_n)]\ \ \text{Days}_{yr}$$

Where "c" is the observed concentration, "t" is the sample date, "Daysyr" is the total number of days in the given year (accounts for leap years), and "n" is the total number of observations in the given year. The subscripts represent the observation number where "0" is Jan 1st at 0 hours, and "f" is December 31st at 2400 hrs. Each annualized mean begins January 1.

This method requires special conditions to handle leap years as well as the first and last records of a subset (e.g., unique combination of site, type, and year). The Visual Basic for Applications (VBA) workbook developed for the TWAM calculations automatically accounts for leap years using a custom-built visual basic procedure. In cases of leap years, the weighting factors are divided by 366 rather than 365. Additionally, for the first record of a year, the weighting factor is calculated as the time interval between a value and January 1st of the corresponding year, and one-half the time interval extending from the value to the subsequent value, divided by the total time in 1 year. For the last record of a year in a subset the weighting factor is calculated as one-half the time interval between a value and the preceding value plus the time interval extending from the value to December 31st of the corresponding year, divided by the total time in 1 year.

6.2.3. 95th Percentile Calculations

The 95th percentile concentration was also computed for each calendar year of observations at a site. In this analysis, a given percentile represents the fraction of the year that the concentration was at or below the given percentile of the distribution of concentration values. This method is based on the method implemented in the USGS WARP beta model (USGS 2004). In general, the 95th percentile indicates that 95% of the time the value was at or below the given concentration. Percentiles were calculated in several steps. First, the observed concentrations within a year for a given site and sample type are ranked from low to high. The corresponding weighting factors (calculated as the fraction of the year the individual concentration represents based on one of the weighting methods described above) are then summed to obtain a cumulative distribution function (CDF), the sum of which equals 1. The concentration for each percentile is then obtained by matching the percentile values to the CDF. If a percentile falls between two values in the CDF, the corresponding weight and concentration is then linearly interpolated. In some cases, the weight corresponding to the lowest observed concentration is greater than a desired percentile; in these cases, exact percentiles could not be calculated. Specific details for each weighting method are described in the following sections.

6.3. Surface Water

6.3.1. ARP Data

Time weighted annualized means were calculated using the method described in the prior section (implemented by TWAM Tool version 2.0). The weighting method used was the same method as that used by the ARP in the data submission to USEPA, with the exception of one modification in the code to account for the last day of the year in each site subset. As described earlier, Table 3 lists the files used in computing TWAMs. For the surface drinking water supplies (SDWS), separate TWAMs were computed for "finished", "raw" sample types. Finished (or treated) water samples were sampled post-treatment and the water treatment system outflow. Raw (or untreated) samples were collected prior to treatment at the treatment system intake. A total of 189 individual drinking water supplies were monitored (Table 2).

6.3.1.1.Regulatory Action Endpoints

The conditional registration agreement includes a number of regulatory action endpoints that, if exceeded by acetochlor or its related degradates of toxicological concern, would trigger mitigation measures or the cancellation of acetochlor registration (USEPA 1994). These endpoints are discussed in detail in the "Regulatory History" report provided in an earlier deliverable. A brief list of the cancellation triggers and the results of the ARP monitoring program are provided below.

In addition to mitigation/cancellation endpoints, acute and chronic exposure to acetochlor and its degradates in surface drinking water was also of concern. For the purposes of this analysis, acute exposure was defined as the overall maximum instantaneous concentration observed at a site. This approach may underestimate actual acute exposure since typically only 14 samples were collected each year (generally bi-weekly samples collected during late winter to late fall) and it is unlikely that the sampling times coincided with peak annual acetochlor concentrations. *Chronic exposure was defined using both the maximum time-weighted average and mean time-weighted annual average for a site.*

6.3.1.1.1.Endpoint 1: 2.0 ppb TWAM

The conditional registration agreement states that "If one (1) community water supply system, that derives its water primarily from surface water, detects an annual time-weighted mean concentration of 2.0 ppb, then the use of acetochlor in the related watershed will be prohibited....... or; the ARP will absorb 100% of the costs required to restore the community water supply system to compliance." Cancellation would automatically occur if two large community water supply systems or ten community water supply systems of any size observed time-weighted mean concentrations of 2.0 ppb or were out of compliance.

No time-weighted annualized means for acetochlor exceeded 2.0 ppb (Table 6). For both raw and finished surface drinking water, roughly 99% of the time-weighted annualized means were below 0.5 ppb.

Table 6. Frequency of time-weighted annualized mean concentrations (ppb) for the parent acetochlor herbicide in raw and finished water drinking water.

	Raw		**Finished**	
Bin	***Frequency***	***Cumulative %***	***Frequency***	***Cumulative %***
0	0	0.00%	12	1.01%
0 – 0.003	33	13.87%	395	34.40%
0.003 – 0.005	48	34.03%	115	44.13%
0.005 – 0.01	34	48.32%	138	55.79%
0.0 – 0.05	63	74.79%	333	83.94%
0.05 – 0.1	25	85.29%	93	91.80%
0.1 – 0.5	34	99.58%	94	99.75%
0.5 – 1.0	1	100.00%	2	99.92%
1.0 - 2.0	0	100.00%	1	100.00%
>2	0	100.00%	0	100.00%
Total	238		1183	

6.3.1.1.2. Endpoint 2: 8.0 ppb Instantaneous Concentration

The conditional registration agreement (USEPA 2004) also states that "If any community water supply system that derives its water primarily from surface water detects a single peak acetochlor concentration of 8.0 ppb, the ARP will make biweekly sampling of that system throughout the following 12 months to determine whether the 2.0 ppb annual time-weighted mean concentration has been exceeded." Acetochlor was detected above 8.0 ppb in 2 cases for the finished water samples (**Table 7**), however, the twelve month annualized mean did not exceed 2.0 ppb (**Table 6**) since none of the sites exceeded an acetochlor TWAM of 2.0 ppb. Acetochlor concentrations in SDWS were the highest of all three studies, followed by raw surface water samples, state ground water samples, and PGW studies as indicated by the cumulative frequency distribution (CDF) for all sample observations (**Figure 7**). The lines on the CDF represent the percent of samples (frequency) that were detected at or below the corresponding concentration. For example, roughly 80% of all raw (untreated) water samples in the SDWS drinking water program were less than or equal to 0.05 ppb.

Table 7. Frequency of occurrence for all instantaneous parent acetochlor concentrations (ppb) in raw and finished water drinking water.

	Finished Water		**RAW Water**	
Bin	***Frequency***	***Cumulative %***	***Frequency***	***Cumulative %***
0	4297	26.00%	530	15.94%
0.0 – 0.003	3107	44.80%	538	32.12%
0.003 - 0.005	1502	53.88%	325	41.89%
0.005 - 0.01	2084	66.49%	536	58.02%
0.01 - 0.05	3279	86.33%	808	0
0.05 - 0.1	832	91.37%	188	87.97%
0.1 - 0.5	1096	98.00%	279	96.36%
0.5 - 1	183	99.10%	71	98.50%
1 - 4	136	99.93%	47	99.91%
4 - 8	10	99.99%	3	100.00%
>8	2	100.00%	0	100.00%
Total	16528		3325	

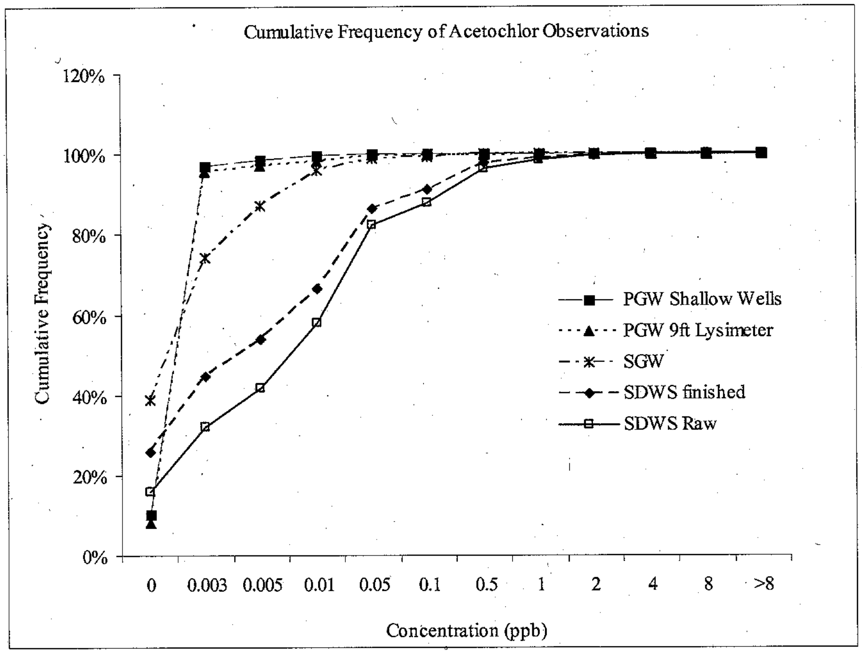


Figure 7. Cumulative frequency distribution for all acetochlor observations for each study. PGW data represented include separate distributions for the 9-foot depth lysimeter data and the shallow groundwater wells for each study.

6.3.1.2.Acute Exposure

Maximum exposures for acetochlor parent were generally higher at the SDWS sites than the PGW and SGW sites (Figure 8). Roughly 85% of the SDWS maximum overall peak finished observations for each site were below 2.0 ppb and 80% of maximum overall peak raw water observations for each site were below 2.0 ppb. Approximately 99% of the PGW and SGW peak observations were below 2.0 ppb. Median values were 0.3 for SDWS raw water, 0.25 for SDWS finished water, 0.02 for SGW ground water, and 0.004 for PGW ground water studies. The majority of overall maximum peak acetochlor concentrations for each site in the state ground water (SGW) program were less than 0.05 ppb.

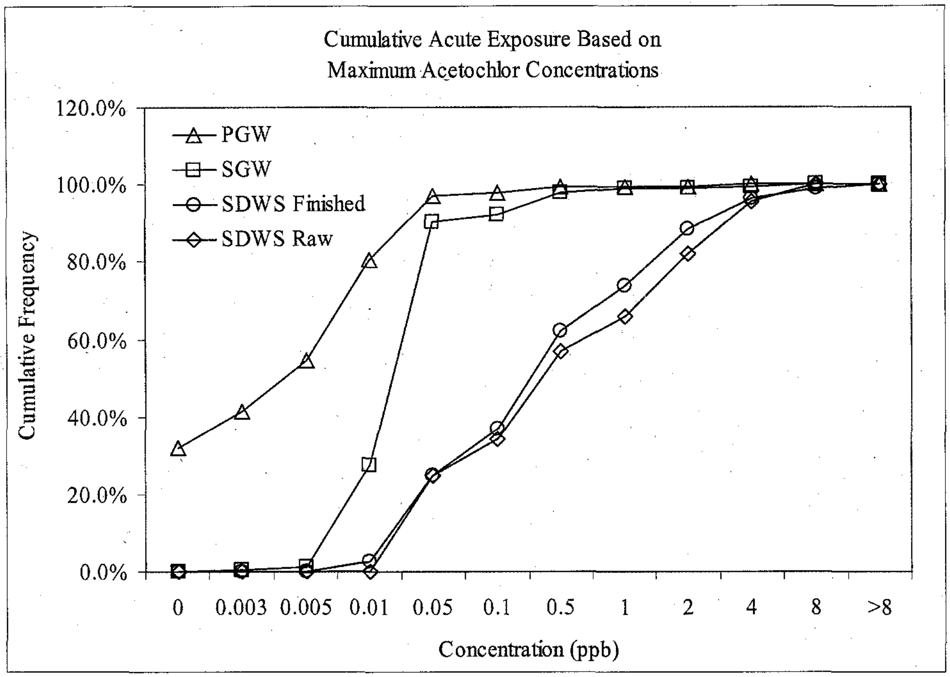


Figure 8. Cumulative frequency distribution for acetochlor acute exposure in all ARP studies, based on the maximum observed concentration at each site. PGW data maximum exposures are provided for each lysimeter and each depth.

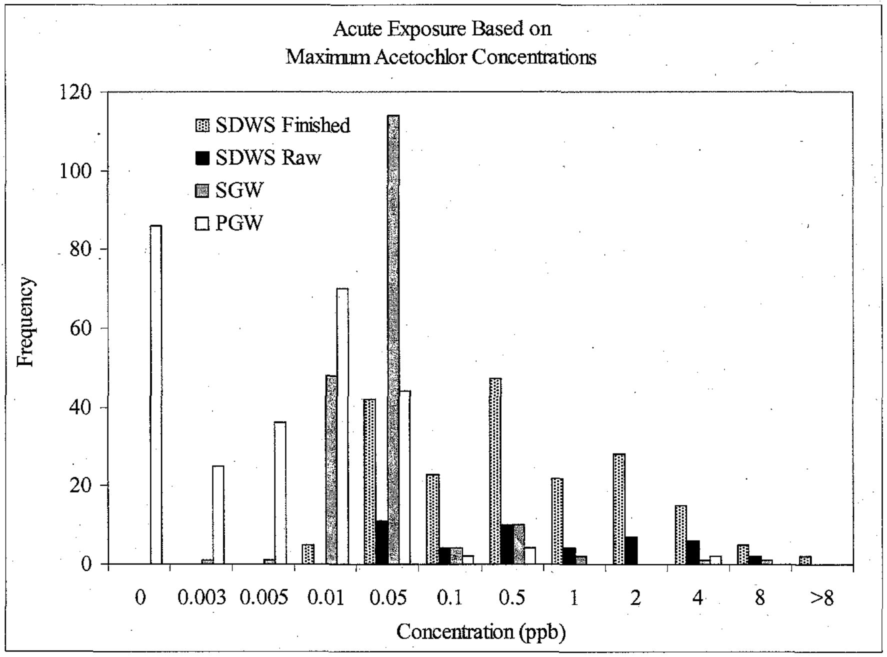


Figure 9. Distribution of acute exposure, based on the maximum observed concentration at each site. PGW data maximum exposures are provided for each lysimeter and each depth.

6.3.1.3.Acute and Chronic Exposure Distribution by Population.

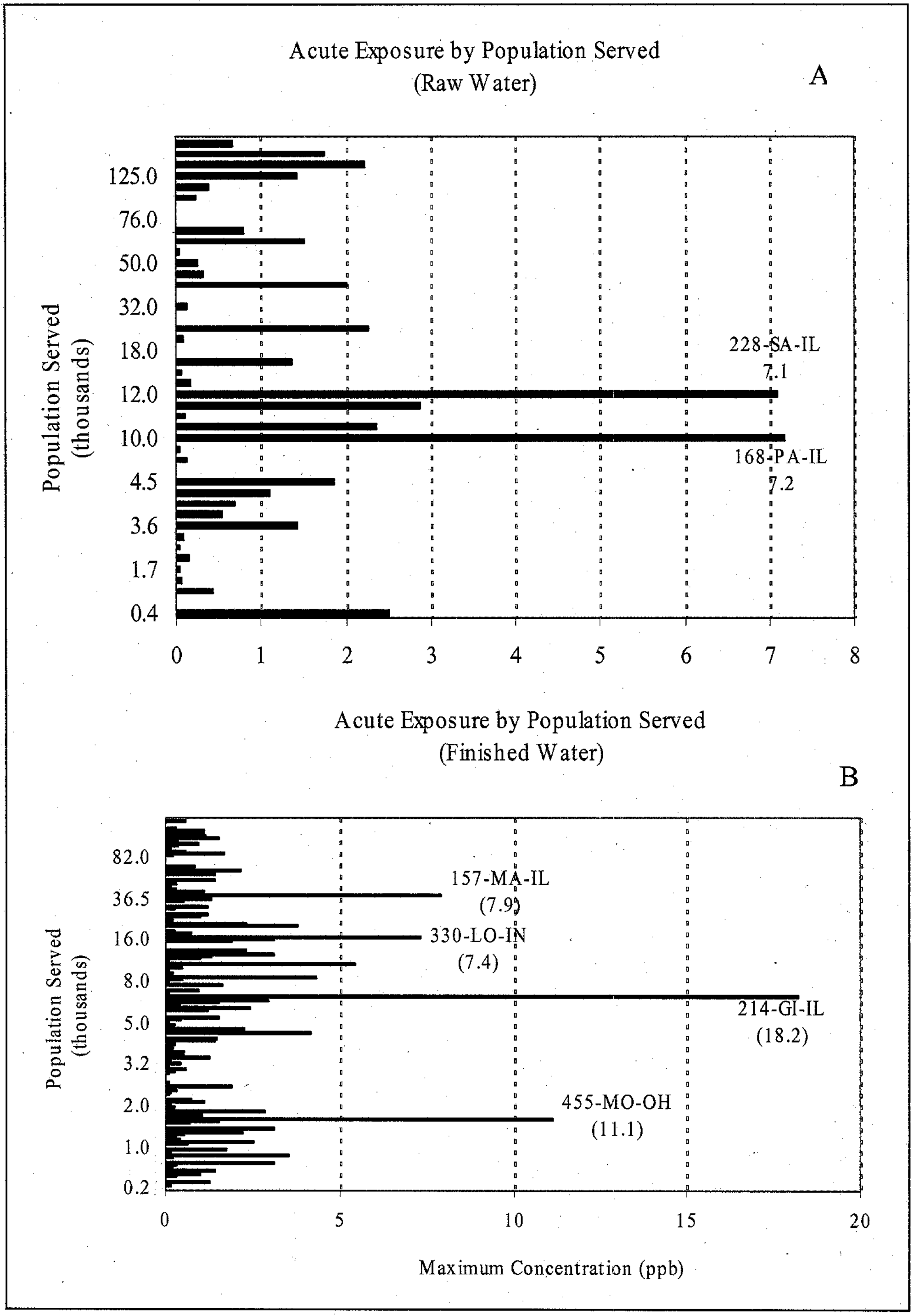


Figure 10. Acute acetochlor exposure distribution by population served for raw (A) and finished (B) water samples.

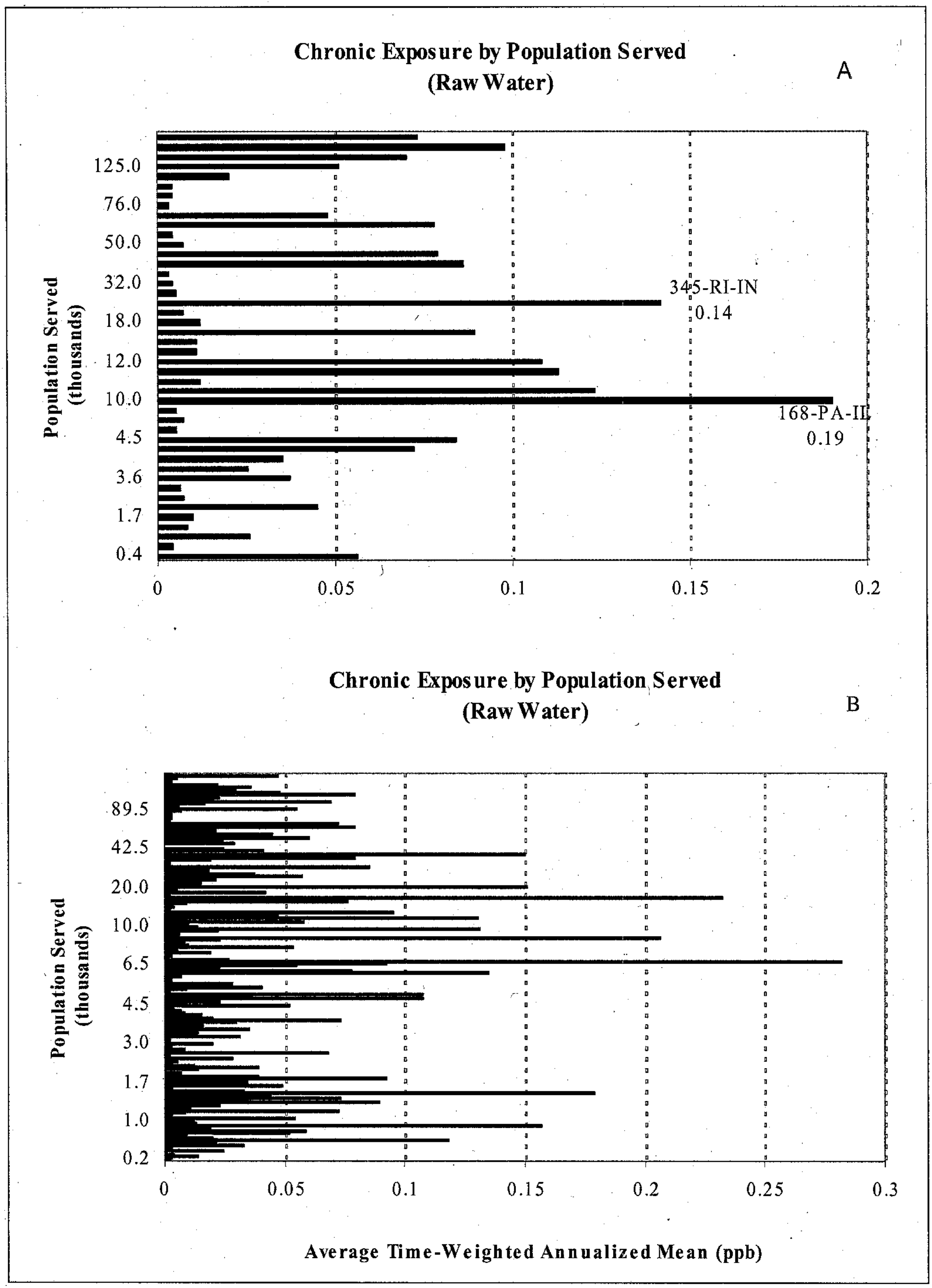


Figure 11. Chronic exposure to parent acetochlor in raw surface drinking water (SDWS) using the average time-weighted mean at each site.

6.3.1.4. Chronic Exposure Distribution by System

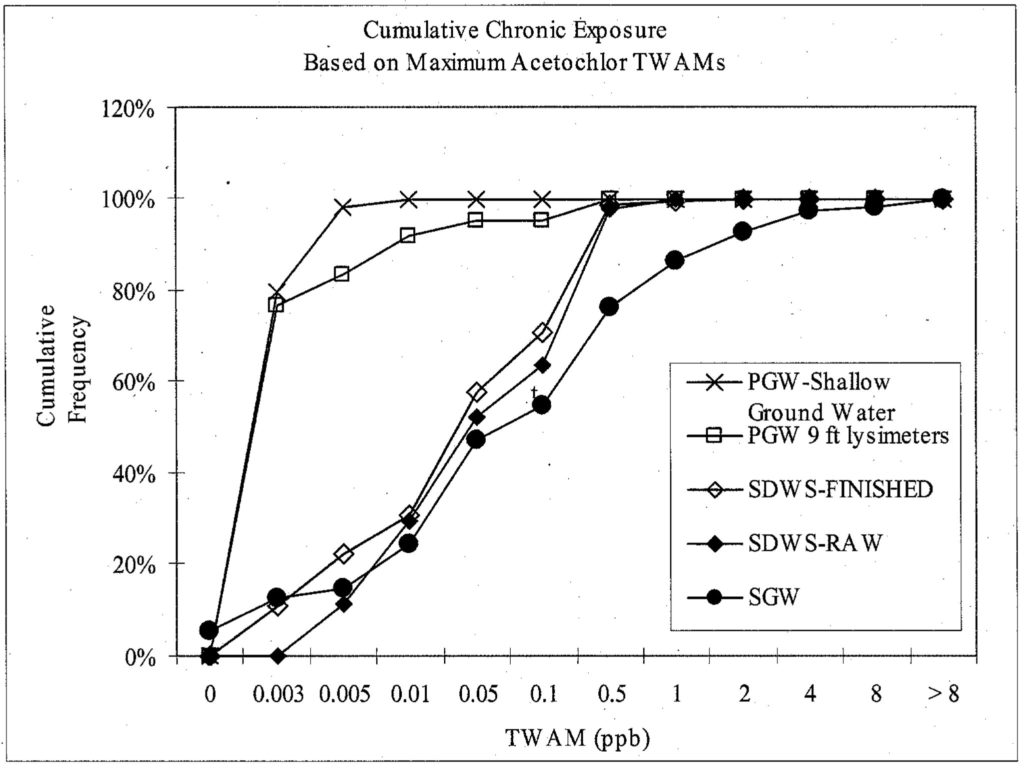


Figure 12. Cumulative frequency distribution for parent acetochlor chronic exposure, based on the highest time-weighted annual mean at each site. PGW chronic exposures are the maximum TWAM for each cluster at 9-foot depth for lysimeters and shallow monitoring wells for ground water.

6.3.2. Surface Water Factorial Analysis

For parent acetochlor, the most toxic of residues, surface water is the dominant medium of exposure. Consequently, the focus of statistical analysis was on factors related to occurrence in surface drinking water supplies. Statistical analyses examined environmental variables that could potentially explain the spatial variability among sites (e.g., watershed size, corn intensity, etc.). In addition, the relationship between raw and finished samples was examined to determine the effects of water treatment.

Appendix 12.7 presents correlation matrices for surface drinking water sites, individually for raw and finished water samples. A number of hypothesized explanatory variables were examined including watershed area, average watershed sales (1994-2003), the mean sales (1994) for the county with the overall highest sales in each watershed, watershed runoff, watershed corn intensity, 30-yr average precipitation, and 30-yr average spring precipitation (April – June). In general, the ancillary variables that were available were unable to explain a significant amount of the variability in maximum observed concentrations (acute exposure), average TWAMS, and maximum TWAMs (chronic exposure). It was originally expected that acetochlor acute and chronic exposure would be moderately to strongly correlated with the variability in acetochlor sales in the associated watersheds, however sales were only weakly correlated ($r < 0.5$).

Some associations were observed between ancillary variables as expected. For example, watershed corn intensity was moderately to strongly correlated with the watershed runoff curve number (RCN) with correlation coefficients (r) ranging from 0.78 for all sites where raw water samples were collected to 0.82

for only those sites where finished water samples were collected. The correlation between runoff curve number and watershed corn intensity is not surprising, since land cover is a factor in generating the curve number.

Statistical analysis of time-weighted means revealed no significant increase or decrease in annualized mean concentrations for acetochlor over time, nor did ARP's analysis detect a change in annualized means over the seven year monitoring period. Scatter plots for raw and finished time-weighted means can be found in Appendix section 12.7.

Raw water concentrations in the SDWS program were significantly ($p < 0.05$) greater than treated water concentrations. A paired two sample t-test for means was performed on those sites and sample dates that had both raw and finished water observations. Results of the t-test are provided in the Appendix section entitled **Statistical Analyses for the ARP monitoring Studies**. Statistical analysis indicates that water treatment plants that use granulated activated carbon (GAC) or powdered activated carbon (PAC) significantly reduce acetochlor concentrations in drinking water ($p < 0.001$)

In nearly half the cases (43%), finished water samples were moderately to strongly associated ($r >= 0.75$) with observed raw water concentrations, suggesting that finished water samples are moderately predictive of raw water concentrations. Raw water concentrations explained at least 75% of the variability in finished water concentrations for 30% of the sites. Raw water concentrations explained at least 50 % ($r^2 >= 0.5$) of the variability in finished water concentrations using a simple linear model. In general increasing the sample size (N) did not result in an increase in correlation between raw and finished water concentrations. Lack of correspondence for some sites may be partially a result of differences in sampling times for raw and finished samples and the uncertainty in residence time for each of the water treatment facilities. Because there is a time lag from when water enters the intake (raw water) to when the treatment processes in completed (finished water) it is unlikely that raw and finished samples were taken from the same volume of water.

Percent reduction due to treatment was also calculated to assess the relative success of treatment. Percent reduction was computed for those observations that had non-zero raw values using the following formula:

$$\text{Percent Reduction} = ((\text{Raw-Finished})/\text{Raw})*100.$$

Figure 13 summarizes the percent reduction in acetochlor parent in surface drinking water supplies sampled. Values on the x-axis represent percent reduction; a value of 100% indicates that all of the acetochlor was eliminated. A negative value means that the concentration went up between pre and post-treatment. Based on the chart roughly 35% of the non-zero samples had complete elimination of Acetochlor, another 15% had about an 80% reduction, another 10% had about a 60% reduction and so forth. About 12.5% of surface water samples had concentrations that increased after treatment.

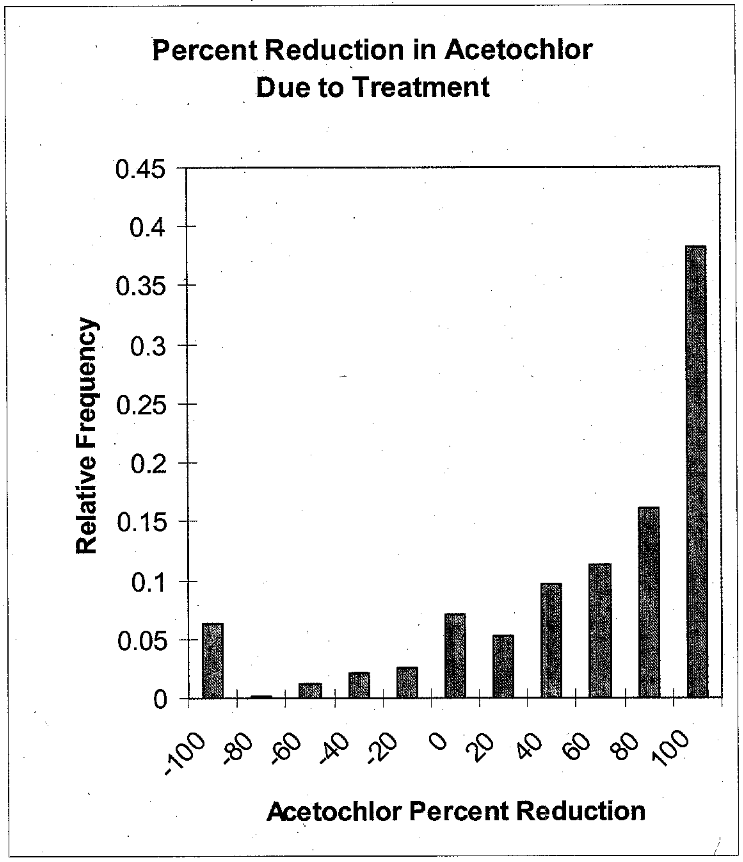


Figure 13. Percent reduction in acetochlor from pre-treatment (raw) to post treatment (finished) sample.

6.3.3. Characterization of Exposure to Surface Water

Exposure to acetochlor parent was significantly higher in the surface water monitoring sites than the ground water monitoring sites (see Figure 7, Figure 8, and Figure 12). Only the surface water monitoring samples represented water from existing drinking water intakes.

While most of the factors for selection for the ground water sites would tend to make these sites susceptible to higher levels of contamination than occurring in samples from actual drinking water wells, this is not an assumption which is directly verifiable. The preponderance of the evidence does indicate that it is proper to base the parent exposure assessment on the surface water monitoring results, nonetheless, there are still some unknowns with regard to the relative conservativeness (i.e., degree of tendency to overestimate exposure) of the ground water monitoring studies by the ARP. For example, a major limitation in a monitoring survey for a new pesticide is that the full impact of the use of the pesticide on ground water quality may not be observed for a number of years. The number of years required for residues to reach ground water at each SGW sampling site is not knowable. Data from the PGW studies show, that even with higher than average rainfall supplemented by irrigation it can take several years for some residues to reach shallow ground water, witness the Nebraska PGW site where residues of the acetochlor ethanesulfonic acid degradates were still moving through the soil pore-water at a 9-foot depth when the study was terminated more than seven years after the only acetochlor application.

The ten overall highest single acetochlor concentrations, time-weighted annualized means, and 95th percentiles for the community water systems were determined for both raw (**Table 8**) and finished (Table 9) water samples. These systems generally draw water from watersheds with high corn crop intensity (ca. 20 to 35%) and include both reservoir and river water sources (**Table 10**). Acetochlor concentrations were highest in Illinois. Eight of the ten highest raw water concentrations, time-weighted annualized means, and 95th percentiles were observed in Illinois, including the overall highest raw water concentration (7.19 ppb), TWAM (0.59 ppb), and 95th percentile (3.31 ppb) were observed at a single site (168-PA-IL) in Illinois. Similarly, six of the ten highest finished water concentrations were observed in Illinois, including the overall highest finished water concentration (18.21 ppb), TWAM (1.43 ppb), and 95th percentile (6.97 ppb) observed at 214-GI-IL. Most of the ten highest observations occurred between the years 1996-1998.

Although statistical analysis of raw versus finished water concentrations indicates that treatment does indeed <u>on average</u> significantly decrease acetochlor concentrations, the top ten finished (treated) water concentrations exceed the top ten raw (untreated) concentrations suggesting a sampling design error. In order to obtain representative samples, finished water samples should be collected after raw water samples at a time interval equal to the system treatment time, or the time required for raw water to pass completely through the treatment system. Any variance in this sampling time could result in sampling two different volumes of water.

Table 8. Ten highest raw (untreated) water concentrations of parent acetochlor at community water system (CWS) intake locations.

Maximum Single Concentration (ppb)			Maximum TWAM (ppb)			Maximum 95th %tile Concentration (ppb)[a]		
CWS Name	Value	Year	CWS Name	Value	Year	CWS Name	Value	Year
168-PA-IL	7.19	1998	168-PA-IL	0.59	1998	168-PA-IL	3.31	1998
228-SA-IL	7.09	1996	168-PA-IL	0.43	1996	222-HI-IL	2.10	1998
168-PA-IL	5.89	1996	228-SA-IL	0.40	1996	1070-WY-MO	1.81	1997
228-SA-IL	3.45	1998	222-HI-IL	0.36	1998	228-SA-IL	1.56	1996
606-KA-IL	2.88	1998	1070-WY-MO	0.32	1997	259-SP-IL	1.44	1998
1070-WY-MO	2.50	1997	345-RI-IN	0.30	1997	168-PA-IL	1.39	1996
222-HI-IL	2.36	1998	222-HI-IL	0.26	1996	225-CE-IL	1.38	1998
345-RI-IN	2.27	1997	259-SP-IL	0.25	1998	228-SA-IL	1.37	1998
259-SP-IL	2.22	1998	606-KA-IL	0.23	1996	603-BL-IL	1.28	1995
225-CE-IL	2.01	1999	603-BL-IL	0.23	1995	557-DM-IA	1.13	2001

[a] Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 9. Ten highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations.

Maximum Single Concentration (ppb)			Maximum TWAM (ppb)			Maximum 95th %tile Concentration (ppb) [a]		
CWS Name	Value	Year	CWS Name	Value	Year	CWS Name	Value	Year
214-GI-IL	18.21	1996	214-GI-IL	1.43	1996	214-GI-IL	6.97	1996
455-MO-OH	11.14	1997	455-MO-OH	0.58	1997	168-PA-IL	3.01	1998
157-MA-IL	7.93	1996	166-NE-IL	0.53	1996	340-NV-IN	2.87	1996
330-LO-IN	7.35	1997	214-GI-IL	0.49	1998	182-GE-IL	2.70	1998
168-PA-IL	5.43	1998	168-PA-IL	0.48	1998	166-NE-IL	2.67	1996
455-MO-OH	5.17	1996	157-MA-IL	0.46	1996	143-SO-IL	2.65	1998

340-NV-IN	4.31	1996	330-LO-IN	0.42	1997	214-GI-IL	2.21	1998
214-GI-IL	4.28	1998	182-GE-IL	0.39	1998	518-US-OH	2.03	1996
537-WM-OH	4.16	2000	518-US-OH	0.37	1996	330-LO-IN	1.94	1996
168-PA-IL	4.14	1996	340-NV-IN	0.37	1996	242-CO-IL	1.71	1996

[a] Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 10. Watershed characteristics for the ten highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations.

CWS Name	**Watershed Area, acres**	**Type**	**Reservoir Volume or Area**	**% Corn Intensity**
214-GI-IL	2996	Reservoir	1200 mg	25.0
455-MO-OH	138245	River	NA	18.7
157-MA-IL	11916	Reservoir	900 mg	34.5
330-LO-IN	524144	River	NA	28.3
168-PA-IL	11733	Reservoir	900 mg	38.7
455-MO-OH	138245	River	NA	18.7
340-NV-IN	68241	River	NA	21.0
214-GI-IL	2966	Reservoir	250 mg	25.0
537-WM-OH	427302	River	NA	28.3
168-PA-IL	11733	Reservoir	900 mg	38.7

The highest overall maximum TWAM, single concentration, and 95th percentile was observed in Illinois, followed by Missouri at nearly half the maximum concentrations observed in Illinois (Table 11 and Table **12**). The top ten raw (untreated) water TWAMs, peak concentrations, and peak 95th percentile concentrations ranged from ranged from 0.007 ppb in WI to 0.591 ppb in IL, 0.044 ppb in OH to 7.186 ppb in IL, 0.019 ppb in PA to 3.313 ppb in IL, respectively. Peak finished (treated) water concentrations were again sometimes higher than pre-treated water samples. The top ten treated water TWAMs, peak concentrations, and peak 95th percentile concentrations ranged from 0.004 in MD to 1.428 ppb in IL, 0.034 ppb in MD to 18.21 ppb in IL, 0.011 in DE to 6.973 in IL, respectively. The highest maximum TWAM for MD occurred three times at two different sites (**Table 12**).

Table 11. Highest raw (untreated) water concentrations of parent acetochlor at community water system (CWS) intake locations in each state (sorted by Max TWAM).

Max TWAM (ppb)				Maximum Single Concentration (ppb)				Max. 95th %tile Concentration (ppb) [a]			
State	Value	Year	CWS Name	State	Value	Year	CWS Name	State	Value	Year	CWS Name
IL	0.591	1998	168-PA-IL	IL	7.186	1998	168-PA-IL	IL	3.313	1998	168-PA-IL
MO	0.317	1997	1070-WY-MO	MO	2.504	1997	1070-WY-MO	MO	1.807	1997	1070-WY-MO
IN	0.304	1997	345-RI-IN	IN	2.265	1997	345-RI-IN	IN	1.118	1997	345-RI-IN
IA	0.217	1996	574-OS-IA	IA	1.762	2001	557-DM-IA	IA	1.129	2001	557-DM-IA
KS	0.085	1999	89-MI-KS	KS	0.426	1999	89-MI-KS	KS	0.272	1999	89-MI-KS
NE	0.045	2001	301-BL-NE	NE	0.161	2001	301-BL-NE	NE	0.131	2001	301-BL-NE
MN	0.019	1999	296-SC-MN	MN	0.251	1999	296-SC-MN	MN	0.066	1999	296-SC-MN
OH	0.010	2001	452-MC-OH	OH	0.044	2001	452-MC-OH	OH	0.033	2001	452-MC-OH
PA	0.010	1996	737-AW-PA	PA	0.241	1996	737-AW-PA	PA	0.019	1998	737-AW-PA
WI	0.007	1996	13-AP-WI	WI	0.046	1996	18-OK-WI	WI	0.024	1996	18-OK-WI

[a] Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 12. Highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations in each state.

Max TWAM (ppb)				Maximum Single Concentration (ppb)				Max. 95th %tile Concentration (ppb)			
State	Value	Year	CWS Name	State	Value	Year	CWS Name	State	Value	Year	CWS Name
IL	1.428	1996	214-GI-IL	IL	18.21	1996	214-GI-IL	IL	6.973	1996	214-GI-IL
OH	0.584	1997	455-MO-OH	OH	11.14	1997	455-MO-OH	OH	2.03	1996	518-US-OH
IN	0.416	1997	330-LO-IN	IN	7.353	1997	330-LO-IN	IN	2.872	1996	340-NV-IN
MO	0.258	1998	1098-GE-MO	MO	1.289	1997	1070-WY-MO	MO	1.114	1998	1098-GE-MO
IA	0.207	1996	570-MO-IA	IA	2.328	1998	572-MP-IA	IA	1.402	1998	572-MP-IA
KS	0.133	2001	125-TO-KS	KS	1.88	1999	25-AT-KS	KS	0.983	1999	71-KC-KS
PA	0.092	1995	729-PH-PA	PA	2.34	1995	729-PH-PA	PA	0.045	1995	769-RE-PA
NE	0.088	1999	301-BL-NE	NE	1.116	1995	303-OM-NE	NE	0.288	2001	303-OM-NE
WI	0.039	1997	17-ME-WI	WI	0.192	1997	17-ME-WI	WI	0.167	1997	17-ME-WI
DE	0.025	1998	652-WI-DE	DE	0.598	1998	652-WI-DE	DE	0.011	1998	651-NE-DE
MN	0.006	1999	296-SC-MN	MN	0.043	1997	277-MI-MN	MN	0.03	1999	296-SC-MN
MD**	0.004	2001	702-LA-MD	MD	0.034	1996	699-HG-MD	MD	0.012	1996	699-HG-MD

[a] Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

** There are also two other Maryland sites with concentration values of 0.004 ppb

6.3.4. Comparison of ARP and WARP beta Model Results

Table 13 presents the highest acetochlor concentrations modeled by the WARP beta model (USGS 2004) for states where ARP also had surface water monitoring locations. For comparison, the top ten peak raw water concentrations measured by the ARP for community water supply systems are also provided. In both data sets, the majority of the top ten peak concentrations were located in Illinois. In general, the maximum time-weighted annualized means measured by the ARP are close to those modeled by WARP, as are the 95%tile values. Recall that the 95th percentile values represent the fraction of the year (e.g., 95 percent of the time) that the concentration was equal to or less than the listed value (USGS 2004).

The modeling results are based on use estimates provided by the National Center for Food and Agricultural Policy (http://www.ncfap.org/database/default.php) These data are different than the annual sales data provided by the ARP. The USGS modeling is based on nationally available hydrologic and soils data.

Table 13. Top ten highest raw water concentrations (ppb) of parent acetochlor modeled by WARP multi-compound regression model and measured by ARP at community water system (CWS) intakes.

WARP results (Beta version, results supplied by USGS) are only for states where ARP also had surface water monitoring locations. WARP data are ranked by maximum 95%tile and measured results by ARP are ranked separately by maximum time-weighted mean and 95%tile.

WARP			ARP				
			Max Single Conc.	Max TWAM		Max 95%tile Conc. [a]	
Site	TWAM	95%tile Conc.		Value	CWS Name	Value	CWS Name
KASKASKIA RIVER (E. FORK) FARINA, IL	0.81	3.77	7.19	0.59	168-PA-IL	3.31	168-PA-IL
LITTLE WABASH RIVER FLORA, IL	0.56	2.64	7.09	0.43	168-PA-IL	2.10	222-HI-IL
LITTLE WABASH RIVER CLAY CITY, IL	0.55	2.60	5.89	0.40	228-SA-IL	1.81	1070-WY-MO
LITTLE WABASH RIVER FAIRFIELD, IL	0.54	2.59	3.45	0.36	222-HI-IL	1.56	228-SA-IL
KASKASKIA RIVER (E. FORK) FARINA, IL	0.54	2.50	2.88	0.32	1070-WY-MO	1.44	259-SP-IL
WILDCAT CREEK KOKOMO, IN	0.52	2.31	2.50	0.30	345-RI-IN	1.39	168-PA-IL
WHITE RIVER NORTH INDIANAPOLIS, IN	0.50	2.28	2.36	0.26	222-HI-IL	1.38	225-CE-IL
KASKASKIA RIVER EVANSVILLE, IL	0.48	2.24	2.27	0.25	259-SP-IL	1.37	228-SA-IL
KASKASKIA RIVER FAYETTEVILLE TWP, IL	0.48	2.22	2.22	0.23	606-KA-IL	1.28	603-BL-IL
KASKASKIA RIVER NEW ATHENS TWP, IL	0.47	2.22	2.01	0.23	603-BL-IL	1.13	557-DM-IA

[a] Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

6.3.5. Summary Results of National Water Quality Assessment (NAWQA) Results

NAWQA data (NAWQA a long-term multi-faceted monitoring program being conducted by the USGS) have included serial monitoring for a large schedule of pesticides, including acetochlor in multiple study areas across the United States. NAWQA monitoring sites are not selected to represent the locations of drinking water intakes nor are they directly selected to represent sites at which specific pesticides are used. They do, however, represent ambient pesticide concentrations in the environment, include many watersheds where agriculture is the documented dominant land use, and may be an indication of vulnerability of sites to runoff of acetochlor (These data are used as an indication of the occurrence pattern and concentration of pesticides in surface source water). Table 14 summarizes acetochlor monitoring concentrations measured in NAWQA study unit locations. The two columns of data represent overall (non-time weighted) mean and maximum concentration data at all sites for which the maximum concentration value is above 1.00 ppb.

Table 14. Acetochlor monitoring concentrations at NAWQA study unit locations.

Site Name	Mean Conc (ppb)	Max Conc (ppb)
MAPLE CREEK NEAR NICKERSON, NE	1.359	61.00
SUGAR CREEK AT MILFORD, IL	0.993	35.90
ELKHORN RIVER AT WATERLOO, NE	1.304	31.00
PLATTE R AT LOUISVILLE NE	0.416	14.20
LA MOINE RIVER AT COLMAR, IL	0.532	11.60
LITTLE COBB RIVER NEAR BEAUFORD, MN	0.361	10.70
MAUMEE RIVER AT WATERVILLE OH	0.596	10.60
SKUNK RIVER AT AUGUSTA, IA	0.768	10.60
SANGAMON RIVER AT MONTICELLO, IL	0.510	9.71
MAUMEE RI AT NEWHAVEN IN	0.710	8.88
OLD MANS CREEK NEAR IOWA CITY, IA	0.636	8.16
WEST FORK CEDAR RIVER AT FINCHFORD, IA	0.366	7.62
SUGAR CREEK AT CO RD 400 S AT NEW PALESTINE, IN	0.238	7.17
CEDAR RIVER NEAR CONESVILLE, IA	0.376	7.10
ST JOSEPH RIVER NEAR NEWVILLE IN	0.373	5.61
AUGLAIZE RIVER NEAR FORT JENNINGS OH	0.515	5.13
LITTLE BUCK CREEK NEAR INDIANAPOLIS, IN	0.053	4.20
MAD RIVER AT ST PARIS PIKE AT EAGLE CITY OH	0.065	4.02
BLACK RIVER NR JEDDO MI	0.292	3.80
CLEAR CK NR SANGER, TX	0.115	3.59
WHITE RIVER AT HAZLETON, IN	0.194	3.56
IOWA RIVER NEAR ROWAN, IA	0.116	3.50
WAPSIPINICON RIVER NEAR TRIPOLI, IA	0.188	3.09
DUCK CREEK AT SEMINARY ROAD NEAR ONEIDA, WI	0.124	2.90
IOWA RIVER AT WAPELLO, IA	0.159	2.89
FLOOD CREEK NEAR POWERSVILLE, IA	0.164	2.56
WAPSIPINICON RIVER NEAR DE WITT, IA	0.360	2.30
BOGUE PHALIA NR LELAND, MS	0.068	2.28
ENGLISH RIVER AT RIVERSIDE, IA	0.117	2.23
ILLINOIS RIVER AT VALLEY CITY	0.240	2.01
ILLINOIS RIVER AT OTTAWA, IL	0.260	2.00
BIG SUNFLOWER RIVER NR ANGUILLA, MS	0.104	1.68
CEDAR RIVER AT GILBERTVILLE, IA	0.111	1.66
IOWA RIVER AT MARENGO, IA	0.184	1.50
MINNESOTA RIVER NEAR JORDAN, MN	0.143	1.50
YAZOO RIVER BL STEELE BAYOU NR LONG LAKE, MS	0.036	1.45
PLATTE RIVER NEAR GRAND ISLAND, NEBR.	0.133	1.40
SOUTH FORK IOWA RIVER NE OF NEW PROVIDENCE, IA	0.090	1.36
WOLF CREEK NEAR DYSART, IA	0.121	1.25

6.3.6. USGS / EPA Pilot Reservoir Monitoring Program

The highest levels of chronic exposure to acetochlor parent most often occur in reservoirs 1(compared to streams and rivers and to ground water), and a significant source of additional monitoring for a number of pesticides in settings of high vulnerability is provided in Bloomquist et al. (2001). Each sampling site included in the USGS reservoir monitoring study consisted of both a reservoir (raw water sample source) and a Community Water System (finished water source). The study focused on small drinking-water supply reservoirs in areas with high pesticide use (not necessarily high acetochlor use areas). The program was implemented with a NAWQA design structure and strong consideration in site selection was given to sites within existing NAWQA Study Units. One drinking water reservoir was chosen in each of 12 states: California, Indiana, Ohio, Oklahoma, Louisiana, Missouri, South Carolina, South Dakota, New York, North Carolina, North Carolina, Pennsylvania and Texas. No samples were taken in Illinois, a high acetochlor usage state.

Table 15. Maximum acetochlor concentration values in pilot reservoir monitoring study (Bloomquist et al., 2001).

State	Reservoir	Maximum Conc (ppb)
SD	Mitchell	0.395
SD	Mitchell	0.395
SD	Mitchell	0.375
SD	Mitchell	0.354
SD	Mitchell	0.334
SD	Mitchell	0.324
SD	Mitchell	0.289
OH	Clermont	0.284
SD	Mitchell	0.265
SD	Mitchell	0.249
SD	Mitchell	0.229

The maximum concentration in the intake water at the Mitchell, South Dakota site was 0.334 ppb and the concentrations in both the outflow from the CWS treatment facility and the reservoir were 0.395 ppb. The highest 67 concentration values were all found at the South Dakota, Ohio and Indiana sites.

6.4. Ground Water

6.4.1. PGW Leaching Summary

Two separate data files were used in this analysis (Table 5). One file contained all the concentration values observed in the PGW studies provided by the ARP, while the second contained raw uncensored concentrations also provided by the ARP. Because of the overwhelming number of censored values (defined in this context as values that were not reported numerically – generally because of the precision and accuracy limitations of the analytical method for low residue levels), the PGW uncensored file was used to compute time-weighted annualized means and percentiles. The underlying assumption here is that the uncensored data represent the best available estimates of unmeasured values (any substitution method for nondetects would be arbitrary).

6.4.2. Comparison of PGW Results to the Acetochlor Regulatory Action Endpoints

The conditional registration agreement states that automatic cancellation of acetochlor will occur if "out of the eight sites, 4 sites in a variety of geographic, and climatic conditions under both vulnerable and general use conditions (as determined by EPA) in corn growing states indicate a pattern of movement of acetochlor toward ground water" (USEPA 1994). ". In the PGW studies, one indication of a pattern of movement was defined as the detection of acetochlor greater than or equal to 1.0 ppb at nine foot lysimeter depth as well as corresponding three and 6 foot depths in that cluster. Table 16 indicates that only one site (Iowa) had detections greater than 1.0 ppb, and moreover it was the only site to have detected concentrations greater than 0.1 ppb in the nine foot lysimeters.

Peak concentrations of the parent acetochlor were determined for each state and are presented separately for three foot lysimeters (Table 17), nine foot lysimeters (Table 18), shallow ground water (Table 19), and deep ground water (Table 20). The maximum soil-pore water residue for parent acetochlor was measured as 3.2 ppb, which was observed in the 9 ft (2.7 m) lysimeters in Iowa (Table 18). According to the pgw_num_final.txt file provided by the registrant, the maximum residue observed in ground water was 0.06 ppb, observed in Iowa. Concentrations in the deep ground water monitoring wells (**Table 20**) were only slightly lower than concentrations in the shallow ground water wells.

Table 16. PGW Sites exceeding 0.1 ppb at 9 feet depth (exceedences only occurred at 1 of the 8 sites).

MAT	DATE[a]	STATE	DEVICE	DEPTH	CLUSTER	RAW CONCENTRATION
0.5	6/24/1996	IA	LY	9	1	2.6
1	7/9/1996	IA	LY	9	1	0.195
0.5	6/24/1996	IA	LY	9	3	3.2
1	7/9/1996	IA	LY	9	3	0.628
1.5	7/24/1996	IA	LY	9	3	0.208
2	8/8/1996	IA	LY	9	3	0.102
0.5	6/24/1996	IA	LY	9	4	0.132
0.5	6/24/1996	IA	LY	9	6	0.365

[a] Date was not provided, but was approximated using the initial treatment date, months after treatment, and assuming average of 30 days per month.

Table 17. Concentrations of AC observed in 3-foot lysimeters from the eight prospective ground water studies.

Max TWAM	Max 95 %tile	Max Concentration

STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.004	0.009	0.008	0.019	0.009	0.024	0.012
IA	0.000	0.000	0.000	0.000	0.000	0.003	0.000
IN	0.006	0.045	0.028	0.195	0.047	0.330	0.228
MN	0.001	0.001	0.000	0.000	0.001	0.001	NA
NE	0.004	0.007	0.010	0.017	0.011	0.018	0.011
OH	NA	NA	NA	NA	NA	0.025	NA
PA	0.009	0.068	0.016	0.129	0.020	0.156	0.118
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed based on uncensored data file; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

Table 18. Concentrations of AC observed in 9-foot lysimeters from the eight prospective ground water studies.

	Max TWAM		**Max 95 %tile**		**Max Concentration**		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.004	0.006	0.006	0.013	0.006	0.014	0.009
IA	0.458	1.639	0.820	2.931	0.900	**3.200**	1.345
IN	0.000	0.000	0.000	0.000	0.000	0.003	0.000
MN	0.000	0.001	0.000	0.000	0.000	0.003	NA
NE	0.003	0.007	0.006	0.018	0.010	0.018	0.011
OH	NA	NA	NA	NA	0.003	0.003	NA
PA	0.003	0.013	0.010	0.061	0.015	0.072	0.062
WI	NA	NA	NA	NA	0.003	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; the ARP provided no uncensored data implying the data was all below detection ; NA = Insufficient uncensored concentrations to compute the value

Table 19. Concentrations of AC observed in Shallow ground water from the eight prospective ground water studies.

	Max TWAM		**Max 95 %tile**		**Max Concentration**		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.002	0.003	0.005	0.008	0.005	0.008	0.004
IA	0.000	0.000	0.000	0.000	0.000	0.025	0.002
IN	0.001	0.000	0.000	0.000	0.003	0.005	0.002

MN	NA	NA	NA	NA	0.003	0.003	NA
NE	0.003	0.008	0.006	0.014	0.007	0.027	0.011
OH	NA	NA	NA	NA	NA	0.003	NA
PA	0.002	0.005	0.003	0.009	0.004	0.011	0.005
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across wells for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

Table 20. Concentrations of AC observed in Deep ground water from the eight prospective ground water studies.

	Max TWAM		**Max 95 %tile**		**Max Concentration**		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.002	0.003	0.006	0.007	0.006	0.008	0.005
IA	0.001	0.003	NA	NA	0.002	**0.06**	NA
IN	0.002	0.004	NA	NA	0.003	0.006	NA
MN	0.005	0.010	NA	NA	0.007	0.014	NA
NE	0.002	0.003	0.007	0.010	0.007	0.012	0.008
OH	NA	NA	NA	NA	NA	0.003	NA
PA	0.001	0.002	0.003	0.008	0.005	0.013	0.005
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across wells for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

6.4.3. SGW Summary

In addition to PGW studies, the ARP was required to monitor 25 wells in each of the expected seven high use states (WI, IL, IA, MN, IN, NE, KS) shown in Figure 4. Sites ranged from vulnerable to general use conditions, including diverse geographic, soil, and climatic conditions.
Numerous studies have demonstrated that the time to recharge of shallow superficial aquifer from the land surface can be several years or more (including the results at some of the ARP's PGW sites - for acetochlor degradates). Therefore, the 7 years of state ground water monitoring data may under-estimate the full potential leaching of acetochlor and its degradates to ground water if this chemical is used annually and with significant frequency for the next 10 or 20 years. Additional concerns relate to the lack of definitive confirmation by the ARP of a hydraulic connection between the ARP monitoring sites and the sampled ground water (i.e., data were not collected specifically to confirm the direction of vadose zone flow and transport during the course of the SGW study). The ARP states the following about how they obtained adequate justification of the locations of their wells in relation to fields treated with acetochlor as part of the SGW program:

> Monitoring wells were sited within or closely adjacent to, and down-gradient of the study plot. Various sources of published ground water data were used (for example, the Department of Natural Resources Hydrologic Assessment, the USGS Hydrologic Atlas and local university data) to assess ground water flow direction for most sites. At sites where published ground water data were not available, trained hydrogeologists evaluated topography in conjunction with surface water drainage features in order to assess ground water flow direction. (Source: De Guzman et al., in press).

The ARP did not attempt to determine the age of the ground water sampled at any location or confirm the travel times for water from the treated field to the sampled ground water via use of tracers. Some indication, at least, may be obtained of the intrinsic vulnerability of the ground water sampled to contamination from leachable pesticides by evaluation of the patterns of detection of other corn herbicides at the SGW sites (atrazine, alachlor, metolachlor, and metabolites of alachlor and metolachlor were routinely analyzed along with acetochlor residues for in all well water samples).

The monitoring data serve as an early indication that pesticide residues may be reaching ground water. ARP found that parent acetochlor demonstrated a confirmed pattern of movement to ground water above 0.1 ppb at only seven sites. However, Table 1 of Appendix 12.8 indicates that acetochlor was detected above 0.1 ppb in 14 individual wells located across five states.

6.4.3.1.Comparison of SGW Results to Regulatory Action Endpoints

In the SGW study parent acetochlor in seven of the approximately 175 wells (there were some wells replaced and lost during the coarse of the study) exceeded a literal interpretation of the SGW regulatory trigger involving a pattern of detections at 0.10 ppb or greater (20 wells with such a pattern of detection would have triggered regulatory action to mitigate ground water contamination). The rate of detection of both acetochlor degradates was much higher than for parent over the 1999 to 2001

6.4.3.2.SGW Acute Exposure

The distribution of maximum observed acetochlor concentrations for each site is given in **Figure 14**. Overall, the majority of values were reported as 0.05 ppb. No sites had detections of acetochlor greater than 8.0 ppb, and only one site had a maximum concentration between 4 and 8 ppb. Roughly 90% of the peak acetochlor values observed for each site were less than or equal to 0.5 ppb.

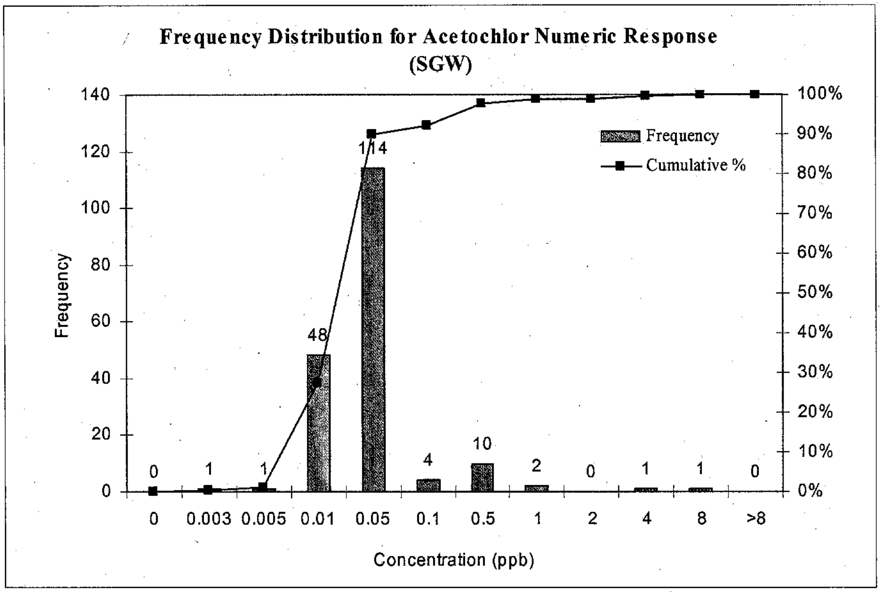


Figure 14. Distribution of maximum acetochlor concentrations observed at each site in the state ground water program.

6.4.3.3.SGW Annual Means

Time-weighted annualized means were computed for each site in the SGW data set based on numeric response data submitted by the ARP. Figure 15 shows the frequency of each time-weighted annualized mean as well as the cumulative frequency distribution. A total of 1,207 annualized means were calculated, with roughly 85% of the TWAMs less than or equal to 0.003.

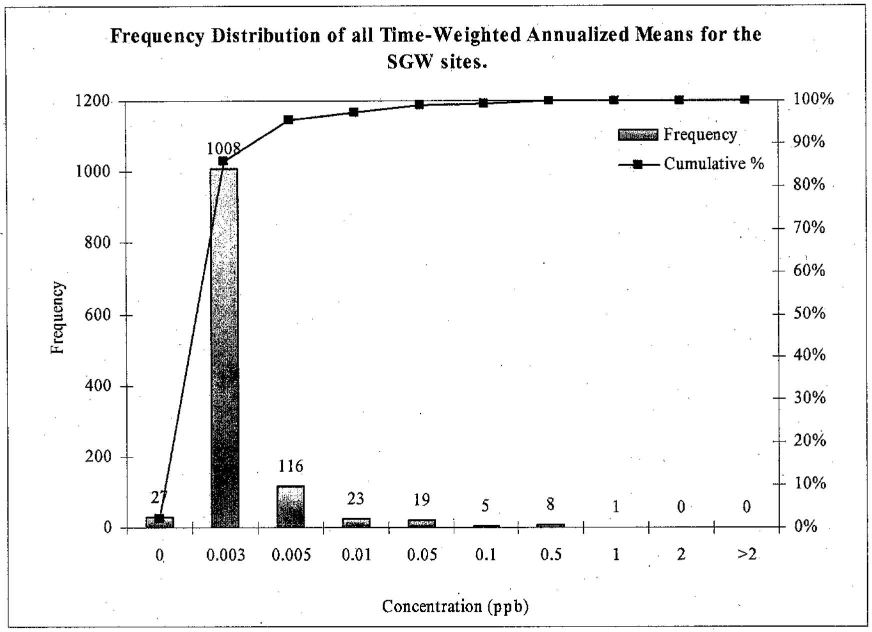


Figure 15. Distribution of all time-weighted annualized means for sites in the state ground water (SGW) monitoring program.

6.4.3.4. Ground Water Factor Analysis

Several environmental variables in the PGW studies were examined to assess their role in observed acetochlor concentrations. Given that at most sites acetochlor was only applied in the first year of the study, this analysis used acute concentrations as the dependent variable. Acute exposure was analyzed individually for three and six foot lysimeters, as well as shallow groundwater. Several hydrogeologic and meteorological factors were selected as independent variables. Factors included average pore water velocity at each site, average hydraulic conductivity, average hydraulic gradient, precipitation for the first three months after treatment, annual precipitation for the 1st year after treatment, 2nd year, 3rd year, and 4th year after treatment, as well as total precipitation during the monitoring period. Results of the analysis are provided in Appendix

Acute exposure in nine foot lysimeters was weakly correlated with annual precipitation 2 years after treatment. Acute exposure in shallow ground water was weakly correlated with total precipitation during the monitoring period, as well as acute exposure in nine foot lysimeters. None of the correlations were statistically significant at $p = 0.05$.

ARP's analysis of the state ground water monitoring program indicated that soil texture was originally hypothesized to be a factor in the geographic distribution of detections. Rather, the detection of acetochlor in shallow ground water was more influenced by site-specific factors related to site topography, irrigation practices, surface water drainages, and the vertical location of the well-screen. Based on the limited availability of data, and given that the scope of the current risk assessment does not attempt to predict concentrations in ground water, no further statistical analysis is warranted at this time.

7. RESIDUES - ACETOCHLOR DEGRADATES

Although the purpose of this assessment is to focus on exposure to the parent acetochlor, some attention was given to the two acetochlor degradates, ethanesulfonic acid (ESA) and oxanilic acid (OXA), monitored in this study. Each of the two degradates were measured in all three monitoring programs. In addition to results for the individual degradates, total combined residues were computed for acetochlor. Each of the degradates were given the same weight as the parent acetochlor using equation three.

Equation 3:

$C_{\text{Combined Residue}} = C_{\text{parent}} + C_{\text{ESA}} + C_{\text{OXA}}$, where C is the concentration in ppb.

Note that if at some point a risk assessment for combined residues would be needed, these calculations would have to be converted to a molar basis before application of any relevant potency factors to such an assessment.

7.1. Surface Water

7.1.1. Acute Exposure Distributions by SDWS Sites

Acute exposure of acetochlor ethanesulfonic acid and oxanilic acid, as well as the combined residues and are presented as a cumulative distribution function in Figure 16. The lines indicate the frequency at which the degradates or combined residues concentration were detected at or below a given concentration. In addition, as the CDF line shifts to the right it indicates a higher concentration at a given frequency. In general, maximum raw water concentrations were greater than finished water samples for both degradates and combined residues up to approximately 0.5 ppb. However, finished water concentrations exceeded maximum raw water once concentrations exceeded roughly 0.5 ppb. This shift in raw versus finished concentrations can be seen at the point where the dotted line intersects the solid line.

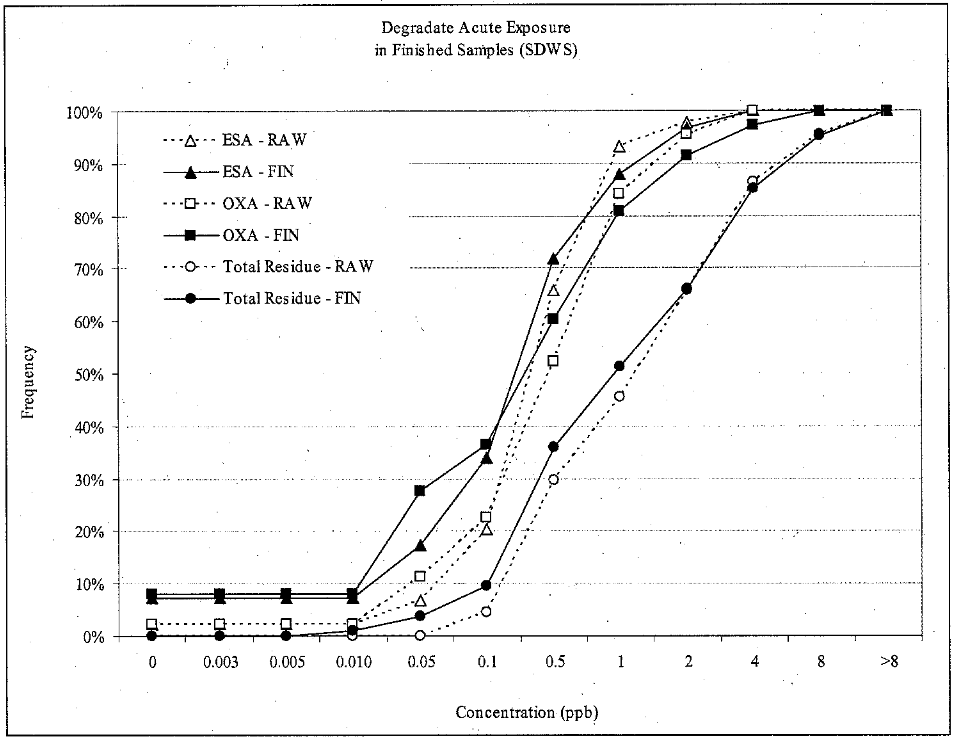


Figure 16. Maximum observed concentrations (acute) of the two acetochlor degradates and Total Combined residues (parent + ESA + OXA) in raw (dashed) and finished (solid) surface drinking water samples.

Percent reduction of ESA and OXA (Figure 17) was also computed for dates where both a raw and finished water sample pair was available. In general OXA had a higher percent reduction than ESA. As with the parent acetochlor, in some cases the finished water sample was higher than the raw water sample as indicated by a negative percent reduction on the chart.

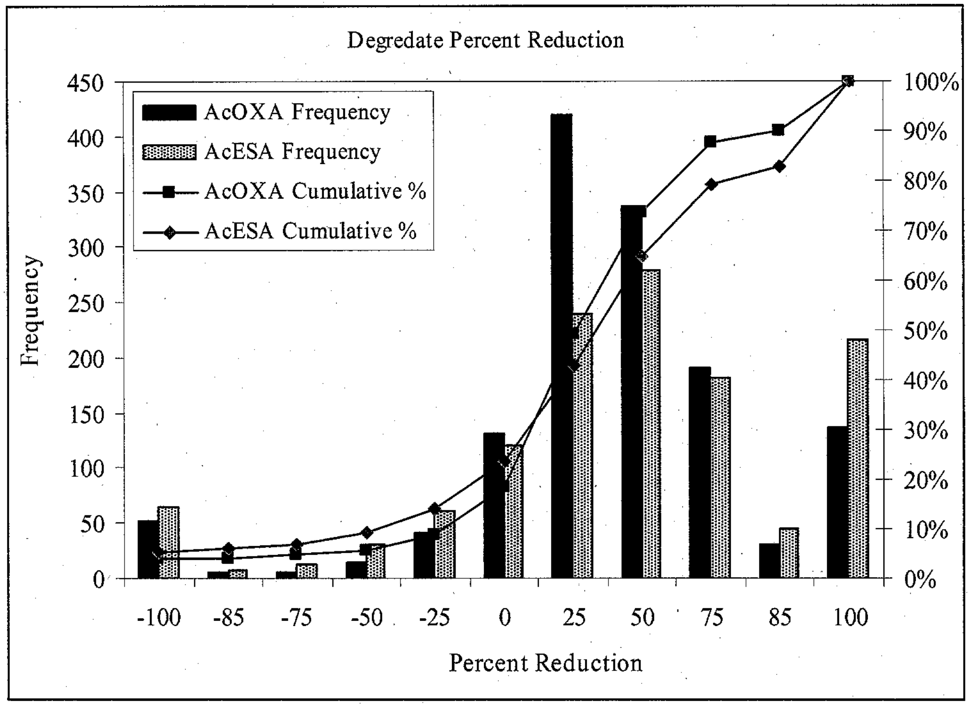


Figure 17. Percent reduction of acetochlor degradates in surface drinking water supplies.

7.1.2. Chronic Exposure Distributions

Chronic exposure for acetochlor degradates and combined residues were also determined for the surface drinking water supplies. Figure 18 presents the cumulative distribution of chronic exposure based on the maximum time-weighted annualized mean for each site. The total residue was computed by summing the concentrations for the parent and degradates. Therefore, the chart only reflects sample observations where a sample was analyzed for both the parent and degradates.

The chart demonstrates that overall, TWAMs for each of the degradates and total combined residues were higher in raw water samples (dotted lines) than in finished water samples (solid lines). This again emphasizes the importance of surface water treatment in reducing exposure to acetochlor degradates.

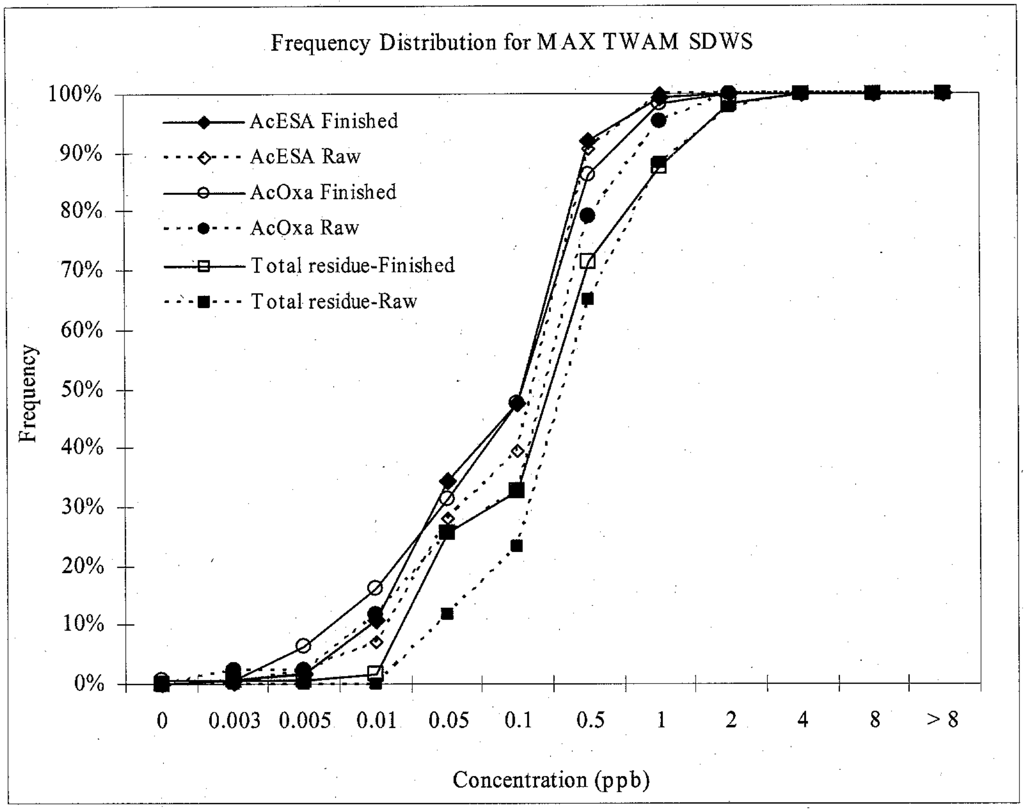


Figure 18. Chronic exposure distribution for acetochlor degradates (ESA and OXA) in surface drinking water supplies using the maximum time-weighted annualized mean for each site. Summary of USGS monitoring results for acetochlor degradates

7.2. Ground Water

Two separate data files were used in this analysis (Table 5). One file contained all the concentration values observed in the PGW studies provided by the ARP, while the second contained raw uncensored concentrations also provided by the ARP. Under the assumption that it represented the best available estimates of unmeasured values (any substitution method for nondetects would be arbitrary), the PGW uncensored file was used to compute time-weighted annualized means and percentiles.

7.2.1. Comparison of Ground Water Degradate Monitoring results to Cancellation / Mitigation Endpoints.

The degradate data are discussed here with regard to the mitigation endpoints included in the acetochlor registration agreement, however, it is not anticipated that the compounds will needed to be included in the residues of concern for the drinking water risk assessment. The conditional registration agreement only requires mitigation or cancellation of acetochlor "residues of concern"once the presence of a "pattern of movement" as specified in the agreement is established. In the PGW studies, one indication of a pattern of movement was defined as the detection of acetochlor or any of its degradates greater than or equal to 1.0 ppb at nine foot lysimeter depth as well as corresponding three and 6 foot depths in that cluster. The Appendix (Section 12.8 of this report) lists all the sites where acetochlor or either of its degradates equaled or exceeded 1.0 ppb at three, six, and nine foot depths. The acetochlor degradate OXA did not exceed 1.0 ppb at three, six, and nine foot depths in any cluster. However in 293 instances, Ac_ESA equaled or exceeded 1.0 ppb at the nine foot lysimeter depth in clusters where Ac_ESA also exceeded 1.0 ppb at the three and six foot depths at some time over the course of investigation.

Seven out of the eight states in the PGW studies demonstrated a pattern of movement of Ac_ESA as defined by exceedence of 1.0 ppb in at least one cluster of lysimeters at three, six, and nine foot depths (see "**Data Tables for the ARP Monitoring Studies Related to Mitigation Endpoints**" in the Appendix). Although the cancellation triggers apply only to the parent acetochlor, the pattern of movement demonstrated by the acetochlor degradates would be important if one of the degradates becomes a toxicological concern.

A cancellation endpoint for the parent acetochlor was the detection of acetochlor at 0.10 ppb or above in 20 or more wells in the state ground water monitoring program followed by two subsequent detections in monthly follow up samples within six months. Again, this does not presently apply to acetochlor degradates, however degradate data was compared to the endpoint for parent. A number of sites in the state ground water monitoring program had acetochlor degradate detections of at least 0.10 ppb as well as in two monthly follow up samples (see Appendix, section 12.7).

7.2.2. PGW Acute Exposure by Site.

Distributions of peak concentrations by site using the maximum of any individual cluster are provided in Table 25. Data are summarized by the peak value across all clusters, as well as the average of all clusters for each depth. Because of the overwhelming number of censored values, maximum TWAMs as well as maximum 95th percentiles were computed based on the uncensored data file provided by the ARP (**Table 5**). In addition, the maximum three consecutive sample running average for each of the eight PGW sites is included. A three consecutive running average was used to reduce the likelihood that the assessment would be based upon statistical outliers. A three value running average was chosen over a three month running average due to the frequency of sampling. In some cases observations were spaced more than one month apart as a result of sampling limitations, such as inclement weather or inadequate sample volume in the well or lysimeter.

Table 21. Concentrations of AC_ESA observed in 9-foot lysimeters from the eight prospective ground water studies.

	Max TWAM		Max 95 %tile		Max Concentration		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.77	2.48	1.31	3.90	1.70	4.30	3.73
IA	0.94	3.17	1.58	5.09	1.68	5.40	3.13
IN	5.79	18.29	9.79	23.39	13.00	24.00	22.67
MN	6.58	13.42	8.84	23.39	9.70	24.00	19.33
NE	2.26	9.21	2.32	11.19	2.33	11.40	11.03
OH	0.36	2.11	1.88	5.81	2.96	6.50	5.87
PA	1.13	2.53	1.41	3.50	1.42	3.59	3.39
WI	9.69	14.44	16.71	29.60	17.00	36.00	22.67

All values are as ppb (ug/L). Values below 0.2 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed; Max TWAM = Maximum time-weighted average based on uncensored data file; Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file; NA = Insufficient uncensored data to compute the value

Table 22. Concentrations of AC_ESA observed in shallow ground water from the eight prospective ground water studies.

	Max TWAM		Max 95 %tile		Max Concentration		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	1.179	2.519	1.370	3.148	1.443	3.220	3.013
IA	0.123	0.240	0.287	0.728	0.312	0.766	0.644
IN	1.237	9.241	1.684	13.470	1.775	14.200	13.400
MN	1.523	3.015	2.592	6.423	2.698	7.700	6.067
NE	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
OH	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PA	1.567	6.848	1.924	8.056	1.962	8.300	7.980
WI	3.533	8.054	4.590	10.679	4.736	11.000	8.133

All values are as ppb (ug/L). Values below 0.2 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed; Max TWAM = Maximum time-weighted average based on uncensored data file; Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file; NA = Insufficient uncensored data to compute the value

Table 23. Comparison of Acetochlor ESA and bromide breakthrough in 9-foot lysimeters at the eight prospective ground-water monitoring sites: Normalized concentrations.[1]

	Application rates lb a.i. / acre		**Ac_ESA Max Concentration**		**Bromide Max Concentration**		**Ac_ESA**	**Bromide**
STATE	Acetochlor	Bromide	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average	Max Moving Average
DE	2.05	89	0.829	2.098	40	80	1.820	52
IA	3.12	98	0.538	1.731	28	58	1.003	16
IN	2.5	98	5.200	9.600	31	61	9.068	23
MN	2.14	82	4.533	11.215	61	107	9.033	13
NE	3.12	98	0.747	3.654	80	133	3.535	125
OH	2.05	98	1.444	3.171	60	112	2.863	NA
PA	3.12	89	0.455	1.151	18	28	1.087	12
WI	1.78	125	9.551	20.225	95	136	12.736	NA

[1] Calculated concentration in ug/L divided by the application rate as pound active ingredient per acre. This gives a comparable concentration for the tracer and pesticide degradate if the observed concentration is proportional to the application rate; Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored data to compute the value

Table 24. Comparison of Acetochlor ESA and bromide breakthrough (with months after treatment) in shallow ground water at the eight prospective ground-water monitoring sites: Normalized concentrations.[1]

	Application rates (as lb ai/A or lb Br/A)		**Ac_ESA Max Concentration**		**Bromide Max Concentration**		**Ac_ESA**	**Bromide**
STATE	Acetochlor	Bromide	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average	Max Moving Average
DE	2.05	59.8	0.702	1.571	98.0	120.6	1.868	114.7
			(33)	*(33)*	*(39)*	*(29)*	*(13.5)*	*(31)*
IA	3.12	65.8	0.112	0.160	31.3	62.6	1.003	65.5
			(24)	*(22)*	*(23)*	*(23)*	*(1.5)*	*(28)*
IN	2.5	65.8	0.684	5.200	29.8	86.4	9.068	81.9
			(6)	*(6)*	*(34)*	*(34)*	*(15)*	*(15)*
MN	2.14	55.1	1.280	3.598	38.7	73.0	9.033	146.0
			(27)	*(30)*	*(38)*	*(27&28)*	*(13)*	*(23)*
NE	3.12	65.8	0.048	0.160	13.4	71.5	3.535	186.2
			(34)	*(34)*	*(54)*	*(54)*	*(83)*	*(87)*
OH	2.05	65.8	0.049	0.049	16.4	20.9	2.863	105.7
			(7)	*(--)*	*(11)*	*(11)*	*(4)*	*(14)*
PA	3.12	59.8	0.628	2.660	11.9	26.8	2.558	40.2
			(55)	*(51)*	*(41)*	*(53)*	*(54)*	*(28)*
WI	1.78	83.9	2.584	6.180	70.0	131.1	12.736	186.2
			(24)	*(24)*	*(24)*	*(23)*	*(14)*	*(16)*

[1] Calculated concentration in ug/L divided by the application rate as pound active ingredient per acre. This gives a comparable concentration for the tracer and pesticide degradate if the observed concentration is proportional to the application rate; single cluster = statistic applies to all observed values for the given depth; cluster average = statistic applies to concentrations averaged across all cluster for a given date for the depth listed; max TWAM = maximum time-weighted average observed; max 95%tile represents the amount of time during the calendar year the concentration was below the listed value; maximum moving average = the single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = insufficient data in the uncensored file to compute the value. Italicized values in parenthesis for each site are the months after treatment that the Ac_ESA or Br concentration was observed.

Table 25. Concentrations of AC_OXA observed in 9-foot lysimeters from the eight prospective ground water studies.

	Max TWAM		Max 95 %tile		Max Concentration		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
IA	<0.1	0.23	0.12	0.37	0.13	0.40	0.13
IN	0.58	1.16	0.69	1.38	0.75	1.50	0.50
MN	0.16	0.18	0.19	<0.1	0.20	2.70	0.90
NE	<0.1	0.12	<0.1	0.13	<0.1	0.13	0.11
OH	<0.1	0.40	0.14	1.53	0.37	2.20	1.10
PA	<0.1	<0.1	0.10	0.26	0.15	0.30	0.17
WI	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All values are as ppb (ug/L). Values below 0.1 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth
Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed
Max TWAM = Maximum time-weighted average based on uncensored data file
Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file.
Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file.
NA = Insufficient data in the uncensored file to compute the value

Table 26. . Concentrations of AC_OXA observed in shallow ground water from the eight prospective ground water studies.

	Max TWAM		Max 95 %tile		Max Concentration		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
IA	<0.1	<0.1	<0.1	0.176	<0.1	0.200	<0.1
IN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MN	0.207	0.296	0.874	1.339	1.300	1.400	1.100
NE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
OH	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WI	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All values are as ppb (ug/L). Values below 0.1 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth
Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed
Max TWAM = Maximum time-weighted average based on uncensored data file
Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file.
Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file.
NA = Insufficient data in the uncensored file to compute the value

7.2.3. Chronic Exposure

Chronic exposure for acetochlor degradates and combined residues were also determined for the state ground water monitoring program. Figure 19 presents the cumulative distribution of chronic exposure based on the maximum time-weighted annualized mean for each site. The total residue was computed by summing the concentrations for the parent and degradates. As such, chart only reflects sample observations where a sample was analyzed for both the parent and degradates. Peak time-weighted annualized means concentrations for Ac_ESA in ground water were higher than those for Ac_OXA in the state monitoring program (Figure 19).

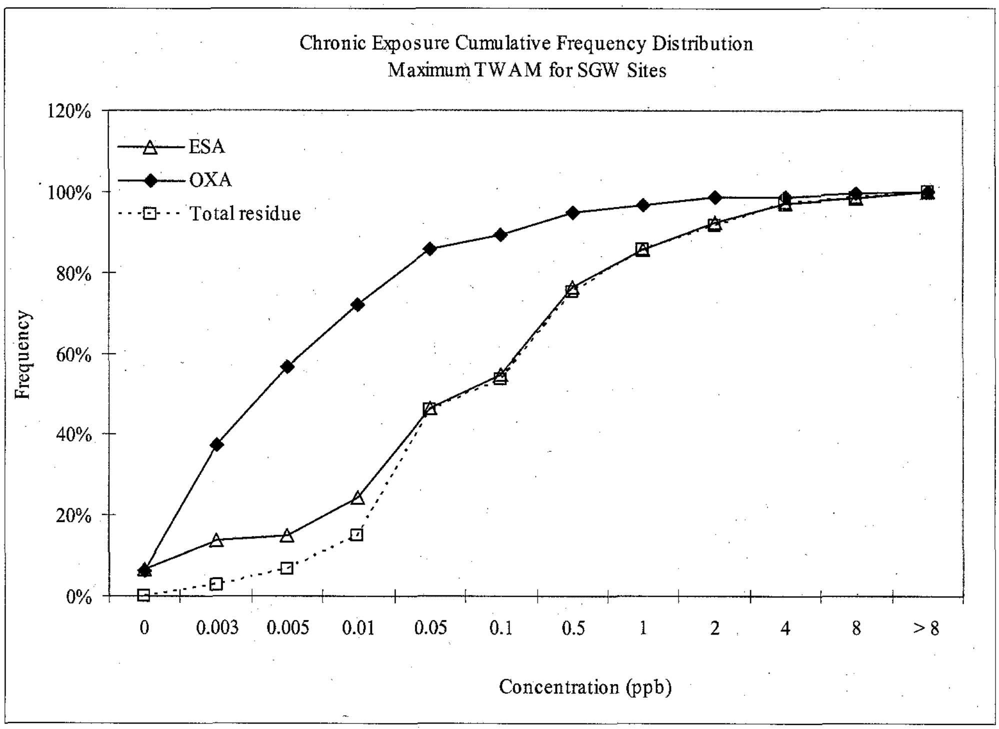


Figure 19. Chronic exposure distribution for acetochlor degradates (ESA and OXA) in the state ground water monitoring program using the maximum time-weighted annualized mean for each site.

7.3. Summary Assessment of Combined Exposure to Acetochlor and its Degradates

Unlike exposure to acetochlor parent alone, the concentration profiles for the ARP studies show that exposure to combined residues can be higher in ground water than surface water (Table 27). The maximum annual mean concentrations in ground water were up to 8x greater than in surface water and the 95th percentile annual mean concentrations were up to about 5x greater than in surface water. Key points to consider in the interpretation of these results are:

1. The surface water data, unlike the ground water data, represent actual drinking water intakes or finished water; however, many of the highest acetochlor use watersheds were not included in the monitoring program.
2. Since this monitoring program started immediately after the registration of acetochlor, the full extent of contamination of ground water possible from the use of acetochlor could not be assessed with confidence in the SGW program since it may take many years to observe the maximum extent of ground water contamination from the use of a pesticide. Even in the PGW program, there was one site (Nebraska) where the leaching of an acetochlor degradate (Ac_ESA) was still moving downward through the vadose zone when sampling was terminated seven years after the original (and only) acetochlor application.
3. In both the SGW and PGW ground water monitoring programs, the water sampled was more vulnerable than most (but not all) water used for drinking water.
4. Based on the available toxicological data, neither acetochlor ESA nor acetochlor OXA are expected to be included in the acetochlor risk assessment.

Table 27. Summary presentation of time-weighted annualized mean concentrations (ppb) for the combined residues of acetochlor (parent + ESA and OXA degradates) in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Study	N	Maximum	95th Percentile	Median
Surface Water - SDWS raw	43	2.04	1.67	0.31
Surface Water - SDWS finished	175	2.91	1.39	0.25
Ground Water (shallow) - PGW site averages	8	3.51	2.83	1.12
Ground Water (shallow) - PGW cluster maximums	8	8.11	7.57	2.85
Ground Water – SGW	176	24.11	3.24	0.08

This study demonstrates that the degradates of acetochlor (and two other acetanilide herbicides, see the following section) can significantly impact ground and surface waters and that exposure to some mobile and persistent degradates can be significantly higher and more widespread in ground water than the respective parent compounds or than in surface waters. Similar results have been obtained by Kalkhoff et al. (1998), Kolpin et al. (1996, 1997, and 1998), and Rheineck and Postle (2000).

8. OTHER CHEMICALS

The ARP collected a wealth of monitoring data for three other pesticides in both the SDWS and SGW studies. Virtually every sample collected in these studies for acetochlor analysis was also analyzed for atrazine, alachlor, and metolachlor. The ethanesulfonic acid and oxanilic acid degradates of both alachlor and metolachlor were also included in the analytical plan.

Sample results for these other analytes are given in Tables 28 to 30 Figures 20 to 22 taken from de Guzman et al. (2005), MRID 45722701, and Hackett et al. (2005). In general, the detection frequency was atrazine > metolachor > alachlor or acetochlor in both studies; changes in usage pattern over the course of the studies had a marked impact on the detection frequency of alachlor (declining use over the 7 years of monitoring in the SDWS) and acetochlor (increasing use over the 7-year monitoring period in the SDWS). Metolachlor degradates were generally detected with greater frequency than alachlor or acetochlor degradates. The sulfonic acid degradates were detected more frequently than the oxanilic acid degradates of the same parent herbicide in ground water; the detection frequency was generally similar for the two degradates in surface waters.

Table 28. Occurrence (%) of TWAMs in Finished Drinking Water at Various Concentrations by Sampling Stratum

	Percent Occurrence					
AMC ($\mu g\ L^{-1}$)	Great	Continental	Smaller Watersheds			
and Analyte	Lakes	Rivers	5-10% CI[1]	11-20% CI	>20% CI	Overall
>0.1 Acetochlor	0.0	5.0	2.4	8.5	12.8	8.1
>1.0 Acetochlor	0.0	0.0	0.0	0.0	0.2	0.1
>0.5 Ac_ESA	0.0	0.0	0.9	1.0	10.6	4.9
>0.5 Ac_OXA	0.0	0.0	5.2	5.2	15.0	8.5
>0.1 Alachlor	0.0	0.0	3.1	5.8	2.6	2.9
>1.0 Alachlor	0.0	0.0	0.0	0.0	0.0	0.0
>0.5 AlESA	0.0	0.0	0.9	3.1	1.5	1.4
>0.5 AlOXA	0.0	0.0	2.6	0.0	0.5	0.8
>0.1 Atrazine	7.6	70.3	58.7	85.7	86.2	74.4
>1.0 Atrazine	0.0	0.8	12.5	30.5	25.8	19.8
>0.1 Metolachlor	0.0	36.4	25.4	44.0	44.7	37.1
>1.0 Metolachlor	0.0	0.0	1.7	2.7	3.0	2.2
>0.5 MeESA	0.0	5.8	15.5	29.9	45.9	29.4
>0.5 MeOXA	0.0	0.0	6.0	20.6	16.4	12.4

[1] CI = Corn production intensity in the watershed.

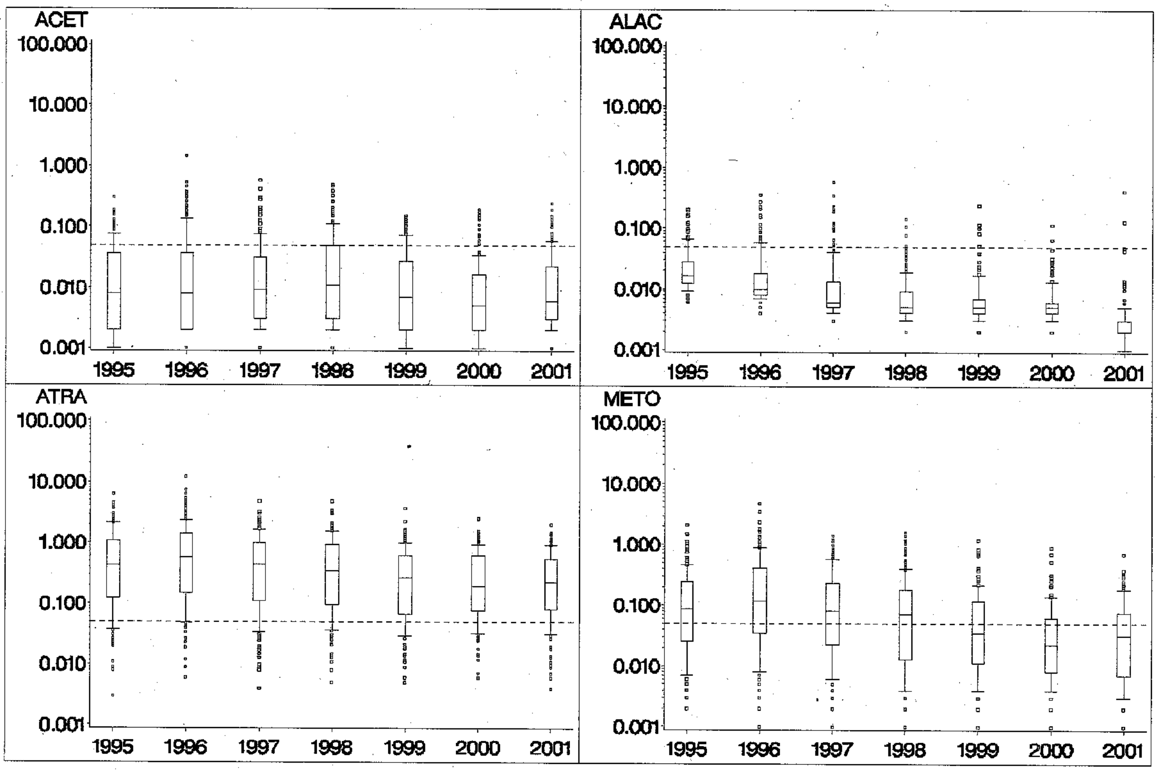


Figure 20. Box plot of annualized mean concentrations (AMCs) of parent herbicides in finished drinking water from the SDWS study (Hackett et al., 2005).

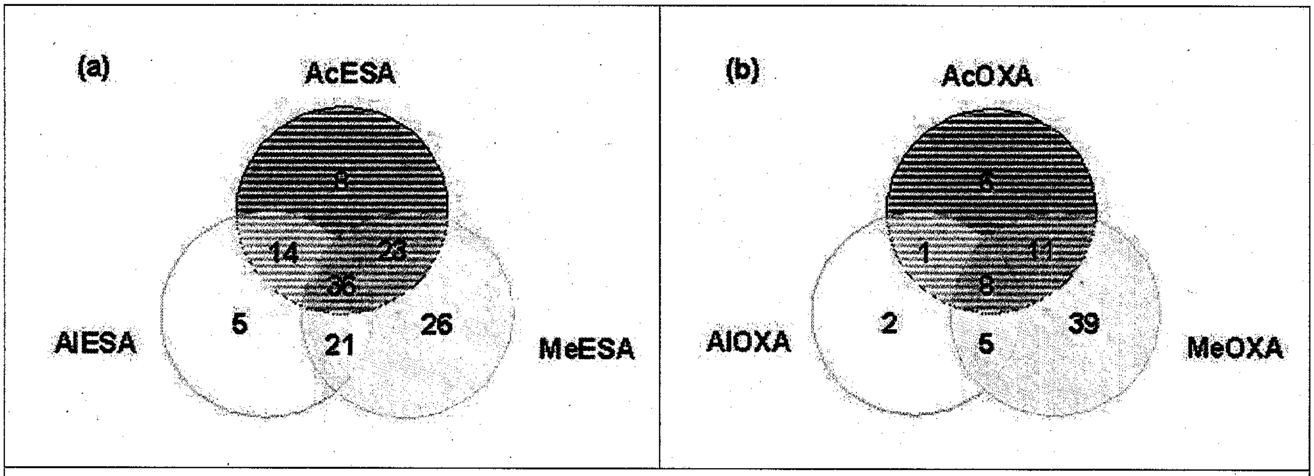


Figure 21. Co-occurrence of (a) sulfonic acid (ESA) degradate residues and (b) oxanilic acid (OXA) degradate residues for acetochlor, alachlor, and metolachlor in the SGW study. Values reflect the number of SGW wells with observed residues (Minimum detection limit was 0.2 ppb for the sulfonic acid degradates and 0.1 ppb for the oxanilic acid degradates). No ESA soil degradate residues were observed in 49 of the 182 wells and no OXA soil degradate residues were observed in 110 of the 182 wells. Source: de Guzman et al. (2005).

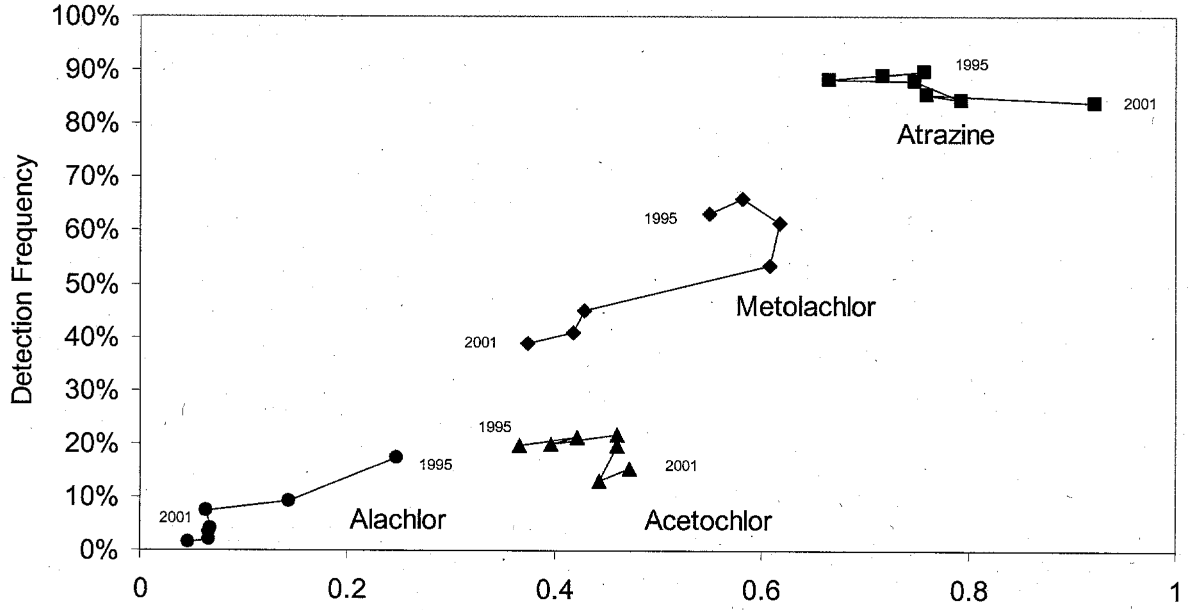


Figure 22. . Frequency of drinking water detections by year for parent herbicides as a function of use (relative use on the x axis) – SDWS study.

Table 29. Summary of the Distribution of Degradate Residues for ARP SGW Analytes – 2001 Data <u>only</u>.

The values represent the numbers of samples with residues fitting the specified criteria.

Compound	Not Detected OR "NR"	LOD to 0.499	0.50 to 0.999 ppb	1.0 to 1.999 ppb	2.0 to 9.999 ppb	>=10.0 ppb	Total
Ac_ESA	475	56	31	32	28	2	624
AlESA	435	48	45	40	51	5	624
MeESA	311	74	59	55	114	11	624
Ac_OXA	578	27	6	7	5	1	624
AlOXA	599	18	0	3	4	0	624
MeOXA	506	80	16	10	12	0	624

Ac_ESA = Acetochlor sulfonic acid
AlESA = Alachlor sulfonic acid
MeESA = Metolachlor sulfonic acid
OXA Limit of Detection (LOD) = 0.10 ppb
Limit of Quantitation (LOQ) = 0.50 ppb.
Source: MRID 45722701.

Ac_OXA = Acetochlor oxanilic acid
AlOXA = Alachlor oxanilic acid
MeOXA = Metolachlor oxanilic acid
ESA Limit of Detection (LOD) = 0.20 ppb

Table 30. Summary of the Distribution of Parent Residues for ARP SGW Analytes – 2001 data <u>only</u>.

Compound	Not Detected (ND) OR "NR"	0.03 to 0.049 ppb	0.05 to 0.099 ppb	0.10 to 0.249 ppb	0.25 to 0.499 ppb	0.50 to 4.999 ppb	>= 5.0 ppb	Total
Acetochlor	611	3	2	2	3	3	0	624
Alachlor	623	ND	1	0	0	0	0	624
Atrazine	400	38	58	87	28	13	0	624
Metolachlor	611	1	9	3	0	0	0	624

The values represent the numbers of samples with residues fitting the specified criteria.
Limit of Detection (LOD) = 0.03 ppb for acetochlor, atrazine, and metolachlor.
Alachlor LOD = 0.05 ppb
Limit of Quantitation (LOQ) = 0.05 ppb.
Source: MRID 45722701.

9. CONCLUSIONS

This analysis characterized the overall detection of acetochlor and its degradates (ethanesulfonic acid, and oxanilic acid) with an emphasis on parent acetochlor, given its inclusion by the Office of Pesticide Programs in the residues of concern for human exposure.

9.1. Parent Acetochlor

Surface water sources are the driver for exposure to parent acetochlor (Table 1). Available data indicate that water treatment involving the use of activated carbon may reduce exposure by close to 50% on average; however limitations on the data preclude generalizing this as a predictable effect of water treatment. In particular, no data are available that match the same water in raw and finished water, the ARP SDWS dataset did not measure samples in intake water from those systems using other types of water treatment, and most of the highest concentrations observed in the SDWS study occurred in finished (not raw) samples.

The highest acetochlor parent concentrations observed in the ARP monitoring program were 1.428 for chronic exposure (**Table 1**) and the highest finished water acute exposure was 18.21 (**Table 9**); all these values were from the surface water monitoring program (SDWS study). Significantly higher exposure levels were observed in the NAWQA monitoring program (**Table 14**), although these sites did not necessarily represent source water for drinking. Geographic analysis of the SDWS monitoring locations and acetochlor usage intensity indicates that the SDWS monitoring program may have missed some of the watersheds in the Midwestern US with the highest acetochlor usage intensities over the monitoring program. Consequently, there is a potential that exposure could be somewhat higher in other areas. Further analysis may be needed if the reported acetochlor concentrations are within a factor of 3 of levels of concern for drinking water.

Limitations in the available data for surface water exposure include:

A number of uncertainties must be recognized when interpreting this exposure assessment. These include the following:

- The surface drinking water supply (SDWS) and state ground water (SGW) monitoring programs were designed to focus on areas of high acetochlor use. The monitoring does not cover the entire geographic distribution of acetochlor use. Conclusions drawn in this report apply only to those areas monitored by the ARP and it may not be possible to generalize to all acetochlor usage areas.

- County level sales data submitted separately by members of the ARP from 1994 -2003 is arguably some of the most extensive data available as a close approximation of acetochlor usage across the US. As such, it has been incorporated in this exposure assessment as a surrogate for acetochlor use in the mapping and statistical analyses. It is assumed that acetochlor sold in an individual county is, in general, also applied in the same county and in the same watershed. However, the exposure characterization recognizes that inter-county as well as inter-watershed transfer of acetochlor does occur in some cases.

- Acute exposure in this risk assessment is defined as the overall maximum observed concentration at a site. The actual peak concentration, however, may have occurred between sampling times. Thus, the maximum observed concentrations reported in this study may underestimate the true maximum acute exposure.

Acetochlor was detected above 8.0 ppb in 2 samples in the surface drinking water supply (SDWS) monitoring program. Two finished (treated water) samples were detected above 8.0 ppb; however the twelve month annualized mean did not exceed 2.0 ppb. In fact, no time-weighted annualized means exceeded 2.0 ppb during the monitoring. No raw (untreated) concentrations were detected above 8.0 ppb. For both raw and finished surface drinking water, roughly 99% of the time-weighted annualized means were below 0.5 ppb. Maximum acetochlor instantaneous concentrations, 95th percentiles, and time-weighted annualized means were observed in Illinois.

9.2. Acetochlor Degradates

Acetochlor degradates ethanesulfonic acid (ESA) and oxanilic acid (OXA) were generally detected more frequently than the parent acetochlor in ground water. Acetochlor was detected above 0.1 ppb at only one site in nine foot lysimeters in the prospective ground water (PGW) studies. The maximum concentration of acetochlor in soil pore water was 3.2 ppb observed in the nine foot lysimeters in Iowa. The maximum residue detected in ground water wells was 0.06 ppb observed in Iowa. In the PGW studies, Ac_ESA demonstrated a pattern of movement as defined by concentrations greater than or equal to 1.0 ppb at three, six, and nine foot lysimeter depths. In 293 instances Ac_ESA was detected above 1.0 ppb at all three lysimeter depths. These exceedences occurred in seven out of the eight states.

Acetochlor was not detected above 8.0 ppb in the state ground water monitoring program. Approximately 90% of the instantaneous concentrations were below 0.5 ppb and 85% of all time-weighted annualized means were less than the minimum detection limit (0.03 ppb).

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Official Submissions to EPA

ARP Submissions -Section 1: ENVIRONMENTAL FATE STUDIES
(Grouped by study type.)

Guideline: 161-1 Hydrolysis

MRID: 00064805
Campbell, D.H.; Hamilton, D.E.; Kloek, J.A.; et al. (1980). The Environmental Studies of Acetochlor: Report No. MSL-1255. Final rept. (Unpublished study received Dec 12, 1980 under 524-EX-56; submitted by Monsanto Co., Washington, D.C.; CDL: 099814-C)

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MRID: 41613301
Howe, R. (1990) New Information on MON 4660 Environmental Fate Studies, Addendum to MSL 4383: Lab Project Number: RD 1010. Un- Published study prepared by Monsanto Agricultural Co. 49 p.

Guideline: 161-2 Photodegradation-water

MRID: 00131388
Letendre, L.; Klemm, G.; Singh, H. (1982) The Environmental Photo- chemistry of Acetochlor: Project No. 7827; Report No. MSL-2748. (Unpublished study received Sep 22, 1983 under 524-348; submit- ted by Monsanto Co., Washington, DC; 071961-C)

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Guideline: 162-2 Anaerobic soil metabolism

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12. APPENDICES

APPENDIX

12.1. Chemical Names and Structures

Table A-1. Chemical names and structures of acetochlor and its degradates discussed in this exposure assessment.

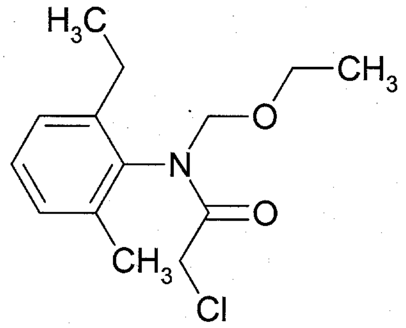
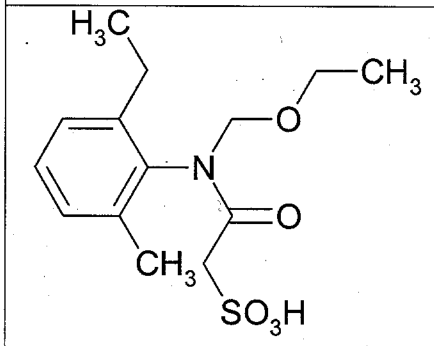
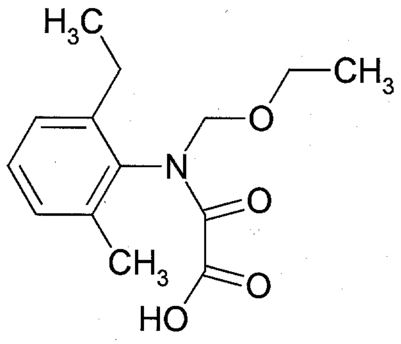
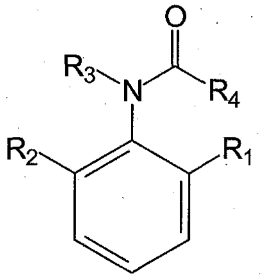
	**Acetochlor** 2'-Ethyl-6'-methyl-N-(ethoxymethyl)-2-chloroacetanilide
	**Acetochlor ethanesulfonic acid** 2-[(2-ethyl-6-methylphenyl)(ethoxymethyl) amino]-2-oxoethanesulfonic acid
	**Acetochlor oxanilic acid** 2-[(2-ethyl-6-methylphenyl)(ethoxymethyl) amino]-2-oxoacetic acid]

Table A-2. Structures of the chloroacetanilide herbicides and their major degradates (Source: ARP pre-publication journal article). Both the SDWS and the SGW studies conducted by the ARP simultaneously monitored for each of these three parent compounds (plus the corn herbicide atrazine) during the full 7 years of monitoring and for each of the degradation products listed during the last 3 years of monitoring.



R_1	R_2	R_3	R_4	Common Name	Abbr.	Chemical Name (CAS)	LOD/LOQ (μg L^{-1})	CAS Number
CH_3	CH_3CH_2	$CH_2OCH_2CH_3$	CH_2Cl	acetochlor	Acet	2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide	0.03/0.05	34256-82-1
CH_3CH_2	CH_3CH_2	CH_2OCH_3	CH_2Cl	alachlor	Alac	2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide	0.05/0.05	15972-60-8
CH_3	CH_3CH_2	$CH(CH_3)CH_2OCH_3$	CH_2Cl	metolachlor	Meto	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)-acetamide	0.03/0.05	51218-45-2
CH_3	CH_3CH_2	$CH_2OCH_2CH_3$	CH_2SO_3H	acetochlor sulfonic acid	Ac_ESA	2-[(ethoxymethyl)(2-ethyl-6-methyl phenyl)amino]-2-oxoethanesulfonic acid	0.20/0.50	187022-11-3
CH_3	CH_3CH_2	$CH_2OCH_2CH_3$	CO_2H	acetochlor oxanilic acid	Ac_OXA	2[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]oxoacetic acid	0.10/0.50	194992-44-4
CH_3CH_2	CH_3CH_2	CH_2OCH_3	CH_2SO_3H	alachlor sulfonic acid	AlESA	[2-(2,6-diethylphenyl)(methoxymethyl) amino]-2-oxoethanesulfonic acid	0.20/0.50	142363-53-9
CH_3CH_2	CH_3CH_2	CH_2OCH_3	CO_2H	alachlor oxanilic acid	AlOXA	[2-(2,6-diethylphenyl)(methoxymethyl) amino]-2-oxoacetic acid	0.10/0.50	171262-17-2
CH_3	CH_3CH_2	$CH(CH_3)CH_2OCH_3$	CH_2SO_3H	metolachlor sulfonic acid	MeESA	2-[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]-2-oxoethane sulfonic acid	0.20/0.50	171118-09-5
CH_3	CH_3CH_2	$CH(CH_3)CH_2OCH_3$	CO_2H	metolachlor oxanilic acid	MeOXA	[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]oxoacetic acid	0.10/0.50	152019-73-3

Atrazine, which is not a chloroacetanilide herbicide, was also monitored in this study, and is denoted by the abbreviation: Atra. Its chemical name is 6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine, and its CAS number is 1912-24-9. Its LOD and LOQ were 0.03 and 0.05 μg L^{-1}, respectively.

APPENDIX

12.2. Acetochlor Registration Agreement – Cancellation / Mitigation Endpoints

The following text is excerpted from the registration agreement (section numbering retained from the agreement):

<u>Excerpt1, Regarding Ground Water Detections</u>:

5.1.3. Response to Ground Water Detections

5.1.3.1 Investigation of Cause of Detections

Any information pertaining to detection of acetochlor and any degradates of toxicological concern which become known to the ARP, Monsanto, Zeneca or their agents will be reported to EPA within 15 days of the date such information becomes known to the ARP, Monsanto, Zeneca, or their agents. The ARP may respond to any detections of acetochlor or its degradates of toxicological concern reported by investigators, using confirmed analytical methods, by sending a qualified third party representative to investigate the incident. The investigation shall be completed within 60 days of receipt of the report and the results reported to EPA within 30 days of completion of the investigation, unless the ARP and EPA agree to extend those deadlines. The investigation may include any additional sampling useful in determining if the detection is due to a point source or intentional contamination. The EPA shall consider the results of any such investigation in determining whether a reported and investigated detection will be considered a "detection" for the purpose of establishing a pattern of movement, or the need for additional mitigation, or for triggering suspension or cancellation under this Section 5.1.3.

5.1.3.2 Exposure Reduction

For detections verified by the ARP's GC/MS method (at ARP's expense), occurring at a level at or above 1.0 ppb in rural drinking water wells, the ARP will offer without conditions a Well Assistance Program to compensate rural well owners by paying for the cost of drilling the new well, or installing and maintaining filters, or connecting to public water supplies, and other appropriate measures. The ARP will unconditionally pay for all costs associated with this remediation up to $5,000 per well (in 1994 dollars). All private rural drinking water wells and community drinking water supply wells in rural areas are eligible for the ARP well assistance program.

Public wells in rural areas which have verified detections (using the ARP's GC-MS method) at ARP's expense of acetochlor at a level at or above 1.0 ppb, that are not associated with product mishandling will be, at ARP's expense, remediated to provide drinking water below a detection limit of 0.10 ppb.

5.1.3.3. Detection Criteria

The data from either the PGW or other sampling/monitoring programs may indicate a pattern of movement of acetochlor or degradates of toxicological concern toward ground water, as a result of use according to label directions or in accordance with widespread and commonly recognized practice. At present, the ARP is not aware of any degradates of toxicological concern. If, in the future, EPA determines there are degradates of toxicological concern, the detection concentrations noted below will be reviewed and will be revised, if appropriate, based upon the toxicologic effect of the degradate. A pattern of movement is defined as being:

- detections of acetochlor or degradates of toxicological concern confirmed by the approved and validated GC-MS method, and
- IN THE PGW STUDIES. Detections of acetochlor or degradates of toxicological concern that are greater than or equal to 0.10 ppb in ground water which are consistent with recharge as measured with tracers and/or suction lysimeters; OR

  Detections of acetochlor or degradates of toxicologic concern at a concentration greater than or equal to 1.0 ppb in soil water collected by suction lysimeters at a depth of 9 feet below the land surface. Such soil water detections must be consistent with the movement of soil water as determined by conservative tracers, and consistent with detections in the three and six foot lysimeters in that cluster. Lysimeter samples from the same depth will be composited to ensure adequate sample size (for the purpose of analysis) when necessary; or

- IN THE STATE MONITORING PROGRAMS. For reports of detections of acetochlor or degradates of toxicological concern in the state monitoring programs described in section 5.1.2, a detection greater than or equal to a concentration of 0.10 ppb in ground water subsequently detected at greater than or equal to 0.10 ppb in two follow-up samples collected monthly over a period of six months; or
- OTHER MONITORING STUDIES (outside of the PGW study or State Monitoring Programs (defined in section 5.1.2)). For reports of any other detections of acetochlor, a detection greater than or equal to a concentration of 0.20 ppb in ground water, subsequently detected at greater than or equal to 0.20 ppb in two or more follow-up samples collected monthly over a period of six months.

If the ARP does not take appropriate steps to secure follow-up sampling, the initial report of the detection shall be treated as sufficient to define a pattern of movement. The determination of what constitutes appropriate steps to be taken is a "reserved issue" subject to the provisions of Section 7A.

5.1.3.4. Additional Mitigation Measures

If EPA determines that a pattern of movement, as defined in 5.1.3.3. has occurred from use in accordance with label directions or in accordance with widespread and commonly recognized practice, then the ARP, in conjunction with EPA, will determine whether the movement is limited to a geographical area or soil type. In that case, the ARP will revise the acetochlor label to include geographic or additional soil type label restrictions.

5.1.3.5. Automatic Suspension

If EPA determines that a pattern of movement toward ground water as defined in 5.1.3.3., above has occurred arising from use in accordance with label directions or in accordance with widespread and commonly recognized practice, and if within 30 days EPA and the ARP cannot agree on an immediate mitigation option, the registration shall be automatically suspended on a geographic basis. This suspension will terminate if EPA determines that the ARP has taken adequate steps to implement appropriate mitigation measures. The determination of appropriate mitigation options shall be governed by the provisions of Section 7.

5.1.3.6. Cancellation

- **GW Scenario 1**

  For the PGW studies, if EPA determines that out of the 8 sites, 4 sites in a variety of geographic, and climatic conditions under both vulnerable and general use conditions, (as determined by EPA) in corn growing areas indicate a pattern of movement of acetochlor toward ground water, as defined in 5.1.3.3. from use in accordance with label directions or in accordance with widespread and commonly recognized practice, registration shall be automatically canceled. The sites at which a pattern of movement occurs shall represent a range of vulnerable and general use soil textures consistent with labeled use.

- **GW Scenario 2**

  For monitoring programs outside the PGW studies, the registration of acetochlor will be automatically canceled if EPA determines that either of the criteria specified below have been met. All detections shall be verified by the ARP's GC-MS method at the ARP's expense.

  - Criterion 1:

    Detections occur in 20 or more wells included in the State Monitoring Program at or above 0.10 ppb followed by two subsequent detections of at least 0.10 ppb in monthly sampling of each of those wells, conducted over a period of six months.

  - Criterion 2:

    Detections occur in 150 or more individual wells at or above 0.20 ppb, followed `by two subsequent detections of at least 0.20 ppb in monthly sampling of each of those wells, conducted over a period of six months across a wide variety of geographic, soil, and climatic conditions in corn growing area.

- **GW Scenario 3**

  For monitoring programs outside the PGW studies, the registration of acetochlor will be automatically canceled if EPA determines that detections occur in twenty (20) or more wells across a wide variety of geographic, soil, and climatic conditions in corn growing areas at a concentration of at least 1.0 ppb, followed by two subsequent detections of at least 1.0 ppb in monthly sampling of each of those wells, conducted over a period of six months. All detections shall be verified by the ARP's GC-MS method at the ARP's expense.

An initial detection shall be treated as sufficient to meet these cancellation criteria if the ARP has failed to take timely and appropriate steps to secure follow-up samples.

If EPA determines at any time that mitigation measures have been or will be undertaken which are likely to be effective, the Agency may treat, for a period of up to 18 months, some or all detections within the area subject to such mitigation measures (mitigation area) as insufficient to meet the cancellation criteria in section 5.1.3.6. No later than 18 months after such mitigation measures have been initiated, EPA shall make a final determination whether the mitigation measures have been or are likely to be effective. During this time, the ARP may investigate whether such mitigation measures have been, or are likely to be, effective. The EPA shall notify the ARP 60 days prior to making its determination, and shall consider the results of any such investigation, if timely received, in making that determination. If EPA's final determination is that the mitigation measures have not been or are not likely to be successful, all detections within the mitigation area shall be subject to the provisions of sections 5.1.3.3., 5.1.3.5., and 5.1.3.6. If EPA's final determination is that the mitigation measures have been or are likely to be successful, some or all detections within the mitigation area may be designated by EPA as insufficient to meet the cancellation provisions of Section 5.1.3.6. Such final determination will be consistent, to the extent feasible, with relevant existing policies and procedures.

Point source contamination detections shall be treated as sufficient to meet these cancellation criteria unless EPA determines that such contamination: (i) does not result from use in accordance with label directions or widespread and commonly recognized practice, or (ii) results from use in accordance with label directions or in accordance with widespread and commonly recognized practice, but that the general cause of the contamination can be mitigated with product stewardship, label language or repair/replacement of damaged or inadequately installed wells.

5.2. State Management Plans

If at any time after the registration EPA decides to nominate acetochlor for inclusion in State Management Plans, the ARP will not file any objection to such inclusion, nor will it challenge such action in any court or administrative forum.

5.3. Continued Stewardship

Regardless of whether the data indicate any pattern of movement toward groundwater, the ARP will continue its product stewardship commitment and cooperate with the Agency to develop and implement additional product stewardship measures considered appropriate.

Excerpt 2, Regarding Surface Water Detections:

6.2 Response to Surface Water Detections

The ARP agrees in principle to provisions relating to surface water, which include a sampling program, investigation of the source of surface water detections, and mitigation measures. The elements of the response to surface water detections will parallel those described in Section 5 for ground water protection.

6.2.1 Investigation of Cause of Detections

The ARP may respond to any detections of acetochlor or degradates of toxicological concern, using confirmed analytical methods, by sending a qualified third party representative to investigate the incident. The investigation shall be completed within 60 days of the incident becoming known to the ARP and the results reported to EPA within 30 days of completion of the investigation, unless the ARP and EPA agree to extend those deadlines. The investigation may include any additional sampling useful in determining if the detection is due to a point source or intentional contamination. The EPA shall consider the results of any such investigation in determining whether a reported and investigated detection will be considered a "detection" for the purpose of establishing the need for mitigation or for triggering cancellation under Section 6.2.2.

6.2.2 Mitigation and Cancellation

At present, the ARP is not aware of any degradates of toxicological concern. If, in the future, EPA determines there are degradates of toxicological concern, the detection concentrations noted below will be reviewed and will be revised, if appropriate, based upon the toxicologic effect of the degradate.

- SW Scenario I:

  If one (1) community water supply system, that derives its water primarily from surface water, detects an annual time-weighted mean concentration of 2.0 ppb, acetochlor, then either;

  - The use of acetochlor in the related watershed will be prohibited. Such prohibition will be implemented by means of amendment of the acetochlor registration to prohibit sale, distribution, and use in the specified watershed. The timing, content, and implementation of such restriction shall be governed by the provisions of Section 7; or
  - The ARP will absorb 100% of costs required to restore the community water supply system to compliance. If EPA determines that the ARP has failed to meet this obligation, it may cancel the registration without opportunity for hearing.
- SW Scenario II:

  If EPA determines that two (2) large (serving 100,000 people) community water supply systems, or ten (10) community water supply systems of any size across a wide variety of corn growing, soil, and climatic have an annual time-weighted mean concentration of 2.0 ppb or are otherwise determined to be out of compliance based on Office of Water criteria, the registration will be automatically canceled.

If any community water supply system that derives its water primarily from surface water detects a single peak concentration of 8.0 ppb of acetochlor, the ARP will make biweekly sampling of that water system throughout the following 12 months to determine whether the 2.0 ppb annual time-weighted mean concentration has been exceeded.

APPENDIX

12.3. Acetochlor Usage – Detailed Summary

CONFIDENTIAL BUSINESS INFORMATION, NOT INCLUDED HERE

APPENDIX

12.4. Locations of Monitoring Sites for the ARP SDWS Study

(Acetochlor Surface Drinking Water Supply Study)

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Corning	IA	Lake Binder	Lake	2126	15.3	23.0	>20% CI	YES
Des Moines	IA	Raccoon River and Infiltration Galleries	River	2304810	31.1	39.4	>20% CI	YES
Iowa City	IA	Iowa River	River	2099081	30.6	40.3	>20% CI	YES
Milford	IA	West Lake Okoboji	Lake	14866	22.9	32.6	>20% CI	YES
Montezuma	IA	Diamond Lake	Reservoir	2724	31.8	33.3	>20% CI	YES
Mount Pleasant	IA	Skunk River	River	2599367	15.6	34.2	>20% CI	YES
Okoboji	IA	West Okoboji Lake	Lake	14866	22.9	32.6	>20% CI	NO
Ottumwa	IA	Des Moines River	River	8569564	31.7	35.5	>20% CI	YES
Panora	IA	Middle Racoon River	River	265272	32.5	41.1	>20% CI	NO
Spirit Lake	IA	Spirit Lake	Lake	43135	25.0	36.2	>20% CI	NO
Winterset	IA	Cedar Lake	Reservoir	10443	35.5	21.7	>20% CI	YES
Altamont	IL	Altamont New Reservoir	Reservoir	521	26.7	28.5	>20% CI	YES
Blandinsville	IL	LaHarpe Creek	River	8779	33.7	35.5	>20% CI	NO
Breese	IL	Shoal Creek	River	480358	35.7	25.2	>20% CI	YES
Carlinville	IL	Carlinville Lake I	Reservoir	15706	28.8	25.0	>20% CI	YES
Carthage	IL	Carthage Lake	Reservoir	1756	33.6	28.4	>20% CI	YES
Charleston	IL	Lake Charleston	Reservoir	1198	28.7	34.4	>20% CI	YES
Clay City	IL	Little Wabash River	River	518175	36.3	26.9	>20% CI	YES
Decatur	IL	Lake Decatur	Reservoir	602057	30.1	41.5	>20% CI	YES
Elgin	IL	Fox River	River	953176	23.4	20.3	>20% CI	YES
Fairfield	IL	Little Wabash River	River	1169567	35.4	25.0	>20% CI	YES
Flora	IL	Little Wabash River	River	491311	36.5	27.3	>20% CI	YES
Georgetown	IL	Little Vermillion River	River	106395	35.7	39.5	>20% CI	YES

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Gillespie	IL	Old Gillespie Lake	Reservoir	2966	30.3	25.0	>20% CI	YES
Greenfield	IL	Greenfield Lake	Reservoir	724	28.1	29.1	>20% CI	YES
Hudson	IL	Lake Bloomington	Reservoir	41942	28.7	44.4	>20% CI	YES
Kankakee	IL	Kankakee River	River	2952111	27.1	37.4	>20% CI	YES
Litchfield	IL	Lake Lou Yeager	Reservoir	69219	23.3	30.1	>20% CI	YES
Mascoutah	IL	Kaskaskia River	River	2844480	29.7	26.3	>20% CI	YES
Mattoon	IL	Lake Paradise	Reservoir	11916	29.3	34.5	>20% CI	YES
Nashville	IL	City of Nashville Reservoir	Reservoir	1013	21.1	23.1	>20% CI	YES
Neoga	IL	Lake Mattoon	Reservoir	34849	32.7	33.5	>20% CI	YES
New Athens	IL	Kaskaskia River	River	3274132	30.6	25.4	>20% CI	YES
New Berlin	IL	Spring Creek	River	16852	34.1	35.2	>20% CI	YES
Oakland	IL	Lake Oakland	Reservoir	6909	26.5	39.7	>20% CI	YES
Olney	IL	East Fork Lake	Reservoir	6644	28.1	28.8	>20% CI	YES
Palmyra	IL	Palmyra-Modesto Lake	Reservoir	826	40.0	25.0	>20% CI	YES
Pana	IL	Lake Pana	Reservoir	4545	33.8	32.3	>20% CI	YES
Paris	IL	Twin Lakes	Reservoir	11733	30.3	38.7	>20% CI	YES
Pittsfield	IL	Lake Pittsfield	Reservoir	6971	40.6	22.6	>20% CI	NO
Shipman	IL	Shipman Reservoir	Reservoir	427	28.6	25.0	>20% CI	NO
Sparta	IL	South City Lake	Reservoir	480	32.0	15.2	>20% CI	YES
Springfield	IL	Lake Springfield	Lake	162178	29.7	34.9	>20% CI	YES
West Salem	IL	West Salem Reservior & shale pit	Reservoir	614	27.2	26.1	>20% CI	NO
White Hall	IL	White Hall Reservoir	Reservoir	613	29.8	29.1	>20% CI	YES
Ferdinand	IN	Old Lake (No. 1)	Reservoir	105	29.7	26.2	>20% CI	NO
Holland	IN	New Holland Lake	Reservoir	348	27.4	26.2	>20% CI	YES
Kokomo	IN	Wildcat Creek	River	121637	37.4	38.0	>20% CI	YES
Logansport	IN	Eel River	River	524144	24.9	28.3	>20% CI	NO
Mitchell	IN	East Fork of the White River	River	2470938	39.5	26.9	>20% CI	YES
North Vernon	IN	Vernon Fork of Muscatatuck River	River	68241	26.3	21.0	>20% CI	YES
Oakland City	IN	Old Lake	Lake	83	31.9	33.8	>20% CI	YES

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Richmond	IN	Middle Fork Reservoir	Lake	30825	25.3	27.2	>20% CI	YES
Santa Claus	IN	Christmas Lake	Reservoir	1583	37.4	21.8	>20% CI	NO
Seymour	IN	East Fork of the White River	River	1516709	33.2	33.8	>20% CI	YES
Speedway	IN	Big Eagle Creek	River	119080	29.2	26.8	>20% CI	YES
Warsaw	IN	Center Lake	Reservoir	444	20.3	30.3	>20% CI	NO
Westport	IN	Sand Creek	River	60170	30.2	43.1	>20% CI	YES
Concordia	MO	Edwin A. Pape Lake	Reservoir	5507	23.8	20.6	>20% CI	YES
Higginsville	MO	Higginsville City Lake	Reservoir	3547	23.5	20.6	>20% CI	YES
Plattsmouth	NE	Beaver Lake	Reservoir	7397	33.5	26.1	>20% CI	YES
Archbold	OH	Tiffin River	River	208202	29.8	23.9	>20% CI	YES
Attica	OH	Honey Creek	River	46710	28.9	24.2	>20% CI	YES
Bowling Green	OH	Maumee River	River	3977343	26.0	23.1	>20% CI	YES
Cedarville	OH	Massies Creek	River	31764	30.4	27.2	>20% CI	NO
Celina	OH	Grand Lake St Marys	Reservoir	72549	32.8	30.9	>20% CI	NO
Columbus	OH	Scioto River	River	665366	27.4	21.4	>20% CI	YES
Defiance	OH	Maumee River	River	1395515	26.8	21.5	>20% CI	YES
Delta	OH	Bad Creek	River	22000	22.0	33.6	>20% CI	YES
Lima	OH	Auglaize River	River	131174	25.2	24.3	>20% CI	NO
McClure	OH	Maumee River	River	3777748	26.0	23.0	>20% CI	YES
McComb	OH	Rader Creek	River	668	30.3	23.4	>20% CI	YES
Metamora	OH	Ten Mile Creek	River	3174	31.5	32.4	>20% CI	YES
Ottawa	OH	Blanchard River	River	394516	27.2	23.5	>20% CI	YES
Upper Sandusky	OH	Upper Sandusky Reservoir	Reservoir	894	29.7	23.8	>20% CI	YES
Van Wert	OH	Town Creek	River	16385	33.3	29.2	>20% CI	NO
West Milton	OH	Stillwater River	River	427302	28.9	28.3	>20% CI	NO
Wilmington	OH	Caesar's Creek Lake	Reservoir	147651	36.9	27.1	>20% CI	YES
Denver	PA	Cocalico Creek	River	12201	30.6	26.4	>20% CI	NO
New Holland	PA	New Holland Reservoir	Reservoir	704	8.0	27.4	>20% CI	NO
Appleton	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES
Menasha	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Oshkosh	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES
Bloomfield	IA	Lake Fisher	Reservoir	1458	40.3	13.9	11-20% CI	NO
Centerville	IA	Lake Rathbun	Reservoir	353792	37.4	13.2	11-20% CI	YES
Chariton	IA	Lake Ellis and Lake Morris	Reservoir	6453	38.0	10.6	11-20% CI	YES
Lenox	IA	Lenox West Lake	Reservoir	100	28.4	19.8	11-20% CI	NO
Mount Ayr	IA	Loch Ayr Reservoir	Reservoir	2563	11.3	13.5	11-20% CI	YES
Osceola	IA	West Lake	Reservoir	6241	24.2	13.5	11-20% CI	YES
Centralia	IL	Raccoon Lake	Reservoir	30293	32.0	12.2	11-20% CI	YES
Coulterville	IL	Coulterville Lake	Reservoir	449	45.3	15.2	11-20% CI	YES
Farina	IL	East Fork of Kaskaskia River	River	2959	30.6	17.1	11-20% CI	YES
Highland	IL	Silver Lake	Reservoir	30593	31.0	17.5	11-20% CI	YES
Salem	IL	Salem Reservoir	Reservoir	2452	29.6	12.2	11-20% CI	YES
Sorento	IL	Sorento Lake	Reservoir	376	40.2	15.8	11-20% CI	NO
Austin	IN	Muscatatuck River	River	223967	28.1	11.8	11-20% CI	NO
Batesville	IN	Biscoff Reservoir	Reservoir	2916	23.1	19.5	11-20% CI	NO
Fort Wayne	IN	St. Joseph River	River	657980	27.0	18.6	11-20% CI	YES
Salem	IN	Lake John Hay	Reservoir	5797	27.6	11.9	11-20% CI	YES
Scottsburg	IN	Scottsburg Reservoir	Reservoir	1977	26.9	11.3	11-20% CI	NO
Horton	KS	Delaware River	River	91634	33.7	11.5	11-20% CI	NO
Ewing	MO	Lewis County Water District Lake	Reservoir	684	30.8	14.0	11-20% CI	YES
Trenton	MO	Thompson River	River	963925	26.8	10.8	11-20% CI	YES
Wyaconda	MO	Wyaconda City Lake	Reservoir	208	13.0	15.3	11-20% CI	YES
Galena	OH	Alum Creek Reservoir	Reservoir	82605	23.4	16.5	11-20% CI	NO
Monroeville	OH	West Branch Huron River	River	138245	29.9	18.7	11-20% CI	YES
New London	OH	Buck Creek	River	40614	29.1	17.3	11-20% CI	NO
Paulding	OH	Flatrock Creek	River	109270	36.5	21.4	11-20% CI	YES
Sunbury	OH	Big Walnut Creek	River	50886	27.8	16.5	11-20% CI	YES
Westerville	OH	Alum Creek	River	95314	32.1	16.4	11-20% CI	YES
Willard	OH	Huron River	River	46081	28.2	18.2	11-20% CI	NO
Williamsburg	OH	East Fork of the Little Miami	River	149474	35.3	18.1	11-20% CI	NO

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATERSHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
		River						
Carlisle	PA	Conodoguinet Creek	River	242629	24.8	12.6	11-20% CI	YES
Hummelston	PA	Swatara River	River	284337	31.0	12.1	11-20% CI	YES
Mechanicsburg	PA	Conodoguinet Creek	River	293855	25.4	12.5	11-20% CI	YES
Norristown	PA	Schuylkill River	River	1133118	28.7	9.2	11-20% CI	YES
Reading	PA	Lake Ontellaunee	Reservoir	120883	34.1	13.1	11-20% CI	YES
Newark	DE	White Clay Creek	River	43629	26.8	10.4	5-10% CI	YES
Wilmington	DE	Red & White Clay Creek	River	100409	27.9	10.6	5-10% CI	YES
Lamoni	IA	Home Lake (Pond)	Reservoir	321	31.8	8.7	5-10% CI	YES
Alto Pass	IL	Little Cedar Lake	Reservoir	19625	17.8	7.3	5-10% CI	YES
Borden	IN	Packwood Branch Reservoir	Reservoir	1275	28.9	10.8	5-10% CI	YES
Dubois	IN	Patoka Lake	Reservoir	108655	31.7	8.4	5-10% CI	YES
Paoli	IN	Lick Creek	River	13424	28.1	8.8	5-10% CI	YES
St. Meinrad	IN	Lake Benet	Reservoir	135	23.7	4.5	5-10% CI	NO
Garnett	KS	Crystal Lake	Reservoir	386	35.8	6.1	5-10% CI	YES
Milford	KS	Milford Lake	Reservoir	15963347	35.3	9.6	5-10% CI	YES
Richmond	KS	Richmond City Lake	Reservoir	557	29.1	5.1	5-10% CI	YES
Topeka	KS	Kansas River	River	36446269	28.2	8.8	5-10% CI	NO
Valley Falls	KS	Delaware River	River	570021	26.1	7.5	5-10% CI	NO
Westphalia	KS	Lake (No Name)	Reservoir	1652	42.9	4.8	5-10% CI	NO
Bel Air	MD	Winter's Run	River	23264	38.5	8.2	5-10% CI	YES
Elkton	MD	Big Elk Creek	River	39985	30.2	9.7	5-10% CI	YES
Frederick	MD	Monocacy River	River	456687	30.0	12.0	5-10% CI	YES
Frederick	MD	Monocacy River	River	456040	27.2	8.9	5-10% CI	YES
Havre de Grace	MD	Susquehanna River	River	17629428	15.0	5.5	5-10% CI	YES
Silver Spring	MD	Howard Duckett Reservoir (Rocky Gorge Re	Reservoir	85109	31.9	5.6	5-10% CI	YES
Moorhead	MN	Red River	River	4309787	20.0	10.8	5-10% CI	YES
Armstrong	MO	Armstrong City Lake	Reservoir	342	28.6	10.4	5-10% CI	YES

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATERSHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Bethany	MO	Old City Lake	Reservoir	191	39.7	10.2	5-10% CI	NO
Butler	MO	Butler City Lake	Reservoir	1965	31.5	6.6	5-10% CI	YES
Cameron	MO	Reservoirs #1 #2 and #3	Reservoir	3274	26.7	8.2	5-10% CI	YES
Edina	MO	New Lake	Reservoir	781	38.5	8.6	5-10% CI	YES
Freeman	MO	South Grand River	River	63850	36.2	5.6	5-10% CI	NO
Gallatin	MO	Lake Viking	Reservoir	9049	32.3	7.1	5-10% CI	YES
Garden City	MO	Lake 1	Reservoir	455	35.2	5.8	5-10% CI	YES
Gentry	MO	Middle Fork Water Co. Lake	Reservoir	4233	29.7	9.5	5-10% CI	NO
Labelle	MO	LaBelle City Lake #1	Reservoir	140	34.2	14.0	5-10% CI	YES
Lancaster	MO	North Lake	Reservoir	728	29.5	6.1	5-10% CI	NO
Marceline	MO	New Marceline Reservoir	Reservoir	2455	24.3	12.6	5-10% CI	YES
Monroe City	MO	South Lake	Reservoir	668	25.5	6.2	5-10% CI	YES
Perryville	MO	Saline Creek	River	36335	26.3	8.6	5-10% CI	NO
Shelbina	MO	Shelbina Lake	Reservoir	1521	43.0	8.8	5-10% CI	YES
Smithville	MO	Smithville Lake	Reservoir	133182	23.5	8.8	5-10% CI	YES
Vandalia	MO	Vandalia Reservoir	Reservoir	3654	28.1	11.8	5-10% CI	YES
Alliance	OH	Deer Creek Lake	Reservoir	162028	21.9	8.5	5-10% CI	YES
Glouster	OH	Burr Oak Lake	Reservoir	20596	27.0	3.7	5-10% CI	YES
Somerset	OH	Somerset Reservoir	Reservoir	572	31.9	8.3	5-10% CI	YES
Wellsville	OH	Little Yellow Creek	River	10832	29.5	9.2	5-10% CI	YES
Beavertown	PA	PL 638	Reservoir	3339	8.4	10.4	5-10% CI	NO
Phoenixville	PA	Schuylkill River	River	771279	28.7	10.4	5-10% CI	NO
West Chester	PA	East Branch of Brandywine River	River	72185	28.3	10.3	5-10% CI	YES
Davenport	IA	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES
Moline	IL	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES
Rock Island	IL	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES
Shipman	IL	Mississippi River	River	115258084	23.1	24.2	Cntl. River	YES
Evansville	IN	Ohio River	River	68358056	21.8	5.6	Cntl. River	YES
Mount Vernon	IN	Ohio River	River	68778138	21.8	5.7	Cntl. River	YES
Atchison	KS	Missouri River	River	266847707	10.1	5.1	Cntl. River	NO

P1 (primary) Community Water Systems only

CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment?
Kansas City	KS	Missouri River	River	268749082	10.2	5.1	Cntl. River	YES
Leavenworth	KS	Missouri River	River	267061176	10.1	5.1	Cntl. River	YES
Minneapolis	MN	Mississippi River	River	12527540	14.6	7.5	Cntl. River	YES
St. Cloud	MN	Mississippi River	River	8774874	12.6	4.0	Cntl. River	YES
Jefferson City	MO	Missouri River	River	319081997	13.1	5.7	Cntl. River	YES
Louisiana	MO	Mississippi River	River	90230044	17.9	22.1	Cntl. River	YES
St. Louis	MO	Mississippi River	River	443533492	15.3	10.1	Cntl. River	YES
St. Louis	MO	Missouri River	River	332845687	29.2	5.6	Cntl. River	YES
Blair	NE	Missouri River	River	203739516	9.3	3.3	Cntl. River	YES
Hartington	NE	Lewis & Clark Lake (Missouri River)	Reservoir	177705449	7.4	0.8	Cntl. River	NO
Omaha	NE	Missouri River	River	204687766	9.4	3.5	Cntl. River	YES
East Liverpool	OH	Ohio River	River	14999469	17.7	2.5	Cntl. River	YES
Chicago	IL	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Michigan City	IN	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Beaver Bay	MN	Lake Superior	Lake	10719768	7.2	0.0	Great Lakes	NO
Cleveland	OH	Lake Erie	Lake	63168475	14.2	8.2	Great Lakes	YES
Willoughby	OH	Lake Erie	Lake	63168475	14.2	8.2	Great Lakes	YES
Cudahy	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Oak Creek	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Port Washington	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES

APPENDIX

12.5. Site Selection for ARP Monitoring Studies

12.5.1. Surface Drinking Water Site Selection (SDWS Study)

Language and subject headings below are directly extracted from:
Hackett, A. (2000) Surface Drinking Water Monitoring Program for Acetochlor and Other Corn Herbicides: Site Selection and Data Collection. Lab Project Number: SWM1100. Unpublished study prepared by Monsanto Company.

1.0 INTRODUCTION AND SUMMARY

Acetochlor is a selective herbicide for control of annual grasses and broadleaf weeds in corn. Acetochlor was registered on March 11, 1994, by the Acetochlor Registration Partnership (ARP), consisting of Monsanto Co. and Zeneca, Inc., and is marketed under trade names such as Harness® (Monsanto) and Surpass® (Zeneca). Acetochlor is registered for use in 42 states and the District of Columbia, and about 80% of yearly production is in the mid-western United States.

EPA and the ARP defined conditions of registration for acetochlor. One requirement of these conditions was to conduct a monitoring program to evaluate the extent of contamination of surface-drinking water with acetochlor over a five-year period. EPA and the ARP agreed that if acetochlor was found above mutually agreed trigger levels at a site, mitigation would be required. If found at numerous sites, its registration could be canceled.

The objective of the monitoring program is to determine seasonal and annualized mean concentrations of acetochlor and other major corn herbicides in finished drinking water derived from surface water sources. The program consists of several phases including: community water system (CWS) selection and data collection; sampling mechanics; execution of sampling; residue analysis; and reporting of results. This report describes the CWS selection and data collection phase of the program. This portion of the study was conducted by Stone Environmental Inc. (SEI, Montpelier, VT) in conjunction with the ARP. Details of sampling mechanics, execution of sampling, and initial analytical results will be reported in the first annual interim report due to EPA by January 31, 1996.

A total of 175 CWSs in nine mid-western and three mid-Atlantic states were selected for the program. The selection process was designed to include a wide array of CWSs with watersheds in areas of corn production, with an emphasis on including worst-case watersheds i.e., smaller watersheds (not on the Great Lakes and Continental Rivers) in areas of high corn production. These watersheds are expected to have higher concentrations of acetochlor after runoff events than larger watersheds which drain areas of both high and low corn production, because dilution would be greater for CWSs taking water from the Great Lakes and Continental Rivers. Data were collected to characterize each community water system included in the program.

The steps for the CWS selection and characterization process are summarized below:

1) Identification of all public CWSs that use surface water in the following 12 states: Illinois, Indiana, Iowa, Minnesota, Nebraska, Kansas, Wisconsin, Ohio, Missouri, Pennsylvania, Maryland, and Delaware.

2) Identification of all CWSs that belong to the target population.

Target Population - All CWSs in the 12 states that:

- use only surface water, or can discretely sample surface water,
- are willing to cooperate and
- have a corn intensity (for smaller watersheds that do not have an intake on a Great Lake or Continental River) greater than or equal to 5%, where corn intensity is the ratio of acreage of harvested corn to total acreage in the upstream watershed.

3) Separation of the target population of CWSs into disjoint (nonoverlapping) strata based on the size of the watershed, the corn intensity (for smaller watersheds), and State that the system is in:

- State
- size of watershed (three major subdivisions)
    - Great Lakes
    - Continental Rivers (Missouri, Mississippi, Ohio Rivers)
    - Smaller Rivers and Lakes
- corn intensity (% corn planted in total area of watershed) (three major subdivisions)
    - 5-10% CI
    - 11-20% CI
    - >20% CI

4) Determination of the number of CWSs to be selected from each stratum. The focus was on strata containing CWS watersheds which are expected to have higher levels of acetochlor after runoff events, based on the size of the watershed and its corn intensity. A higher percentage of CWSs from these strata were chosen.

5) Random selection (using random number generation) of the appropriate number of CWSs from each stratum. All CWSs meeting the target population criteria were selected from the identified strata (for example, the >20% corn intensity, smaller watershed strata). A total of 175 CWSs were required for the study.

6) Collection of information for each selected CWS regarding intake location, sources of water, treatment, customer information, point of finished water sampling, soil types, and corn intensity of the watershed(s) for that system.

7) Removal of systems that did not meet target population criteria based on additional data collected. Systems were replaced in the same stratum and state, if possible, by additional random selection from the stratum. If there were no systems available in the same stratum, then a system was randomly selected from another stratum with available CWSs.

8) Generation of maps of watersheds for each CWS. Data entry into a Geographical Information System (GIS).

The final distribution of selected CWSs by state, size, and corn intensity is presented in Table 1. The top number in each stratum (delineated by a box) is the total number of CWSs meeting the target population criteria in that stratum. The middle number in each stratum is the number of CWSs selected from that stratum, and the bottom percentage is the percentage of CWSs selected from the total population in that stratum. The highest percentage of CWSs, 100% of the available CWSs, were selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. The bulk of the selected CWSs are located on watersheds with higher corn intensity, but the program also includes CWSs representative of other watersheds in corn growing areas.

Data regarding population and CWS source(s) were collected, watersheds for the 175 selected CWSs were mapped, and watershed areas and corn intensities were determined. Each of the 175 systems was visited and inspected to confirm data. Characteristics of the 175 selected CWSs including total population for all the CWSs, watershed areas and corn intensities for all watersheds, are summarized in Table 2. The 175 CWSs serve populations ranging from 167 to 5,100,000 people. The watersheds associated with the 175 CWSs cover areas ranging from 83 to 443,533,492 acres. All of the 175 CWSs in the program use some type of conventional treatment (coagulation, flocculation, sedimentation, and filtration) for their water. There are 21 CWSs using a granular activated carbon (GAC) treatment and 111 CWSs using a powdered activated carbon (PAC) treatment. Most of the GAC units are used by systems in the >20% and 11-20% corn intensity strata, strata that cover the higher corn-growing areas. A total of 124 CWSs have at least one reservoir. Maps showing corn intensity in the 12 states, watershed boundaries, and intake locations are displayed in Figures 1, 2, and 3, respectively. A table of CWSs and their characteristics is in Appendix A. State maps, individual site data sheets and maps for each system are in Appendix C, and are grouped by state. The state maps include a map of watershed boundaries, and a map of intake locations with site codes for each state. The site data sheets provide information on treatment method, surface water source (s), population served, training dates of CWS samplers, corn intensity, location of intake, soil texture and hydrologic group. Maps of all watersheds are included with each site data sheet. Based on the watershed maps and the data collected on CWS sources, watershed areas, corn intensities, population, and treatment methods, the 175 selected CWSs represent a diverse group of sampling sites.

2.0 MATERIALS AND METHODS

2.1 Site Selection

A total of 175 surface water CWSs in 12 states (IL, IN, IA, KS, MN, NE, WI, OH, MO, PA, MD, and DE) were selected for the surface water program. Procedures for the identification and selection of CWSs are described in sections 2.1.1 - 2.1.4 of this report.

2.1.1 Identification of Public CWSs

Lists of public Community Water Systems that use surface water in the 12 states were obtained from state agencies and the American Water Works Association (AWWA).[1]

The total number of surface water CWSs originally identified in each of the 12 states is shown in Table 3.

2.1.2 Identification of CWSs in the Target Population

Two procedures were used to identify which of the CWSs in each state fell into the target population:

1) Information was obtained by telephone interviews with operators from each of the CWSs.

2) Subsequently, for smaller watersheds, corn intensity for each CWS watershed was determined. Corn intensity was used as a surrogate for acetochlor usage for two principal reasons. Firstly, acetochlor was only registered in 1994 and use of first-year sales data would not be an accurate predictor of 1995 and following years' use. To achieve the use-reduction targets specified in the agreement, acetochlor will eventually become a major corn herbicide, so corn use is an excellent surrogate. Secondly, because Monsanto and Zeneca are competing in the market place with separate products, sharing sales data on a local level could be viewed as anti-competitive and thereby prohibited by United States' law.

Operator Interview Process

Telephone interviews were conducted by SEI staff with CWS operators to provide a general overview of the program, determine if operators were willing to cooperate in a five-year monitoring study, confirm preliminary information obtained during the identification of CWSs that use surface water, and to collect additional information needed to determine if the system fitted the target population. A standard operating procedure (SOP) was developed for the interview procedure in order to obtain consistent information from all CWS personnel. The procedure for the operator interview process is described in the following paragraphs.

Initial contact with operators was conducted by telephone. The interviewer attempted to contact an individual in a managerial position for the water system to ensure that cooperation was obtained from an employee with authority. If a manager was difficult to reach, an operator was interviewed. An overview of the program, and the program requirements regarding sampling and shipping were described to the operator. Every effort was made to encourage participation in the program by emphasizing the benefits to the CWS to be derived from receiving additional data on water quality. If the system was willing to participate, the following information was obtained or confirmed:

a) name of system, operator, telephone and fax numbers, and address;
b) whether the CWS uses surface water year round, or if it is an emergency or back-up source;
c) whether the system uses ground water in addition to surface water, and if so, whether it is possible to sample the surface water discretely;
d) whether the source is indeed a surface water source, and not a pit or static water body fed in the

e) number of sources supplying the CWS, name of each source and whether a particular source is a river, lake, reservoir, or some other type;
f) general location of intake(s), the specific location was determined at a later date if the system was selected.

Communication was continued with sites initially meeting the target population criteria to provide detailed information about the monitoring program, confirm information listed above, and obtain additional information regarding treatment of water, flow measurement, and population served.

Calculation of Corn Intensity (CI)

During the CWS selection process, CI values for each CWS meeting the criteria were determined manually using the procedure outlined below. However, the CI values provided in the Table of CWSs and Characteristics in Appendix A reflect more accurate values computed using GIS. For the selection process, the approximate corn intensity of a watershed was determined for watersheds associated with CWSs that initially met the target population criteria based on the operator interview process, and also did not draw water from a Continental River or one of the Great Lakes (henceforth "smaller watersheds"). First, the watersheds were drawn for each CWS according to the process described below:

1) If possible, the intake of the CWS was located on a USGS Hydrologic Unit Map (HUM) based on information obtained from the CWS contact during the operator interview process. Landmarks, such as roads, railroad tracks, bridges, towns, and rivers, were identified to aid in location of intakes. Intakes on smaller water bodies could not be located on the 1:500,000 scale HUM, because the water bodies were not shown on these maps. Therefore, their locations were marked on a larger-scale map[2], and transferred to the HUM. For instance, if the intake was located on a reservoir which did not appear on the HUM, the reservoir would be located on a larger-scale map. Its distance from a town or another landmark was noted and using that information, its location was identified on the HUM based on the location of the landmark. If the site was in Illinois, Ohio, Minnesota, Wisconsin, Pennsylvania, Maryland, or Delaware, a state atlas at a scale of 1:150,000 was used. For the remaining states where such an atlas was unavailable, a road atlas, with a more detailed scale, was used.

2) The direction of water flow was determined by examining the hydrology and/or topography of the surrounding area.

3) The watershed was drawn to encompass all areas upstream or draining to the lake, reservoir, or point of intake on the river. Where possible the USGS Hydrologic Unit Code (HUC)

boundaries (regional, subregional, accounting unit, cataloging unit) were used to define the watershed.

Corn intensity (CI) values for each county were calculated by dividing the acreage of harvested corn for each county[3] by the total acreage of the county[4]. Harvested acres of corn for grain and silage were added to give total acreage of harvested corn. Corn cropping data from 1992 were used in this study. Calculations of corn intensity for a few sample counties are shown in the table below:

State Name	County Name	Total County Acres	1992 Harvested Acres of Corn Grain	1992 Harvested Acres of Corn Silage	Corn Intensity (%)
	(a)	(b)	(c)	(d)	[(c+d)/b] x 100
Indiana	Allen	437852.5	84154	1987	19.67
Iowa	Adair	361858.5	102811	1577	28.85
Ohio	Adams	379027.9	15792	1154	4.47
Illinois	Alexander	158236.6	11253	50	7.14

Mylar overlay maps with county outlines were generated using ArcInfo software. Counties were shaded on the mylar according to their corn intensity value. A unique color was assigned to each of the following categories:

a) 0-5% CI
b) 5-10% CI
c) 11-20% CI
d) >20% CI

The Mylar overlays with county outlines were on the same scale as the Hydrologic Unit Code maps on which the watersheds were drawn. The appropriate Mylar overlay and map were superimposed in order to visually estimate the CI of each watershed. If a particular watershed was dominantly one color, the watershed was considered to be in that corn intensity category. If no predominant color was discernable, then the approximate area of each county within the watershed was estimated to the nearest $1x\ 10^5$ acres using a transparent grid graduated in inches and fractions of inches. Each 0.5 inch square (0.25 square inches) is equivalent to approximately 10,000 acres at the 1:500,000 scale of the HUC maps. The corn intensity of the watershed was then estimated using the following formula:

$(P_a \times CI_a) + (P_b \times CI_b)$ = Average CI percentage for the watershed, where

P_a = percentage of watershed in county a
CI_a = corn intensity of county a
P_b = percentage of watershed in county b'
CI_b = corn intensity of county b

The formula was modified to include all counties that made up a significant portion of the area of the watershed. For CWSs with more than one watershed, only the primary water sources were included in the CI determination. If more than one watershed or source CI was determined and the two sources did not have the same CI category, then a weighted average was used to determine the CI for the system.

After estimation of corn intensity, smaller watersheds were placed in the appropriate corn intensity category. All smaller watersheds with less than 5% CI were removed from the target population.

2.1.3 Separation of Target Population of CWSs into Disjoint Strata

The CWSs meeting the criteria of the target population were separated into disjoint strata based on their state, the size of their watershed, and for smaller watersheds, their corn intensity (CI). There are five strata for each of the twelve states:

1. Great Lakes (Erie, Superior, Michigan)
2. Three Continental Rivers (Missouri, Mississippi, and Ohio)

   Smaller Watersheds with

3. 5-10% CI
4. 11-20% CI
5. >20% CI

There are a total of 60 strata for the 12 states. The disjoint strata structure is displayed in Table 1.

2.1.4 Random Selection of CWSs from each Stratum

Concentrations of acetochlor and other corn herbicides are likely to be higher in smaller watersheds with higher corn intensity. Acetochlor concentrations are expected to be lower in major rivers and lakes where herbicide levels will be diluted after runoff events. Therefore, CWSs on smaller watersheds with >20% CI are expected to potentially have the highest concentrations of acetochlor after runoff events, while CWSs on the Great Lakes are expected to potentially have the lowest concentrations of acetochlor after runoff events. A higher percentage of CWSs were selected from strata expected to have higher concentrations of acetochlor after runoff events. However, all strata are represented in this program.

Computer-generated random numbers were assigned to CWSs in each stratum. A certain number of CWSs from each stratum was selected by choosing the sites with the lowest random numbers. If a system subsequently needed to be removed due to unwillingness to participate, or some other reason which eliminated the system from the target population, then where possible, another system was randomly selected from the same stratum. If no systems were available in the same stratum for use as replacements, then a system was randomly selected from another stratum with available CWSs, where possible, from the next stratum in the same state. In general, the replacement CWSs were selected from strata with available CWSs, expected to have the highest concentrations of acetochlor after runoff events.

2.2 Data Collection for Selected CWSs

Specific data for each selected CWS was collected and verified using a standard operating procedure and data collection forms. Each CWS representative was contacted by telephone, and subsequently during a site visit, and asked to verify data previously obtained and to supply additional information about their system.

Detailed information was obtained on the location of each CWS intake, and the location was marked on a 7.5 minute USGS topographic map. Other data obtained are listed below:

1) name of system and owner
2) contact name
3) telephone and fax number
4) address and county
5) description and name(s) of primary source(s) of water
6) whether there is a reservoir, and if so, the approximate volume of the reservoir
7) description, name(s), and location(s) of alternative source(s) of water
8) frequency of backup supply use and date last used
9) treatment method and filtration type
10) whether system uses granular activated carbon treatment and is willing to collect raw water
11) whether system measures river flow and how
12) location of any nearby gaging stations
13) whether system measures stage height
14) peak and average volumes of surface water treated daily
15) whether system sells water to other CWSs, and the names of the customer CWSs
16) population served, population served by water sold to other CWSs
17) location of any pesticide storage/shipping facilities in watershed
18) whether system has a refrigerator/freezer to freeze ice packs
19) proximity of available shipping services
20) whether system is capable of collecting samples Mon.-Thurs, year round
21) number of staff available to collect samples, names(s) and title(s)
22) whether CVs/resumes are available for samplers
23) whether the intake was located and reference provided
24) comments for system participants

2.3 Drawing of Watersheds

Watersheds were drawn for each selected CWS following a standard procedure. Watershed boundaries provided: 1) a basis for the maps of all watersheds included in the program, and 2) the points and lines used to create Geographical Information System (GIS) coverages. The process for drawing watersheds is summarized below.

- The intake location was marked on a 7.5 minute USGS topographic map based on detailed information obtained during the telephone interview and confirmed during site visits.

- The intake location was transcribed from the 7.5 minute USGS topographic map onto the map of appropriate scale for drawing the watershed. The appropriate scale map was selected by choosing a USGS topographic or hydrologic unit map that provided the most detail possible and also was suitable for reduction to an 8.5 x 11 inch page.

- The watershed was drawn by connecting points of highest elevation upstream from the intake. This was done by following the drainage divide, a continuous line joining the points from which surface water will flow in different directions. These points can be determined from the contour lines of a topographic map by observing the slope of the land and thus, noting which way the water will flow. The highest points surrounding land that slopes towards all tributaries of a water body are joined together to delineate the drainage divide. With few exceptions, the drainage divide cannot cross any bodies of water. The area within the drainage divide defines the watershed.

- The watershed was drawn initially in pencil and then traced onto Mylar. Geographic reference points (latitude and longitude) were also marked on the Mylar.

For systems with more than one intake, the individual intakes and their associated watersheds were designated as primary (P1, P2, etc), or as backup (B1, B2, etc). Watersheds were drawn for all primary intakes. Back-up source watersheds were drawn only if the back-up source was likely to provide more than 20% of the volume on sampling weekdays between March 15 and August 31, the time period when peak concentrations of herbicides due to field runoff are expected. All primary and significant backup watersheds were drawn in order to obtain realistic watershed data for the surface water used by the system.

For systems with watersheds on the Great Lakes or Continental Rivers, the watersheds were drawn on appropriate small scale maps (referenced on each map in the site data section in Appendix C) to provide the individual site map. The intake locations for Great Lake watersheds were traced onto Mylar along with geographic reference points (latitude and longitude) and existing ArcInfo polygon lines from EPA sources[5] were used to delineate the watersheds for GIS. The watershed was drawn initially in pencil and then traced onto Mylar. Geographic reference points (latitude and longitude) were marked on the Mylar.

Watersheds for Continental Rivers are available on the USGS 1:500,000 Hydrologic Unit Maps (HUMs). The HUMs are available for each state, and the Continental Rivers commonly extend through several state maps. To use existing data, watershed boundaries were drawn using both the HUMs and the USGS State Series 1:500,000 Topographic Maps. Both maps are of the same scale. The procedure for drawing the Continental River watersheds is described below:

- Locate the intake on the Topographic Map
- Overlay the appropriate Hydrologic Unit Map with the Topographic Map, and draw the watershed boundaries on the Topographic Map until they connect with a hydrologic unit code boundary.
- Reverse the maps so the Hydrologic Unit Map is over the Topographic Map, and trace the intake location and watershed boundaries onto the Hydrologic Unit Map. The Hydrologic Unit Map was used as the base map for the Mylar trace.
- Trace the watershed onto Mylar. Geographic reference points (latitude and longitude) were also marked on the Mylar.

The boundaries of all watersheds traced on Mylar were scanned and converted to digitized polygons to serve as a basis for a Geographic Information System (GIS) database. This allows other data (e.g. soil texture and hydrologic group, and weather data) to be overlaid and compared to specific watersheds. Corn intensity (based on county data)[3,4] and watershed area were calculated for each watershed using GIS. Corn intensity had been previously estimated using the method described in Section 2.1.2. in order to determine if watersheds belonged to the target population, and to assign watersheds to categories of corn intensity. GIS provided a more accurate determination of corn intensity. Most of the GIS-calculated corn intensities are within the range of the stratum of the associated CWS, but as can be seen in Table 2 and in more detail in the Table of CWSs and

Characteristics in Appendix A, some of the watersheds have GIS-calculated corn intensities that are higher or lower than their CWS stratum corn-intensity range. Both determinations of corn intensity are based on county corn data. An area index, that is a relative measure of the proportion of each county contained in a watershed, was calculated for each watershed. This provides information on the reliability of the corn intensity based on county data. Details regarding calculation of corn intensity, area index, and watershed area using GIS are provided below in Section 2.4. Details regarding GIS databases and mapping are provided in Appendix B.

2.4 GIS Calculation of Corn Intensity and Watershed Area

2.4.1 Corn Intensity

ArcInfo GIS software is used to assist in the calculation of watershed corn intensity (WCI) for each watershed. County corn intensities are used to calculate this number. An intersection is made of the county (polygon) ArcInfo GIS coverage (database) with the watershed ArcInfo GIS coverage using ArcInfo's "Union" command. This process results in the creation of county watershed (polygon) coverage. A new item in the PAT file (the polygon attribute table-the database file) is then created using the ArcInfo "Additem" command to accept the values for the percentage of watershed within each county. To calculate this percentage, the following formula is used in the ArcInfo program:

$$P = \frac{\text{WSCTY}}{\text{TOTAL}} * 100$$

where:
P = Percentage of watershed within the county
WSCTY = area of watershed in the county
TOTAL = total area of watershed polygon

Another item in the PAT file is created to accept values for the average CI of each watershed. The average CI for each watershed is calculated in ArcInfo using the following formula:

$$\text{WCI Percentage} = (\text{P}a \times \text{CI}a) + (\text{P}b \times \text{CI}b) + \ldots + (\text{P}nth \times \text{CI}nth)$$

where:
WCI = Watershed Corn Intensity
P*a* = percentage of watershed in county *a*
CI*a* = corn intensity of county *a*
P*b* = percentage of watershed in county *b*
CI*b* = corn intensity of county *b*
P*nth* = percentage of watershed in *nth* county
CI*nth* = corn intensity of the *nth* county

For each watershed an "area index" is calculated. The index is a relative measure of the proportion of each county contained in the watershed and thus, provides information regarding the reliability of the calculated WCI. For example, if a watershed has three counties and each county has greater than 50% of its area within the watershed, the calculated watershed corn intensity is likely more accurate than for a watershed in which the counties have only 20% of their areas within the watershed. The formula for calculating the index is:

$$\textbf{AREA INDEX} = \frac{\sum_{i=a}^{n} WSCTY_i}{\sum_{i=a}^{n} CTY_i} * 100$$

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where:
WSCTY = acreage of watershed in county *i*
CTY = acreage of county *i*

2.4.2 Watershed Area

Geographic locations are stored as vector data in ArcInfo. The ArcInfo software is able to perform precise planimetric area calculations on polygons delineated by these vectors. The area is calculated through preprogrammed algorithms in the software.

The watershed areas for the Great Lakes do not include the area of the lake itself. This has an impact on the calculation of the CI. Because of the smaller areas, the GIS-calculated CI will be a higher number than if the calculation had included area of the lake. Also some of the Great Lakes' watersheds extend into Canada where county corn intensities are not available, and are not included in the calculation.

3.0 RESULTS AND DISCUSSION

3.1 CWS Distribution

The distribution of CWSs in the surface water program is displayed in Table 1.

3.1.1 States

A total of 175 CWSs were required for inclusion in the surface water program. Initially, all 175 sites were to be located in the seven core states (IL, IN, IA, KS, MN, NE, and WI) as defined by the March, 1994, registration agreement. The rationale was that these seven states accounted for over 80% of the corn production, and therefore, acetochlor would be used predominantly in these states. However, based on data collected in the Fall of 1994 by the ARP, it was clear that several of the core states, KS, MN, NE, and WI, had very few surface water CWSs in areas of greater than 5% corn intensity. The ARP and EPA discussed these data and the possibility of expanding the surface water program to include additional states, in order to avoid over-sampling in several of the originally identified states. The outcome of these discussions resulted in inclusion of five more states, OH, MO, PA, MD, and DE. By including these states, the ARP was able to identify hundreds of additional CWSs that used surface water. Many of these were smaller CWSs in areas of greater than

5% intensity. The expansion to additional states is likely to benefit interpretation of the data obtained from this study.

3.1.2 Watershed Size and Corn Intensity

Watersheds were separated into three size strata:

1) Great Lakes
2) Continental Rivers
3) Smaller Watersheds

An objective of the selection process was to represent all three sizes of watersheds, but focus on the watersheds expected to have the highest concentrations of acetochlor after runoff events. Therefore, the highest percentage of watersheds was selected from the Smaller Watershed strata and the lowest percentage from the Great Lakes strata. A total of 150 CWSs (71% of the available CWSs were selected from the Smaller Watershed strata, a total of 17 were selected from the Continental River strata (43% of the available CWSs), and a total of 8 from the Great Lakes strata (14% of the available CWSs).

The Smaller Watershed strata were further separated by their corn intensity into three additional strata:

1) 5-10% Corn Intensity
2) 11-20% Corn Intensity
3) >20% Corn Intensity

A second objective of the selection process was to represent all three corn intensity ranges but focus on the watersheds expected to have the highest concentrations of acetochlor after runoff events. Therefore, the highest percentage of watersheds was selected from the >20% Corn Intensity strata and the lowest percentage from the 5-10% Corn Intensity strata. A total of 76 CWSs were selected from the >20% Corn Intensity strata (100% of the available CWSs), a total of 31 CWSs from the 11-20% Corn Intensity strata (66% of the available CWSs), and a total of 43 CWSs from the 5-10% strata (49% of the available CWSs).

Corn intensity is used as a surrogate for acetochlor usage, and the strata expected to have the highest levels of acetochlor are the Smaller Watershed, >20% Corn Intensity strata.

3.2 Characterization of CWSs

Corn intensity (for the 12 states included in the program), watershed boundaries, and CWS intake locations are displayed on maps in Figures 1-3.

The watersheds associated with the 175 selected CWSs are in the 12 states included in the program, and also extend into 12 other states and Canada. The watersheds extending into Canada and the 12 other states are listed below:

Great Lakes:	Canada, New York, Michigan
Mississippi River:	Canada, Colorado, Wyoming, Montana, North Dakota, South Dakota

Ohio River:	New York, West Virginia, Kentucky, Tennessee, North Carolina
Missouri River:	Canada, Colorado, Wyoming, Montana, North Dakota, South Dakota
Kansas and Republican Rivers:	Colorado
Red Rivers:	North Dakota, South Dakota

CWSs were generally characterized by their size and corn intensity, population served, watershed area, treatment type, and whether a reservoir is used. An overview of the characteristics of the 175 CWSs in the surface water program is provided in Table 2.

All of the 175 CWSs in the program use some type of conventional treatment (coagulation, flocculation, sedimentation, and filtration) for their water. There are 21 CWSs using a granular activated carbon (GAC) treatment and 111 CWSs using a powdered activated carbon (PAC) treatment. Most of the GAC units are used by systems in the >20% and 11-20% corn intensity strata, strata that cover the higher corn-growing areas. A total of 124 CWSs have at least one reservoir. The 175 CWSs serve populations ranging from 167 to 5,100,000 people. The watersheds associated with the 175 CWSs cover areas ranging from 83 to 443,533,492 acres. An overview of CWS distribution by population and strata is presented in Figure 4. The distribution of watershed area by strata is presented in Figure 5. This data includes watershed area for all watersheds (primary: P1, P2 and back-up: B1, B2) for a given CWS that are likely to provide more than 20% of the volume on sampling weekdays between March 15 and August 31. The number of CWSs with reservoirs and GAC treatment is compared to the total number of CWSs in each stratum in Figure 6.

A table of the 175 CWSs and 200 watersheds, sorted by state, strata and site code, with system name and address, total population served (including population served by sales to other systems), GIS-calculated corn intensity and watershed area(s) for all watersheds for a given CWS, whether system uses GAC and/or PAC, or has a reservoir, source code, is in Appendix A. Detailed information on each of the 175 selected CWSs is presented in site data sheets in Appendix C and organized by state and site code. A state map with watershed boundaries, and a state map with intake locations marked and identified by site code are included with the site data sheets for each state. Maps of all watersheds associated with a site are also included with each site data sheet. The site data sheets provide the following information:

1) system name, delivery address, mailing address, telephone, fax
2) treatment information including type of treatment, and peak and average volume treated/day
3) watershed stratum
4) population served and population sold
5) names of CWS samplers and dates of training
6) source information including source name, watershed area, source type, volume/area for reservoirs, backup frequency, and whether stage height is measured
7) corn intensity for each watershed calculated by GIS using county data, and area index providing information on the proportion of the counties within the watershed
8) location of intake, latitude and longitude, for each watershed
9) hydrologic group and soil texture information for all watersheds that are not Great Lake or Continental River watersheds

4.0 CONCLUSIONS

A site selection process was conducted to identify 175 CWSs in 12 states. Data regarding population and CWS source(s) were collected, and watershed areas and corn intensities were determined. Each of the 175 systems was visited, inspected, and data confirmed. Watersheds for the 175 systems were mapped. The selected CWSs represent a broad spectrum based on geographic diversity, general size and corn intensity of the watersheds. The data for the selected systems demonstrate the extensive diversity of the ARP surface water monitoring program. The watersheds are representative of the key acetochlor-use states, with a few extending into numerous states not included in the program. The CWSs are supplied by surface water from a variety of sources including small rivers and lakes, larger rivers and lakes, and reservoirs, and employ a wide variety of treatment methods. The selected watersheds span a large range of watershed area, and serve a large range of populations.

The highest percentage of CWSs, 100% of the available CWSs, was selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. Almost 50% of the sites were selected from smaller watersheds with >20% corn intensity, the watersheds expected to have the highest concentrations of acetochlor after runoff events. The focus on more vulnerable watersheds with higher corn intensity combined with the diversity of watersheds selected for this study will allow us to obtain both a worst-case and representative evaluation of the impact of acetochlor and other corn herbicide usage on surface drinking water in significant corn-growing areas of the United States.

12.5.2. Site Selection – SGW Study

The description below is taken from De Guzman et al (2005), a more comprehensive description is available in:
MRID: 43899601
Hendley, P. (1995) State Ground Water Monitoring Program for Acetochlor and Other Corn Herbicides--Part 1: Site Selection and Site Details: Lab Project Number: ACET-94-GW-01: RR 95-087B: GWMSIT05.DOC. Unpublished study prepared by Zeneca Ag Products and Levine-Fricke, Inc. 3217 p.

Site Selection Criteria

The goal of the first phase of the study was to establish a network of 175 monitoring sites in regions of high corn production in each of the seven states representing a range of soil textures typical of corn agriculture in those regions. Each site was expected to have shallow ground water, as defined by each state (Table 1), unprotected by restrictive subsurface layers. A new monitoring well was installed within or closely adjacent to and down-gradient of each site. Initially, the seven-state area was evaluated to determine the counties with significant corn production. The evaluation was based on the most recent (1987) United States Department of Agriculture (USDA) Agricultural Product Statistics available at that time. An area-weighted distribution of soil textures across the selected counties in each state was obtained from STATSGO, a USDA-National Resources Conservation Service (NRCS) spatial soils database (USDA, 2004). This distribution was used to develop initial targets for the numbers of sites to be assigned to each soil texture in each state. Table 2 details the planned and actual distribution of GWM sites by soil texture.

Potential monitoring sites were also required to: 1) be representative of the irrigation and crop rotation practices performed on the particular soil type and region; 2) be able to accommodate a new monitoring well installed within or adjacent to, and down-gradient of a 4.0-hectare (minimum) treated study plot; 3) be free of any historical application of acetochlor; 4) not be prone to flooding, runoff or run-on; 5) be relatively flat (< 8% slope); 6) accommodate the installation of a monitoring well without drilling into bedrock; and 7) have a site landowner who agreed, via a formal agreement with the ARP, to follow a specific acetochlor use plan.

Site Characterization and Well Installation

Once a GWM site was confirmed to meet the above criteria, it was visited by ARP personnel to collect additional characterization data. A topographical survey, hydrogeological assessment, soil characterization and a cooperator interview were conducted. If available, published maps of the site and vicinity were obtained, including county roadmaps, plat maps, USGS 7.5-minute quadrangles, NRCS County Soils maps, and aerial photos. Furthermore, a detailed map of each site was produced in order to identify site-specific features, such as access lanes, study plot location, irrigation and other farming equipment, tile drains, ditches and other waterway features. Historical pesticide use, dating back to 1990 (when available), cropping and other agronomic practices were obtained by interviewing the cooperators. A minimum 4.0-hectare portion of the farm was designated as the study plot. Ten soil cores (0 – 0.15 m) were collected from representative locations in the study plot. These soil cores were composited and a subsample was analyzed (A&L Great Lakes Laboratories Inc., Fort Wayne, IN) for pH, organic carbon/organic matter, cation exchange capacity, USDA texture classification and bulk density.

Monitoring wells were sited within or closely adjacent to, and down-gradient of the study plot. Various sources of published ground water data were used (for example, the Department of Natural Resources Hydrologic Assessment, the USGS Hydrologic Atlas and local university data) to assess ground water flow direction for most sites. At sites where published ground water data were not available, trained hydrogeologists evaluated topography in conjunction with surface water drainage features in order to assess ground water flow direction.

Monitoring wells were installed by licensed commercial drilling contractors under the direct supervision of a professional geologist/hydrogeologist and in compliance with state and local guidelines. Each boring was drilled using a hollow-stem auger advanced by a rotary drill rig. Continuous core soil samples were collected from each boring and lithologic descriptions were recorded using the Unified Soil Classification System (USCS). Each monitoring well was constructed with 0.05 m (inside diameter) polyvinyl chloride (PVC) casing with flush-threaded joints and 0.254-mm machine-slotted screen. A filter pack of coarse sand to fine gravel was placed in the annular space surrounding and up to approximately 0.6 m above the well screen. The length and position of the well screen was defined by each state (Table 1). A minimum 0.9 m bentonite seal was installed in the annular space above the filter pack. The remaining annular space from 0.6 to 0.9 m bgs was sealed using a Portland cement grout or a bentonite grout. The PVC casing extended up to approximately 0.9 m above the surface grade and was protected by a 0.1 m inside diameter steel protective casing and a locking cap. Wooden posts were installed in a square formation 0.2 m from the monitoring well for added protection against farm equipment. Figure 1 illustrates the typical well construction details of the GWM wells. After well installation, each monitoring well was thoroughly developed and equipped with a dedicated bladder pump. Each of the 175 monitoring wells was locked and access was limited to ARP personnel.

Each monitoring well was surrounded by an 'acetochlor-free' buffer zone to minimize the chance of direct spray drift contamination of the monitoring wellhead and sampling area. Acceptable buffer zones were defined by each state and ranged from 9.1 - 45.7 m (Table 1). Each of the 175 wells was given a unique ID, which followed a standard SSnn format where "SS" reflected the state abbreviation and the "nn" represented a sequential number within the state (e.g. IL01 - IL25). Figure 2 shows the approximate location of the sites. Exact locations of the sites and wells were held confidential in order to minimize the risk of vandalism or sabotage and to protect the privacy of the cooperator.

Monitoring began in 1995 with every cooperator expected to plant corn and treat the study plot with an acetochlor product that spring. In later years, the cooperators were expected to follow their typical cropping plans (e.g. continuous corn or a crop rotation), provided that by the end of the 5-year monitoring program, each of the 175 sites would be cropped to corn three times, and therefore, would receive at least three acetochlor applications. In order to accommodate the 2-year extension, a new agreement was made between the ARP and the cooperators in 1999, which specified that another corn crop be planted and treated with an acetochlor formulation during at least one of the two additional growing seasons. Therefore, each cooperator was required to make at least four acetochlor treatments during the course of the 7-year study.

12.5.3. PGW Study Site Selection and Characterization

The following description is taken from Newcombe et al. (2005), more detailed descriptions are found in the Final Reports and Site Characterization reports for each of the eight studies (see Bibliography section).

PGW site selection criteria

Careful selection of PGW monitoring sites is critical to ensure that study results are useful in risk assessments and pesticide regulatory decisions. A combination of US EPA (US EPA 1995 and 1998) and ARP-specific site selection criteria were followed to locate candidate sites for the acetochlor PGW program. These criteria included;

- Uniform soil characteristics
- Unconfined aquifer
- Less than 9 m depth to the water table
- Less than or equal to 2% topographic slope
- Sufficient distance from drainage features to ensure stable hydraulic gradient conditions
- No impeding low-permeability layers between the surface and water table
- No prior acetochlor use
- Absence of seasonally high water tables
- Farmer and/or landowner cooperation
- Adherence to the acetochlor soil use restriction in the United States. This restriction prohibits the use of acetochlor on sands with less than 3% organic matter, loamy sands

with less than 2% organic matter, or sandy loams with less than 1% organic matter, when ground water is less than 9 m below land surface.

The US EPA required that studies be conducted on the following soil textures; loamy sand (1), sandy loam (2), loam (1) silt loam (3), and clay loam (1). This distribution includes most soils on which corn is grown in the United States, but is weighted towards coarser-textured soils.

Site identification

Preliminary site identification activities included a review of available soils, agronomy, and hydrogeologic data. Geographic Information System overlays of land use and soil type were created to identify sub-county areas for further investigation. During visits to candidate sites, preliminary surface-soil samples were collected for laboratory characterization, and hand auger borings collected to determine the nature of vadose zone material, and if possible, to determine depth to ground water at each site.

Site characterization

Site characterization activities included surface soil and subsoil characterization, aquifer characterization, and the conduct of a site survey. Surface soil (0-15 cm) was collected from each proposed PGW study location to assess variability of surface-soil texture, pH, organic matter, cation exchange capacity, and disturbed bulk density. Soil samples were collected using a stainless steel trowel or hand auger and shipped to a contract laboratory for characterization. Subsurface soil at each study location was characterized during piezometer or monitoring well installation activities. Boreholes for piezometer and monitoring well installation were advanced using 11-cm inner diameter, 150 cm-long hollow stem augers mounted on a drilling rig. Soil samples were collected during drilling operations using a 5-cm outer-diameter, 61-cm-long split-spoon sampling device. Split-spoon samples were placed on plastic sheeting for lithologic description and partitioned into discrete lithologic horizons, sub-sampled, then shipped to a contract laboratory for soil characterization.
Shelby tube sampling was conducted to obtain relatively undisturbed soil samples for the measurement of vertical saturated hydraulic conductivity and undisturbed bulk density. Soil samples were collected using 8-cm o.d., 76-cm-long steel Shelby tubes. A hollow-stem auger-drilling rig was used to advance the Shelby tube into the soil profile. Samples were scheduled to be collected in 61-cm increments from land surface to ground water; however the presence of coarse materials (cobbles and stones) in the vadose zone prevented the collection of continuous cores at two PGW study locations.

Aquifer properties were assessed by observations made during piezometer and monitoring-well drilling activities, and by measurements recorded after instrumentation. Aquifer characterization included the types of materials encountered below the water table, depths to ground water, ground water flow direction, hydraulic gradient, hydraulic conductivity, porosity, and pore-water velocity.

Table 1: Topography and Soil Characterization Summary

PGW Study Location	Slope (%)	NRCS Soil Series [†]	Surface Soil Organic Matter (%)[‡]	Surface Soil pH	Subsoil Textures [†]	Avg. Hydraulic Conductivity[§] (mm/hr)	
Wisconsin	<0.5	Richford loamy sand	1.6[¶]	6.4	Loamy Sand	0-1.2 m	177
					Sand	1.2-2.4 m	358
					Sandy loam	2.4-3.6 m	810
						3.6-4.8 m	1482
						>4.8 m	776
Ohio	<0.5	Genessee silt loam Fox silt loam	2.9	7.7	Clay loam	0-1.2 m	293
					Loam	1.2-2.4 m	153
					Sandy loam	2.4-3.6 m	NA
						3.6-4.8 m	NA
						>4.8 m	NA
Minnesota	<0.5	Estherville sandy loam	3.5	6.3	Sandy loam	0-1.2 m	180
					Loamy sand	1.2-2.4 m	331
					Sand	2.4-3.6 m	NA
						3.6-4.8 m	NA
						>4.8 m	NA
Nebraska	<0.5	Kenesaw silt loam Coly-Kenesaw silt loam	1.8	5.7	Loam	0-1.2 m	75
					Silt loam	1.2-2.4 m	45
						2.4-3.6 m	28
						3.6-4.8 m	18
						>4.8 m	84
Iowa	<2	Marshall silty clay loam Minden silty clay loam	3.9	5.6	Silty clay loam	0-1.2 m	207
					Silt loam	1.2-2.4 m	84
						2.4-3.6 m	172
						3.6-4.8 m	87
						>4.8 m	1.0
Indiana	<0.5	Door loam Lydick loam	3.0	6.7	Sandy clay loam	0-1.2 m	64
					Sandy loam	1.2-2.4 m	190
					Sand	2.4-3.6 m	244
						3.6-4.8 m	742
						>4.8 m	978

Pennsylvania	<2	Clarksburg silt loam Duffield silt loam	2.7	6.3	Loam	0-1.2 m	382
					Sandy loam	1.2-2.4 m	138
						2.4-3.6 m	95
						3.6-4.8 m	19
						>4.8 m NA	NA
Delaware	<1	Sassafras sandy loam	2.9	5.8	Sandy loam	0-1.2 m	30
					Loamy sand	1.2-2.4 m	86
					Sand	2.4-3.6 m	30
						3.6-4.8 m	129
						>4.8 m	NA

Depths to ground water were recorded to assess ground water flow direction and hydraulic gradients at each study location. Monitoring wells were instrumented with dedicated submersible pumps; consequently depths to ground water were only measured in the piezometers located at the corners of the test plot and on the periphery of the study location. Depths to ground water were measured manually from a fixed surveyed point on the top of the casing of each piezometer.

The depths to ground water and corresponding elevations were used to create ground water elevation contour maps for each ground water-sampling event at each study location. Ground water flow direction and hydraulic gradient were assessed from these contour maps.

Hydraulic gradients were estimated by calculating the difference in ground water elevation (m) between two points along a line-oriented perpendicular to the ground water elevation contour lines. The difference between ground water elevations was divided by the horizontal distance between the two points to obtain a resulting gradient (m/m).

Table 2: Aquifer Characterization Summary

PGW Study	Aquifer soil textures determined[†]	Depth to ground water[‡] (m)	Hydraulic Gradient (m/m)[§]	Hydraulic Conductivity (m/day)	Porosity (%)	Pore-water velocity (m/day)[¶]
Wisconsin	Loamy sand Sandy loam Sand	7.6-10	1.5×10^{-3}	0.16	40	1.9×10^{-3}
Ohio	Sandy loam Loamy sand	0.6-5.2	4.5×10^{-4}	17.9	35	0.8×10^{-1}
Minnesota	Sand Loamy sand Sandy loam	4.8-6.4	2.5×10^{-4}	14.5	32	0.4×10^{-1}
Nebraska	Silt loam Loam Sandy loam	7.0-9.7	5.4×10^{-4}	0.8	38	0.4×10^{-2}
Iowa	Sand Silt loam Loam	1.2-8.5	6.6×10^{-4}	13.1	32	0.9×10^{-1}
Indiana	Sand	7-9.1	1.0×10^{-3}	6.0	32	0.6×10^{-1}
Pennsylvania	Sandy loam Loam	1.8– 7.3	2.6×10^{-3}	1.7	40	0.4×10^{-1}
Delaware	Sand Sandy loam Loamy sand	3.3-6.1	4.2×10^{-4}	1.4	32	0.6×10^{-2}

[†] Soil texture determined by 3-fraction analysis (% sand, silt, and clay)

[‡] Depth to ground water listed is below ground surface, and minimum and maximum value determined in the test plot corner piezometers during the course of the study

[§] Hydraulic gradient listed is the average value determined during the course of the study

[¶] Pore-water velocity listed is the average value determined during the course of the study

Hydraulic conductivity of the aquifer was estimated by conducting rising or falling-head slug tests in randomly selected monitoring wells located in the test plot. The slug test data were used to calculate the hydraulic conductivity of the aquifer in the vicinity of the well, using standard formulae for monitoring wells screened in unconfined aquifers (Bouwer et al., 1976 and 1989).

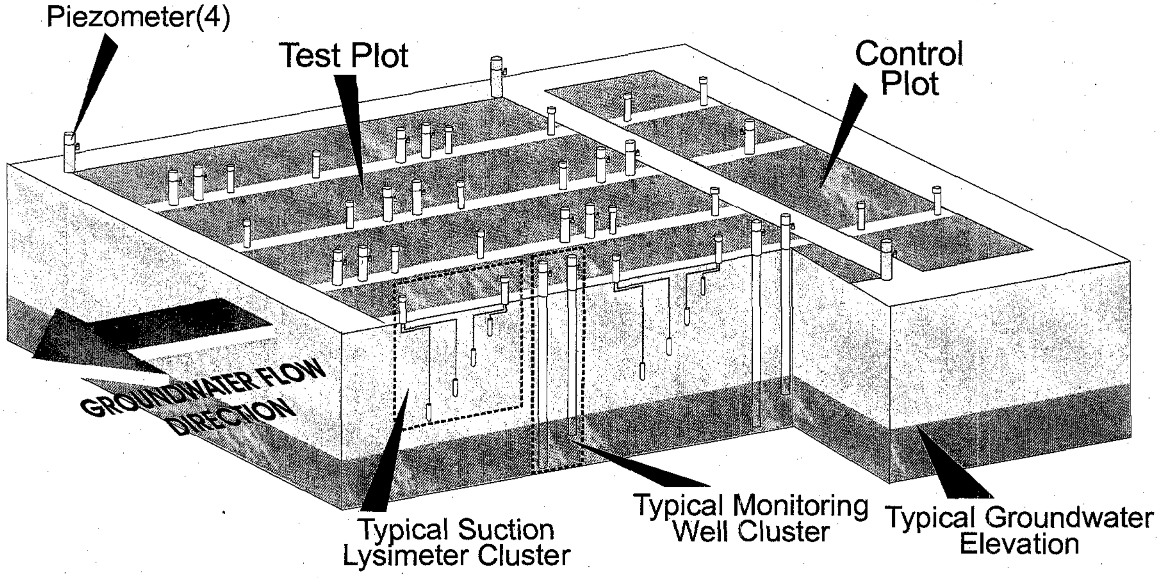
Porosity of the aquifer material was not measured directly, but was estimated empirically based on the types of sediments (Driscoll, 1986) encountered below the water table during monitoring well installation. Pore-water velocity values were calculated using hydraulic conductivity, hydraulic gradient, and porosity data.

Study design and instrumentation

Each PGW site was instrumented in accordance with the US EPA draft guidance document on the conduct of PGW studies (US EPA, 1995 and 1998) with the exception of the Wisconsin and Ohio PGW studies, which were initiated prior to the issue of US EPA's 1995 guidance document. The US EPA agreed to the instrumentation configuration for these studies prior to instrumentation.

Each PGW study consisted of an approximately 1.2-ha test plot adjacent to a 0.2-ha control plot. The control plot was located hydrogeologically upgradient from the test plot (Fig. 1). The test and control plots were instrumented with suction lysimeters (for sampling soil-pore water) installed at varying depths within the vadose zone, and ground water monitoring wells screened at varying depths within the aquifer (Fig. 1).

Figure 1: PGW Study Layout and Instrumentation



In summary, each PGW site was instrumented with seven piezometers to measure depths to ground water and to monitor variations in ground water flow direction and hydraulic gradient. A single piezometer was installed at each of the four-corners of the test plot (Fig. 1), and three piezometers were located around the periphery of the PGW study location.

Piezometers were constructed with flush-threaded, 5-cm-i.d., Schedule 40 polyvinyl chloride (PVC) casing and 0.25 mm slotted screen. Piezometers were completed above ground with a concrete pad, steel protective outer casing, and locking cap. Horizontal coordinates and top-of-casing elevations of each piezometer were professionally surveyed.

Monitoring wells were installed to collect ground water samples and were arranged in clusters within each test plot. For the Wisconsin and Ohio PGW studies, ten monitoring wells were installed at each PGW study location. One monitoring well was installed in each control plot, and three clusters of three monitoring wells were installed in each test plot. The clusters consisted of one shallow, one deep, and one extra deep monitoring well (Fig. 2).

For the six remaining PGW studies, 17 monitoring wells were installed at each PGW study location. One monitoring well was installed in each control plot, and eight clusters of two monitoring wells were installed in each test plot. The clusters consisted of one shallow and one deep monitoring well (Fig. 3).

Approximate monitoring well screen lengths and positions were as follows:

Control plot well:	4.5 m screen positioned with approximately 1.5 m of screen above the water table at the time of well installation.
Test plot shallow wells:	3 m screen positioned with approximately 1.5 m of screen above the water table at the time of well installation.
Test plot deep wells:	1.5 m screen positioned approximately 1.5 m below the water table at the time of well installation.
Test plot extra-deep wells:	(Wisconsin and Ohio only): 1.5 m screen positioned approximately 3 m below the water table at the time of well installation.

The positioning of each monitoring well screen at each PGW site was dictated by the depth to ground water encountered during monitoring well borehole advancement. Screens for the shallow monitoring wells were 3 m in length, to enable ground water samples to be collected in the event the depth to ground water increased after monitoring well installation. Monitoring well clusters were installed in a linear arrangement, with a 3-meter distance between each monitoring well within a cluster. Monitoring wells were constructed as described for the piezometers.

APPENDIX

12.6. Analytical Method Summary Descriptions for the ARP Monitoring Programs

SDWS Study (from Hackett et al., 2005)

Sample Analysis

We employed two analytical methods, one for parent compounds and the other for degradates. Both relied on mass spectrometry for detection. Samples were generally not filtered prior to analysis, although raw water samples occasionally required the use of a sea sand filtration step. Parent herbicides were analyzed using stable isotope dilution gas chromatography/mass spectrometry (GC/MS), preceded by solid phase extraction for cleanup and concentration (Fuhrman et al. 1996). The method involved addition of deuterated analogs of each analyte, as internal standards, to a 200 mL water sample prior to extraction, concentration, and analysis.

We analyzed for the oxanilic and sulfonic acid degradates of acetochlor, alachlor, and metolachlor by direct aqueous injection reversed-phase liquid chromatography tandem mass spectrometry (LC/MS/MS). The samples were injected directly into an LC/MS/MS (HP1100/Sciex API-3000) without prior concentration, cleanup or filtration (Hackett et al. 2003).

All surface water samples were refrigerated at 2-10 °C upon receipt at Monsanto, before extraction or preparation for analysis. Replicate samples were transferred to a freezer at –20 □ 5 °C. Sample extracts were either analyzed immediately or refrigerated at 2-10 °C until analysis. All reported analytes demonstrated acceptable storage stability under these conditions, which was confirmed both through separate storage stability studies and by analysis of field-fortified samples. The median times from collection to extraction and collection to analysis were 7 and 9 days, respectively.

SGW Study (from de Guzman et al., 2005)

Analytical Methodology

Ground water samples were analyzed for parent acetochlor, alachlor, atrazine and metolachlor during the first four years of the GWM. For the final three years, samples were also analyzed for the tertiary amide soil degradates of acetochlor, alachlor and metolachlor, specifically tertiary amide sulfonic acid (ESA) and tertiary amide oxanilic acid (OXA). A complete list of the target compounds, including common name, chemical name and CAS number, is as follows: acetochlor (2-chloro-N-(ethoxylmethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), CAS No. 34256-82-1, alachlor (2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)-acetamide), CAS No. 15972-60-8, atrazine (6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine), CAS No. 1912-24-9, metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)-

acetamide), CAS No. 51218-45-2, acetochlor oxanilic acid ([(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]-oxoacetic acid, sodium salt), CAS No. 194992-44-4 (free acid), acetochlor sulfonic acid (2-[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid, sodium salt), CAS No. 187022-11-3 (free acid), alachlor oxanilic acid ([(2,6-diethylphenyl)(methoxymethyl)amino]- oxoacetic acid, sodium salt), CAS Nos. 140939-14-6 (free acid) and 171262-17-2 (free acid), alachlor sulfonic acid (2-[(2,6-diethylphenyl)(methoxymethyl)amino]-2-oxoethanesulfonic acid, sodium salt), CAS Nos. 140939-15-7 (sodium salt) and 142363-53-9 (free acid), metolachlor oxanilic acid ([(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]oxoacetic acid, sodium salt), CAS No. 152019-73-3 (free acid), and metolachlor sulfonic acid (2-[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl))amino]-2-oxoethanesulfonic acid, sodium salt), CAS No. 171118-09-5 (free acid).

GC/MS method for parent herbicides. Parent herbicides were analyzed using stable isotope dilution gas chromatography/mass spectrometry (GC/MS), which was preceded by solid phase extraction for cleanup and concentration. The method involved addition of deuterated analogs of each analyte, as surrogates, to the 200-mL sample prior to extraction, concentration, and analysis (Fuhrman et al., 1996). Based on actual prior fortification data, the Limit of Detection (LOD) and Limit of Quantification (LOQ) of this method was determined to be 0.03 µg L-1 and 0.05 µg L-1, respectively, for all non-polar analytes (Hackett et al., 2003), with the exception of alachlor, whose LOD was 0.05 µg L-1 due to higher background levels of this compound.

LC/MS/MS method for chloroacetanilide degradates. The ESA and OXA soil degradates of acetochlor, alachlor, and metolachlor were analyzed by direct aqueous injection reversed-phase liquid chromatography tandem mass spectrometry (LC/MS/MS). The samples were injected directly into the LC/MS/MS (HP1100/Sciex API-3000) without prior concentration, cleanup or filtration (Hackett et al., 2003). Based on actual prior fortification data, the LOQ of all six polar degradates was determined to be 0.50 µg L-1. The LOD for the three OXA soil degradates was 0.10 µg L-1, and for the three ESA soil degradates, the LOD was 0.20 µg L-1.

Storage stability. All ground water samples were stored in a refrigerator at 2 - 10 °C upon receipt at Monsanto, before extraction or preparation for analysis. Replicate samples were transferred to a freezer at –20 °C □ 5 °C. Sample extracts were either analyzed immediately or stored in a refrigerator at 2 - 10 °C before analysis. All reported analytes demonstrated acceptable storage stability under these conditions.

PGW Study (from Newcombe et al., 2005)

Analytical methodology

Three laboratory facilities were used to analyze acetochlor PGW program samples; (1) Zeneca Agrochemicals, Jealott's Hill Research Centre, Bracknell, United Kingdom, (2) Covance Laboratories, Harrogate, United Kingdom, (3) Monsanto Company St. Louis, MO, USA. Limits of detection (LOD) and LOQ varied slightly among the methods used at the various laboratories and are briefly summarized below. The common names, chemical names and structures, and CAS registry numbers of the analytes of interest are provided in Table 4.

Potassium bromide – soil-pore water and ground water

Bromide residues in water were determined using ion chromatography (IC) with conductivity detection. Water samples were analyzed directly by IC with no sample pre-treatment required. The LOQ of the analytical method was 100 µg L-1 and the LOD approximately 30 µg L-1.

Acetochlor – soil

Acetochlor residues in soil were determined by gas-liquid chromatography (GC) using a Mass Selective Detector (MSD). The LOQ of the analytical method was 0.01 mg kg-1 and the LOD was approximately 0.005 mg kg-1. For the application rate verification analysis, where acetochlor residues were significantly higher, the LOD was calculated as 0.02 mg kg-1.

APPENDIX

12.7. Statistical Analyses for the ARP monitoring Studies

12.7.1. SDWS

12.7.1.1.Pearson Product Moment Correlation Coefficients for Raw vs. Finished Water Samples

Correlation coefficients and coefficients of determination for raw versus finished water samples for each of the P-1 study sites in the surface drinking water data set were derived using the CORR procedure in SAS version 9.1 (SAS 2004). This analysis was aimed at determining whether finished water concentrations observed at facilities that utilize activated charcoal in water treatment (the only sites for which the raw water analytical results are available) could be predicted by raw water concentrations observed at that facility. Finished and raw water observations were paired by site and by the date the sample was collected.

A correlation coefficient (r) is an index of the degree linear association of two variables, X and Y generated using a simple linear regression model to predict variable Y from variable X. Correlation coefficients are directional in that variables exhibit positive and negative correlations. The coefficient of determination (r^2) provides an estimate of how well the relationship can be defined by a straight line and is neither positive nor negative.

Table 31 provides correlation coefficients for raw versus finished surface water samples for all P-1 sites in the SDWS data set. In nearly half the cases (43%), finished water samples were moderately to strongly associated (r >=0.75) with observed raw water concentrations. For 30% of the sites, raw water concentrations explained at least 75% of the variability in finished water concentrations, and in 50 % of the cases raw water concentrations explained at least half (r^2 >= 0.5) of the variability in finished water concentrations using a simple linear model. In general increasing the sample size (N) did not result in an increase in correlation between raw and finished water concentrations. Lack of correspondence for some sites may be partially a result of differences in sampling times for raw and finished samples and the uncertainty in residence time for each of the water treatment facilities. Because there is a time lag from when water enters the intake (raw water) to when the treatment processes in completed (finished water) it is unlikely that raw and finished samples were taken from the same volume of water.

Table 31. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (r)	Coefficient of Determination (r^2)
168-PA-IL	98	0.9932	0.9864

Table 31. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (r)	Coefficient of Determination (r^2)
1009-CO-MO	83	0.9895	0.9792
346-SA-IN	28	0.9841	0.9684
89-MI-KS	71	0.9739	0.9484
301-BL-NE	14	0.9696	0.9401
1070-WY-MO	84	0.9692	0.9393
228-SA-IL	98	0.9552	0.9124
225-CE-IL	70	0.9409	0.8853
606-KA-IL	98	0.9276	0.8604
582-WI-IA	98	0.9039	0.8171
344-DU-IN	98	0.9016	0.8128
556-DA-IA	70	0.8858	0.7847
152-BR-IL	83	0.8745	0.7648
603-BL-IL	98	0.8545	0.7302
259-SP-IL	98	0.8478	0.7188
557-DM-IA	91	0.8390	0.7039
351-SE-IN	43	0.7851	0.6164
245-OL-IL	98	0.7773	0.6042
577-RA-IA	98	0.7551	0.5702
268-NA-IL	98	0.7346	0.5397
1092-SL-MO	27	0.7324	0.5365
574-OS-IA	98	0.7101	0.5042
197-EL-IL	98	0.6670	0.4449
1016-HI-MO	70	0.6544	0.4282
155-CH-IL	42	0.6101	0.3722
328-KO-IN	57	0.5966	0.3559
222-HI-IL	98	0.5764	0.3323
244-SP-IL	98	0.5636	0.3177
296-SC-MN	98	0.4836	0.2338
170-AL-IL	98	0.4469	0.1997
345-RI-IN	43	0.4403	0.1938
593-HE-PA	98	0.3897	0.1519
997-WE-PA	98	0.3806	0.1449
452-MC-OH	14	0.3340	0.1116
242-CO-IL	56	0.3283	0.1078
18-OK-WI	98	0.2517	0.0633
548-CH-IA	28	0.2080	0.0433
1069-VA-MO	84	0.2036	0.0414
569-MI-IA	83	0.1976	0.0390

Table 31. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (r)	Coefficient of Determination (r^2)
1038-GA-MO	14	0.1393	0.0194
737-AW-PA	98	0.1008	0.0102
332-MC-IN	98	0.0935	0.0087
13-AP-WI	98	0.0517	0.0027
371-AL-OH	14	0.0146	0.0002

The effect of water treatment on acetochlor concentrations in the surface drinking water supplies was also examined. A paired two sample t-test for means was performed on those sites and sample dates that had both raw and finished water observations. Results of the t-test are provided in Table 32. Statistical analysis indicates that water treatment plants that use granulated activated carbon (GAC) or powdered activated carbon (PAC) significantly reduce acetochlor concentrations in drinking water (p <0.001)

Table 32. Paired t-test for raw versus finished water samples.

	RAW	FINISHED
Mean	0.076	0.030
Variance	0.097	0.030
Observations	3325	3325
Pearson Correlation	0.858	
Hypothesized Mean Difference	0.000	
df	3324.000	
t Stat	14.296	
P(T<=t) one-tail	<0.001	
t Critical one-tail	1.645	
P(T<=t) two-tail	<0.001	
t Critical two-tail	1.961	

12.7.1.2.Analysis of Factors Related to Occurrence of Acetochlor

For parent acetochlor, the most toxic of residues, surface water is the dominant medium of exposure. Consequently, the focus of statistical analysis was on factors related to occurrence in surface drinking water supplies. Two levels of analysis were required. The first analysis examined environmental variables could potentially explain the temporal variability in acetochlor concentrations *within a site*

(e.g, rainfall amounts). The second level of analysis examined environmental variables that could potentially explain the spatial variability *among sites* (e.g., watershed size, corn intensity, etc.,).

The tables in the following section present Pearson's correlation matrices for surface drinking water sites, individually for raw and finished water samples. Correlation coefficients greater than 0.5 are shown in shaded cells and bold font.

In general, the ancillary variables that were available were unable to explain a significant amount of the variability in maximum observed concentrations (acute exposure), average TWAMS, and maximum TWAMs (chronic exposure). It was originally expected that acetochlor acute and chronic exposure would be moderately to strongly correlated with the variability in acetochlor sales in the associated watersheds, however sales were only weakly correlated ($r < 0.5$).

Some associations were observed between ancillary variables as expected. For example, watershed corn intensity was moderately to strongly correlated with the watershed runoff curve number (RCN) with correlation coefficients (r^2) ranging from 0.78 for all sites where raw water samples were collected to 0.82 for only those sites where finished water samples were collected. The correlation between runoff curve number and watershed corn intensity is not surprising, since land cover is a factor in generating the curve number.

The lack of correlation between watershed corn intensity (% of watershed cropped as corn) and watershed sales was unexpected. Part of the explanation may be related to violations of the assumption that acetochlor sold in a county is actually applied in the same county. Additionally, the total area cropped in a watershed is likely to be more correlated to total sales in a watershed. Refining the sales estimate to be more reflective of actual usage in the county is also likely to improve the correlation. In the current analysis, maximum and average watershed sales were determined using GIS to compute an average and maximum sales value for all counties that were wholly or partially within the drainage area for a site. This is only a coarse estimate that could be refined by weighting the values in each county by the fraction of the county that is within the drainage area. One option would be to employ the methodology used by the USGS to generate pesticide usage. Additional analysis may be necessary to investigate the relationship between watershed sales and watershed corn intensity. This may

12.7.2. CORRELATION MATRICES (r^2) FOR FACTORS RELATED TO THE OCCURRENCE OF ACETOCHLOR IN SURFACE DRINKING WATER SUPPLIES.

TYPE=RAW ANALYTE=ACETOCHLOR

	MAX CONC	MAX TWAM	AVG TWAM	MAX WS SALES	AVG WS SALES	WS CORN INT	WSHED AREA ACRES	WS RUNOFF RATING	WS RCN	AVE PPT	AVE_SPR(APR_MAY_JUNE)
MAX CONC	1	**0.90968**	**0.80287**	-0.03763	0.0155	0.02844	-0.099	0.19272	-0.03778	0.09178	0.12141
p=		<.0001	<.0001	0.8201	0.9254	0.8414	0.5488	0.1711	0.7903	0.5441	0.4215
MAX TWAM		1	**0.91683**	0.10095	0.14664	0.04916	-0.07858	0.31534	0.03282	-0.03133	0.10452
p=			<.0001	0.5409	0.373	0.7293	0.6344	0.0228	0.8173	0.8363	0.4894
AVG TWAM			1	0.16822	0.2084	0.1089	-0.1052	0.39726	0.13515	-0.05047	0.0989
p=				0.306	0.203	0.4422	0.5239	0.0035	0.3394	0.739	0.5132
MAX_WS_SALES				1	**0.91023**	-0.06938	0.04003	**0.69005**	0.01621	-0.23407	-0.18546
p=					<.0001	0.6747	0.8088	<.0001	0.922	0.1515	0.2583
AVG_WS_SALES					1	-0.02849	-0.14627	**0.76207**	0.02463	-0.08057	-0.00725
p=						0.8633	0.3743	<.0001	0.8817	0.6258	0.9651
WS_CORN_INT						1	0.0049	0.18291	**0.78228**	0.09362	0.28261
p=							0.9764	0.1943	<.0001	0.536	0.057
WSHED_AREA_ACRES							1	-0.22928	-0.05634	**-0.66987**	**-0.64615**
p=								0.1603	0.7334	<.0001	<.0001
WS_RUNOFF_RATING								1	0.2287	-0.1193	0.02634
p=									0.1029	0.4297	0.862
WS_RCN									1	0.26665	0.25775
p=										0.0732	0.0837
AVE_PPT										1	**0.70699**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

TYPE=RAW ANALYTE=AC_ESA

	MAX CONC	MAX TWAM	AVG TWAM	MAX WS SALES	AVG WS SALES	WS CORN INT	WSHED AREA ACRES	WS RUNOFF RATING	WS RCN	AVE PPT	AVE_SPR(APR_MAY_JUNE)
MAX CONC	1	**0.93765**	**0.92534**	0.35044	0.40398	-0.00239	-0.18141	**0.50226**	0.04886	0.08075	0.03614
p=		<.0001	<.0001	0.031	0.0119	0.9867	0.2757	0.0002	0.7335	0.598	0.8137
MAX TWAM		1	**0.98928**	0.38003	0.46886	0.0824	-0.22055	**0.51583**	0.13918	0.08355	0.05036
p=			<.0001	0.0186	0.003	0.5654	0.1833	0.0001	0.33	0.5853	0.7425
AVG TWAM			1	0.36782	0.44719	0.08639	-0.2176	**0.53202**	0.16759	0.07717	0.02955
p=				0.0231	0.0049	0.5466	0.1894	<.0001	0.2398	0.6144	0.8472
MAX_WS_SALES				1	**0.90986**	-0.07213	0.03606	**0.6861**	0.01931	-0.21605	-0.17224
p=					<.0001	0.6669	0.8298	<.0001	0.9084	0.1927	0.3011
AVG_WS_SALES					1	-0.03033	-0.14992	**0.76113**	0.02693	-0.06323	0.00493
p=						0.8566	0.369	<.0001	0.8725	0.7061	0.9766
WS_CORN_INT						1	0.00394	0.1833	**0.78283**	0.10375	0.29088
p=							0.9813	0.1979	<.0001	0.4976	0.0526
WSHED_AREA_ACRES							1	-0.23749	-0.0552	**-0.68354**	**-0.6485**
p=								0.1511	0.742	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23354	-0.09106	0.04801
p=									0.0991	0.5519	0.7541
WS_RCN									1	0.27109	0.25881
p=										0.0717	0.086
AVE_PPT										1	**0.69863**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_IN = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

TYPE=RAW ANALYTE=AC_OXA

	MAX CONC	MAX TWAM	AVG TWAM	MAX WS SALES	AVG WS SALES	WS CORN INT	WSHED AREA ACRES	WS RUNOFF RATING	WS RCN	AVE PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	**0.93301**	**0.91866**	0.13114	0.18678	-0.0324	-0.16615	0.25298	0.05454	0.13176	0.01277
p=		<.0001	<.0001	0.4326	0.2615	0.8214	0.3188	0.0733	0.7039	0.3883	0.9337
MAX TWAM		1	**0.98943**	0.18408	0.26059	0.08263	-0.19169	0.26467	0.13518	0.13598	0.06509
p=			<.0001	0.2686	0.1141	0.5643	0.2489	0.0605	0.3443	0.3731	0.671
AVG TWAM			1	0.20066	0.2704	0.09252	-0.18483	0.28301	0.16429	0.12939	0.0396
p=				0.2271	0.1006	0.5184	0.2666	0.0442	0.2493	0.3969	0.7962
MAX_WS_SALES				1	**0.90986**	-0.07213	0.03606	**0.6861**	0.01931	-0.21605	-0.17224
p=					<.0001	0.6669	0.8298	<.0001	0.9084	0.1927	0.3011
AVG_WS_SALES					1	-0.03033	-0.14992	**0.76113**	0.02693	-0.06323	0.00493
p=						0.8566	0.369	<.0001	0.8725	0.7061	0.9766
WS_CORN_INT						1	0.00394	0.1833	**0.78283**	0.10375	0.29088
p=							0.9813	0.1979	<.0001	0.4976	0.0526
WSHED_AREA_ACRES							1	-0.23749	-0.0552	**-0.68354**	**-0.6485**
p=								0.1511	0.742	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23354	-0.09106	0.04801
p=									0.0991	0.5519	0.7541
WS_RCN									1	0.27109	0.25881
p=										0.0717	0.086
AVE_PPT										1	**0.69863**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1

TYPE=FINISHED ANALYTE=ACETOCHLOR

	MAX CONC	MAX TWAM	AVG TWAM	MAX WS SALES	AVG WS SALES	WS CORN INT	WSHED AREA ACRES	WS RUNOFF RATING	WS RCN	AVE PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	**0.9427**	**0.86867**	0.14362	0.16023	0.09696	-0.04165	0.21547	0.12951	-0.01151	-0.05418
p=		<.0001	<.0001	0.0746	0.0464	0.1537	0.6069	0.0014	0.0562	0.8774	0.4676
MAX TWAM		1	**0.89153**	0.1383	0.16995	0.14409	-0.04334	0.24343	0.17299	-0.05567	-0.07242
p=			<.0001	0.0861	0.0345	0.0335	0.5923	0.0003	0.0105	0.4554	0.3313
AVG TWAM			1	0.22615	0.20047	0.09705	-0.03819	0.31138	0.18002	-0.07154	-0.1104
p=				0.0047	0.0124	0.1533	0.6371	<.0001	0.0077	0.3372	0.1379
MAX_WS_SALES				1	**0.89329**	-0.00252	0.0892	**0.71138**	0.01268	-0.28792	-0.26106
p=					<.0001	0.9752	0.2697	<.0001	0.8755	0.0003	0.001
AVG_WS_SALES					1	0.02687	-0.0681	**0.74732**	-0.01835	-0.2415	-0.18251
p=						0.74	0.3998	<.0001	0.8207	0.0025	0.023
WS_CORN_INT						1	-0.08315	0.2414	**0.81822**	0.07058	0.26884
p=							0.3037	0.0003	<.0001	0.3438	0.0002
WSHED_AREA_ACRES							1	-0.08321	-0.10273	-0.46226	-0.44379
p=								0.3033	0.2034	<.0001	<.0001
WS_RUNOFF_RATING								1	0.22106	-0.1422	-0.19303
p=									0.001	0.0555	0.009
WS_RCN									1	0.11193	0.15593
p=										0.1325	0.0356
AVE_PPT										1	**0.60527**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_IN = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

TYPE=FINISHED ANALYTE=AC_ESA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	**0.83489**	**0.81411**	0.28225	0.2827	0.15449	-0.08288	0.42043	0.22937	-0.07571	-0.13567
p=		<.0001	<.0001	0.0007	0.0007	0.0278	0.3303	<.0001	0.001	0.3308	0.0804
MAX TWAM		1	**0.9757**	0.32186	0.35346	0.20089	-0.10542	0.44736	0.27	-0.12625	-0.17281
p=			<.0001	0.0001	<.0001	0.0041	0.2151	<.0001	<.0001	0.104	0.0255
AVG TWAM			1	0.37042	0.40565	0.20608	-0.09916	**0.50223**	0.26727	-0.13097	-0.18918
p=				<.0001	<.0001	0.0032	0.2437	<.0001	0.0001	0.0916	0.0143
MAX_WS_SALES				1	**0.89848**	0.00297	0.09208	**0.71218**	0.01218	-0.30334	-0.26312
p=					<.0001	0.9722	0.2792	<.0001	0.8864	0.0003	0.0017
AVG_WS_SALES					1	0.02455	-0.07068	**0.74803**	-0.01119	-0.23449	-0.17726
p=						0.7734	0.4067	<.0001	0.8956	0.0053	0.0362
WS_CORN_INT						1	-0.0814	0.24167	**0.82681**	0.07485	0.27167
p=							0.339	0.0005	<.0001	0.3363	0.0004
WSHED_AREA_ACRES							1	-0.0874	-0.09998	-0.48056	-0.44911
p=								0.3045	0.2399	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23259	-0.1407	-0.18504
p=									0.0008	0.0697	0.0167
WS_RCN									1	0.11822	0.16063
p=										0.1281	0.0381
AVE_PPT										1	**0.62157**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

INISHED ANALYTE=AC_OXA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	**0.73401**	**0.72528**	0.20807	0.21914	0.15941	-0.07487	0.32559	0.22749	0.00018	-0.04199
p=		<.0001	<.0001	0.0136	0.0093	0.0231	0.3793	<.0001	0.0011	0.9982	0.59
MAX TWAM		1	**0.96304**	0.21535	0.27765	0.25049	-0.10435	0.31642	0.28598	-0.08452	-0.07366
p=			<.0001	0.0106	0.0009	0.0003	0.2198	<.0001	<.0001	0.2775	0.3441
AVG TWAM			1	0.2776	0.3396	0.24915	-0.09597	0.38097	0.27995	-0.08497	-0.09639
p=				0.0009	<.0001	0.0003	0.2593	<.0001	<.0001	0.275	0.2153
MAX_WS_SALES				1	**0.89848**	0.00297	0.09208	**0.71218**	0.01218	-0.30334	-0.26312
p=					<.0001	0.9722	0.2792	<.0001	0.8864	0.0003	0.0017
AVG_WS_SALES					1	0.02455	-0.07068	**0.74803**	-0.01119	-0.23449	-0.17726
p=						0.7734	0.4067	<.0001	0.8956	0.0053	0.0362
WS_CORN_INT						1	-0.0814	0.24167	**0.82681**	0.07485	0.27167
p=							0.339	0.0005	<.0001	0.3363	0.0004
WSHED_AREA_ACRES							1	-0.0874	-0.09998	-0.48056	-0.44911
p=								0.3045	0.2399	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23259	-0.1407	-0.18504
p=									0.0008	0.0697	0.0167
WS_RCN									1	0.11822	0.16063
p=										0.1281	0.0381
AVE_PPT										1	**0.62157**
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_IN = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

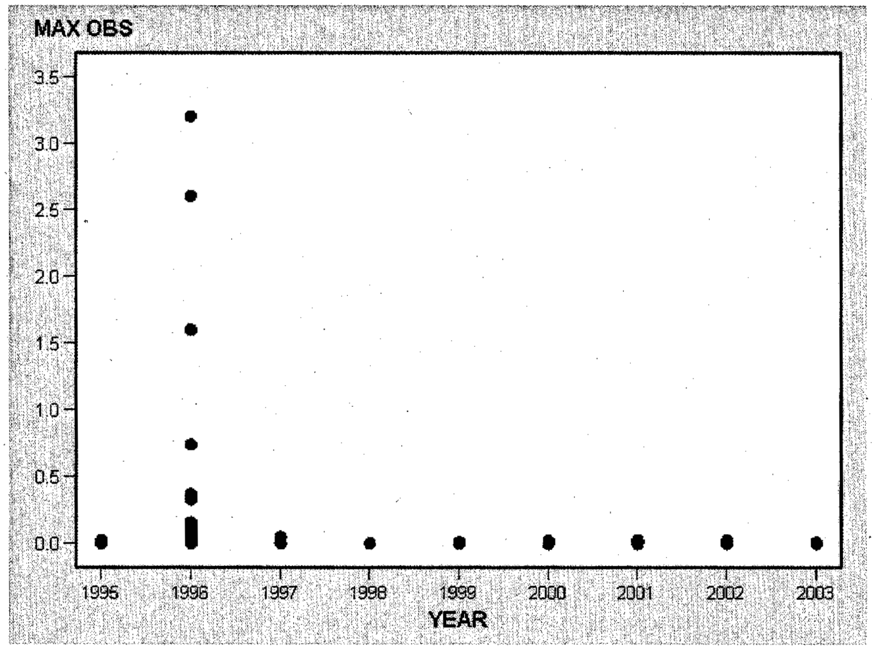
Time-weighted means over time

PGW maximum observations for each lysimeter as well as time-weighted means derived from the censored data file were examined for trends over time. Plots of time-weighted means versus year are provided in the subsequent section. In general, peak concentrations of acetochlor, ESA, and OXA were greatest in the early years of monitoring from 1996 to 1998. Bromide peak concentrations tended to be highest during 1998. Highest time weighted means for acetochlor, ESA, and OX were observed between 1996 and 1998.

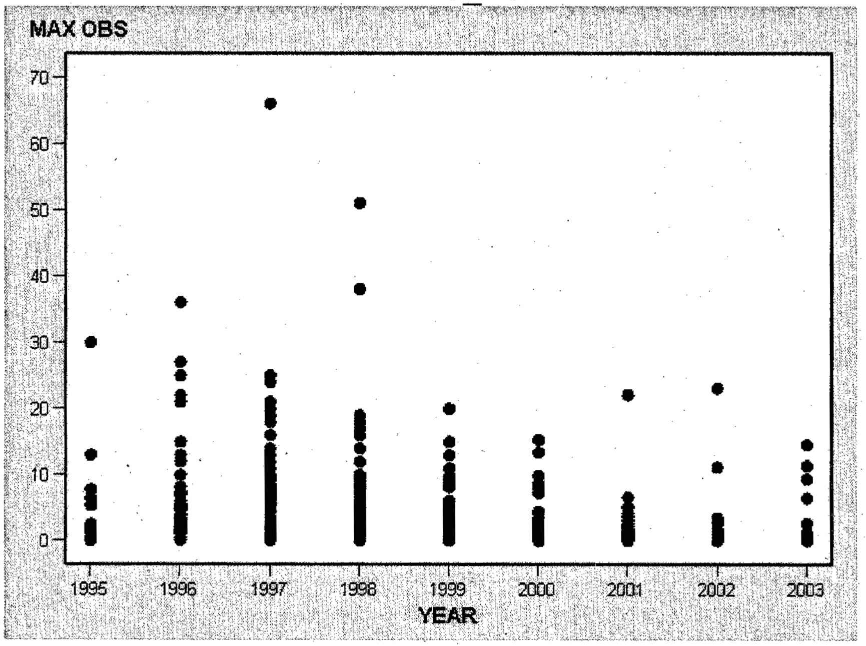
12.7.3. MAXIMUM OBSERVED CONCENTRATIONS (PER YEAR) OVER TIME FOR THE PGW STUDIES.

```
Correlations Plots
Scatter plot of 'MAX OBS' by YEAR
```

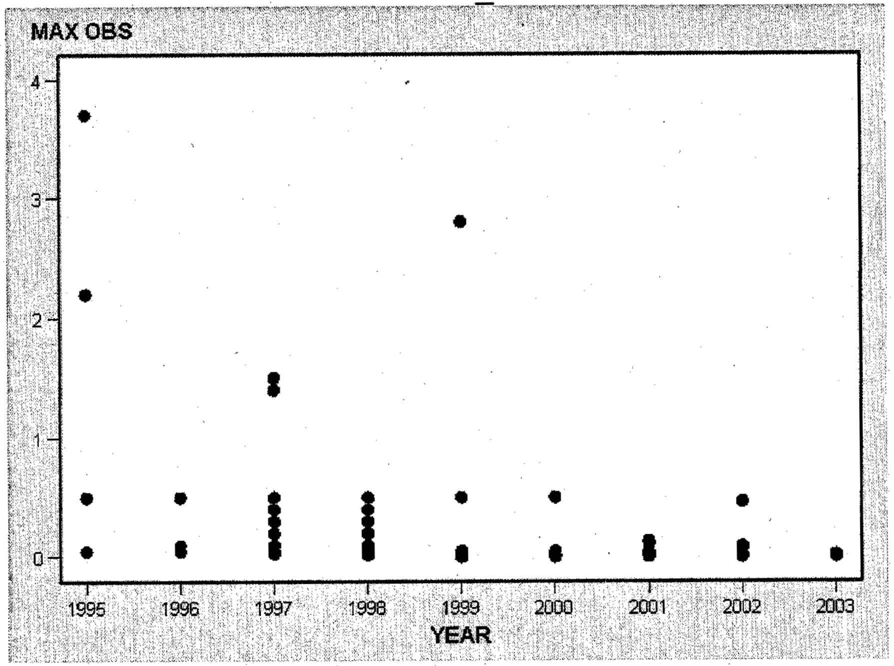
TYPE=AC

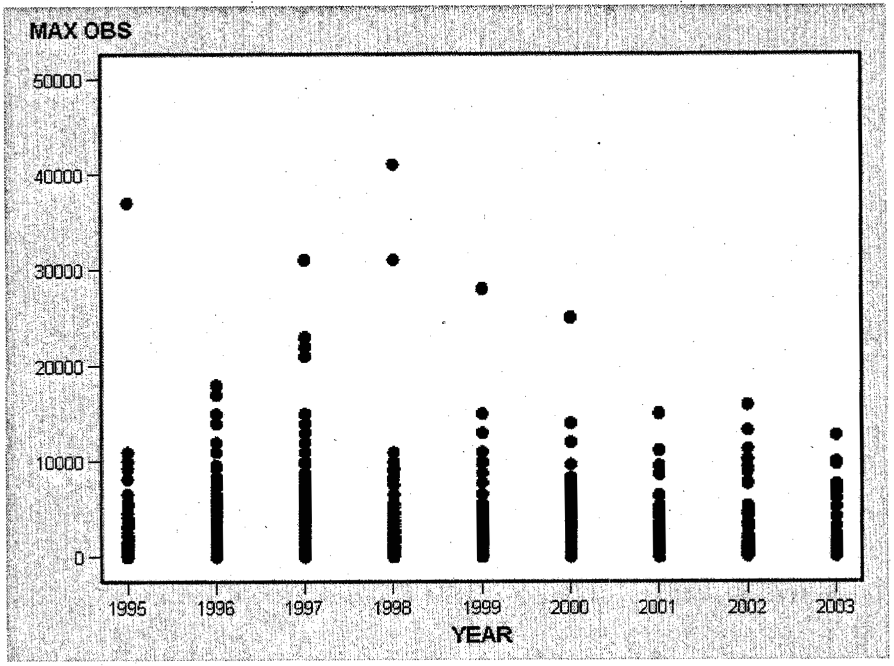


TYPE=AC_ESA



```
Correlations Plots
Scatter plot of 'MAX OBS' by YEAR
```

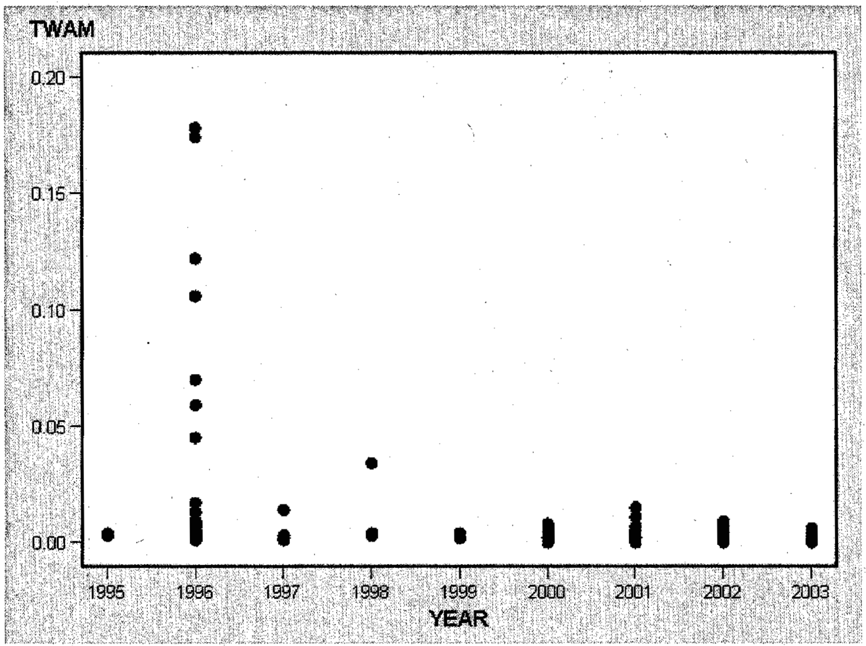

TYPE=AC_OXA


TYPE=BR

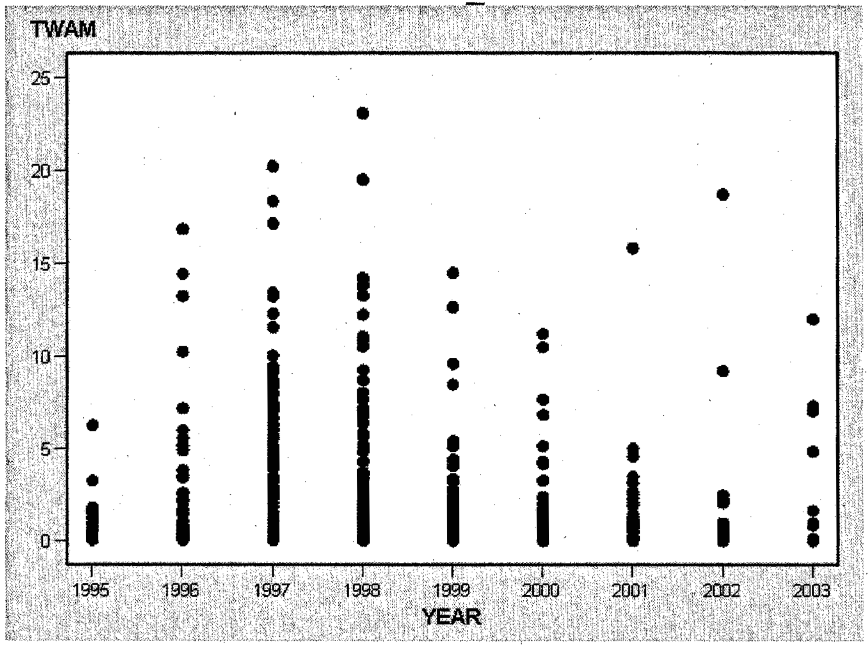
12.7.4. TIME-WEIGHTED ANNUALIZED MEANS OVER TIME FOR THE PGW STUDIES.

```
Correlations Plots
Scatter plot of TWAM by YEAR
```

TYPE=AC



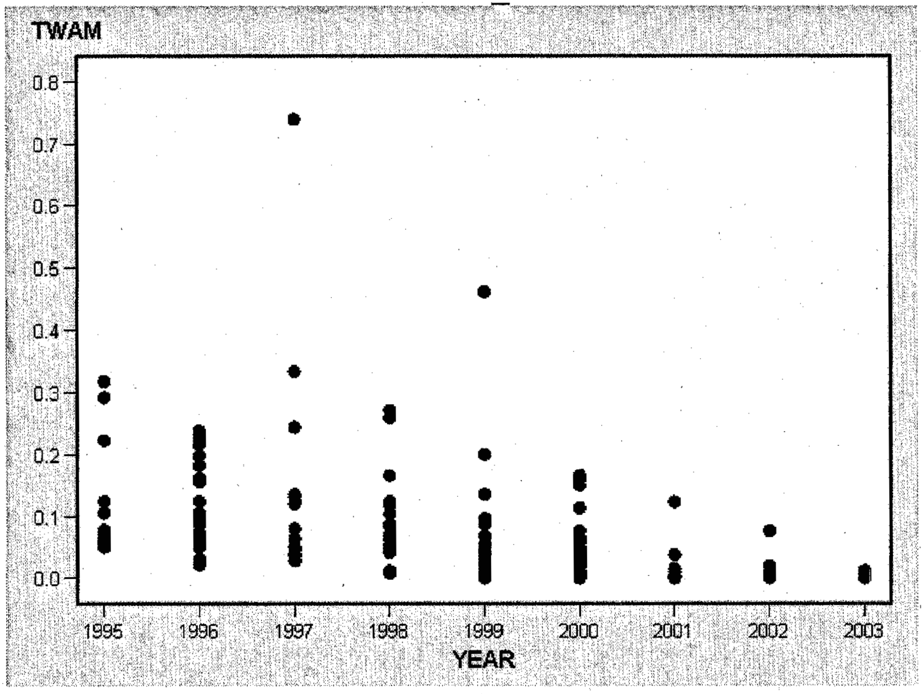
TYPE=AC_ESA



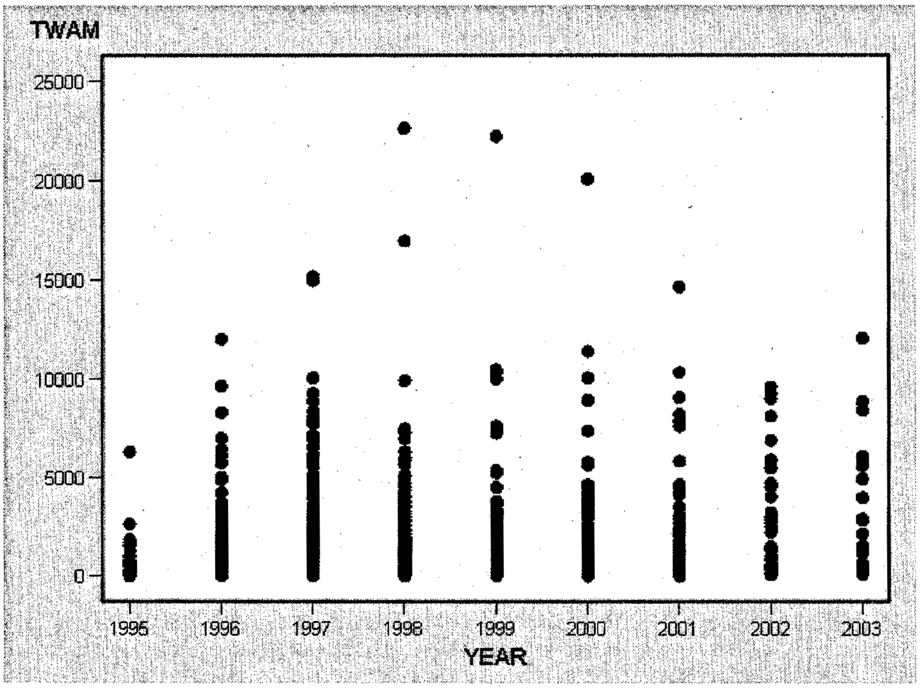
Correlations Plots

Scatter plot of TWAM by YEAR

TYPE=AC_OXA



TYPE=BR



12.7.5. CORRELATION MATRICES (r^2) FOR FACTORS RELATED TO ACETOCHLOR ACUTE EXPOSURE IN THE PROSPECTIVE GROUND WATER STUDIES.

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	AE_3FT	AE_9FT	AE_SHGW	PPT3MOS	PPT1YR	PPT2YR	PPT3YR	PPT4YR	PPT_TOT	AVG_HC	AVG_PWV	AVG_HG
AE_3FT	1	-0.22757	-0.31336	-0.07682	0.40856	0.1471	0.05601	0.09501	0.05572	-0.18503	-0.12216	**0.53558**
p=		*0.5878*	*0.4938*	*0.8565*	*0.3149*	*0.7281*	*0.8952*	*0.8229*	*0.8957*	*0.6609*	*0.7732*	*0.1713*
AE_9FT		1	**0.5803**	-0.12632	0.04307	**0.59107**	0.30713	0.32253	0.076	0.33555	0.17678	-0.03546
p=			*0.172*	*0.7657*	*0.9194*	*0.1228*	*0.4593*	*0.4359*	*0.858*	*0.4165*	*0.6754*	*0.9336*
AE_SHGW			1	-0.09752	-0.41872	0.31223	-0.1394	0.062	**0.54038**	-0.04658	-0.39305	0.02066
p=				*0.8352*	*0.3498*	*0.4954*	*0.7656*	*0.8949*	*0.2105*	*0.921*	*0.3831*	*0.9649*
PPT3MOS				1	-0.35631	-0.2604	**-0.66558**	**-0.63715**	-0.4388	0.20764	0.41885	**-0.53312**
p=					*0.3863*	*0.5334*	*0.0716*	*0.0893*	*0.2768*	*0.6217*	*0.3017*	*0.1737*
PPT1YR					1	**0.62496**	**0.77424**	**0.73588**	0.43935	-0.03077	-0.1655	**0.62**
p=						*0.0976*	*0.0241*	*0.0374*	*0.2761*	*0.9423*	*0.6953*	*0.1011*
PPT2YR						1	**0.72921**	**0.84462**	**0.60217**	-0.05395	-0.20217	0.15564
p=							*0.0401*	*0.0083*	*0.1142*	*0.899*	*0.6311*	*0.7129*
PPT3YR							1	**0.95157**	0.45759	0.11494	-0.2965	0.31123
p=								*0.0003*	*0.2543*	*0.7864*	*0.4758*	*0.453*
PPT4YR								1	**0.67654**	-0.05389	-0.45033	0.30683
p=									*0.0654*	*0.8992*	*0.2628*	*0.4598*
PPT_TOT									1	-0.4631	**-0.72074**	0.41897
p=										*0.2478*	*0.0437*	*0.3015*
AVG_HC										1	0.03648	-0.25309
p=											*0.9317*	*0.5453*
AVG_PWV											1	-0.27042
p=												*0.5171*
AVG_HG												1
p=												

Generated by the SAS System (Local, XP_PRO) on 16NOV2004 at 4:57 PM

AE_3FT = Acute exposure for 3 foot depth lysimeters
AE_9FT = Acute exposure for 9 foot depth lysimeters
AE_SHGW = Acute exposure for shallow ground water
PPT3MOS = precipitation for the first three months of study
PPT1YR = precipitation for the first year, second year, etc., of study
PPT_TOT = total precipitation for the study
AVG_HC = Average hydraulic conductivity
AVG_PWV = Average pore water velocity
AVG_HG = Average hydraulic gradient

APPENDIX

12.8. Data Tables for the ARP Monitoring Studies Related to Mitigation Endpoints

State Ground Water Monitoring Program.

Table 33. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of "pattern of movement".

Site	Date	Conc (ppb)
IA07	6/1/1995	0.8
IA07	7/1/1995	0.391
IA07	8/1/1995	0.131
IA07	5/1/1997	4.354
IA07	6/1/1997	1.266
IA07	7/1/1997	0.283
IA07	8/1/1997	0.143
IA07	9/1/1997	0.106
IA07	6/1/1999	0.396
IA07	7/1/1999	0.132
IA07	6/1/2001	0.23
IA09	5/1/1997	0.14
IL08	5/1/1995	0.268
IL08	6/1/1995	0.105
IL24	5/1/1995	2.168
IL24	6/1/1995	1.036
IL24	7/1/1995	0.379
IL24	8/1/1995	0.246
IL24	9/1/1995	0.305
IL24	10/1/1995	0.313
IL24	11/1/1995	0.246
IL24	12/1/1995	0.144
KS06	8/1/1998	0.112
KS06	10/1/1998	0.139
KS06	11/1/1998	0.105
KS06	12/1/1998	0.24
KS09	3/1/2001	0.453
KS14	4/1/1996	0.12
KS14	5/1/1996	0.145
KS14	6/1/1996	0.122
KS14	7/1/1996	0.135
KS14	8/1/1996	0.291
KS14	9/1/1996	0.171
KS14	10/1/1996	0.26

Table 33. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of "pattern of movement".

Site	Date	Conc (ppb)
KS14	11/1/1996	0.177
KS14	12/1/1996	0.158
KS14	1/1/1997	0.319
KS14	2/1/1997	0.206
KS14	3/1/1997	0.152
KS14	4/1/1997	0.133
KS14	5/1/1997	0.132
KS14	6/1/1997	0.137
KS14	7/1/1997	0.148
KS14	8/1/1997	0.218
KS14	9/1/1997	0.221
KS14	10/1/1997	0.214
KS14	11/1/1997	0.171
KS17	3/1/1998	0.159
KS17	4/1/1998	0.143
KS17	7/1/1998	0.108
KS17	8/1/1998	0.131
KS17	9/1/1998	0.163
KS17	10/1/1998	0.188
KS17	11/1/1998	0.106
KS17	12/1/1998	0.155
KS17	1/1/1999	0.109
KS17	3/1/1999	0.125
KS17	4/1/1999	0.181
KS17	5/1/1999	0.16
KS17	9/1/1999	0.135
KS19	10/1/1998	0.107
KS19	11/1/1998	0.109
KS19	12/1/1998	0.131
KS19	1/1/1999	0.149
KS19	2/1/1999	0.145
KS19	3/1/1999	0.178
KS19	4/1/1999	0.215
KS19	5/1/1999	0.2
KS19	6/1/1999	0.153
KS19	7/1/1999	0.11
KS19	10/1/1999	0.107
KS19	11/1/1999	0.106
KS25	7/1/1998	0.118
MN13	9/1/1995	0.101
MN24	5/1/1995	0.105
MN25	6/1/2001	0.741
MN25	7/1/2001	0.456
MN25	9/1/2001	0.611

Table 33. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of "pattern of movement".

Site	Date	Conc (ppb)
MN25	10/1/2001	0.694
MN25	11/1/2001	0.499
MN25	12/1/2001	0.168
NE16	6/1/1999	0.186
NE16	8/1/1999	0.534

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA01	3/1/1999	0.367	IA01	3/1/2001	0.242
IA01	6/1/1999	0.547	IA01	6/1/2001	0.154
IA01	9/1/1999	0.528	IA07	6/1/1999	19.1
IA01	12/1/1999	0.471	IA07	9/1/1999	2.55
IA01	3/1/2000	0.178	IA07	12/1/1999	1.3
IA01	6/1/2000	0.819	IA07	3/1/2000	0.819
IA01	9/1/2000	0.438	IA07	9/1/2000	0.251
IA01	12/1/2000	0.645	IA07	12/1/2000	0.224
IA01	3/1/2001	1.33	IA07	3/1/2001	0.112
IA01	6/1/2001	5.38	IA07	6/1/2001	10.4
IA01	9/1/2001	1.6	IA07	9/1/2001	3.36
IA01	12/1/2001	1.56	IA07	12/1/2001	0.324
IA02	3/1/1999	0.176	IA09	6/1/1999	3.15
IA02	6/1/1999	0.36	IA09	6/1/2001	2.72
IA02	12/1/1999	0.913	IA23	9/1/1999	0.118
IA02	3/1/2000	0.445	IA23	12/1/1999	0.115
IA02	6/1/2000	0.22	IA23	3/1/2000	0.132
IA02	3/1/2001	0.147	IA23	9/1/2000	0.178
IA02	6/1/2001	0.104	IA23	12/1/2000	0.117
IA02	9/1/2001	0.188	IL04	3/1/1999	6.48
IA02	12/1/2001	0.147	IL04	6/1/1999	4.6
IA03	3/1/1999	0.134	IL04	9/1/1999	7.32
IA03	6/1/1999	0.421	IL04	12/1/1999	4.72
IA03	9/1/1999	0.214	IL04	3/1/2000	5.56
IA03	12/1/1999	0.205	IL04	6/1/2000	0.662
IA04	6/1/1999	0.274	IL04	9/1/2000	0.628
IA04	9/1/1999	0.474	IL04	12/1/2000	0.702
IA04	12/1/1999	0.187	IL04	3/1/2001	0.462
IA04	3/1/2000	0.167	IL04	6/1/2001	0.47
IA04	6/1/2000	0.204	IL04	9/1/2001	0.345
IA04	9/1/2000	0.105	IL04	12/1/2001	0.23
IA04	9/1/2001	0.128	IN16	3/1/1999	0.1

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA07	6/1/1999	20	IN16	12/1/2001	0.392
IA07	9/1/1999	4.84	KS10	3/1/1999	0.794
IA07	12/1/1999	3.27	KS10	6/1/1999	0.574
IA07	3/1/2000	2.03	KS10	9/1/1999	0.846
IA07	6/1/2000	0.262	KS10	12/1/1999	0.723
IA07	9/1/2000	0.891	KS10	3/1/2000	1.13
IA07	12/1/2000	0.688	KS10	6/1/2000	1.3
IA07	3/1/2001	0.119	KS10	9/1/2000	2.15
IA07	6/1/2001	10.8	KS10	12/1/2000	1.43
IA07	9/1/2001	7.92	KS10	3/1/2001	1.29
IA07	12/1/2001	1.68	KS10	6/1/2001	2.17
IA07-2	3/1/1999	3.85	KS10	9/1/2001	1.27
IA07-2	6/1/1999	2.11	KS10	12/1/2001	0.971
IA07-2	9/1/1999	0.464	KS14	3/1/1999	0.184
IA07-2	12/1/1999	0.163	KS14	6/1/1999	0.183
IA07-2	3/1/2000	0.302	MN05	12/1/2001	0.153
IA07-2	6/1/2000	0.237	MN06	9/1/2001	0.235
IA07-2	9/1/2000	0.131	MN13	12/1/1999	0.107
IA07-2	12/1/2000	0.14	MN13	6/1/2001	0.103
IA07-2	3/1/2001	0.168	MN17	6/1/2001	0.819
IA07-2	6/1/2001	0.13	MN17	9/1/2001	0.559
IA09	6/1/1999	2.68	MN17	12/1/2001	0.176
IA09	12/1/1999	0.213	MN25	6/1/1999	0.339
IA09	6/1/2001	1.6	MN25	12/1/1999	0.156
IA09	12/1/2001	0.128	MN25	3/1/2000	0.191
IA10	9/1/2001	0.844	MN25	6/1/2000	0.177
IA10	12/1/2001	0.144	MN25	9/1/2000	0.145
IA11	9/1/1999	0.277	MN25	12/1/2000	0.101
IA11	12/1/1999	0.326	MN25	6/1/2001	6.17
IA11	3/1/2000	0.23	MN25	7/1/2001	1
IA11	6/1/2000	0.224	MN25	9/1/2001	1.56
IA11	9/1/2000	0.524	MN25	10/1/2001	2.45
IA11	12/1/2000	0.4	MN25	11/1/2001	1.98
IA12	3/1/1999	0.113	MN25	12/1/2001	0.868
IA12	12/1/1999	0.124	NE07	9/1/2000	0.109
IA12	6/1/2000	0.104	NE07	12/1/2000	0.111
IA12	9/1/2000	0.157	NE07	6/1/2001	0.133
IA12	9/1/2001	0.114	NE07	9/1/2001	0.143
IA12	12/1/2001	0.1	NE07	12/1/2001	0.158
IA13	12/1/1999	0.12	NE13	9/1/1999	0.172
IA13	3/1/2000	0.269	NE16	3/1/1999	0.193
IA13	9/1/2000	0.147	NE16	6/1/1999	0.248
IA13	12/1/2000	0.271	NE16	9/1/1999	0.221
IA13	3/1/2001	0.201	NE25	3/1/2001	0.383

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA13	6/1/2001	0.128	NE25	6/1/2001	0.132
IA13	9/1/2001	0.144	WI03	3/1/2001	0.486
IA13	12/1/2001	0.206	WI03	6/1/2001	1.01
IA14	3/1/1999	0.249	WI03	9/1/2001	1.36
IA14	6/1/1999	0.245	WI03	12/1/2001	0.412
IA14	12/1/1999	0.102	WI04	3/1/1999	0.332
IA14	3/1/2000	0.778	WI04	6/1/1999	0.421
IA14	6/1/2000	0.216	WI04	9/1/1999	0.234
IA14	9/1/2000	0.694	WI05	3/1/1999	0.121
IA14	3/1/2001	0.738	WI05	6/1/1999	0.103
IA14	6/1/2001	0.554	WI11	3/1/1999	2.7
IA14	9/1/2001	0.585	WI11	6/1/1999	1.61
IA14	12/1/2001	0.831	WI11	9/1/1999	1.15
IA15	3/1/1999	1.88	WI11	12/1/1999	1.45
IA15	6/1/1999	2.12	WI11	1/1/2000	0.364
IA15	9/1/1999	1.39	WI11	2/1/2000	0.427
IA15	12/1/1999	1.79	WI11	3/1/2000	0.427
IA15	3/1/2000	1.82	WI11	6/1/2000	0.759
IA15	6/1/2000	1.25	WI11	9/1/2000	0.118
IA15	9/1/2000	1.33	WI11	12/1/2000	0.556
IA15	12/1/2000	1.64	WI11	3/1/2001	0.336
IA15	3/1/2001	1.61	WI11	6/1/2001	0.921
IA15	6/1/2001	1.63	WI11	9/1/2001	0.183
IA15	9/1/2001	1.31	WI12	9/1/1999	0.148
IA15	12/1/2001	1.49	WI12	12/1/1999	0.724
IA16	3/1/1999	0.135	WI12	1/1/2000	0.738
IA16	12/1/1999	0.162	WI12	2/1/2000	0.57
IA16	3/1/2000	0.136	WI12	3/1/2000	0.57
IA16	6/1/2000	0.216	WI12	6/1/2000	0.133
IA16	9/1/2000	0.21	WI12	12/1/2000	0.36
IA16	12/1/2000	0.129	WI23	3/1/1999	3.7
IA16	3/1/2001	0.149	WI23	6/1/1999	3.06
IA16	6/1/2001	0.139	WI25	6/1/2000	0.1
IA16	9/1/2001	0.168	WI25	9/1/2000	0.14
IA17	3/1/1999	0.304	WI25	12/1/2000	0.121
IA17	6/1/1999	0.952	WI27	3/1/1999	0.587
IA17	9/1/1999	0.567	WI27	6/1/1999	0.261
IA17	12/1/1999	0.577	WI27	9/1/1999	0.127
IA17	3/1/2000	0.166	WI27	12/1/1999	0.138
IA17	6/1/2000	0.16	WI27	9/1/2000	0.101
IA17	9/1/2000	0.223	WI27	9/1/2001	0.232
IA17	12/1/2000	0.397	WI27	12/1/2001	0.326
IA17	3/1/2001	0.126	WI28	3/1/1999	0.325
IA17	6/1/2001	0.375	WI28	6/1/1999	0.909

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA17	9/1/2001	0.468	WI28	9/1/1999	0.78
IA17	12/1/2001	0.354	WI28	12/1/1999	1.02
IA18	6/1/1999	0.876	WI28	2/1/2000	1.53
IA18	9/1/1999	0.304	WI28	3/1/2000	1.53
IA18	12/1/1999	0.125	WI28	6/1/2000	0.466
IA19	6/1/1999	0.665	WI28	9/1/2000	0.535
IA19	6/1/2000	0.254	WI28	12/1/2000	0.554
IA20	3/1/1999	0.107	WI28	3/1/2001	0.526
IA20	6/1/1999	0.183	WI28	6/1/2001	0.258
IA20	9/1/1999	0.204	WI28	9/1/2001	0.202
IA20	12/1/1999	0.195	WI28	12/1/2001	0.237
IA20	3/1/2000	0.135			
IA21	6/1/1999	0.452			
IA21	9/1/1999	0.177			
IA21	12/1/1999	0.176			
IA22	3/1/1999	0.512			
IA22	6/1/1999	0.515			
IA22	9/1/1999	0.312			
IA22	12/1/1999	0.119			
IA22	6/1/2001	0.119			
IA22	9/1/2001	0.194			
IA23	9/1/1999	0.287			
IA23	12/1/1999	0.337			
IA23	3/1/2000	0.442			
IA23	6/1/2000	0.445			
IA23	9/1/2000	0.931			
IA23	12/1/2000	0.528			
IA23	3/1/2001	0.51			
IA23	6/1/2001	0.505			
IA23	9/1/2001	0.481			
IA23	12/1/2001	0.543			
IA24	6/1/1999	0.374			
IA24	9/1/1999	0.858			
IA24	12/1/1999	0.892			
IA24	3/1/2000	0.311			
IA25	6/1/2000	0.125			
IA25	3/1/2001	0.509			
IA25	6/1/2001	0.225			
IL01	3/1/1999	0.632			
IL01	6/1/1999	0.754			
IL01	9/1/1999	0.577			
IL01	12/1/1999	0.51			
IL01	3/1/2000	0.458			
IL01	6/1/2000	0.428			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IL01	9/1/2000	0.516			
IL01	12/1/2000	0.478			
IL01	3/1/2001	0.332			
IL01	6/1/2001	0.338			
IL01	9/1/2001	0.347			
IL01	12/1/2001	0.342			
IL02	3/1/1999	0.219			
IL02	6/1/1999	0.194			
IL02	6/1/2000	0.155			
IL04	3/1/1999	12.6			
IL04	6/1/1999	9.25			
IL04	9/1/1999	14.7			
IL04	12/1/1999	14.4			
IL04	3/1/2000	14.3			
IL04	6/1/2000	1.79			
IL04	9/1/2000	3.17			
IL04	12/1/2000	6.62			
IL04	3/1/2001	1.89			
IL04	6/1/2001	5.44			
IL04	9/1/2001	5.21			
IL04	12/1/2001	5.56			
IL05	6/1/1999	2.31			
IL05	12/1/1999	0.14			
IL05	3/1/2000	0.147			
IL08	6/1/1999	0.137			
IL08	3/1/2000	0.203			
IL08	6/1/2000	0.111			
IL08	9/1/2001	0.544			
IL08	12/1/2001	0.173			
IL10	3/1/1999	1.22			
IL10	6/1/1999	0.942			
IL10	9/1/1999	0.412			
IL10	12/1/1999	0.14			
IL10	6/1/2000	0.116			
IL10	6/1/2001	0.167			
IL10	9/1/2001	1.62			
IL10	12/1/2001	1.26			
IL14	3/1/1999	0.203			
IL14	6/1/1999	0.112			
IL15	3/1/1999	0.172			
IL15	6/1/1999	0.163			
IL15	9/1/1999	0.155			
IL15	12/1/1999	0.112			
IL17	9/1/1999	0.114			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IL18	3/1/1999	0.233			
IL18	6/1/1999	0.217			
IL18	9/1/1999	0.103			
IL18	12/1/1999	0.11			
IL18	3/1/2000	0.207			
IL18	6/1/2000	0.256			
IL18	9/1/2000	0.111			
IL18	9/1/2001	0.126			
IL18	12/1/2001	0.142			
IL24	9/1/1999	0.156			
IL24	3/1/2000	0.146			
IN02	9/1/2000	0.102			
IN02	3/1/2001	0.101			
IN08	9/1/1999	0.109			
IN08	12/1/1999	0.133			
IN08	6/1/2000	0.124			
IN08	9/1/2000	0.143			
IN08	12/1/2000	0.153			
IN08	3/1/2001	0.289			
IN08	6/1/2001	0.199			
IN08	9/1/2001	0.225			
IN08	12/1/2001	0.299			
IN14	6/1/2000	0.158			
IN14	3/1/2001	0.112			
IN14	6/1/2001	0.23			
IN14	9/1/2001	0.163			
IN14	12/1/2001	0.139			
IN16	3/1/1999	0.848			
IN16	6/1/1999	0.721			
IN16	9/1/1999	0.594			
IN16	12/1/1999	0.466			
IN16	6/1/2000	0.262			
IN16	9/1/2000	0.233			
IN16	12/1/2000	0.175			
IN16	3/1/2001	0.226			
IN16	6/1/2001	0.18			
IN16	12/1/2001	0.2			
IN17	3/1/2000	0.285			
KS04	3/1/1999	0.312			
KS04	6/1/1999	1.5			
KS04	9/1/1999	1.94			
KS04	12/1/1999	1.31			
KS04	3/1/2000	0.869			
KS04	6/1/2000	0.985			

Table 34. **Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.**

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
KS04	9/1/2000	0.816			
KS04	12/1/2000	0.828			
KS04	3/1/2001	0.494			
KS04	6/1/2001	0.373			
KS04	9/1/2001	0.366			
KS04	12/1/2001	0.237			
KS08	12/1/1999	0.118			
KS09	3/1/2001	0.134			
KS09	6/1/2001	0.239			
KS10	3/1/1999	1.28			
KS10	6/1/1999	1.31			
KS10	9/1/1999	2.23			
KS10	12/1/1999	2.1			
KS10	3/1/2000	4.08			
KS10	6/1/2000	4.23			
KS10	9/1/2000	7.37			
KS10	12/1/2000	5.95			
KS10	3/1/2001	7.55			
KS10	6/1/2001	11.1			
KS10	9/1/2001	8.56			
KS10	12/1/2001	9.08			
KS11	6/1/2001	0.163			
KS12	9/1/2000	0.21			
KS12	12/1/2000	0.112			
KS13	3/1/1999	0.202			
KS13	6/1/1999	0.534			
KS13	9/1/1999	0.237			
KS13	12/1/1999	0.212			
KS13	3/1/2000	0.283			
KS13	9/1/2000	0.174			
KS13	12/1/2000	0.487			
KS13	6/1/2001	0.198			
KS13	9/1/2001	0.225			
KS14	3/1/1999	1.4			
KS14	6/1/1999	1.43			
KS14	9/1/1999	1.11			
KS14	12/1/1999	1.34			
KS14	3/1/2000	0.875			
KS17	9/1/1999	0.23			
KS17	12/1/1999	0.131			
KS17	3/1/2000	0.179			
KS17	6/1/2000	0.196			
KS17	9/1/2000	0.226			
KS17	12/1/2000	0.182			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
KS17	3/1/2001	0.209			
KS17	6/1/2001	0.235			
KS17	9/1/2001	0.201			
KS17	12/1/2001	0.171			
KS19	3/1/1999	0.263			
KS19	6/1/1999	0.206			
KS19	9/1/1999	0.242			
KS19	12/1/1999	0.121			
KS19	9/1/2000	0.125			
KS19	12/1/2001	0.107			
KS21	3/1/2000	0.35			
KS25	3/1/1999	0.546			
KS25	6/1/1999	0.614			
KS25	9/1/1999	0.522			
KS25	12/1/1999	0.485			
KS25	3/1/2000	0.672			
KS25	6/1/2000	0.492			
KS25	9/1/2000	0.392			
KS25	12/1/2000	0.371			
KS25	3/1/2001	0.271			
KS25	6/1/2001	0.167			
KS25	9/1/2001	0.153			
KS25	12/1/2001	0.185			
MN05	3/1/1999	0.226			
MN05	6/1/1999	0.149			
MN05	9/1/1999	0.255			
MN05	12/1/1999	0.3			
MN05	3/1/2000	0.26			
MN05	6/1/2000	0.266			
MN05	3/1/2001	0.399			
MN05	6/1/2001	0.549			
MN05	9/1/2001	0.307			
MN05	12/1/2001	1.32			
MN06	12/1/1999	0.264			
MN06	6/1/2001	0.112			
MN06	9/1/2001	0.901			
MN06	12/1/2001	1.29			
MN08	3/1/1999	0.858			
MN08	6/1/1999	0.844			
MN08	9/1/1999	0.253			
MN08	12/1/1999	0.541			
MN08	3/1/2000	1.28			
MN08	6/1/2000	1.03			
MN08	3/1/2001	0.508			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	**Date**	**Conc**	**Site**	**Date**	**Conc**
MN08	6/1/2001	0.318			
MN13	3/1/1999	0.152			
MN13	6/1/1999	0.229			
MN13	9/1/1999	0.172			
MN13	12/1/1999	0.206			
MN13	3/1/2000	0.217			
MN13	6/1/2000	0.212			
MN13	9/1/2000	0.188			
MN13	6/1/2001	0.311			
MN13	9/1/2001	0.337			
MN13	12/1/2001	0.205			
MN14	9/1/1999	0.106			
MN17	3/1/1999	0.755			
MN17	6/1/1999	0.827			
MN17	9/1/1999	1.65			
MN17	12/1/1999	0.952			
MN17	3/1/2000	0.941			
MN17	6/1/2000	0.797			
MN17	9/1/2000	0.917			
MN17	12/1/2000	0.983			
MN17	3/1/2001	0.471			
MN17	6/1/2001	3.04			
MN17	9/1/2001	4.31			
MN17	12/1/2001	4.29			
MN18	3/1/1999	0.552			
MN18	6/1/1999	0.298			
MN18	9/1/1999	0.568			
MN18	12/1/1999	1			
MN18	3/1/2000	1.05			
MN18	6/1/2000	0.416			
MN18	6/1/2001	0.535			
MN25	3/1/1999	0.387			
MN25	6/1/1999	1.62			
MN25	9/1/1999	3.76			
MN25	12/1/1999	4.06			
MN25	3/1/2000	2.52			
MN25	6/1/2000	1.75			
MN25	9/1/2000	1.69			
MN25	12/1/2000	1.67			
MN25	3/1/2001	0.731			
MN25	7/1/2001	2.71			
MN25	9/1/2001	3.39			
MN25	10/1/2001	5.29			
MN25	11/1/2001	4.42			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
MN25	12/1/2001	2.36			
NE01	9/1/2000	0.119			
NE01	3/1/2001	0.187			
NE01	6/1/2001	0.197			
NE01	9/1/2001	0.248			
NE01	12/1/2001	0.365			
NE02	3/1/1999	6.85			
NE02	6/1/1999	6.4			
NE02	9/1/1999	6.65			
NE02	12/1/1999	7.72			
NE02	3/1/2000	6.5			
NE02	6/1/2000	5.7			
NE02	9/1/2000	2.78			
NE02	12/1/2000	4.06			
NE02	3/1/2001	3.61			
NE02	6/1/2001	3.14			
NE02	9/1/2001	3.11			
NE02	12/1/2001	3.06			
NE03	3/1/1999	0.911			
NE03	6/1/1999	0.802			
NE03	9/1/1999	0.941			
NE03	12/1/1999	1.53			
NE03	3/1/2000	0.491			
NE03	6/1/2000	0.281			
NE03	9/1/2000	0.479			
NE03	12/1/2000	0.339			
NE03	3/1/2001	0.228			
NE03	6/1/2001	0.381			
NE03	9/1/2001	0.605			
NE03	12/1/2001	1.45			
NE04	3/1/1999	0.25			
NE04	6/1/1999	0.691			
NE04	9/1/1999	0.319			
NE04	12/1/1999	0.514			
NE04	3/1/2000	0.384			
NE04	6/1/2000	1.41			
NE04	9/1/2000	0.773			
NE04	12/1/2000	0.926			
NE04	3/1/2001	1.37			
NE04	6/1/2001	1.01			
NE04	9/1/2001	0.711			
NE04	12/1/2001	0.888			
NE05	3/1/1999	3.38			
NE05	6/1/1999	2.74			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
NE05	9/1/1999	2.53			
NE05	12/1/1999	3.56			
NE05	3/1/2000	4.27			
NE05	6/1/2000	4.08			
NE05	9/1/2000	2.23			
NE05	12/1/2000	2.44			
NE05	3/1/2001	0.54			
NE05	6/1/2001	0.641			
NE05	9/1/2001	0.975			
NE05	12/1/2001	1.27			
NE06	6/1/1999	0.147			
NE06	9/1/1999	0.167			
NE06	12/1/1999	0.123			
NE06	6/1/2000	0.141			
NE06	9/1/2000	0.119			
NE06	12/1/2000	0.112			
NE06	3/1/2001	0.124			
NE06	12/1/2001	0.181			
NE07	9/1/1999	0.141			
NE07	12/1/1999	0.109			
NE07	6/1/2000	0.149			
NE07	9/1/2000	0.211			
NE07	12/1/2000	0.146			
NE07	3/1/2001	0.304			
NE07	6/1/2001	0.363			
NE07	9/1/2001	0.411			
NE07	12/1/2001	0.513			
NE10	9/1/2001	0.1			
NE10	12/1/2001	0.153			
NE12	12/1/2000	0.115			
NE12	9/1/2001	0.272			
NE12	12/1/2001	0.377			
NE13	3/1/1999	0.262			
NE13	6/1/1999	0.269			
NE13	9/1/1999	0.553			
NE13	12/1/1999	0.352			
NE13	3/1/2000	0.36			
NE16	3/1/1999	0.833			
NE16	6/1/1999	0.477			
NE16	9/1/1999	0.716			
NE17	3/1/1999	0.875			
NE17	6/1/1999	0.929			
NE17	9/1/1999	1.01			
NE17	12/1/1999	0.597			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
NE17	3/1/2000	0.516			
NE17	6/1/2000	0.315			
NE17	9/1/2000	0.502			
NE17	12/1/2000	0.534			
NE17	3/1/2001	0.497			
NE17	6/1/2001	0.8			
NE17	9/1/2001	0.604			
NE17	12/1/2001	0.609			
NE18	9/1/1999	0.301			
NE18	12/1/1999	0.138			
NE18	3/1/2001	0.154			
NE18	6/1/2001	0.184			
NE19	3/1/1999	0.752			
NE19	6/1/1999	0.843			
NE19	9/1/1999	2.44			
NE19	12/1/1999	1.64			
NE19	3/1/2000	2.09			
NE19	6/1/2000	2.15			
NE19	9/1/2000	1.33			
NE19	12/1/2000	0.928			
NE19	3/1/2001	1.66			
NE19	6/1/2001	1.64			
NE19	9/1/2001	1.56			
NE19	12/1/2001	1.08			
NE23	6/1/1999	0.164			
NE23	9/1/1999	0.103			
NE23	12/1/1999	0.126			
NE25	3/1/2001	0.959			
NE25	6/1/2001	0.325			
NE25	9/1/2001	0.183			
NE25	12/1/2001	0.22			
WI01	3/1/1999	1.02			
WI01	6/1/1999	0.5			
WI01	9/1/1999	0.206			
WI01	12/1/1999	0.864			
WI01	2/1/2000	0.565			
WI01	3/1/2000	0.565			
WI01	6/1/2000	0.112			
WI01	9/1/2000	0.116			
WI01	6/1/2001	0.409			
WI01	9/1/2001	0.766			
WI01	12/1/2001	1.89			
WI03	3/1/1999	1.38			
WI03	6/1/1999	1.5			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI03	9/1/1999	0.817			
WI03	12/1/1999	1.17			
WI03	2/1/2000	1.13			
WI03	3/1/2000	1.13			
WI03	6/1/2000	0.879			
WI03	9/1/2000	1.04			
WI03	12/1/2000	1.11			
WI03	3/1/2001	1.2			
WI03	6/1/2001	2.27			
WI03	9/1/2001	1.93			
WI03	12/1/2001	2.91			
WI04	3/1/1999	1.98			
WI04	6/1/1999	2.09			
WI04	9/1/1999	2.44			
WI04	12/1/1999	2.44			
WI04	2/1/2000	2.05			
WI04	3/1/2000	2.05			
WI04	6/1/2000	1.79			
WI04	9/1/2000	0.999			
WI04	12/1/2000	0.801			
WI04	3/1/2001	0.639			
WI04	6/1/2001	0.496			
WI04	9/1/2001	0.282			
WI04	12/1/2001	0.582			
WI05	3/1/1999	2.41			
WI05	6/1/1999	2.59			
WI05	9/1/1999	0.382			
WI05	12/1/1999	0.892			
WI05	2/1/2000	0.107			
WI05	3/1/2000	0.107			
WI05	6/1/2000	0.827			
WI05	9/1/2000	0.153			
WI05	12/1/2000	0.18			
WI05	3/1/2001	0.498			
WI05	6/1/2001	0.119			
WI05	12/1/2001	0.113			
WI06	3/1/1999	2.77			
WI06	6/1/1999	2.31			
WI06	9/1/1999	0.519			
WI06	12/1/1999	0.477			
WI08	3/1/1999	0.215			
WI08	9/1/1999	0.142			
WI08	2/1/2000	0.124			
WI08	3/1/2000	0.124			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI09	6/1/1999	2.7			
WI09	9/1/1999	1.64			
WI09	12/1/1999	0.514			
WI09	2/1/2000	0.372			
WI09	3/1/2000	0.372			
WI10	3/1/1999	0.1			
WI10	6/1/1999	0.125			
WI10	9/1/1999	0.13			
WI10	6/1/2001	0.248			
WI10	9/1/2001	0.24			
WI11	3/1/1999	3.2			
WI11	6/1/1999	2.84			
WI11	9/1/1999	1.62			
WI11	12/1/1999	3.12			
WI11	1/1/2000	0.848			
WI11	2/1/2000	0.798			
WI11	3/1/2000	0.798			
WI11	6/1/2000	1.86			
WI11	9/1/2000	0.434			
WI11	12/1/2000	0.89			
WI11	3/1/2001	1.1			
WI11	6/1/2001	1.67			
WI11	9/1/2001	5.26			
WI11	12/1/2001	1.67			
WI12	3/1/1999	0.15			
WI12	12/1/1999	0.168			
WI12	1/1/2000	0.122			
WI12	2/1/2000	0.118			
WI12	3/1/2000	0.118			
WI12	9/1/2000	0.105			
WI12	12/1/2001	0.341			
WI15	9/1/1999	0.133			
WI15	12/1/1999	0.101			
WI20	3/1/1999	0.343			
WI20	6/1/1999	0.456			
WI20	9/1/1999	0.275			
WI20	9/1/2000	0.121			
WI20	3/1/2001	0.136			
WI20	6/1/2001	0.11			
WI20	9/1/2001	0.167			
WI20	12/1/2001	0.171			
WI21	3/1/1999	0.221			
WI21	6/1/1999	0.28			
WI21	9/1/1999	0.273			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI21	12/1/1999	0.128			
WI21	9/1/2000	0.456			
WI21	12/1/2000	0.235			
WI21	3/1/2001	0.111			
WI21	6/1/2001	0.124			
WI21	9/1/2001	0.211			
WI22	3/1/1999	0.162			
WI22	2/1/2000	0.16			
WI22	3/1/2000	0.16			
WI22	6/1/2000	0.147			
WI22	9/1/2000	0.221			
WI22	12/1/2000	0.145			
WI22	3/1/2001	0.216			
WI22	12/1/2001	0.156			
WI23	3/1/1999	11.7			
WI23	6/1/1999	10.5			
WI25	9/1/1999	0.159			
WI25	12/1/1999	0.168			
WI25	2/1/2000	0.168			
WI25	3/1/2000	0.168			
WI25	6/1/2000	0.194			
WI25	9/1/2000	0.215			
WI25	12/1/2000	0.22			
WI25	3/1/2001	0.188			
WI25	6/1/2001	0.12			
WI25	9/1/2001	0.164			
WI25	12/1/2001	0.174			
WI26	3/1/1999	0.265			
WI26	6/1/1999	0.294			
WI26	9/1/1999	0.374			
WI26	12/1/1999	0.378			
WI26	2/1/2000	0.263			
WI26	3/1/2000	0.263			
WI26	6/1/2000	0.364			
WI26	9/1/2000	0.56			
WI26	12/1/2000	0.365			
WI26	3/1/2001	0.447			
WI26	6/1/2001	1.79			
WI26	9/1/2001	2.87			
WI26	12/1/2001	2.73			
WI27	3/1/1999	1.76			
WI27	6/1/1999	1.33			
WI27	9/1/1999	1.08			
WI27	12/1/1999	1.25			

Table 34. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	**Date**	**Conc**	**Site**	**Date**	**Conc**
WI27	2/1/2000	0.785			
WI27	3/1/2000	0.785			
WI27	6/1/2000	1			
WI27	9/1/2000	1.51			
WI27	3/1/2001	1.56			
WI27	6/1/2001	2.2			
WI27	9/1/2001	5.16			
WI27	12/1/2001	3.33			
WI28	3/1/1999	0.303			
WI28	6/1/1999	1.09			
WI28	9/1/1999	1.01			
WI28	12/1/1999	1.2			
WI28	2/1/2000	1.4			
WI28	3/1/2000	1.4			
WI28	6/1/2000	0.655			
WI28	9/1/2000	1.12			
WI28	12/1/2000	0.943			
WI28	3/1/2001	0.977			
WI28	6/1/2001	1.48			
WI28	9/1/2001	0.942			
WI28	12/1/2001	1.04			

PGW

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
1	ESA	DE	6	**1**	9	2.61	3
2	ESA	DE	6	**2.4**	10	2.61	3
3	ESA	DE	6	**3.9**	12.5	2.61	3
4	ESA	DE	6	**3.9**	13	2.61	3
5	ESA	DE	6	**3.7**	13.5	2.61	3
6	ESA	DE	6	**3.6**	14	2.61	3
7	ESA	DE	6	**2.1**	14.5	2.61	3
8	ESA	DE	6	**4.3**	15	2.61	3
9	ESA	DE	6	**3.5**	15.5	2.61	3
10	ESA	DE	6	**3.1**	16	2.61	3
11	ESA	DE	6	**2.4**	16.5	2.61	3
12	ESA	DE	6	**2.6**	17	2.61	3

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
13	ESA	DE	3	**1.1**	17.5	9.9	1.1
14	ESA	DE	6	**2.7**	17.5	2.61	3
15	ESA	DE	3	**1.2**	18	9.9	1.1
16	ESA	DE	6	**2.5**	18	2.61	3
17	ESA	DE	3	**1.3**	19	9.9	1.1
18	ESA	DE	6	**2.9**	19	2.61	3
19	ESA	DE	3	**1.4**	20	9.9	1.1
20	ESA	DE	3	**1.3**	21	9.9	1.1
21	ESA	DE	3	**1.7**	22	9.9	1.1
22	ESA	DE	6	**1.4**	22	2.61	3
23	ESA	DE	3	**2.5**	23	9.9	1.1
24	ESA	DE	6	**4.3**	23	2.61	3
25	ESA	DE	3	**1.9**	24	9.9	1.1
26	ESA	DE	6	**2.8**	24	2.61	3
27	ESA	DE	3	**2**	25	9.9	1.1
28	ESA	DE	6	**2.6**	25	2.61	3
29	ESA	DE	3	**2.3**	26	9.9	1.1
30	ESA	DE	6	**2.5**	26	2.61	3
31	ESA	DE	3	**3.1**	27	9.9	1.1
32	ESA	DE	6	**1.7**	27	2.61	3
33	ESA	DE	1	**1.1**	28	1.2	1.4
34	ESA	DE	3	**3.2**	28	9.9	1.1
35	ESA	DE	1	**1.3**	29	1.2	1.4
36	ESA	DE	3	**3.5**	29	9.9	1.1
37	ESA	DE	3	**2.85**	30	9.9	1.1
38	ESA	DE	3	**2.94**	31	9.9	1.1
39	ESA	DE	1	**1.06**	33	1.2	1.4
40	ESA	DE	1	**1.13**	34	1.2	1.4
41	ESA	DE	3	**1.45**	36	9.9	1.1
42	ESA	DE	1	**1.15**	36	1.2	1.4
43	ESA	DE	3	**1.43**	37	9.9	1.1
44	ESA	DE	1	**1.05**	37	1.2	1.4
45	ESA	DE	3	**1.13**	38	9.9	1.1
46	ESA	DE	3	**1.05**	39	9.9	1.1
47	ESA	DE	1	**1.01**	39	1.2	1.4
48	ESA	DE	6	**1.7**	11	2.61	3
49	ESA	DE	6	**3.2**	12	2.61	3
50	ESA	IN	6	**3.6**	2	12	2.2
51	ESA	IN	4	**1.2**	2.5	3.3	1.3
52	ESA	IN	6	**8.1**	2.5	12	2.2
53	ESA	IN	4	**1.1**	3.5	3.3	1.3

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
54	ESA	IN	6	**13**	3.5	12	2.2
55	ESA	IN	6	**16**	4	12	2.2
56	ESA	IN	6	**16**	4.5	12	2.2
57	ESA	IN	6	**21**	5	12	2.2
58	ESA	IN	6	**22**	5.5	12	2.2
59	ESA	IN	4	**13**	9	3.3	1.3
60	ESA	IN	6	**10**	9	12	2.2
61	ESA	IN	7	**15**	9	6.9	4.5
62	ESA	IN	2	**1.7**	10	18	17
63	ESA	IN	4	**10**	10	3.3	1.3
64	ESA	IN	6	**7**	10	12	2.2
65	ESA	IN	7	**19**	10	6.9	4.5
66	ESA	IN	2	**2.3**	11	18	17
67	ESA	IN	4	**10**	11	3.3	1.3
68	ESA	IN	6	**6.8**	11	12	2.2
69	ESA	IN	7	**16**	11	6.9	4.5
70	ESA	IN	2	**3.1**	12	18	17
71	ESA	IN	4	**11**	12	3.3	1.3
72	ESA	IN	6	**6.7**	12	12	2.2
73	ESA	IN	7	**18**	12	6.9	4.5
74	ESA	IN	8	**3.3**	12	4.6	7.3
75	ESA	IN	2	**3.6**	13	18	17
76	ESA	IN	4	**10**	13	3.3	1.3
77	ESA	IN	6	**3.1**	13	12	2.2
78	ESA	IN	7	**21**	13	6.9	4.5
79	ESA	IN	2	**5.4**	14	18	17
80	ESA	IN	4	**10**	14	3.3	1.3
81	ESA	IN	6	**6.2**	14	12	2.2
82	ESA	IN	7	**24**	14	6.9	4.5
83	ESA	IN	8	**7.6**	14	4.6	7.3
84	ESA	IN	2	**5.4**	15	18	17
85	ESA	IN	4	**6.3**	15	3.3	1.3
86	ESA	IN	6	**5.2**	15	12	2.2
87	ESA	IN	7	**23**	15	6.9	4.5
88	ESA	IN	8	**5.8**	15	4.6	7.3
89	ESA	IN	2	**5.4**	16	18	17
90	ESA	IN	4	**3.8**	16	3.3	1.3
91	ESA	IN	6	**4.6**	16	12	2.2
92	ESA	IN	7	**20**	16	6.9	4.5
93	ESA	IN	8	**4.3**	16	4.6	7.3
94	ESA	IN	2	**6.9**	18	18	17

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
95	ESA	IN	4	**5.7**	18	3.3	1.3
96	ESA	IN	6	**4.3**	18	12	2.2
97	ESA	IN	7	**22**	18	6.9	4.5
98	ESA	IN	8	**2.8**	18	4.6	7.3
99	ESA	IN	2	**1.7**	22	18	17
100	ESA	IN	3	**3.5**	22	7	6.1
101	ESA	IN	4	**2.2**	22	3.3	1.3
102	ESA	IN	6	**6.6**	22	12	2.2
103	ESA	IN	7	**5.1**	22	6.9	4.5
104	ESA	IN	2	**19**	23	18	17
105	ESA	IN	3	**1.8**	23	7	6.1
106	ESA	IN	4	**1.1**	23	3.3	1.3
107	ESA	IN	5	**2.3**	23	7.6	3.6
108	ESA	IN	6	**1.4**	23	12	2.2
109	ESA	IN	7	**16**	23	6.9	4.5
110	ESA	IN	8	**8.2**	23	4.6	7.3
111	ESA	IN	2	**18**	24	18	17
112	ESA	IN	3	**2**	24	7	6.1
113	ESA	IN	5	**1.9**	24	7.6	3.6
114	ESA	IN	7	**14**	24	6.9	4.5
115	ESA	IN	8	**6.9**	24	4.6	7.3
116	ESA	IN	2	**17**	27	18	17
117	ESA	IN	3	**1.2**	27	7	6.1
118	ESA	IN	5	**1**	27	7.6	3.6
119	ESA	IN	7	**10**	27	6.9	4.5
120	ESA	IN	8	**4.3**	27	4.6	7.3
121	ESA	IN	2	**17**	28	18	17
122	ESA	IN	7	**8.6**	28	6.9	4.5
123	ESA	IN	8	**3.3**	28	4.6	7.3
124	ESA	IN	2	**12**	29	18	17
125	ESA	IN	7	**6.6**	29	6.9	4.5
126	ESA	IN	8	**2.4**	29	4.6	7.3
127	ESA	IN	7	**6.1**	30	6.9	4.5
128	ESA	IN	2	**13**	33	18	17
129	ESA	IN	2	**8.8**	34	18	17
130	ESA	IN	7	**1.7**	34	6.9	4.5
131	ESA	IN	8	**1.1**	34	4.6	7.3
132	ESA	IN	2	**10**	35	18	17
133	ESA	IN	7	**1.9**	35	6.9	4.5
134	ESA	IN	8	**1.3**	35	4.6	7.3
135	ESA	IN	2	**8.9**	36	18	17

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement". criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
136	ESA	IN	7	**1.4**	36	6.9	4.5
137	ESA	IN	7	**1.2**	37	6.9	4.5
138	ESA	IN	2	**8.1**	45	18	17
139	ESA	IN	2	**6.7**	46	18	17
140	ESA	IN	2	**2.8**	50	18	17
141	ESA	IN	2	**1.94**	52	18	17
142	ESA	MN	4	**3.8**	4.5	13	6.1
143	ESA	MN	6	**3.7**	4.5	4.5	20
144	ESA	MN	3	**2**	5	7	10
145	ESA	MN	4	**10**	5	13	6.1
146	ESA	MN	5	**1.1**	5	3	21
147	ESA	MN	6	**7.5**	5	4.5	20
148	ESA	MN	7	**3.3**	5	11	19
149	ESA	MN	1	**1.7**	11	9.7	13
150	ESA	MN	2	**5.6**	11	9.4	22
151	ESA	MN	3	**5.7**	11	7	10
152	ESA	MN	4	**12**	11	13	6.1
153	ESA	MN	5	**5.1**	11	3	21
154	ESA	MN	6	**9.2**	11	4.5	20
155	ESA	MN	7	**11**	11	11	19
156	ESA	MN	8	**2.1**	11	14	21
157	ESA	MN	1	**4**	12	9.7	13
158	ESA	MN	2	**6.4**	12	9.4	22
159	ESA	MN	3	**3.9**	12	7	10
160	ESA	MN	5	**7.5**	12	3	21
161	ESA	MN	6	**8**	12	4.5	20
162	ESA	MN	7	**24**	12	11	19
163	ESA	MN	8	**3.1**	12	14	21
164	ESA	MN	1	**5**	13	9.7	13
165	ESA	MN	2	**8**	13	9.4	22
166	ESA	MN	4	**2.8**	13	13	6.1
167	ESA	MN	5	**7.5**	13	3	21
168	ESA	MN	6	**8.1**	13	4.5	20
169	ESA	MN	7	**23**	13	11	19
170	ESA	MN	8	**2.6**	13	14	21
171	ESA	MN	2	**16**	14	9.4	22
172	ESA	MN	7	**11**	14	11	19
173	ESA	MN	8	**2.1**	14	14	21
174	ESA	MN	1	**5.7**	15	9.7	13
175	ESA	MN	2	**20**	15	9.4	22
176	ESA	MN	3	**4.8**	15	7	10

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
177	ESA	MN	4	**6.7**	15	13	6.1
178	ESA	MN	5	**9.4**	15	3	21
179	ESA	MN	6	**2.6**	15	4.5	20
180	ESA	MN	7	**11**	15	11	19
181	ESA	MN	8	**2.3**	15	14	21
182	ESA	MN	1	**4.6**	16	9.7	13
183	ESA	MN	2	**21**	16	9.4	22
184	ESA	MN	3	**4**	16	7	10
185	ESA	MN	4	**6**	16	13	6.1
186	ESA	MN	5	**6.6**	16	3	21
187	ESA	MN	6	**1.8**	16	4.5	20
188	ESA	MN	7	**14**	16	11	19
189	ESA	MN	1	**5.3**	17	9.7	13
190	ESA	MN	3	**4.4**	17	7	10
191	ESA	MN	4	**4.9**	17	13	6.1
192	ESA	MN	5	**7.6**	17	3	21
193	ESA	MN	6	**1.4**	17	4.5	20
194	ESA	MN	7	**16**	17	11	19
195	ESA	MN	1	**4**	18	9.7	13
196	ESA	MN	1	**1.8**	22	9.7	13
197	ESA	MN	3	**3.1**	22	7	10
198	ESA	MN	4	**3.1**	22	13	6.1
199	ESA	MN	5	**5.7**	22	3	21
200	ESA	MN	7	**12**	22	11	19
201	ESA	MN	8	**2.2**	22	14	21
202	ESA	MN	1	**2.2**	23	9.7	13
203	ESA	MN	2	**14**	23	9.4	22
204	ESA	MN	3	**2.2**	23	7	10
205	ESA	MN	4	**1.7**	23	13	6.1
206	ESA	MN	5	**3.5**	23	3	21
207	ESA	MN	7	**6.3**	23	11	19
208	ESA	MN	8	**1.5**	23	14	21
209	ESA	MN	1	**2.4**	24	9.7	13
210	ESA	MN	2	**12**	24	9.4	22
211	ESA	MN	3	**2**	24	7	10
212	ESA	MN	4	**1.6**	24	13	6.1
213	ESA	MN	5	**3.6**	24	3	21
214	ESA	MN	7	**7.5**	24	11	19
215	ESA	MN	8	**1.4**	24	14	21
216	ESA	MN	1	**1.6**	27	9.7	13
217	ESA	MN	3	**1.9**	27	7	10

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
218	ESA	MN	4	**1.6**	27	13	6.1
219	ESA	MN	5	**1.9**	27	3	21
220	ESA	MN	7	**5.4**	27	11	19
221	ESA	MN	1	**1.7**	28	9.7	13
222	ESA	MN	3	**2**	28	7	10
223	ESA	MN	4	**1.7**	28	13	6.1
224	ESA	MN	5	**2.1**	28	3	21
225	ESA	MN	7	**6.7**	28	11	19
226	ESA	MN	8	**1**	28	14	21
227	ESA	MN	1	**1.2**	29	9.7	13
228	ESA	MN	3	**1.5**	29	7	10
229	ESA	MN	4	**1.2**	29	13	6.1
230	ESA	MN	5	**1.4**	29	3	21
231	ESA	MN	7	**5.3**	29	11	19
232	ESA	MN	2	**2**	34	9.4	22
233	ESA	MN	2	**3.7**	35	9.4	22
234	ESA	MN	7	**1.1**	35	11	19
235	ESA	MN	2	**2.2**	36	9.4	22
236	ESA	MN	2	**1.8**	37	9.4	22
237	ESA	NE	2	**1.3**	23	11	5.9
238	ESA	NE	7	**1.7**	32	4.25	13
239	ESA	NE	6	**1.03**	44	23.1	22
240	ESA	NE	6	**1.07**	47	23.1	22
241	ESA	NE	8	**2.33**	64	18	24
242	ESA	NE	8	**2.81**	65	18	24
243	ESA	NE	8	**3.65**	66	18	24
244	ESA	NE	8	**6.92**	71	18	24
245	ESA	NE	8	**9.3**	72	18	24
246	ESA	NE	6	**1.29**	72	23.1	22
247	ESA	NE	8	**11.1**	73	18	24
248	ESA	NE	6	**1.43**	73	23.1	22
249	ESA	NE	8	**9.26**	74	18	24
250	ESA	NE	6	**1.6**	74	23.1	22
251	ESA	NE	8	**10.5**	75	18	24
252	ESA	NE	6	**1.84**	75	23.1	22
253	ESA	NE	8	**11.2**	77	18	24
254	ESA	NE	6	**3.28**	77	23.1	22
255	ESA	NE	8	**11.4**	83	18	24
256	ESA	NE	6	**4.19**	83	23.1	22
257	ESA	NE	8	**7.67**	85	18	24
258	ESA	NE	6	**7.74**	85	23.1	22

Table 35. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by "pattern of movement" criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
259	ESA	NE	8	**3.95**	87	18	24
260	ESA	NE	7	**2.72**	87	4.25	13
261	ESA	NE	6	**9.42**	87	23.1	22
262	ESA	NE	4	**1.26**	87	1.4	66
263	ESA	NE	2	**1.08**	87	11	5.9
264	ESA	OH	1	**1.3**	2.5	5.4	1.2
265	ESA	OH	1	**6**	3	5.4	1.2
266	ESA	OH	1	**5.1**	3.5	5.4	1.2
267	ESA	OH	1	**6.5**	4	5.4	1.2
268	ESA	OH	1	**3.4**	5	5.4	1.2
269	ESA	OH	1	**1.3**	11	5.4	1.2
270	ESA	OH	1	**3.8**	12	5.4	1.2
271	ESA	PA	4	**1.2**	7	2	1.2
272	ESA	PA	4	**1.8**	9	2	1.2
273	ESA	PA	3	**1.3**	10	1	3
274	ESA	PA	4	**2.7**	10	2	1.2
275	ESA	PA	8	**2.7**	10	2.8	2.4
276	ESA	PA	3	**1.1**	11	1	3
277	ESA	PA	4	**1.7**	11	2	1.2
278	ESA	PA	4	**1.7**	12	2	1.2
279	ESA	PA	4	**1.4**	13	2	1.2
280	ESA	PA	4	**1.3**	14	2	1.2
281	ESA	PA	4	**1.4**	15	2	1.2
282	ESA	PA	4	**1.6**	16	2	1.2
283	ESA	PA	4	**1.7**	18	2	1.2
284	ESA	PA	4	**1.4**	20	2	1.2
285	ESA	WI	2	**1.7**	4.5	13	1.8
286	ESA	WI	2	**1.5**	7	13	1.8
287	ESA	WI	2	**4.1**	11	13	1.8
288	ESA	WI	2	**24**	12	13	1.8
289	ESA	WI	2	**25**	13	13	1.8
290	ESA	WI	2	**19**	14	13	1.8
291	ESA	WI	2	**11**	15	13	1.8
292	ESA	WI	2	**3**	23	13	1.8
293	ESA	WI	2	**3.6**	24	13	1.8