Appendices II.E.1-7

Prepared by:
U.S. Environmental Protection Agency

TABLE OF CONTENTS

II. NMC Cumulative Risk Assessment

E. Drinking Water

Appendix E-1 Summary of Surface Water Monitoring Data for NMC Pesticides

This appendix summarizes available surface water monitoring for the N-methyl carbamate (NMC) pesticides from USGS NAWQA monitoring, USDA Pesticide Data Program (PDP) monitoring, and additional water monitoring studies identified in the individual NMC chemical assessments.

1. USGS NAWQA Monitoring for N-Methyl Carbamates

The U.S. Geological Survey (USGS) National Water Quality Assessment (NAWQA) program has been collecting pesticide monitoring data from sites across the country since 1991. N-methyl carbamate (NMC) pesticides included in the USGS analytical methods include aldicarb, aldicarb sulfoxide, aldicarb sulfone, carbaryl, carbofuran, Methiocarb, methomyl, oxamyl, and propoxur. With the assistance or Rick Bell of the USGS NAWQA program, the Agency obtained all the USGS monitoring for these NMC pesticides in both ground water and surface water through November 15, 2004. The following tables provide summaries of reported NMC detections for each NAWQA study unit by land use type.

The NAWQA study did not focus on drinking water and the monitoring reflects a range of ambient waters. Also, the study sites were not targeted to high pesticide or NMC use areas. OPP tried to focus on those sampling sites that fed into drinking water sources or were reflective of drinking water sources in the region. The monitoring results are most valuable in identifying areas and conditions under which NMC pesticides may be found in ambient waters. Such information is useful in identifying potential vulnerable areas and in evaluating the model estimates where monitoring sites occur in the same area as the exposure scenarios.

Figures II.E.1.1 through II.E.1.4 show the NAWQA Study Units in relation to cumulative carbamate use areas. The monitoring data are listed by the 4-letter study unit identification (SUID) codes displayed on the maps.

Figure II.E-1- NAWQA Study Units in the Northwestern US in Relation to Cumulative Carbamate Use

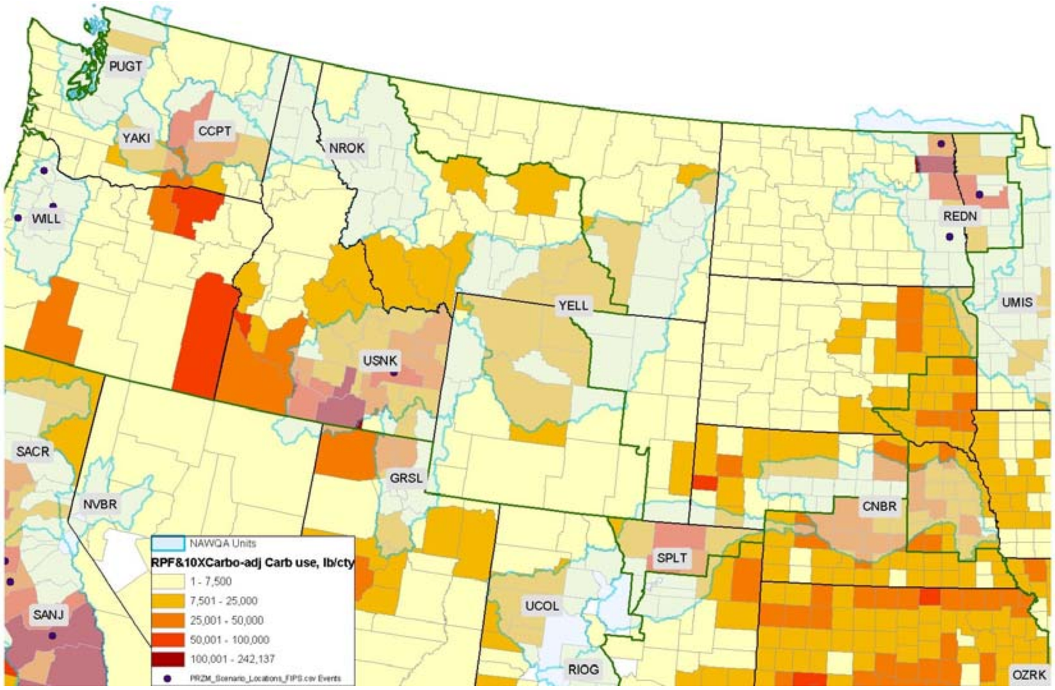


FIgure II.E.1-2 NAWQA Study Units in the Southwestern US in Relation to Cumulative Carbamate Use

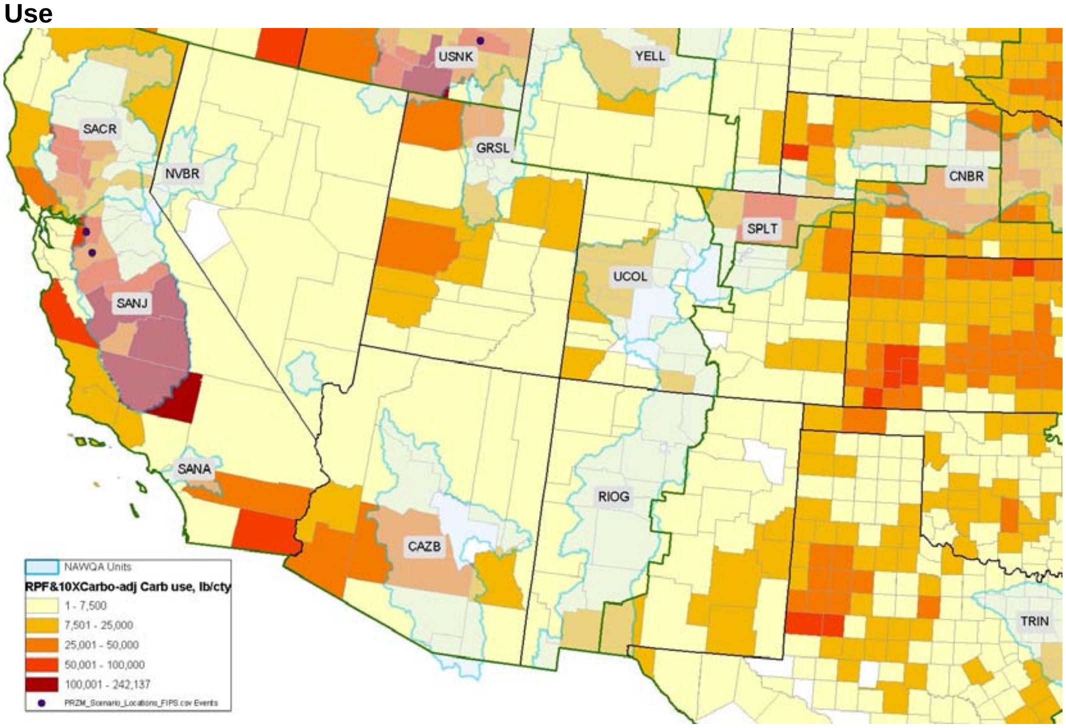


FIgure II. E.1-3- NAWQA Study Units in the Northeastern US in Relation to Cumulative Carbamate Use

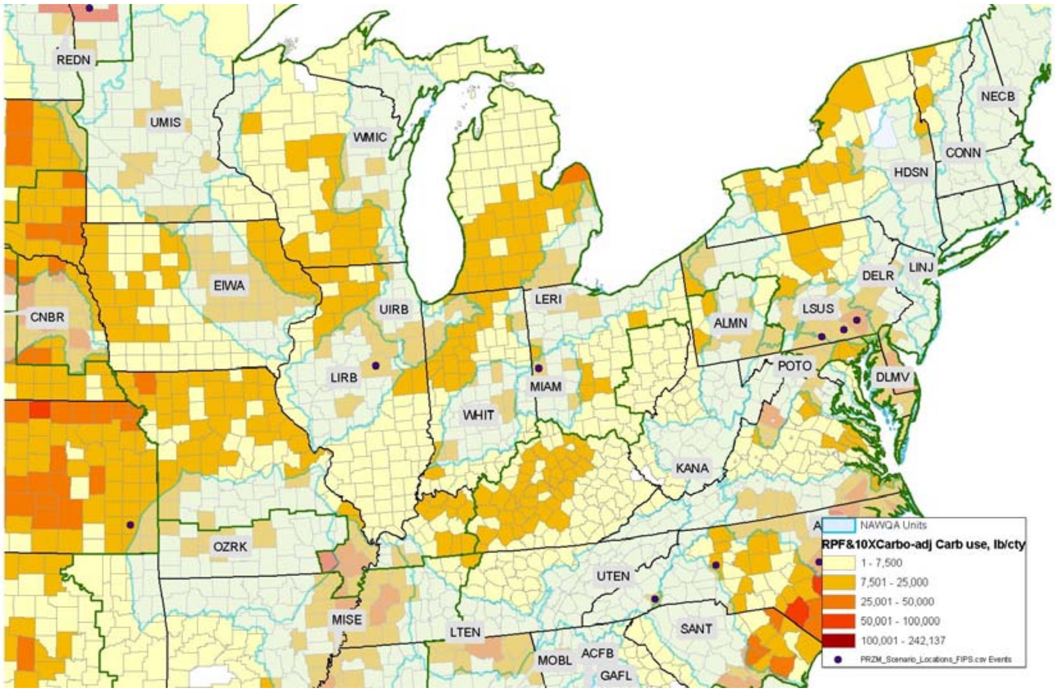
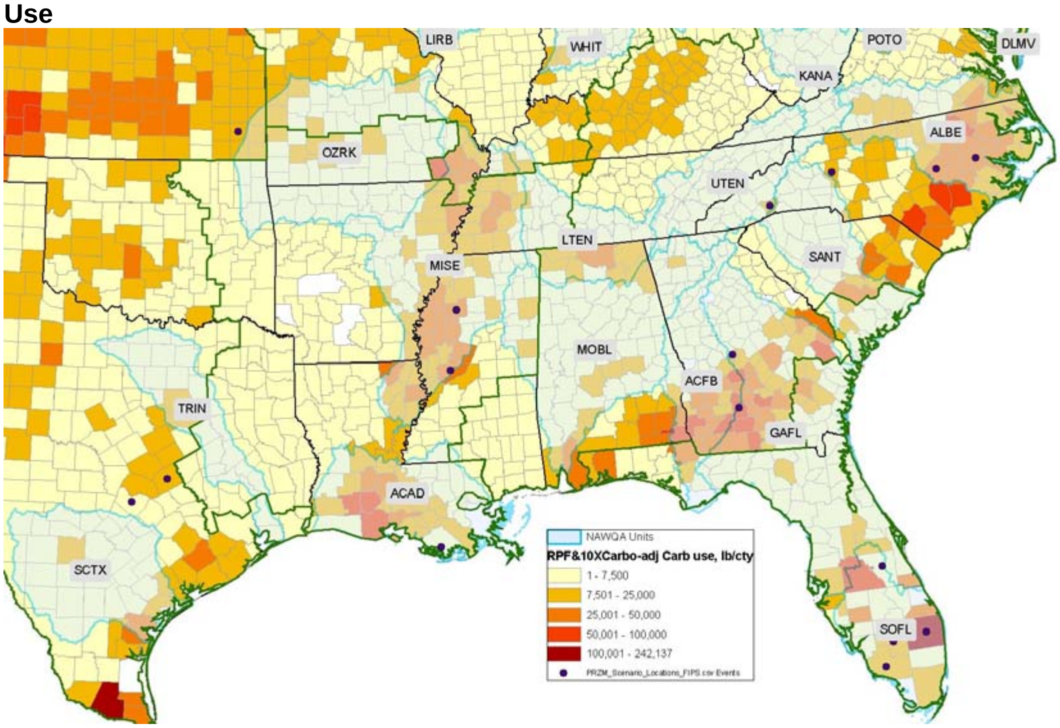


FIgure II.E.1-4- NAWQA Study Units in the Southeastern US in Relation to Cumulative Carbamate Use



Tables II.E.1.1-7 Study units which had one or more detects of each of the NMC chemicals. Those NAWQA study units which had no reported detects were not included in the tables.

Table II.E.1-1 Detections of aldicarb, aldicarb sulfone, and aldicarb sulfoxide in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
Aldicarb							
ACFB	Cropland	0.040	0.040	0.040	0.040	0.0%	0
ALBE	Agriculture	0.340	0.078	0.016	0.016	1.2%	1
GAFL	Agriculture	0.040	0.040	0.040	0.023	0.0%	0
MISE	Cropland	0.550	0.550	0.550	0.016	0.0%	0
NVBR	Mixed	0.050	0.034	0.016	0.016	0.0%	0
REDN	Cropland	0.510	0.140	0.016	0.016	1.3%	1
SANJ	Mixed	0.460	0.072	0.040	0.040	0.7%	1
SANT	Cropland	0.480	0.350	0.016	0.016	3.4%	1
SPLT	Agriculture	0.016	0.016	0.016	0.016	0.0%	0
SPLT	Mixed	0.080	0.061	0.016	0.016	3.3%	1
SPLT	Urban	0.040	0.040	0.040	0.040	0.0%	0
TENN	Cropland	0.040	0.040	0.040	0.040	0.0%	0
TENN	Mixed	0.040	0.040	0.022	0.016	0.0%	0
WILL	Agriculture	0.040	0.040	0.040	0.040	0.0%	0
YELL	Mixed	1.200	1.031	0.550	0.550	3.7%	1
Aldicarb Sulfone							
ACFB	Cropland	0.020	0.020	0.020	0.020	0.0%	0
ALBE	Agriculture	0.016	0.016	0.016	0.016	0.0%	0
GAFL	Agriculture	0.020	0.020	0.020	0.017	0.0%	0
MISE	Cropland	0.100	0.100	0.100	0.016	0.0%	0
NVBR	Mixed	0.070	0.061	0.016	0.016	2.1%	1
REDN	Cropland	0.016	0.016	0.016	0.016	0.0%	0
SANJ	Mixed	0.090	0.020	0.020	0.020	0.0%	0
SANT	Cropland	0.016	0.016	0.016	0.016	0.0%	0
SPLT	Agriculture	0.016	0.016	0.016	0.016	0.0%	0
SPLT	Mixed	0.016	0.016	0.016	0.016	0.0%	0
SPLT	Urban	0.157	0.050	0.020	0.020	1.3%	1
TENN	Cropland	0.042	0.042	0.039	0.036	25.0%	1
TENN	Mixed	0.022	0.021	0.020	0.016	1.0%	1
WILL	Agriculture	0.020	0.020	0.020	0.020	0.0%	0
YELL	Mixed	0.260	0.218	0.100	0.100	0.0%	0
Aldicarb Sulfoxide							
ACFB	Cropland	0.920	0.021	0.021	0.021	0.6%	1
ALBE	Agriculture	0.021	0.021	0.021	0.021	0.0%	0
GAFL	Agriculture	0.290	0.021	0.021	0.021	0.8%	1
MISE	Cropland	1.910	0.222	0.021	0.021	1.2%	2
NVBR	Mixed	0.050	0.037	0.021	0.021	0.0%	0
REDN	Cropland	0.021	0.021	0.021	0.021	0.0%	0

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
SANJ	Mixed	0.090	0.021	0.021	0.021	0.7%	1
SANT	Cropland	1.200	0.870	0.021	0.021	3.4%	1
SPLT	Agriculture	0.980	0.472	0.021	0.021	1.9%	1
SPLT	Mixed	0.021	0.021	0.021	0.021	0.0%	0
SPLT	Urban	0.021	0.021	0.021	0.021	0.0%	0
TENN	Cropland	0.043	0.042	0.038	0.033	25.0%	1
TENN	Mixed	0.065	0.045	0.027	0.021	2.9%	3
WILL	Agriculture	0.021	0.021	0.021	0.021	2.6%	3
YELL	Mixed	0.140	0.130	0.076	0.021	0.0%	0

Table II.E.1-2 Detections of carbaryl by two analytical methods in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
Carbaryl (Anal. Meth 49310)							
ACFB	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
ACFB	Cropland	0.0284	0.0284	0.0284	0.0284	0.6%	1
ACFB	Mixed	0.07	0.06371	0.01	0.008	4.2%	5
ACFB	Residential	0.12	0.097	0.04	0.0284	14.5%	24
ACFB	Urban	0.97	0.511	0.066	0.0332	12.7%	7
ALBE	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
ALBE	Mixed	0.0284	0.0284	0.0284	0.0284	10.5%	6
ALBE	Not Applicable	0.0284	0.0284	0.0284	0.0284	30.8%	4
ALBE	Urban	0.1089	0.080592	0.0284	0.0284	58.1%	25
ALMN	Urban	0.09	0.0695	0.008	0.008	3.8%	1
CCYK	Agriculture	0.8732	0.053016	0.0284	0.0284	7.5%	13
CCYK	Mixed	0.0284	0.0284	0.0284	0.0284	5.4%	6
CNBR	Agriculture	0.05	0.039416	0.0284	0.0284	2.0%	1
CONN	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
CONN	Mixed	0.02	0.01568	0.008	0.008	2.7%	1
CONN	Urban	2.9	0.6264	0.061	0.0284	14.1%	14
COOK	Residential	0.11	0.1094	0.107	0.104	28.6%	2
GAFL	Agriculture	0.03	0.0284	0.0284	0.0284	0.0%	0
GAFL	Mixed	0.0284	0.0284	0.0284	0.0284	2.5%	2
GAFL	Not Applicable	0.0284	0.0284	0.0284	0.0284	5.4%	2
GAFL	Urban	0.07	0.0583	0.0305	0.008	2.5%	1
HDSN	Agriculture	0.0284	0.02024	0.008	0.008	0.0%	0
HDSN	Mixed	0.008	0.008	0.008	0.008	0.0%	0
HDSN	Residential	0.07	0.058768	0.0284	0.01412	3.6%	1
HDSN	Urban	0.22	0.22	0.22	0.22	100.0%	1
KANA	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
KANA	Mixed	0.07	0.05388	0.008	0.008	3.7%	1
LERI	Cropland	0.0284	0.0284	0.0284	0.0284	0.0%	0
LERI	Mixed	0.0284	0.0284	0.0284	0.0284	0.0%	0
LERI	Pasture	0.008	0.008	0.008	0.008	0.0%	0

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
LERI	Urban	0.0284	0.0284	0.0284	0.01122	5.9%	2
LINJ	Agriculture	0.05	0.0479	0.0395	0.029	16.7%	1
LINJ	Forest	0.008	0.008	0.008	0.008	0.0%	0
LINJ	Mixed	0.23	0.1988	0.09	0.046	28.0%	7
LINJ	Residential	0.04	0.0392	0.036	0.032	33.3%	3
LINJ	Urban	0.008	0.008	0.008	0.008	2.5%	1
LSUS	Agriculture	0.34	0.085	0.008	0.008	2.3%	2
LSUS	Mixed	0.008	0.008	0.008	0.008	0.0%	0
LSUS	Urban	0.008	0.008	0.008	0.008	0.0%	0
MISE	Cropland	0.02	0.0104	0.008	0.008	0.6%	1
MISE	Mixed	0.008	0.008	0.008	0.008	0.0%	0
MISE	Urban	0.26	0.2432	0.178	0.09	20.0%	5
NVBR	Mixed	0.05	0.03068	0.008	0.008	0.0%	0
NVBR	Urban	0.0284	0.0284	0.0284	0.0284	2.3%	2
PODL	Agriculture	0.0284	0.0284	0.0284	0.0284	0.0%	0
PODL	Mixed	0.008	0.008	0.008	0.008	0.0%	0
PODL	Not Applicable	0.1196	0.098272	0.07	0.05959	4.5%	2
PODL	Urban	0.12	0.1136	0.08876	0.05964	41.5%	27
SACR	Cropland	0.04	0.03264	0.008	0.008	12.5%	3
SACR	Mixed	0.008	0.008	0.008	0.008	0.0%	0
SACR	Urban	0.55	0.5365	0.4405	0.316	39.3%	11
SANJ	Agriculture	0.18	0.0735	0.0284	0.0284	13.9%	10
SANJ	Mixed	0.09	0.029408	0.0284	0.0284	1.4%	2
SANJ	Not Applicable	0.0284	0.0284	0.0284	0.0284	0.0%	0
SANT	Cropland	0.008	0.008	0.008	0.008	0.0%	0
SANT	Forest	0.008	0.008	0.008	0.008	0.0%	0
SANT	Mixed	0.008	0.008	0.008	0.008	0.0%	0
SANT	Urban	0.05	0.03656	0.008	0.008	3.0%	1
SCTX	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
SCTX	Mixed	0.14	0.08588	0.008	0.008	2.4%	1
SCTX	Urban	0.2	0.1825	0.12	0.08	16.7%	6
SOFL	Agriculture	0.008	0.008	0.008	0.008	0.0%	0
SOFL	Cropland	0.02	0.02	0.008	0.008	2.3%	2
SOFL	Mixed	0.008	0.008	0.008	0.008	0.0%	0
SPLT	Agriculture	2	1.576	0.1425	0.008	7.4%	4
SPLT	Mixed	0.008	0.008	0.008	0.008	0.0%	0
SPLT	Not Applicable	0.0284	0.0284	0.0284	0.0284	0.0%	0
SPLT	Urban	4.4	3.386	1.75	0.72	51.9%	41
TENN	Agriculture	0.011	0.00857	0.008	0.008	0.0%	0
TENN	Cropland	0.0284	0.0284	0.0284	0.0284	25.0%	1
TENN	Forest	0.011	0.01073	0.01	0.0086	0.0%	0
TENN	Mining	0.24	0.19592	0.0196	0.008	5.0%	1
TENN	Mixed	0.11	0.0284	0.0109	0.008	4.9%	5
TENN	Urban	0.008	0.008	0.008	0.008	0.0%	0
TRIN	Agriculture	0.05	0.0323	0.008	0.008	0.6%	1

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
TRIN	Forest	0.008	0.008	0.008	0.008	0.0%	0
TRIN	Mixed	0.008	0.008	0.008	0.008	0.0%	0
TRIN	Not Applicable	0.0328	0.031304	0.0284	0.0284	11.4%	4
TRIN	Rangeland	0.008	0.008	0.008	0.008	0.0%	0
TRIN	Urban	0.47	0.368	0.105	0.05	22.6%	7
WHMI	Cropland	0.05	0.0284	0.0284	0.0284	1.9%	4
WHMI	Mixed	0.0284	0.0284	0.0284	0.0284	2.2%	3
WHMI	Not Applicable	0.0653	0.059396	0.03578	0.0284	5.9%	1
WHMI	Urban	0.0415	0.038356	0.0284	0.0284	32.0%	8
WILL	Agriculture	0.0809	0.062523	0.0284	0.0284	7.0%	8
WILL	Mixed	0.07	0.0642	0.05	0.03056	6.7%	2
WILL	Urban	0.25	0.199096	0.05766	0.0284	38.6%	22
WMIC	Cropland	0.0284	0.009632	0.008	0.008	0.0%	0
WMIC	Mixed	0.0284	0.0284	0.0284	0.0284	0.0%	0
Carbaryl (Anal. Meth 82680)							
ACAD	Cropland	0.206	0.055964	0.041	0.041	20.2%	57
ACAD	Forest	0.236	0.2096	0.041	0.041	13.6%	11
ACAD	Mixed	0.161	0.13403	0.041	0.041	27.7%	26
ACAD	Urban	0.482	0.38813	0.2405	0.1767	64.1%	41
ACFB	Agriculture	0.01	0.00923	0.00615	0.003	8.3%	1
ACFB	Cropland	0.041	0.041	0.041	0.041	3.8%	7
ACFB	Mixed	0.174	0.098176	0.06266	0.041	48.6%	86
ACFB	Not Applicable	0.0924	0.074481	0.041	0.041	34.0%	34
ACFB	Residential	0.24	0.20448	0.07786	0.0451	54.2%	123
ACFB	Urban	1.9	0.8793	0.121	0.1	73.3%	44
ALBE	Agriculture	0.15	0.1102	0.0502	0.017	28.1%	56
ALBE	Forest	0.01	0.00979	0.00895	0.0079	25.0%	1
ALBE	Mixed	0.469	0.25472	0.0588	0.041	47.7%	113
ALBE	Not Applicable	0.36	0.2589	0.041	0.041	50.9%	54
ALBE	Urban	0.197	0.139682	0.04347	0.041	85.7%	36
ALMN	Mixed	0.006	0.00513	0.003	0.003	3.3%	1
ALMN	Urban	0.613	0.61207	0.59405	0.38289	34.4%	11
CAZB	Agriculture	0.336	0.3316	0.314	0.09	14.6%	6
CAZB	Mixed	0.09	0.0784	0.0365	0.0173	13.3%	4
CCYK	Agriculture	33.5	0.34724	0.08617	0.041	36.4%	183
CCYK	Mixed	0.175	0.05794	0.041	0.041	17.9%	50
CCYK	Not Applicable	0.041	0.041	0.041	0.041	66.7%	4
CCYK	Other/Mixed	0.16	0.155198	0.13599	0.11198	75.0%	6
CNBR	Agriculture	0.101	0.041	0.041	0.041	3.8%	8
CNBR	Cropland	0.138	0.11848	0.0404	0.0082	11.8%	2
CNBR	Mixed	0.49	0.08461	0.041	0.041	11.8%	25
CONN	Agriculture	0.012	0.01182	0.0111	0.0102	15.8%	3
CONN	Mixed	0.0971	0.082944	0.041	0.041	20.8%	26
CONN	Urban	3.2	1.2033	0.1626	0.041	36.5%	70
COOK	Residential	0.332	0.31751	0.2657	0.2296	75.0%	18

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
DELR	Agriculture	0.452	0.28169	0.03843	0.01128	14.0%	6
DELR	Cropland	0.573	0.18152	0.041	0.041	20.6%	34
DELR	Forest	0.041	0.041	0.041	0.041	2.1%	1
DELR	Mixed	0.617	0.061848	0.041	0.041	36.1%	66
DELR	Residential	2.41	0.528	0.148	0.12	66.3%	67
DELR	Urban	0.154	0.119776	0.04021	0.02784	34.9%	22
GAFL	Agriculture	0.083	0.041	0.041	0.041	4.6%	11
GAFL	Mixed	0.154	0.06258	0.041	0.041	26.2%	49
GAFL	Not Applicable	0.0842	0.066056	0.041	0.041	18.6%	8
GAFL	Urban	0.441	0.32922	0.1067	0.04018	52.9%	37
GRSL	Agriculture	0.174	0.13011	0.041	0.041	29.4%	10
GRSL	Commercial/Industrial	0.128	0.128	0.128	0.128	100.0%	1
GRSL	Mixed	0.0928	0.086912	0.06608	0.041	50.8%	33
GRSL	Rangeland	0.041	0.041	0.041	0.041	5.6%	1
GRSL	Residential	0.411	0.31552	0.1308	0.07672	56.8%	71
GRSL	Urban	0.0315	0.031284	0.03042	0.02934	75.0%	3
HDSN	Agriculture	0.041	0.041	0.041	0.041	2.5%	5
HDSN	Mixed	0.0641	0.041	0.041	0.041	11.1%	17
HDSN	Residential	0.86	0.4424	0.194	0.118	49.3%	36
HDSN	Urban	1.6	1.6	1.6	1.6	100.0%	1
KANA	Agriculture	0.0061	0.005108	0.003	0.003	3.0%	1
KANA	Mixed	0.092	0.072008	0.01748	0.01056	31.0%	9
LERI	Cropland	0.432	0.114254	0.041	0.041	8.6%	21
LERI	Mixed	0.143	0.11234	0.05306	0.041	24.4%	30
LERI	Pasture	0.0311	0.021665	0.01135	0.00633	11.5%	6
LERI	Urban	0.222	0.17386	0.08472	0.041	44.1%	26
LINJ	Agriculture	0.3	0.274872	0.17436	0.08192	53.8%	7
LINJ	Commercial/Industrial	0.189	0.185253	0.170265	0.15153	75.0%	3
LINJ	Forest	0.0441	0.038146	0.02114	0.01746	33.3%	9
LINJ	Mixed	0.353	0.2498	0.1544	0.1104	58.6%	51
LINJ	Residential	0.13	0.13	0.1155	0.0973	41.9%	13
LINJ	Urban	0.043	0.04012	0.03294	0.01414	28.6%	14
LIRB	Cropland	0.124	0.042102	0.041	0.041	6.6%	12
LIRB	Mixed	0.041	0.041	0.041	0.041	5.3%	5
LSUS	Agriculture	0.647	0.15816	0.01792	0.00888	18.1%	44
LSUS	Mixed	0.057	0.04728	0.0277	0.0057	12.2%	10
LSUS	Urban	0.15	0.124	0.0572	0.031	29.4%	32
MISE	Cropland	0.0944	0.041	0.041	0.041	4.4%	10
MISE	Forest	0.041	0.041	0.041	0.041	16.7%	1
MISE	Mixed	0.041	0.041	0.041	0.041	7.1%	8
MISE	Urban	0.359	0.33409	0.23325	0.1695	77.1%	37
MOBL	Cropland	0.041	0.041	0.041	0.041	10.6%	7
MOBL	Mixed	0.041	0.041	0.041	0.041	16.1%	19

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
MOBL	Pasture	0.0041	0.004078	0.00399	0.00388	33.3%	1
MOBL	Urban	0.422	0.30602	0.073755	0.041	28.6%	48
NECB	Mixed	0.131	0.114017	0.050585	0.041	48.1%	25
NECB	Urban	1.1	0.48234	0.1687	0.0641	43.3%	55
NROK	Cropland	0.0065	0.00629	0.00545	0.0044	14.3%	1
NROK	Mixed	0.006	0.005675	0.004375	0.00335	7.1%	1
NROK	Urban	0.006	0.00576	0.0048	0.0036	9.1%	1
NVBR	Mixed	0.173	0.102895	0.041	0.041	27.9%	38
NVBR	Urban	0.215	0.11368	0.06544	0.0452	30.3%	47
OAHU	Mixed	0.294	0.2697	0.1788	0.0683	25.0%	7
OAHU	Urban	0.37	0.33463	0.23865	0.11277	32.1%	9
OZRK	Pasture	0.079	0.04241	0.041	0.041	2.6%	4
PODL	Agriculture	0.186	0.08662	0.041	0.041	13.3%	42
PODL	Mixed	0.061	0.041	0.041	0.041	21.1%	47
PODL	Not Applicable	0.218	0.072272	0.041	0.041	9.7%	9
PODL	Urban	2	1.3516	0.38235	0.234	80.4%	135
PUGT	Agriculture	0.133	0.114648	0.04696	0.0093	9.4%	3
PUGT	Mixed	0.23	0.046256	0.041	0.041	7.0%	7
PUGT	Residential	0.0218	0.021189	0.018745	0.01413	21.4%	3
PUGT	Urban	0.483	0.23484	0.0571	0.041	26.3%	25
REDN	Cropland	0.008	0.004846	0.003	0.003	1.7%	2
RIOG	Mixed	0.082	0.0448	0.041	0.041	5.6%	11
RIOG	Not Applicable	0.044	0.04313	0.03965	0.0353	75.0%	3
RIOG	Urban	0.036	0.0357	0.0345	0.033	50.0%	2
SACR	Cropland	0.657	0.39204	0.0989	0.0809	38.8%	19
SACR	Mixed	0.0725	0.061622	0.041	0.041	24.2%	24
SACR	Urban	1.55	1.2024	0.41225	0.2915	96.4%	54
SANA	Mixed	0.145	0.095185	0.063925	0.04352	53.7%	44
SANA	Not Applicable	0.0261	0.025638	0.02379	0.02148	33.3%	1
SANA	Residential	0.008	0.008	0.008	0.008	100.0%	1
SANA	Urban	0.307	0.150616	0.041	0.041	16.4%	12
SANJ	Agriculture	0.7	0.33832	0.0884	0.041	45.3%	216
SANJ	Mixed	5.2	0.18284	0.0475	0.041	37.3%	326
SANJ	Not Applicable	0.041	0.041	0.041	0.041	21.9%	7
SANJ	Urban	0.411	0.38097	0.30505	0.2084	97.1%	33
SANT	Cropland	0.041	0.041	0.041	0.041	9.0%	10
SANT	Forest	0.0064	0.005108	0.003	0.003	2.6%	1
SANT	Mixed	0.0593	0.043928	0.041	0.041	7.1%	6
SANT	Urban	0.16	0.14173	0.04217	0.041	50.0%	44
SCTX	Agriculture	0.0903	0.064395	0.008875	0.00398	11.8%	4
SCTX	Mixed	0.172	0.073811	0.041	0.041	31.5%	29
SCTX	Urban	0.168	0.1599	0.1088	0.06848	47.3%	26
SOFL	Agriculture	0.0071	0.006854	0.00587	0.00464	14.3%	1
SOFL	Cropland	0.414	0.04102	0.041	0.041	7.0%	14
SOFL	Mixed	0.273	0.21036	0.041	0.041	46.4%	13

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
SPLT	Agriculture	1.5	0.377	0.07125	0.041	16.5%	17
SPLT	Mixed	0.143	0.13802	0.092915	0.06116	56.7%	76
SPLT	Not Applicable	16.5	0.9832	0.09117	0.05094	32.1%	36
SPLT	Urban	5.5	4.976	1.72	0.69	89.2%	140
TENN	Agriculture	0.0456	0.041	0.041	0.041	4.2%	7
TENN	Cropland	0.101	0.059892	0.041	0.041	9.2%	8
TENN	Forest	0.041	0.041	0.041	0.0276	4.9%	4
TENN	Mining	0.72	0.53208	0.06312	0.01064	21.6%	8
TENN	Mixed	0.921	0.084364	0.041	0.041	15.7%	48
TENN	Urban	0.007	0.00676	0.0058	0.0046	14.3%	1
TRIN	Agriculture	0.205	0.06115	0.041	0.041	7.5%	15
TRIN	Forest	0.009	0.00894	0.0087	0.0084	50.0%	1
TRIN	Mixed	0.183	0.13196	0.098	0.06288	57.3%	51
TRIN	Not Applicable	0.167	0.16294	0.142	0.094	57.6%	34
TRIN	Rangeland	0.009	0.00834	0.0057	0.003	8.3%	1
TRIN	Urban	0.4	0.358	0.23	0.19	41.9%	13
UCOL	Agriculture	0.0227	0.015484	0.00552	0.00324	11.1%	5
UCOL	Mixed	0.041	0.041	0.041	0.041	11.8%	6
UCOL	Other/Mixed	0.041	0.041	0.041	0.041	7.7%	1
UIRB	Cropland	0.0708	0.054112	0.041	0.041	14.0%	8
UIRB	Mixed	0.0992	0.065536	0.041975	0.041	36.6%	49
UIRB	Urban	0.14	0.1342	0.0963	0.07612	64.4%	38
UMIS	Agriculture	0.041	0.041	0.041	0.041	1.2%	1
UMIS	Mixed	0.0827	0.041	0.041	0.041	4.7%	7
UMIS	Urban	0.175	0.108374	0.041	0.041	23.6%	30
USNK	Agriculture	0.19	0.041109	0.041	0.041	4.0%	8
WHMI	Agriculture	0.19	0.148967	0.03184	0.01858	44.7%	17
WHMI	Cropland	0.46	0.0814	0.041	0.041	13.6%	68
WHMI	Mixed	0.065	0.041	0.041	0.041	12.8%	49
WHMI	Not Applicable	0.041	0.041	0.041	0.041	21.4%	12
WHMI	Urban	0.672	0.16322	0.074925	0.04939	46.9%	60
WILL	Agriculture	2	0.48862	0.05632	0.041	39.6%	72
WILL	Mixed	0.132	0.041	0.041	0.041	24.6%	32
WILL	Urban	0.842	0.44676	0.238	0.1082	66.3%	55
WMIC	Cropland	0.045	0.041	0.041	0.041	1.4%	2
WMIC	Mixed	0.045	0.041	0.041	0.041	18.2%	22
YELL	Mixed	0.041	0.041	0.041	0.041	1.9%	3

Table II.E.1-3 Detections of carbofuran by two analytical methods in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
Carbofuran (Anal. Meth. 49309)							
ACAD	Cropland	1.35	0.9564	0.12	0.12	3.0%	1
ACAD	Mixed	0.12	0.12	0.12	0.12	6.3%	1

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
ALBE	Agriculture	0.028	0.028	0.028	0.028	0.0%	0
ALBE	Mixed	0.028	0.028	0.028	0.028	0.0%	0
ALBE	Not Applicable	0.0065	0.006476	0.00638	0.00616	15.4%	2
CCYK	Agriculture	0.13	0.12	0.12	0.12	1.2%	2
CCYK	Mixed	0.12	0.12	0.12	0.12	0.0%	0
CNBR	Agriculture	0.05	0.03922	0.028	0.028	2.0%	1
CNBR	Cropland	0.49	0.43456	0.2128	0.028	7.7%	1
CNBR	Mixed	0.3066	0.22302	0.028	0.028	3.2%	1
CONN	Agriculture	0.08	0.07064	0.0332	0.028	5.3%	1
CONN	Mixed	0.028	0.028	0.028	0.028	0.0%	0
GAFL	Agriculture	0.028	0.028	0.028	0.028	0.0%	0
GAFL	Mixed	0.028	0.028	0.028	0.028	2.5%	2
LERI	Cropland	0.12	0.12	0.12	0.12	1.4%	1
LERI	Mixed	0.12	0.12	0.12	0.028	0.0%	0
LINJ	Agriculture	0.12	0.1154	0.097	0.074	0.0%	0
LINJ	Forest	0.12	0.11908	0.1154	0.1108	0.0%	0
LINJ	Mixed	0.12	0.12	0.1016	0.028	0.0%	0
LINJ	Urban	0.12	0.08412	0.028	0.028	2.5%	1
LIRB	Cropland	2.02	0.634	0.12	0.12	2.8%	4
LIRB	Mixed	1.32	1.0578	0.7845	0.458	1.4%	1
LSUS	Agriculture	0.27	0.0643	0.028	0.028	1.2%	1
LSUS	Mixed	0.028	0.028	0.028	0.028	0.0%	0
LSUS	Urban	0.028	0.028	0.028	0.028	0.0%	0
MISE	Cropland	2.82	0.7882	0.3455	0.12	8.1%	13
MISE	Mixed	0.33	0.2313	0.12	0.12	2.1%	1
MISE	Urban	0.028	0.028	0.028	0.028	0.0%	0
PODL	Agriculture	0.056	0.0322	0.028	0.028	11.6%	10
PODL	Mixed	0.028	0.028	0.028	0.028	0.0%	0
PODL	Not Applicable	0.29	0.29	0.29	0.20933	25.0%	11
PODL	Urban	0.1	0.05392	0.028	0.028	1.5%	1
REDN	Agriculture	0.028	0.028	0.028	0.028	0.0%	0
REDN	Cropland	0.4	0.3475	0.028	0.028	2.6%	2
REDN	Mixed	0.059	0.05726	0.028	0.028	0.0%	0
REDN	Not Applicable	0.028	0.028	0.028	0.028	0.0%	0
RIOG	Agriculture	0.028	0.028	0.028	0.028	0.0%	0
RIOG	Mixed	0.28	0.115	0.028	0.028	3.0%	2
SACR	Cropland	0.2	0.2	0.1925	0.141	20.8%	5
SACR	Mixed	0.12	0.12	0.12	0.12	0.0%	0
SACR	Urban	0.12	0.12	0.12	0.12	0.0%	0
SANJ	Agriculture	0.79	0.24898	0.028	0.028	6.9%	5
SANJ	Mixed	0.09	0.028504	0.028	0.028	4.3%	6
SANT	Cropland	0.12	0.09424	0.028	0.028	3.4%	1
SANT	Mixed	0.028	0.028	0.028	0.028	0.0%	0
SPLT	Agriculture	1.8	1.2859	0.4825	0.1624	11.1%	6
SPLT	Mixed	0.028	0.028	0.028	0.028	0.0%	0

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
SPLT	Urban	0.028	0.028	0.028	0.028	0.0%	0
TENN	Agriculture	0.038	0.03557	0.028	0.028	0.0%	0
TENN	Cropland	0.0056	0.0056	0.0056	0.0056	0.0%	0
TENN	Mining	0.028	0.028	0.028	0.028	0.0%	0
TENN	Mixed	0.06	0.03796	0.0343	0.028	1.0%	1
TENN	Urban	0.028	0.028	0.028	0.028	0.0%	0
TRIN	Agriculture	1.8	0.964	0.0291	0.028	3.8%	6
TRIN	Not Applicable	0.056	0.056	0.056	0.0448	0.0%	0
TRIN	Rangeland	0.028	0.028	0.028	0.028	0.0%	0
TRIN	Urban	0.056	0.056	0.056	0.056	0.0%	0
UCOL	Agriculture	1.81	1.724	0.6125	0.54	31.8%	14
UCOL	Mixed	0.29	0.29	0.29	0.29	0.0%	0
WHMI	Cropland	0.52	0.0551	0.028	0.028	2.3%	5
WHMI	Mixed	0.056	0.04592	0.028	0.028	0.7%	1
WHMI	Not Applicable	0.0116	0.01064	0.0068	0.0056	5.9%	1
WILL	Agriculture	13.2711	9.043899	1.64	0.531	36.0%	41
WILL	Mixed	0.05	0.05	0.05	0.0302	10.0%	3
WILL	Urban	0.028	0.028	0.028	0.028	0.0%	0
Carbofuran (Anal. Meth. 82674)							
ACAD	Cropland	1.84	0.69522	0.1083	0.04008	20.1%	57
ACAD	Mixed	0.744	0.70773	0.0757	0.03894	23.4%	22
ACFB	Residential	0.02	0.02	0.02	0.02	0.5%	1
ACFB	Urban	0.008	0.00525	0.003	0.003	1.8%	1
ALBE	Agriculture	0.14	0.04842	0.018	0.003	8.5%	17
ALBE	Mixed	0.48	0.086472	0.02	0.02	4.2%	10
CAZB	Agriculture	0.57	0.358	0.036	0.03	2.4%	1
CAZB	Mixed	0.087	0.07917	0.051	0.0355	3.3%	1
CCYK	Agriculture	0.14	0.05315	0.02	0.02	4.8%	22
CCYK	Mixed	0.123	0.04147	0.02	0.02	2.5%	7
CNBR	Agriculture	0.59	0.4034	0.03631	0.02	15.1%	30
CNBR	Cropland	0.326	0.30984	0.2452	0.2178	35.3%	6
CNBR	Mixed	0.35	0.25174	0.05784	0.02672	20.3%	43
CONN	Agriculture	0.05	0.04154	0.0077	0.003	5.3%	1
CONN	Mixed	0.03	0.02	0.02	0.02	0.8%	1
DELR	Agriculture	0.05	0.0374	0.01988	0.01028	4.7%	2
DELR	Cropland	0.1	0.0418	0.02008	0.02	2.4%	4
DELR	Forest	0.0452	0.035908	0.02	0.02	2.1%	1
DELR	Mixed	0.1	0.0418	0.0245	0.02	0.5%	1
DELR	Residential	0.109	0.02	0.02	0.02	1.0%	1
EIWA	Cropland	1.5	0.49112	0.08788	0.02	11.8%	27
EIWA	Mixed	0.2	0.10953	0.06395	0.02	10.7%	9
EIWA	Not Applicable	0.02	0.01779	0.00895	0.003	7.1%	1
GAFL	Agriculture	0.03	0.02	0.02	0.02	2.1%	5
GAFL	Mixed	0.287	0.025754	0.02	0.02	2.7%	5
GRSL	Mixed	0.05	0.041552	0.02	0.02	1.5%	1

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
GRSL	Residential	0.04	0.03	0.02	0.02	1.6%	2
HDSN	Agriculture	0.1	0.0203	0.02	0.02	0.5%	1
HDSN	Commercial/Industrial	0.021	0.021	0.021	0.021	100.0%	1
HDSN	Mixed	0.03	0.0248	0.02	0.02	0.7%	1
LERI	Cropland	0.188	0.03368	0.02	0.02	3.3%	8
LERI	Mixed	0.328	0.25324	0.03503	0.02	5.7%	7
LINJ	Agriculture	0.132	0.11754	0.0597	0.0107	30.8%	4
LINJ	Forest	0.0185	0.015432	0.00559	0.003	7.4%	2
LINJ	Mixed	0.0635	0.04329	0.02	0.02	10.3%	9
LINJ	Urban	0.0546	0.049848	0.02378	0.01644	24.5%	12
LIRB	Cropland	1.01	0.56058	0.040595	0.02	13.2%	24
LIRB	Mixed	0.0872	0.073758	0.02846	0.02	7.4%	7
LSUS	Agriculture	0.476	0.101004	0.0359	0.01032	13.2%	32
LSUS	Mixed	0.341	0.26729	0.019	0.0094	13.4%	11
LSUS	Urban	0.062	0.01772	0.003	0.003	0.9%	1
MISE	Cropland	2.63	1.114	0.3668	0.1278	14.7%	33
MISE	Mixed	0.549	0.24676	0.08614	0.0516	12.4%	14
MISE	Urban	0.02	0.02	0.02	0.02	2.1%	1
MOBL	Urban	0.05	0.0283	0.02	0.02	1.8%	3
NVBR	Mixed	0.051	0.03195	0.02	0.02	2.9%	4
NVBR	Urban	0.026	0.02	0.02	0.02	0.6%	1
OZRK	Pasture	0.25	0.02	0.02	0.02	2.6%	4
PODL	Agriculture	0.17	0.07118	0.02	0.02	9.8%	31
PODL	Mixed	0.16	0.1178	0.02	0.02	5.4%	12
PODL	Not Applicable	0.04	0.031638	0.02	0.02	18.7%	14
PODL	Urban	0.46	0.02732	0.02	0.02	1.8%	3
PUGT	Agriculture	0.005	0.00438	0.003	0.003	3.1%	1
REDN	Agriculture	0.11	0.06905	0.00825	0.003	6.5%	3
REDN	Cropland	0.43	0.3976	0.0867	0.0164	12.2%	14
REDN	Mixed	0.1	0.08344	0.0248	0.0148	11.8%	11
REDN	Not Applicable	0.15	0.138	0.092	0.04	19.4%	6
RIOG	Agriculture	0.15	0.11374	0.0486	0.04	21.1%	8
RIOG	Mixed	0.75	0.1359	0.02	0.02	9.2%	18
SACR	Cropland	0.412	0.30304	0.1302	0.10056	55.1%	27
SACR	Mixed	0.0744	0.066658	0.0286	0.02	12.1%	12
SACR	Urban	0.0565	0.053145	0.0225	0.02	3.6%	2
SANA	Mixed	0.02	0.02	0.02	0.02	2.4%	2
SANJ	Agriculture	0.982	0.21375	0.03795	0.02	14.7%	70
SANJ	Mixed	0.156	0.03552	0.02	0.02	5.3%	46
SANJ	Urban	0.06	0.06	0.054	0.0264	3.0%	1
SANT	Cropland	0.31	0.0335	0.02	0.02	4.5%	5
SANT	Mixed	0.035	0.0224	0.02	0.02	2.4%	2
SCTX	Mixed	0.085	0.046234	0.0228	0.02	5.4%	5
SOFL	Cropland	0.328	0.067086	0.02	0.02	4.5%	9

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	Number of Detects
SPLT	Agriculture	1.2	0.9604	0.347	0.228	25.2%	26
SPLT	Mixed	0.14	0.1068	0.05376	0.0344	17.3%	23
SPLT	Urban	0.059	0.02484	0.02	0.02	1.9%	3
TENN	Agriculture	0.0895	0.02	0.02	0.02	2.4%	4
TENN	Cropland	0.02	0.02	0.02	0.02	3.4%	3
TENN	Mining	0.011	0.010496	0.00432	0.003	2.7%	1
TENN	Mixed	0.22	0.05056	0.02	0.02	5.9%	18
TENN	Urban	0.0054	0.005256	0.00468	0.00396	14.3%	1
TRIN	Agriculture	7	2.638	0.1919	0.0206	14.5%	29
TRIN	Not Applicable	0.02	0.02	0.02	0.02	2.3%	1
TRIN	Rangeland	0.031	0.02792	0.0156	0.003	8.3%	1
TRIN	Urban	0.24	0.1689	0.003	0.003	6.5%	2
UCOL	Agriculture	1.69	1.37848	0.9192	0.5352	44.4%	20
UCOL	Mixed	0.163	0.1091	0.03065	0.0254	27.5%	14
UIRB	Cropland	0.332	0.30288	0.09092	0.02	10.5%	6
UIRB	Mixed	0.2	0.139867	0.02	0.02	6.0%	8
UMIS	Agriculture	0.939	0.18384	0.02	0.02	3.5%	3
UMIS	Mixed	0.2	0.1816	0.02	0.02	2.7%	4
UMIS	Urban	0.05	0.0275	0.02	0.02	1.6%	2
USNK	Agriculture	0.0703	0.05015	0.02	0.02	1.0%	2
WHMI	Agriculture	0.0829	0.054817	0.0036	0.003	2.6%	1
WHMI	Cropland	0.95	0.12815	0.02	0.02	6.3%	30
WHMI	Forest	0.019	0.019	0.019	0.019	100.0%	1
WHMI	Mixed	0.157	0.06	0.02	0.02	7.1%	27
WHMI	Not Applicable	0.0464	0.044024	0.03452	0.02264	10.0%	1
WILL	Agriculture	32.2	11.783	3.4125	0.7767	68.1%	124
WILL	Mixed	0.181	0.074189	0.02	0.02	13.8%	18
WILL	Urban	0.038	0.031112	0.02	0.02	6.0%	5
WMIC	Agriculture	0.045	0.04164	0.0282	0.0114	11.1%	1
WMIC	Cropland	0.097	0.073224	0.02	0.02	4.1%	6
WMIC	Mixed	0.119	0.02	0.02	0.02	3.3%	4
YELL	Mixed	0.0335	0.02735	0.02	0.02	1.9%	3

Table II.E.1-4 Detections of Methiocarb in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	No. Detect
TRIN	Mixed	0.23	0.179	0.026	0.026	3.8%	1
WILL	Agriculture	0.1	0.02948	0.026	0.026	2.6%	3

Table II.E.1-5 Detections of Methomyl in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	No. Detect
ALBE	Mixed	0.021	0.019	0.017	0.017	5.3%	3
CAZB	Agriculture	0.270	0.169	0.017	0.017	2.4%	1
GAFL	Mixed	0.017	0.017	0.017	0.017	1.3%	1

LSUS	Agriculture	0.190	0.043	0.017	0.017	1.2%	1
MISE	Cropland	0.650	0.278	0.017	0.017	3.7%	6
MISE	Mixed	0.090	0.057	0.017	0.017	2.2%	1
MOBL	Cropland	0.017	0.017	0.017	0.017	11.1%	1
NVBR	Urban	0.140	0.034	0.017	0.017	1.1%	1
SANJ	Agriculture	0.670	0.429	0.214	0.043	19.4%	14
SANJ	Mixed	0.090	0.052	0.017	0.017	2.9%	4
SOFL	Cropland	0.470	0.436	0.168	0.017	8.0%	7
SPLT	Urban	0.017	0.017	0.017	0.017	1.3%	1
TRIN	Agriculture	1.000	0.227	0.017	0.017	1.9%	3
WILL	Agriculture	0.020	0.017	0.017	0.017	1.8%	2

Table II.E.1-6 Detections of Oxamyl in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	No. Detect
PUGT	Agriculture	0.16	0.1569	0.1445	0.129	34.4%	11
SANJ	Agriculture	0.0254	0.020146	0.018	0.018	1.4%	1
WILL	Agriculture	0.07	0.01974	0.018	0.018	0.9%	1

Table II.E.1-7 Detections of Propoxur in USGS NAWQA surface water monitoring sites summarized by study unit (Suid) and land use.

Suid	Land Use	Max Detect	99th	95th	90th	Pct Detect	No. Detect
ACFB	Residential	0.290	0.143	0.035	0.035	0.6%	1
ALBE	Mixed	0.035	0.035	0.035	0.035	14.0%	8
CAZB	Agriculture	0.190	0.128	0.035	0.035	2.4%	1
CCYK	Mixed	0.035	0.035	0.035	0.035	0.9%	1
GAFL	Mixed	0.035	0.035	0.035	0.035	18.8%	12
GAFL	Not Applicable	0.035	0.025	0.008	0.008	5.4%	2
LERI	Urban	0.035	0.035	0.035	0.035	2.9%	1
NVBR	Urban	0.035	0.035	0.035	0.035	4.7%	4
PODL	Urban	0.035	0.035	0.035	0.035	10.0%	6
REDN	Agriculture	0.035	0.035	0.035	0.035	4.3%	2
SANJ	Agriculture	0.070	0.047	0.035	0.035	13.9%	10
SANJ	Mixed	0.090	0.046	0.035	0.035	16.7%	23
SPLT	Agriculture	0.110	0.071	0.035	0.035	1.9%	1
SPLT	Urban	0.035	0.035	0.035	0.035	2.5%	2
TRIN	Not Applicable	0.035	0.035	0.035	0.035	8.6%	3

1. Review of USDA Pesticide Data Program Drinking Water Monitoring 2001 - 2003

The United States Department of Agriculture implemented the Pesticide Data Program (PDP) in January 1991 to “improve the quality and quantity of information available on chemical residues in domestically produced and imported food.” Drinking water sampling was added to PDP’s scope of work in 2001, with the intent of providing data to EPA’s Office of Pesticide Programs to “perform human health and environmental fate risk assessments”. From 2001 through 2003 PDP focused on sampling finished water at a small number of sites (21 – 35) across the nation. This approach was subsequently modified to incorporate pair sampling of finished and untreated samples at different locations in a monitoring program that began in 2004 and is continuing to the present. The PDP analyzed samples for approximately 200 pesticide compounds; however, this assessment focuses only on results for N-Methyl carbamate pesticides identified to have a common mode of activity.

a. Scope of PDP 2001 – 2003 water monitoring

In 2001, PDP initiated an expansion of its monitoring program to include drinking water. They sampled finished (post-treatment) drinking water at 21 community water supply facilities located in New York and California, two highly populated regions with divergent climates and hydrogeological conditions. While the actual monitoring sites are not identified in publicly available reports, those reports do indicate that sites were selected to “reflect the diversity of land uses within California and New York and included major metropolitan areas, agricultural regions, and highly protected watersheds.” Only “finished” drinking water samples were collected. “Finished” water has been subject to treatment processes that can vary substantially from location to location as well as over time at a specific location. The PDP describes source waters for water systems participating in PDP finished drinking water sampling as “primarily surface waters”, and indicates that they represent very large systems. An examination of sites monitored confirms that only surface-water source drinking water facilities were sampled. Water samples were collected by personnel of the water treatment facility.

Sampling frequency varied throughout the study depending on the site, the analyte, and the year. In 2001, between 10 and 18 samples were collected per site. Samples were analyzed for 4 to 8 different NMCs, depending on monitoring location (the rationale for selecting analytes is not provided). The program was expanded in 2002 to include more frequent monitoring at the 2001 sites (in general from monthly sampling to 2x-monthly) and to add limited monitoring at 5 new sites (in Colorado, Kansas, and Texas). Samples were collected at these new sites in 2002 on a weekly basis in November and December and analyzed for only one NMC (propoxur), a compound which is used indoors. In 2003, monitoring was again expanded to increase the number of samples collected at the sites added in 2002 (increasing the sampling frequency to weekly monitoring for roughly half the year, depending on the analyte), and the number of NMC analytes increased from 1 to 3 at those sites. PDP also added nine new monitoring sites in 2003 in 5 states (Michigan, Ohio, North Carolina, Oregon, and Washington). Only 12 samples total were collected at these sites in 2003, all in the months of December and January) and those samples were analyzed for 2 NMCs. Table 1 summarizes the NMC analytes at each site and sampling frequencies for each of the three years of the program.

b. Methods

Sampling was conducted by Water Treatment Facilities participating in the PDP water monitoring program using water sampling kits provided by PDP in accordance with a schedule and protocols developed by PDP. A review of these protocols indicates they required the following:

At each site, three 1-liters samples of finished drinking water were to be collected in amber glass bottles with Teflon-lined caps pretreated with dechlorinating chemicals. QA/QC included field blanks and sample tracking forms. Samples are to be labeled and packed by the sample collector, placed in insulated sampling kits with freezer, sealed, and shipped on the same day they are collected to the testing laboratory.

Upon arrival at the testing laboratory, samples were visually examined for acceptability and discarded if warm to the touch or leaking. Samples were refrigerated until time of analysis and extracted within 96 hours of collection. A one-liter bottle was extracted for compounds amenable to GC analysis and one for compounds amenable to HPLC analysis. The remaining bottle was held in reserve or extracted for specialty compounds requiring separate extraction/analytical procedures [e.g., ethane sulfonic acid (ESA) and oxanilic acid (OA) analogues of alachlor, acetochlor, and metolachlor]. Extraction methods used were based on SPE methods developed by the U.S. Geological Survey (USGS) and were independently validated by each testing laboratory. Samples were analyzed using MS detection (single and tandem GC and HPLC technologies), selective detectors, or post-column derivatization HPLC detection systems."

LODs for different analytes ranged from 0.6 – 60 ppt. They did change throughout the three-year study, but not significantly

c. Monitoring results

California 2001. In 2001, samples were collected at 10 locations in California and analyzed for 8 different NMCs (aldicarb sulfone and sulfoxide, carbaryl, carbofuran, methiocarb, methomyl, oxamyl, propoxur). Sampling was generally once a month (see table 1). A total of 135 samples were collected at these 10 sites.

Two NMCs, Carbaryl and oxamyl, were detected at 4 different sites in California. Both pesticides co-occurred in samples collected in August or September. A summary of pesticide detections in California from 2001 is provided in Table II.E.1.8.

Table II.E.1-8 – Pesticides detected in PDP monitoring of finished drinking water in California in 2001.

site	date	Carbaryl	Oxamyl	Site det freq	location

		(ppt)	(ppt)	per chem	
5004	9/5/2001	75	56.9	1/17 (6%)	East Bay (Walnut Creek)
5006	9/11/2001	93	51.2	1/16 (6%)	Contra Costa
5007	8/21/01	64.9	79	1/14 (7%)	City of Tracy
5009	8/8/2001	79	66.2	1/15 (7%)	City of Sacramento

New York 2001. Samples were collected at 11 locations in New York for analysis and analyzed for four NMCs (carbaryl, carbofuran, pirimicarb, and propoxur). A total of 164 samples were collected at these sites, generally once a month. No NMCs were detected in samples collected in New York.

Monitoring in 2002. In 2002 sampling frequencies were expanded to twice a month in California and New York at the same locations sampled in 2001. Five additional sites were added in Colorado (2), Kansas (2), and Texas (2), but these sites were sampled infrequently and analyzed for only one NMC, propoxur, which is used indoors. Thus little additional information was provided for NMCs from monitoring at the new sites.

The PDP report for 2002 indicated that "Of the 27 community water systems surveyed, 7 sites had source water in protected watersheds, which are defined as source water in an area controlled for chemical applications and land use; 4 of the source water intakes were in urban regions, defined as less than 10 percent of the land around the source water used for agriculture; and 16 of the sites were located in predominantly agricultural areas, defined as regions where more than 20 percent of the land surrounding the source water is used for agriculture."

California 2002. Samples were collected at 11 locations in California (one new site was added) and analyzed for 8 different NMCs (aldicarb sulfone and sulfoxide, carbaryl, carbofuran, methiocarb, methomyl, oxamyl, propoxur). Sampling occurred generally twice a month (see Table 1), with the exception of pirimicarb for which only one sample was analyzed.. A total of 267 samples were collected at these 11 sites. Carbofuran was the only NMC detected in 2002. Samples from one location were found to contain carbofuran at two sampling periods (in May and March). A summary of pesticide detections in CA from 2002 is provided in Table II.E.1.9.

Table II.E.1-9 – Pesticides detected in PDP monitoring of finished drinking water in California in 2002.

site	date	Carbofuran (ppt)	Site det freq per chem	location
5007	5/6/02	79	2/23 (9%)	city of Tracy
5007	3/25/02	53		

New York 2002. Samples were collected at 11 locations in New York and analyzed for 7 different NMCs (carbaryl, carbofuran, methiocarb, methomyl, oxamyl, pirimicarb, and propoxur). Sampling occurred generally twice a month. A total of approximately 281 samples were collected at these 11 sites (not all samples were analyzed for all NMCs.

In 2002, carbofuran was the only NMC detected in New York. Carbofuran was reported in samples collected on four different dates at the same location (in June, July, August, and September). A summary of pesticide detections in NY from 2002 is provided in **Table II.E.1.10**

Table II.E.1-10 Pesticides detected in PDP monitoring of finished drinking water in New York in 2002.

site	date	Carbofuran (ppt)	Site det freq per chem	location
5004	7/8/02	0.999	4/26 (15%)	southern cayuga lake
	9/09/02	0.999		
	8/12/02	0.999		
	6/17/02	3.2		

Kansas, Colorado, Texas 2002. Five additional monitoring sites were added in 2002: two in Colorado, two in Kansas, and one in Texas. Monitoring at these sites provided little additional information on NMCs, as samples were analyzed for only one NMC compound (propoxur) and samples were only collected in November and December. None of the samples collected contained propoxur above the LOD.

Monitoring in 2003. In 2003 samples continued to be collected at the same locations in California and New York twice a month, but were analyzed for fewer NMCs in California in 2003. Sampling increased at the five new monitoring sites added in 2002 (two sites in Colorado, Kansas, and one in Texas), with samples collected weekly for half the year and analyzed for three NMCs. In 2003, additional sites were added in Michigan (1), Ohio (2), North Carolina (3), Oregon (1), and Washington (2), but these sites provided little additional information as were sampled infrequently (one to two times in the winter) and analyzed for only two NMCs.

The 2003 annual report contains more information on the locations sampled in this program, stating that, “Reservoirs are the source waters for 10 of the 11 sites in New York as well as all of the sites in Colorado, Kansas, and Texas. Rivers are the predominant source waters for the sites in California.” They also indicate that “Of the 27 community water systems surveyed, 7 sites had source water in protected watersheds, which are defined as source water in an area controlled for chemical applications and land use; 4 of the source water intakes were in urban regions, defined as less than 10 percent of the land around the source water used for agriculture; and 16 of the sites were located in predominantly agricultural areas, defined as regions where more than 20 percent of the land surrounding the source water is used for agriculture.”

California 2003. Samples were collected at 11 locations in California and analyzed for 5 different NMCs (carbaryl, carbofuran, methomyl, oxamyl, and propoxur); aldicarb degradates and methiocarb analyses were terminated. Sampling continued generally twice a month (see table1). A total of 246 samples were collected at these 11 sites.

Two NMCs, carbaryl and carbofuran, were detected at 2 of the sites in CA. Carbofuran detections occurred at one site in January, March, April, May, and July. Carbaryl detections occurred at two sites (in May and June at one site, and in November at the other site). A summary of pesticide detections in CA from 2003 is provided in **Table II.E.1.11** .

Table II.E.1-11 Pesticides detected in PDP monitoring of finished drinking water in California in 2003.

site	date	Carbaryl (ppt)	Carbofuran (ppt)	site det freq/chem	location
5007	5/5/2003		12	Carbo :8/26 (35%)	city of Tracy (west of SF)
	1/6/2003		5		
	4/7/2003		5		
	3/10/2003		20		
	7/14/2003		5		
	6/16/2003	5		carbaryl: 2/26 (8%)	
	5/19/2003	18	5		
	4/22/2003		11.7		
	3/24/2003		13		
5009	11/3/2003	5		1/22 (5%)	city of Sacramento

New York 2003. Samples were collected at 11 locations in New York and analyzed for 7 different NMCs (carbaryl, carbofuran, methiocarb, methomyl, oxamyl, pirimicarb, and propoxur). Sampling occurred generally twice a month. A total of 286 samples were collected at these 11 sites

None of the 7 NMCs were detected above the LOD in New York in 2003.

Kansas, Colorado, Texas 2003. At the five monitoring sites added in 2002, sampling frequencies increased to weekly for roughly half the year, depending on the chemical analyzed. Samples were analyzed for carbofuran and methiocarb from June through December, and for propoxur from January through May. Sampling was spatially limited (one to two sites per state), and provided only limited additional information on NMCs. None of the samples collected in 2003 contained NMCs above the LOD in 2003.

Michigan, Ohio, North Carolina, Oregon, and Washington 2003. At the nine monitoring sites added in 2003, sampling was extremely limited, with one to 2 samples collected per site in either December of January. In these 5 states, a total of 12 samples were collected from the nine monitoring locations. These samples were analyzed for carbofuran and carbaryl. None of the samples collected contained NMCs above the LOD.

d. Summary

Between 21 and 36 locations were monitored by the PDP Program from 2001 – 2003. The majority of these locations were located in California and New York. Samples were collected at different locations at different times and were analyzed for different N-Methyl carbamates at different locations and at different times. The rationale for these monitoring design decisions is not available. This program only sampled treated drinking water, and thus does not represent pesticides that may have been in source water but removed during the treatment process.

This PDP monitoring program provides some information that is useful for assessments of drinking water exposure, but the data are of limited value for exposure assessment, and do not represent exposure nationally. We can conclude that:

- Several NMC compounds were found in finished drinking water (carbaryl, carbofuran, and oxamyl).
- Concentrations found were low, none exceeding 80 ppt.
- NMC Detections were reported at a number of different sites, occurring in only one sample collected at the sites. In some cases NMCs occurred in multiple samples collected over time (up to 35% of the samples with detections of a single compound in a year).
- The magnitude of these detections can be interpreted as a minimum exposure level at these sites but can not be interpreted to be representative of overall exposure.
- Given the site-to-site variability in factors associated with pesticide exposure, this study-- with samples collected at 36 or fewer sites nationally-- cannot be used to represent national exposure to pesticides in finished drinking water. Monitoring is most representative of sites sampled in California and New York, where locations were largely located and most frequently sampled.
- From the information provided it is not possible to discern pesticide usage or the timing of applications in the watersheds of the drinking water supply facilities sampled. This puts a severe limitation on our ability to interpret results.

2. Additional surface water monitoring data reported in the individual chemical assessments

a. Aldicarb

Aldicarb residues have not been detected frequently or in high amounts in surface water in the USGS NAWQA monitoring studies – 0.2% detections with a maximum concentration of 0.5 ug/L based on the 2001 national summary by Martin et al (2003; see http://ca.water.usgs.gov/pnsp/pestsw/Pest-SW_2001_Text.html). While the NAWQA monitoring sites are not targeted to aldicarb use areas and the frequency of sampling is not designed to capture peak concentrations in surface water, the results suggest that actual concentrations of aldicarb residues in surface water are likely to be closer to the single or sub-parts per billion range than to 10-30 ppb.

b. Carbaryl

In addition to NAWQA monitoring, several other monitoring studies that included carbaryl were summarized in EPA's revised drinking water assessment for carbaryl (USEPA, 2007). These are summarized below.

In the joint USGS-USEPA Pilot Reservoir Monitoring Study, carbaryl was detected at 5 of 12 reservoir sites: 4 at the intake, 2 at the outflow, and two in finished. The highest carbaryl concentration detected was 0.043 µg L^{-1} at Blue Marsh Reservoir in Pennsylvania while the carbaryl degradate, 1-naphthol, was found at 0.228 µg L^{-1} at Higginsville, Missouri. As with the NAWQA data which uses similar analytical protocols, all detections of carbaryl were qualified due to high background variability of the measurements. These data are consistent with other data which show widespread low-level contamination of carbaryl in surface water.

In 2003, EPA reviewed the final report from a drinking water study voluntarily conducted by Aventis for carbaryl (USEPA 2003b). Concentrations measured at sites sampled were low (roughly 2 to 31 ppt) in source drinking water (pre-treatment) and generally lower in treated drinking water. Interestingly, the highest concentrations were found in finished drinking water not in source drinking water (181 ppt). The study provides data useful for characterizing the overall exposure to carbaryl, but it cannot be used to estimate exposure quantitatively due to drawbacks which include the following:

- The study provided insufficient supporting data on non-agricultural sales and national-scale non-agricultural carbaryl usage to determine the relative vulnerability of the systems representing "home and garden" usage effects.
- The study design was insufficient to prove that sites sampled represent the "the highest probable risk of human exposure to carbaryl in surface water in each state".
- The monitoring interval (one week to two weeks) is unlikely to capture peak concentrations necessary for estimating acute dietary risk, given the variable nature of the exposure.

A survey of salmonid-bearing streams in Washington State included an urban watershed (Thorton Creek) and three agricultural drainages in the Lower Yakima watershed (Burke et al, 2006). Carbaryl was not detected above the practical quantitation limit, or PQL, of 0.19 µg/L in any of 78 sampling events from the urban Thornton Creek watershed between 2003-2005. Carbaryl was detected in samples collected in the agricultural

Lower Yakima watershed. In 2003 carbaryl was detected in the Marion drain at 0.14 ppb (in 1 of 18 samples); carbaryl was not detected in 2004 or 2005 at this location. Carbaryl was detected in 2004 in the Sulfur Creek Wasteway at 0.16 ppb (in 1 of 31 samples); carbaryl was not detected in 2003 or 2005 at this location. On June 18, 2003, carbaryl was detected at a concentration of 10 µg/L in the upper Spring Creek station, and 1.7 µg/L at the mid-Spring Creek station.

This report also summarized "historical" data for these two areas, collected largely by the USGS. They observed that since monitoring of Thornton Creek began in 1996, pesticides used have changed over the years, including the phase out of diazinon in 2004. They concluded that carbaryl detection rates have risen slightly over the years, although the longer term trend in carbaryl concentrations in urban areas is not clear and may vary by region due to differences in pest pressure and perhaps marketing of different products. The magnitude of carbaryl detections has not approached carbaryl endangered species or invertebrate toxicological benchmarks. Reported detection frequencies were substantially higher in the USGS studies (100% to 43%), largely due to their more sensitive analytical methods. Peak concentrations measured by the USGS in Thornton Creek were: 4.78 µg/L (1999); 1.89 µg/L (2002); 0.212 µg/L (2003); 0.142 µg/L (2004).

c. Carbofuran

EPA summarized surface water monitoring data in a 2005 drinking water assessment (EPA, 2005c). Monitoring studies showed carbofuran detections in rivers (including the Mississippi, the Rio Grande, the Colorado, and the Columbia River), creeks, and streams in at least 26 states. Much of the monitoring data obtained by EFED is over 10 years old, and in the past decade, labels for carbofuran have changed. In some cases, these label changes have included reductions in application rates (e.g., from 3 lbs a.i./A to 2 lbs a.i./A for some crops). A possible result of these label changes is that fewer carbofuran detections have been reported and less carbofuran monitoring data is available in the last few years. However, EFED is not certain if the fewer detections are linked to label changes or if they are simply a result of fewer monitoring studies being conducted. Monitoring programs can never cover every potential vulnerable site and can only give general ideas of the prevalence of a pesticide in the environment. Modeling estimates, however, are designed to address these uncertainties by using conservative model inputs and scenarios. Despite the uncertainties with the monitoring data, it is valuable in that it provides a basis for comparison with modeling simulations.

A summary of monitoring study results from studies that had carbofuran detections and which could potentially represent drinking water concentrations are summarized in Table 5. Details of the studies can be found in the carbofuran IRED. This table lists only those monitoring studies that could possibly represent drinking water sources and does not include studies on water bodies that clearly would not be a drinking water source (e.g., irrigation ditch).

Table II.E.1-12 Summary of surface water studies with detections. Concentrations are in ppb.

Study	Concentration (ppb) Peak (average)	Notes
Iowa raw water, 1986 (multisite)	17 (median = 0.05)	5 detects out of 15 samples, LOD =0.1, median = 0.05
Lake Erie, Rock Creek, 1984	6.04 (time weighted mean = 0.14)	LOD =0.05, 87 samples, number of detects not reported
Lake Erie, Honey Creek, 1984	5.75 (time weighted mean = 0.3)	LOD =0.05, 100 samples, number of detects not reported
Lake Erie, Lost Creek, 1984	4.05 (time weighted mean= 0.13)	LOD =0.05, 57 samples, number of detects not reported
Lake Erie, Maumee Creek, 1984	2.72 (time weighted mean = 0.21)	LOD =0.05, 88 samples, number of detects not reported
Lake Erie, Honey Creek, 1985	2.44 (time weighted mean = 0.15)	LOD =0.04, 121 samples, number of detects not reported
Louisiana, 1992-1996	2.3 (median = below detect)	LOD unknown, 4 detects out of 855 samples
Ohio, Maumee Creek, raw, 1988	2.05 (median = below detect)	LOD unknown, 8 detects out of 20 samples
Lake Erie, Cuyohoga River, 1983	1.98 (time weighted mean = 0.60)	LOD = 0.05, 25 samples
Lake Erie, Sandusky Creek, 1985	1.61 (time weighted mean = 0.15)	LOD = 0.05, 82 samples
Colorado, S. Platte, 1994	1.2 (median = below detect)	LOD = 0.013, irrigated ag land, 25 samples, 12 detects
Ohio, Sandusky River, 1988	1.2 (mean < 0.58)	14 detects out of 19 samples, near treatment plant, LOD unknown
Nasqan, Mississippi, 1998	1.0 (median = below detect)	LOD = 0.003, 112 detects, 908 samples
Sacramento River, Sacramento Valley, 1990	0.6 (mean = below detect);	LOD = 0.003, zero in 2001 due to discontinued use
Lake Erie, Raisin River, 1983	0.58 (time weighted mean = 0.17)	LOD = 0.05, 32 samples
NASQAN, Rio Grande R., 1998	0.166 (median = below detect)	LOD = 0.003, 17 detects, 249 samples

San Joaquin R. Basin, Salt Slough	0.097 (median = below detect)	LOD = 0.003, 4 detects, 26 samples
NASQAN, Colorado R., 1998	0.06 (median = below detect)	LOD = 0.003, 11 detects, 187 samples
San Joaquin R. Basin, 1993	0.052 (median = below detect)	LOD = 0.003, 5 detects, 28 samples
San Joaquin R. Basin, Orestimba, 1993	0.045 (median = below detect)	LOD = 0.003, 6 detects, 48 samples
San Joaquin R. Basin, Merced, 1993	0.024 (median = below detect)	LOD = 0.003, 4 detects, 48 samples
San Joaquin R. Basin, Columbia, 1993	0.022 (median = below detect)	LOD = 0.003,
NASQAN, Columbia R., 1998	0.022 (median = below detect)	0.003, 13 detects, 278 samples
USGS reservoir monitoring study, 2000	0.019 (median = below detection)	

d. Methomyl

Limited monitoring data were available at the time of the original re-registration evaluation for methomyl in 1998. No surface water monitoring studies other than NAWQA were evaluated for methomyl.

e. Oxamyl

The 2000 IRED for oxamyl concluded that available monitoring data suggests that oxamyl is more likely to be detected in groundwater than in surface water. In the STORET database (as of 1999), only 14 detects were reported out of more than 3,300 surface water samples. Neither of these studies were targeted specifically in oxamyl use areas or during times of known oxamyl use and, thus, may not necessarily reflect potential peak oxamyl concentrations that may occur in surface waters when runoff events occur shortly after oxamyl is applied. However, the data suggest that oxamyl is not likely to be found in most surface waters and, when it is found, is not likely to persist. Generally, oxamyl is not detected in concentrations >1 ppb in most surface- or ground-water studies. These results are generally consistent with our understanding of the fate and transport properties of oxamyl.

This appendix summarizes available ground water monitoring for the N-methyl carbamate (NMC) pesticides from USGS NAWQA monitoring and additional water monitoring studies identified in the individual NMC chemical assessments.

3. USGS NAWQA Monitoring for N-Methyl Carbamates

The U.S. Geological Survey (USGS) National Water Quality Assessment (NAWQA) program has been collecting pesticide monitoring data from sites across the country since 1991. N-methyl carbamate (NMC) pesticides included in the USGS analytical methods include aldicarb, aldicarb sulfoxide, aldicarb sulfone, carbaryl, carbofuran, Methiocarb, methomyl, oxamyl, and propoxur. With the assistance or Rick Bell of the USGS NAWQA program, the Agency obtained all the USGS monitoring for these NMC pesticides in both ground water and surface water through November 15, 2004. The following tables provide summaries of reported NMC detections for each NAWQA study unit by land use type.

The NAWQA study did not focus on drinking water and the monitoring reflect a range of ambient waters. Also, the study sites were not targeted to high pesticide or NMC use areas. The monitoring results are most valuable in identifying areas and conditions under which NMC pesticides may be found in ambient waters. Such information is useful in identifying potential vulnerable areas and in evaluating the model estimates where monitoring sites occur in the same area as the exposure scenarios.

The USGS National Water-Quality Assessment (NAWQA) program began in 1990 as an effort to catalog the quality of water resources in the United States by collecting surface and groundwater data in selected watersheds. Chemical, biological, and physical parameters are measured at 59 study units across the United States. In the period between May, 1993 and September, 2003, approximately 6700 groundwater samples were tested for an assortment of carbamate pesticides and metabolites. Most sites were sampled only once, although repeat samples were taken at some locations. Carbofuran and carbaryl were tested for in 6500 of these samples while 9 other compounds including aldicarb and methomyl were tested for in approximately 4200 samples each.

a. Aldicarb

Aldicarb and its metabolites aldicarb sulfoxide and aldicarb sulfone were tested for in 4223 groundwater samples, resulting in 1 detection of aldicarb (0.01 ppb), 22 detections of aldicarb sulfoxide (0.004 – 1.8 ppb), and 15 detections of aldicarb sulfone (0.009 – 0.141 ppb). Several additional samples were tested for individual compounds with no detections. The large majority of the detections (87%) were found in the Southeast, primarily in Georgia and Alabama, although only 27% of the total sampling was carried out in this region. The two highest aldicarb sulfoxide concentrations, 1.8 and 0.26 ppb, were measured outside of the Southeast, in Connecticut and Idaho, respectively. The only detection of aldicarb was found in Indiana. 29 detections (76%) occurred in the years 2000 to 2003, despite the fact that only 18% of the sampling was conducted in these years. In part, this can be attributed to improved detection limits for aldicarb sulfoxide in that time period, but this only applies to about a third of these more recent detections. See the tables below for further details on these results.

Table II.E.2-13 Summary of sampling and detections for aldicarb and its metabolites from USGS NAWQA ground water monitoring sites

	Aldicarb	Aldicarb Sulfoxide	Aldicarb Sulfone
Total Detections:	1	22	15
Total Samples:	4263	4226	4223
Range (ppb):	0.01 (E)	0.004 (E) - 1.8	0.009 (E) - 0.141
Detection Limit (ppb):	0.04 - 0.21	0.016 - 0.2	0.0082 - 0.05

Table II.E.2-14 Detections for aldicarb and its metabolites by region and time from USGS NAWQA ground water monitoring sites

	1993-1996		1997-1999		2000-2003		*Grand Total*	
Region	Det.	Ttl No.	Det.	Ttl No.	Det.	Ttl No.	Det.	Ttl No.
Middle Atlantic	--	358	1	62	--	70	1	490
Midwest	1	409	--	253	--	168	1	830
New England	2	130	--	--	--	31	2	161
Pacific		376		85		142		603
Rocky Mountain	1	403	--	97	--	83	1	583
Southeast	4	562	--	354	29	241	33	1157
Southwest		253		98		48		399
Grand Total	8	2491	1	949	29	783	38	4223

b. Carbaryl

Carbaryl was detected at greater than the detection limit (0.003 µg/L) in 58 out of 6,575 groundwater samples from 1,034 ground water sampling sites across the country. Detections ranged from 0.002 to 0.539 ug/L (95^{th} percentile: 0.0525 ug/L). Detections were mainly associated with three uses: wheat (5.8 % of well samples from wheat land use), orchards and vineyards (1.7 % of well samples from orchard and vineyard land use), and urban (1.8% of urban groundwater samples). Detections were concentrated primarily in the Middle Atlantic (41% of detects) and Southeast (21% of detects).

c. Carbofuran

6558 groundwater samples were tested for carbofuran, with 58 positive detections ranging from 0.0018 to 1.3 ppb, with an average of 0.01 ppb and a 99th percentile value of 0.95 ppb. The highest concentrations of carbofuran were found in agricultural areas in Connecticut in 1993 (1.3 ppb) and in California in

1997 (0.686 ppb). The largest number of detections were found in the middle Atlantic region, which had 31% of the total detections, although only 11% of the samples were collected in that region.

4259 samples, all but 113 from the same set as carbofuran, were tested for the metabolite 3-hydroxycarbofuran. Detectable 3-hydroxycarbofuran was found in only one sample, from a mixed use area in Iowa in 1998, which measured 0.07 ppb. Sampling for the metabolite 3-ketocarbofuran did not begin until the year 2000, and so only 763 samples were tested for this compound. There were no detections. For each of the compounds, approximately half of the samples were collected in the Southeast and the Midwest. See the tables below for further details on these results.

Table E.2-15 Summary of sampling and detections for carbofuran and its metabolites from USGS NAWQA ground water monitoring sites

	Carbofuran	3-hydroxy carbo	3-keto carbo
Total Detections:	58	1	0
Total Samples:	6558	4259	763
Range (ppb):	0.0018 (E) - 1.3 (E)	0.07	-
Detection Limit (ppb):	0.003 (75%) 0.02 (25%)	0.014 (75%) 0.0058 (23%)	1.5

Table II.E.2-16 Detections for carbofuran and its metabolites by region and time from USGS NAWQA ground water monitoring sites

	1993-1996		1997-1999		2000-2003		*Grand Total*	
Region	Det.	Ttl No.	Det.	Ttl No.	Det.	Ttl No.	Det.	Ttl No.
Middle Atlantic	10	419	6	137	2	151	18	707
Midwest	4	577	2	439	3	511	9	1527
New England	1	131	--	39	1	116	2	286
Pacific	--	437	8	169	1	286	9	892
Rocky Mountain	2	434	--	202	4	290	6	926
Southeast	3	616	4	482	4	567	11	1665
Southwest	1	273	--	141	2	141	3	555
Grand Total	21	2887	20	1609	17	2062	58	6558

d. Other NMC pesticides

NAWQA monitored for four other carbamates in groundwater. **Methiocarb** had no detections out of 4274 samples. **Propoxur** had 8 detections out of 4248 samples, with a range of 0.0057 to 0.3 ppb. Detections were reported in Delaware, Florida, Georgia, Maryland, and Virginia. **Methomyl** had 3 detections out of 4224 samples, with a range of 0.04 to 0.38 ppb. Detections occurred in Minnesota, New Jersey, and Virginia. **Oxamyl** had 12 detections out of 4222 samples, with a range of 0.02 to 2.56 ppb. Detections occurred in British Columbia, Illinois, Minnesota, and Washington.

4. Additional Ground Water Monitoring Studies Summarized in the Individual NMC Chemical Assessments

a. Aldicarb

The revised drinking water assessment for aldicarb (USEPA, 2006) included an evaluation of two recent groundwater monitoring datasets from Florida: a USGS/FL Department of Agriculture study on the central ridge (Lake Wales Ridge) and sampling of private wells by the FL Department of Environmental Protection. The Lake Wales Ridge study measured aldicarb concentrations in monitoring wells located in citrus groves along the Central Ridge of Florida (Lake Wales Ridge). These monitoring wells are not drinking water wells, but reflect ambient pesticide concentrations in ground water beneath the citrus groves. The FL DEP dataset consists of private well monitoring data across the state of Florida. While the data represent potable drinking water wells, no information is available on well depth, aldicarb use in the vicinity, or distance between the well and the treated field. A third monitoring set recently submitted by Bayer CropScience provides recent (2005) monitoring of aldicarb residues in private drinking wells in other parts of the US.

i. Lake Wales Ridge, FL, ambient groundwater monitoring

In an on-going groundwater monitoring study on the Florida Central Ridge (http://fisc.er.usgs.gov/Lake_Wales_Ridge/), the USGS and the Florida Department of Agriculture is monitoring 31 wells within and around citrus groves on the Ridge. Well depths range from 4 feet to 110 feet deep (two thirds in the 20 to 60 foot range), and pH ranged from 3.9 to 6.9 (median about 5). Concentrations as high as 23 ppb have been recorded in one 26-ft well, while a 4-ft well had reported concentrations as high as 21 ppb. This study is not targeted for any specific pesticide, but rather is designed as a survey mechanism—that is, it is not known how much aldicarb was used nor is it known how far aldicarb was used from the wells. The Agency compared estimated aldicarb concentrations from PRZM with results of the study in Appendix II.E.7.

ii. Private drinking water well monitoring in FL

The Florida Department of Environmental Protection (FDEP) monitors private drinking water wells in rural areas. The monitoring is not comprehensive, but instead is instituted when there has been an indication of a problem (personal communication, FDEP). Total aldicarb residues (parent, sulfoxide and sulfone degradates) as high as 47 ppb were reported in private drinking water wells in the early 1990s in the FDEP study. The concentrations dropped off in subsequent years. The reduction in concentrations of aldicarb may have resulted from label changes which reduced application rates and applied well setback requirements. Specific reductions at home sites also were also likely the result of a Florida State program to install carbon filters or to pipe water in from treatment facilities when contamination was found. Other reasons for the decline include the possibility of discontinued use in the vicinity of the contaminated areas (personal communication FDEP) or increased method detection limit.

Method detection limits (MDL) for aldicarb residues vary over time in this monitoring study. In 1999 and earlier, the MDL for aldicarb sulfone and aldicarb sulfoxide ranged from 0.077 to 0.73 ug/L. Between 2000 and 2004, the MDL ranged from 2.1 to 3.3 ug/L for aldicarb sulfone and from 2.4 to 4.0 ug/L for aldicarb sulfoxide. Estimated concentrations for total aldicarb residues are below the high MDL for the individual degradates. This further complicates interpretations regarding the effectiveness of label changes in reducing aldicarb residues in private wells.

iii. Private drinking water well monitoring by Bayer CropScience

Bayer CropScience conducted a retrospective ground water monitoring study to look for residues of aldicarb and its sulfoxide and sulfone metabolites in potable water from private wells in aldicarb use areas. This study monitored 1,673 drinking water wells and collected information on ground-water depth, well depth, casing depth, well type and age, soil types, recent aldicarb use history, crops, and distance of the well from the treated field. The study provides useful information on measured concentrations of aldicarb residues in drinking water wells in selected areas of the United States with recent/current aldicarb use. The study sampled 1,673 drinking water wells in five regions of the country: the Southeastern US (800 wells), the Mississippi Delta (169 wells), the Pacific Northwest (303 wells), Texas (201 wells), and California (200 wells).

A review of the study (USEPA, 2007a) found that

- Aldicarb residues – predominantly the sulfoxide and sulfone metabolites – were detected in 10 percent of the wells sampled (160 out of 1,673), with the greatest frequencies of detections in the Southeastern US (16%, with a maximum detect of 2.9 ug/L) and the Mississippi Delta (9%, with a maximum detect of 2.6 ug/L) regions. Because the single samples represent a snapshot in time, the Agency assumed that the measured concentrations reflected a median concentration for that particular well.

- Aldicarb detections showed a regional pattern, with this highest frequency of detects in Alabama (22%) and South Carolina (21%) in the Southeast region and southeastern Missouri/northeastern Arkansas (23%) in the Mississippi Delta region.

- Frequency and magnitudes of detection for aldicarb residues were generally greater for wells located within 300 feet of a field (~10% of wells had detections); aldicarb residues were detected in 4-6% of wells located >300 feet from the field, although detections were < 1ug/L. Because the existing label has well setback requirements of 300 feet for vulnerable soils, the Agency assumed that the monitoring data for those wells that meet the setback criteria reflect aldicarb applications no closer than 300 feet from the well.

- Frequency and magnitudes of detection for aldicarb residues also were generally greater where the reported ground water was closer to the surface (23% detects for groundwater at <25 feet; 12% for groundwater at 25-50 feet), although residues were detected in 9% of wells where the depth to groundwater was not known or not reported, with maximum detects of up to 2.66 ug/L. Aldicarb residues were detected in 24-30% of wells with reported well depths of <100 feet. However, detects of up to 2.66 ug/L were reported for deeper or unknown well depths.

- A comparison of wells located near fields with restricted soils (as identified in the TEMIK® 15G label) to those where the surrounding fields contained no restricted soils showed that, while the frequency of aldicarb detections was greater for wells near restricted soil types, the magnitude of aldicarb residues was greater for wells with no restricted soil types.

b. Carbaryl

Available evidence from valid scientific studies documented in EPA's 2003 risk assessment for carbaryl show that it has has a limited potential to leach to ground water. In addition to NAWQA monitoring documented above, the Agency looked at the Pesticides in Groundwater Database and STORET (USEPA, 2003a).

As a result of normal agricultural use, detections of carbaryl residues have been reported in groundwater from several states. As reported in the U.S. EPA. Pesticides in Groundwater Database (Jacoby et al., 1992), carbaryl was detected in 0.4% of wells sampled. Carbaryl was detected in California (2 out of 1433 wells), Missouri (11 out of 325 wells), New York (69 out of 21027 wells) Rhode Island (13 out of 830 wells) and Virginia (11 out of 138 wells). The maximum concentration detected was 61.0 μg/L, though typically the measured concentrations were significantly lower. (an earlier report of a high concentration on 610 μg/L was determined to be the result of a spill, with the sample collected at a sump (personal communication with Suffolk Co Dept of Health, 2007)

The EPA Storage and Retrieval (STORET) water quality database was queried on May 12, 1999 for reports of measurements of carbaryl in groundwater. The database contained 9,389 records indicating that analysis was done for carbaryl. Out of these, only 4 reported concentrations above the detection limits. These analyses were all from one well in Cleveland, OK in 1988. The four reported concentrations were between 0.8 and 1 ppb.

c. Carbofuran

The following is a brief summary of ground water monitoring data for carbofuran based on EPA's 2005 risk assessment for carbofuran (USEPA, 2005d). Results of two early prospective ground water (PGW) studies with carbofuran confirmed that it leaches to ground water in vulnerable environments. Carbofuran concentrations reported ranged from <1.0 - 21 ppb for applications of 1 lb/a.i./A in one use season to <1.0 - 65 ppb for application of 3 lb/a.i./A in one use season. Using data from these studies and adjusting for current label rates on those soils (from 3 to 2 lb a.i./A), the estimated long-term concentrations ranged from 17 - 23 ppb in shallow ground water. Peak concentrations would be higher.

Historically, in non-targeted water monitoring studies, carbofuran has been found in the ground waters of at least 19 states. Non-targeted sampling conducted by the USGS reported carbofuran in 1.31 percent of wells sampled from agricultural areas, with a 95th percentile concentration less than the reporting limit (<0.003 ppb). Both the frequency of detection and the concentrations reported are uncertain, however, due to analytical method problems which would underestimate concentrations. The most vulnerable drinking water sites appear to be shallow private wells near carbofuran use areas, where the groundwater has a low pH. Although contemporary targeted and non-targeted monitoring is limited in availability, carbofuran concentrations in non-targeted studies are relatively low (less than 1 ppb). Targeted monitoring data would provide a better indication of the concentrations of carbofuran which might occur in these areas during the application season.

Degradate 3-hydroxycarbofuran was included as an analyte in a small number of ground-water monitoring programs. One of these programs was the Suffolk County, New York monitoring program, in which 3-hydroxycarbofuran was detected in 34 wells at concentrations as high as 10 ppb. Another monitoring program conducted in the Potomac-Raritan-Magothy and Kirkwood-Cohansey aquifer recharge areas in New Jersey did not result in detections of the degradate in 90 wells in 1987-88. The more comprehensive Iowa Statewide Rural Well Survey resulted in detections of 3-hydroxycarbofuran in three wells (0.05 ppb, 0.13 ppb and 0.98 ppb in wells as deep as 50 feet) and also degradate 3-ketocarbofuran in three wells (0.003 ppb, 0.028 ppb and 0.027 ppb, the last in a 242-foot deep well). No detections of 3-hydroxycarbofuran were reported in the 1349 wells sampled in the National Pesticide Survey of the late 1980s. More recent, nontargeted NAWQA monitoring found 3-hydroxycarbofuran in two wells at a concentration of 0.07 ppb; it isn't clear what percentage of the 1477 wells received recharge from carbofuran use areas.

d. Oxamyl

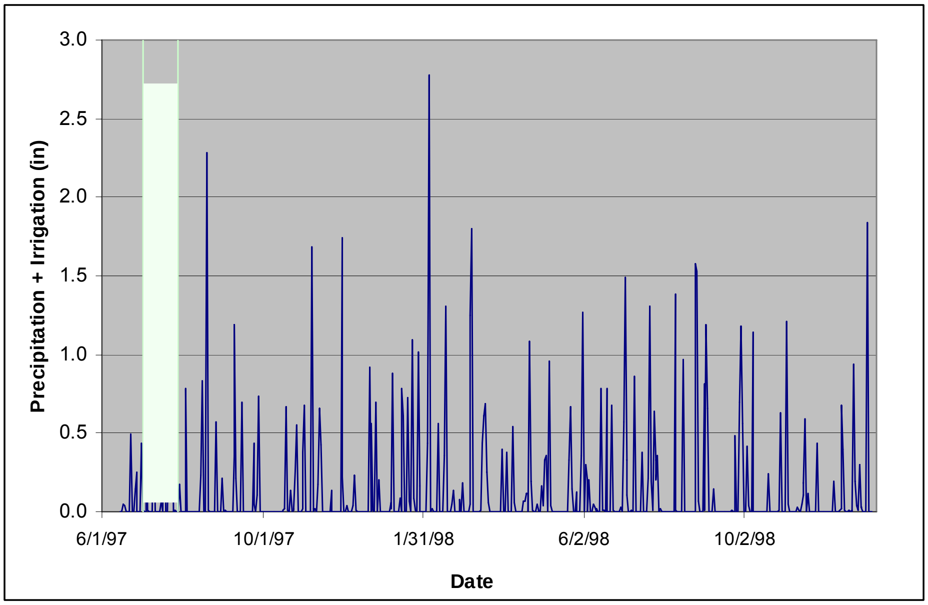
Monitoring results are much more limited for oxamyl than for aldicarb. Oxamyl has not been detected in the FDEP monitoring program (FDEP, 2005). It has only recently been included in the USGS monitoring study along the FL Central Ridge, but results are not yet available (Choquette 2005, personal communication).

A small-scale prospective groundwater (PGW) monitoring study was conducted for oxamyl and its oxime metabolite in Tarboro, North Carolina, in the coastal plain region. The study site represents highly vulnerable soil and hydrogeologic characteristics. The soil at the site is a Tarboro loamy sand series, characterized by excessive drainage and negligible runoff. It has a sand to loamy sand texture with a layer of sandy loam to sandy clay loam at approximately two to four feet. The top foot of soil has an average organic matter content of 0.85% and a pH of 5.8. Below this, the organic matter content ranges from 0.10 to

0.23% while the pH ranges from 4.3 to 7.9, generally lower at the top and increasing with depth. Based on undisturbed soil samples, the average field capacity is 9.6% in the top two feet and 15.1% from two to four feet and the bulk density at those depths averages 1.42 g/cm^3.

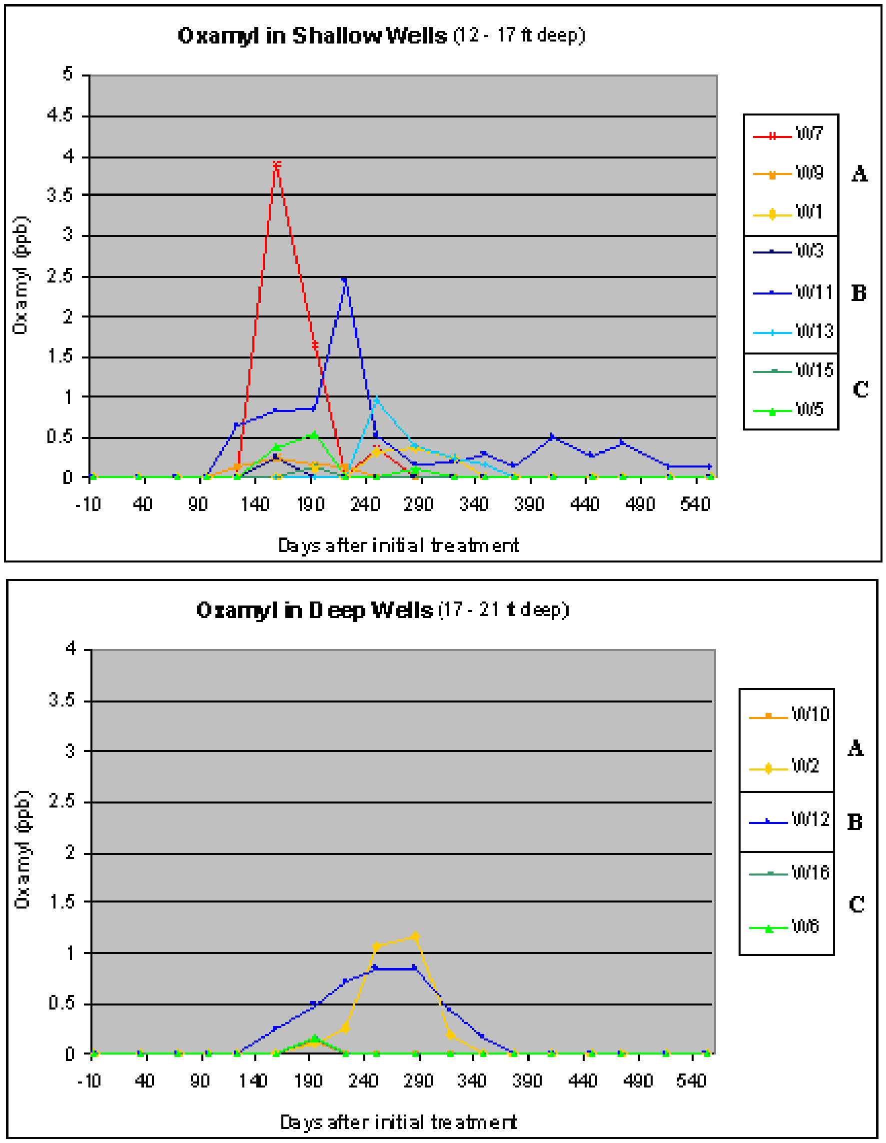
The study site has a history of cotton, soybeans, peanuts, tobacco, and corn production. For this investigation, cotton was planted on May 22, 1997 and multiple applications of oxamyl as well as a single application of a conservative bromide tracer were subsequently applied. The cotton was harvested in November and peanuts planted the following summer. Precipitation was supplemented with overhead center pivot irrigation to bring the combined precipitation and irrigation to 56.41 in., 120% of the historical mean precipitation (Figure II.E.2.1).

Figure II.E.2. 1 - Precipitation and irrigation throughout the study period. The oxamyl application period is highlighted in light green.



In July, a series of 5 ground broadcast applications of oxamyl were made on a 2 acre plot at 6 to 8 day intervals. The first two applications were at a rate of 0.5 lb/A and the rest at 1.0 lb/A. This represents the maximum labeled seasonal rate using the minimum application intervals. Oxamyl reached all shallow wells, initially detected between days 124 and 194 after treatment. In one well, oxamyl persisted throughout the entire study period while in the others there were no detections beyond 376 days. The maximum detection was 3.91 ppb (Figure II.E.7.16). Oxamyl was only detected in 5 of the deeper wells, appearing by day 194 after treatment and undetected by day 378. The range of concentrations detected at this depth was 0.12 to 1.17 ppb (Figure II.E.2.2).

II.E.2. 2 – Oxamyl concentrations in shallow wells (top) and deep wells (bottom). Wells are grouped into subplots A, B, and C, where A is the most northern. Within each subplot, wells are listed upgradient to downgradient. Odd numbered shallow wells share a cluster.



5. Summary of State Monitoring for N-Methyl Carbamates

The EPA Office of Pesticide Programs (OPP) contacted the lead pesticide agencies in each state during the summer of 2004 to determine whether any of the N-methyl carbamates (NMC) in this cumulative assessment group have been included in State ground- or surface-water monitoring programs over the last decade. When monitoring programs were performed by agencies other than the lead pesticide agency, OPP contacted them as well. Many state agencies offered to provide data if information has not yet been made available online.

State monitoring programs included few, if any, NMCs in their analysis. The majority of States have focused monitoring efforts on ground-water, particularly on five herbicides proposed for Pesticide Management Plans. With few exceptions, State monitoring programs have not specifically been targeted to the areas and timing of NMC application. Because of this, and because most NMCs are not required by the Safe Water Act to be included as analytes in drinking water sampling, data from State monitoring programs are used as important supplemental data for the NMC cumulative drinking-water risk assessment.

One exception to this is private well monitoring data conducted by the Florida Department of Environmental Protection (FL DEP), which proved to be valuable in developing and evaluating the ground-water modeling approach the Agency used for this cumulative exposure assessment.

This section briefly summarizes state monitoring programs pertinent to the NMC CRA. The focus of State monitoring programs has been on groundwater. Where provided, a summary of surface water is also included.

a. Arizona

Wang Yu of the Arizona Department of Environmental Quality Groundwater Monitoring Unit provided a data set (1994 – 2003) based on statewide monitoring efforts routinely undertaken by the Pesticide Contamination Prevention Program and Ambient Groundwater Monitoring Program of ADEQ. From 1997 – 2003 there were only four detections of NMCs (methomyl, and aldicarb sulfxide and sulfone); 90% of the samples with NMC detections were collected in 1994. NMCs detected included: aldicarb sulfone (9 ug/L) and sulfoxide (2.6 ug/L); carbaryl (2.5 – 24 ug/L); methomyl (0.17 – 50 ug/L); oxamyl (1.2 – 24 ug/L); propoxur (7 – 150 ug/L).

b. Arkansas

Charles Armstrong of the Arkansas State Plant Board Pesticides Division said that they monitor for carbamates but they have never had any detections.

c. Colorado

Greg Naugle, the Groundwater Quality Coordinator for the Colorado Department of Public Health and Environment, sent a summary of the carbamate sampling conducted by the Colorado Agricultural Chemicals in Groundwater Program. The carbamate screen that was run included aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, 3-hydroxycarbofuran, methiocarb, methomyl, 1-napthol, oxamyl (vydate), and propoxur (baygon).

Mr. Naugle reported that since 1992, the program has analyzed approximately 570 samples with detection limits varying between about 0.23 and 4 ppb. Through 2004, no samples have been analyzed with concentrations above the detection limit.

Michael Lewis, a Water-Quality Specialist with the U.S. Geological Survey, Water Resources Division Colorado District, sent two spreadsheets with separate statewide pulls from the database for GW and SW data. He also said that the data is most likely limited to the South Platte and Upper Colorado NAWQA study units.

The spreadsheets contain all available carbamate data for ground water and surface water sites sampled by the USGS WRD in Colorado from 01/1990 through 06/2004. The spreadsheets are formatted to highlight the "hits", which he believes are all reported as estimated (E) concentrations. These typically are for carbaryl and carbofuran. The values are reported as estimated, because of variable method performance with the analytical method. These data should be included in the NAWQA database.

d. Connecticut

Judith Singer of the Connecticut Department of Environmental Protection provided data from a USGS report which covered the Connecticut, Housatonic and Thames River watersheds from 1979 to 1989. The data indicated that oxamyl was detected in four ground water samples with a concentration range of 0.5-2.5 ug/l (reporting level was 0.5 ug/l).

e. Delaware

Scott Blaier of the Delaware Department of Agriculture indicated that although there is a significant amount of ground water monitoring for herbicides, there is little done in monitoring for insecticides, and none for the carbamate family. Mr. Blaier provided an internet link to the document entitled The Impact of Known and Suspected Contaminant Sources on Select Public Drinking Water Supplies in Delaware prepared by Department of Natural Resources and Environmental Control Division of Air and Waste Management Division of Water Resources, Delaware Health and Social Services Division of Public Health in September 2002. This document reported that 188 chemicals where tested for in the laboratory analyzed samples, including three carbamate pesticides: aldicarb, aldicarb sulfone, and oxamyl. However, none of these carbamates were detected in any of the 53 ground-water samples and 8 surface water samples selected from across the state. The report indicated that selection of the sampling locations was based on vulnerability.

f. Florida

Andrew Priest of the Florida Department of Environmental Protection provided the agency with two spreadsheets. The carbamates that the Florida DEP monitors for in groundwater are aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, 3-hydroxycarbofuran, methiocarb, methomyl, oxamyl, and propoxur (baygon). Mr. Priest stated that they have taken over 6,000 samples and no carbamates have been detected except for aldicarb.

Dr. Chris Wilson, an Environmental Toxicologist at the University of Florida's Indian River Research and Education Center, conducted a study to monitor pesticides in a surface water body located in a citrus rich region of southeast Florida. For the study, Dr. Wilson's team collected one water sample daily at the discharge point for the small agricultural watershed over a one-year period. They analyzed the samples for aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, methiocarb, methomyl, oxamyl, and propoxur. Dr. Wilson stated that his team has a manuscript that has been accepted by the Bulletin of Environmental Contamination and Toxicology detailing the results for aldicarb, aldicarb sulfoxide, and aldicarb sulfone. He said that, based on separate field studies conducted, they have found that aldicarb has a half-life of 2-4 days in Florida surface waters. Dr. Wilson's team also detected carbaryl, methomyl and oxamyl in a few samples. In addition to the carbamates, they have also monitored for organophosphates and copper. He supplied the agency with the poster that he presented at a local watershed meeting in early 2004 that gives a better explanation.

g. Georgia

Steve Cole of the Georgia Department of Agriculture Pesticide Division reported that their lab is currently running Method 525.5 for groundwater samples. This method recovers carbamates, but the detection method (GC/XSD) does not detect carbamates, therefore, they have no data on carbamates. In the past, the department did monitor for carbamates and had no detects.

h. Illinois

Ms. Jeri Long from the Drinking Water Compliance Unit of the Illinois Environmental Protection Agency supplied spreadsheets with monitoring data for five NMCs from all Illinois community water systems (almost all finished drinking water) collected from 1994 - 2004. Samples from these public wells were sampled for aldicarb aldicarb sulfoxone , aldicarb sulfoxide(DLs = 0.7 ug/L), carbofuran (DL = 4 ug/L), and oxamyl (DL = 20 ug/L); no detections were reported in over 6700 samples analyzed for each compound.

i. Indiana

George Neely from the Indiana Department of Environmental Management, Drinking Water Branch, provided the agency with information and data from the Drinking Water Compliance database for Indiana. The database contains point of entry data (after treatment) for Public Water Systems. The data that Mr. Neely supplied the agency only includes ground water systems and covers the period from1993 to 2004.

Mr. Neely reported that Indiana has 656 Community ground water systems and 690 non-transient, non-community (NTNC) ground water systems. He also noted that "transient" public water systems are not included in the data because these systems are not required to sample regulated SOCs.

The Indiana drinking water database has data on seven of the carbamates and five of the carbamates are on the "unregulated SOC" list for Indiana. These are aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, and methomyl . After the initial sampling for unregulated SOCs , systems are not required to submit these again. However, Mr. Neely reported that roughly 50% of the systems submit both regulated and unregulated every time they sample for SOCs and therefore a significant amount of data on these carbamates exists in the database. The other two carbamates, carbofuran and oxamyl (vydate), are both included on the list of regulated SOCs for Indiana. Therefore, Indiana's database has the most information on these two compounds.

Mr. Neely stated that the most common SOC sampling frequency for ground water systems in Indiana is once every three years or once during each compliance period. He noted that there are only four entries that show a carbamate detection in the database, and the last detection was in 1997. The following four carbamates were each detected one time over the last 11 years: methomyl, oxamyl (vydate), carbofuran, and aldicarb. For the group of five carbamates (aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, and methomyl) on the unregulated SOC list, a total of 2970 samples have been recorded since 1993 with "zero" results, and only two samples have had detections. For the two carbamates on the regulated list (carbofuran and oxamyl), a total of 6849 samples have been recorded since 1993 with "zero" results, and only two samples have had detections.

j. Kansas

Anthony Stahl of the Kansas Department of Health and Environment, Bureau of Environmental Field Services, reports that carbofuran is the only carbamate that is included in their routine ambient ground water for pesticides and herbicides. The Groundwater Monitoring Network (1996 - 2001) included approximately 200 wells used for water supply, monitoring, irrigation, and other combinations of uses. No detectins were reported.

Data were provided from the Ambient Stream Chemistry Network as well, with NMC analysis only for carbofuran. Over 700 samples were analyzed between 1994 and 2003; carbofuran was detected 17 times (including two duplicate samples) at concentrations from 6.7 0 0.54 ug/L (DL == 0.5 ug/L).

k. Maine

Heather Jackson of the Maine Department of Agriculture, Maine Board of Pesticides Control reported that at one time, the Board of Pesticides Control looked for carbaryl, carbofuran, methomyl, oxamyl, and aldicarb in surface or groundwater. However, aldicarb has been the only carbamate detected.

Robert Batteese Jr., Maine Department of Agriculture, Director of Maine Board of Pesticides Control, provided results of the aldicarb groundwater-monitoring program, containing results of samples taken in September of 1993. There were 34 samples taken and results showed no detectable residues in 24 wells (MDL = 0.5 ppb). Rhone-Poulenc voluntarily cancelled the registration for aldicarb use on potatoes in April 1990. After 1988, the last year of significant aldicarb usage, the number of wells being sampled decreased, as well as the percentage that actually showed detections. In 1993, the Board of Pesticide

Control decided that the monitoring effort could be stopped because levels were low enough to warrant a halt. He also reported that sampling for aldicarb began as early as 1979 when the possibility of detecting aldicarb in groundwater in and around potato growing areas was brought to the Board of Pesticide Control's attention. The majority of these potatoes areas lie within northern Maine, where soils are well drained and underlain by fractured bedrock. The lower temperature of the groundwater in this area is also thought to have allowed aldicarb to persist longer when compared with other regions. Between 1982 and 1993, over 300 wells were sampled.

l. Massachusetts

Damon Guterman from the Drinking Water Program of the Massachusetts Department of Environmental Protection provided the agency with a spreadsheet of the seven carbamates that are included in their Safe Drinking Water Act monitoring program (five were part of the previous unregulated SOC list). These include aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, methomyl, and oxamyl (vydate). All samples were of finished water collected from wells. Over 20,000 samples were analyzed for NMCs from 1992 to 2004; 14 detections were reported from 1994 - 2003, including aldicarb (0.5 ug/L), carbaryl (0.7 – 1.0 ug.L), carbofuran (0.2 – 0.9 ug.L), methomyl (0.5 ug/L), oxamyl (2.0 ug/L).

Mr. Guterman stated that "the Drinking Water Program makes every attempt to ensure that this data is accurate, complete and current. However, no guarantee is given that this data is error free. In addition, since updates and corrections are occurring at all times the data are time sensitive. Any published use of this data should include this disclaimer and acknowledge the Massachusetts Department of Environmental Protection, Drinking Water Program."

m. Michigan

Sainey Drammeh, from the Department of Information Technology of the Michigan Department of Environmental Quality, provided the agency with monitoring data from 1994 to2004; however, no data were available for 7 of the 10 years . Ms. Drammeh stated that this monitoring was conducted to ensure that the state's water quality is up to EPA standards. All data on NMCs were from ground water wells. Between 1996 and 1998, aldicarb was reported in two samples (both 6.7 ug/L); aldicarb sulfoxide in 2 samples (1.9 and 6.7 ug/L); methiocarb in 5 samples (5.7 – 100.8 ug/L), and one sample each with aldicarb sulfone (10.5 ug/L), carbaryl (7.9 ug/L), carbofuran (7.4 ug/L), methomyl (7.4 ug/L), and oxamyl (6.9 ug/L).

Dennis Bush from the Water Division of Michigan Department of Environmental Quality stated that they do not routinely monitor for carbamates in their surface water program. In 1997, Mr. Bush co-wrote a staff report which summarized the results of pesticide monitoring conducted in 1992 for some of the tributaries to the Saginaw Bay, which he summarized for the Agency: "In 1992, a total of 103 water samples were collected from the Saginaw Bay watershed. The samples were collected primarily from the mouths of 27 tributaries to the Saginaw Bay. The samples were analyzed for 27 pesticides. Carbofuran, the only carbamate pesticide studied, was detected in 16 out of the 103 samples at concentrations ranging from 0.54 to 4.04 ug/L (the detection limit for carbofuran was 0.5 ug/L)."

n. Mississippi

Shedd Landreth of the Mississippi Department of Environmental Quality reported that the Mississippi Agricultural Chemical Groundwater Monitoring Program began in 1989. The goal of this program was to determine if the use of agricultural chemicals was impacting the groundwater quality of the state. Since the program's start, 1239 samples from 1101 wells have been taken. Analyses for approximately 100 volatile organic and inorganic compounds, as well as 100 pesticides, have been conducted on each sample. This study does include carbamates, however they are unable to detect for Formetanate HCL and Thiocarb. There have been no detections of any carbamates in any of the sampled wells

o. Missouri

Dianne Holtmeyer of the Public Drinking Water Branch of the Missouri Department of Natural Resources provided the agency with a data set that contains the results for monitoring conducted using Method 531 from 1995 until mid-May 2004 on surface and ground water.

p. Montana

Bob Church at the Montana Department of Agriculture reported that they do monitor for carbamates in the groundwater. The specific carbamates sampled for are: aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, 3-hydroxy carbofuran, and methomyl. A search in the years 1999 - 2004 yielded no detections of any carbamates in their groundwater monitoring program. There is currently no sampling of surface water for carbamates through the Montana Department of Agriculture.

q. New Mexico

Both Marjorie Lewis and Bonnie Rabe of the New Mexico Department of Agriculture reported that they were unaware of any programs that specifically looked at carbamates and if there have been any programs, they are not aware of detections.

r. North Carolina

Dr. Henry Wade, North Carolina Department of Agriculture and Consumer Services, Pesticide Section, reported that from 1991-1995 they tested water samples from shallow groundwater monitoring wells across the state. Dr. Wade stated they had 13 wells on different farms where aldicarb was used within 300 feet of the wells up to 5 years before the water samples were collected. There were no detections of aldicarb or its degradates. Some new shallow monitoring wells were installed on one farm where the department had tested previously for pesticides. In January 1996, they had detections in 3 wells of two aldicarb degradates. These wells were sampled again in March and July of 1996 and twice in 1998. The two aldicarb degradates were not detected.

G73: aldicarb sulfoxide 7.4 ppb; aldicarb sulfone 3.2 ppb
G212: aldicarb sulfoxide 1.0 ppb; aldicarb sulfone 1.0 ppb
G215: aldicarb sulfoxide 3.0 ppb; aldicarb sulfone 1.5 ppb

Also from 1991-1995, Dr. Wade reported testing of 20 wells on farms where carbaryl was used, 6 wells on farms where carbofuran was used, and 13 wells on farms where methomyl was used. These pesticides were not detected.

Jim Blose, Division of Water Quality of the North Carolina Department of Environment and Natural Resources, provided findings from limited pesticide analyses that were carried out for a series of watershed investigations. Mr. Blose reported that the only two carbamates analyzed were carbaryl and carbofuran. Both baseflow and storm samples were collected. Carbaryl was detected in one of the watersheds at two sites (0.56 – 3.62 ug/L); carbofuran was not detected. The reported limit of detection was 0.005 ug/L

s. North Dakota

William Schuh, North Dakota State Water Commission and Norene Bartelson, North Dakota Department of Health reported that North Dakota conducts an Ambient Monitoring Program for approximately 60 pesticides and nitrates, targeting the most vulnerable aquifers. These aquifers are sampled on a one square-mile grid; each year there are 200-300 sites sampled. Aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, methomyl and oxamyl are included as analytes. Data are summarized in annual reports, as well as in a five-year summary report. Detections are as follows:

1992: Carbofuran was detected in a single well at a concentration of 1.10 ug/l.
1996: Aldicarb sulfoxide was detected in the regular and duplicate wells, concentration 0.650 ug/l, concentration 0.730 ug/l, respectively.
1998: Methomyl was detected in two wells; concentrations were 2.360 ug/l and 1.450 ug/l.
1999: Carbaryl was detected in one well, concentration 1.0 ug/l

t. Ohio

Todd Kelleher, Ohio Environmental Protection Agency, reported that the only carbamates that are currently required as part of the Safe Drinking Water Act monitoring in Ohio are carbofuran and oxamyl. Monitoring for other carbamates, aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, and methomyl occurred in the past but was discontinued when these compounds were not included in the Unregulated Contaminant Monitoring Rule (UCMR). He reported that there have been no detections of carbamates in the public drinking water systems in the past ten years.

u. South Carolina

Kathy Stecker, South Carolina Department of Health and Environmental Control, Bureau of Water, confirmed that South Carolina does not monitor carbamates in their ambient surface water monitoring program.

Jerry Moore, South Carolina Department of Pesticide Regulation, reported that they only test for aldicarb, carbaryl, and carbofuran. He said the department has been monitoring groundwater for these compounds since 1991 (approximately 2500 samples from private wells), and they have had no detections thus far (detection limits described as "not very low".

v. Tennessee

Richard Strickland, Tennessee Department of Agriculture, reported that between April 1996 and April 1999, monitoring for two carbamates, aldicarb and carbofuran, did take place. Neither of these pesticides were detected during this time

w. Texas

Alan Cherepon, Resource Conservation Specialist for the Texas Commission on Environmental Quality, searched their database of nearly 20,000 analytes and found that aldicarb (total) is the only carbamate that has been. Aldicarb (total) was sampled by Rhone Poulenc in 1979, 1987, and 1988 (locations not specified). No detections were reported; however, he noted that because of the age of the data, detection levels may have been much higher. He also identified sampling from the Fort Worth area by the USGS in 1993-1994, which included methiocarb, oxamyl, and propoxur. No detections were indicated. Mr. Cherepon also reported that the Public Drinking Water Program does not monitor for any carbamates.

Gary Regner, the Public Drinking Water Section of the Texas Commission on Environmental Quality provided the agency with drinking water monitoring data. Mr. Regner reported that Texas no longer monitors drinking water for carbamates, but they have in the past (1992 – 2002), using EPA method 531, for aldicarb sulfoxide, aldicarb sulfone, oxamyl, aldicarb, carbofuran, methomyl, 3-hydroxycarbofuran, baygon, carbaryl, and methiocarb. Mr. Regner reported that of the 6183 samples collected over the time period, there were no carbamate detections. Samples were collected at public water systems from entry points. Mr. Regner reported that this is treated drinking water before it enters the distribution system.

x. Washington

Ginny Stern and Jack Eden of the Washington Department of Health supplied a data set of carbamate monitoring data from January 1996 to December of 2003. This monitoring data mainly consists of groundwater, but includes several surface water samples. The data were collected at sites determined to be vulnerable that are a source of drinking water. NMCs detected include: two detections of aldicarb sulfone (0.003, 1.6 ug/L); one detection of aldicarb sulfoxide (4.8 ug/L); four of carbofuran (0.01 – 3.3 ug/L); one of methiocarb (2 ug/L); two of methomyl (1.4, 2.4 ug/L); and one of oxamyl (4.0 ug/L). All samples, with the exception of aldicarb sulfone, were untreated water.

y. West Virginia

Doug Hudson, from the West Virginia Department of Agriculture, reported that they have conducted carbamate groundwater monitoring in the past and have never had any detections.

z. Wisconsin

William Phelps, Wisconsin Department of Natural Resources, reviewed the groundwater monitoring data in the Groundwater Retrieval Network/Groundwater and Environmental Monitoring System (GRN/GEMS). This database contains groundwater monitoring results from public drinking water supply wells, private drinking supply wells, non-point source priority watershed projects, special groundwater studies, and the Bureau of Waste's GEMS monitoring results (typically monitoring wells around landfills). Monitoring data were available from 1984 to present, for the following carbamates:

Aldicarb (more than 160 detections: 1 – 260 ug/L; LOQ unknown)
Aldicarb Sulfone (32 detections: 3.1– 13 ug/L; LOQ unknown)
Aldicarb Sulfoxide (30 detections: 3.2– 16 ug/L; LOQ unknown)
Carbaryl (1 detection: 1 ug/L; LOQ unknown)
Carbofuran (1 detection: 1 ug/L; LOQ 0.9 ug/L)
Methomyl no detections; LOQ 0.5 ug
Oxamyl (1 detection: 1.6 ug/L; LOQ 1.0 ug/L)
Propoxur (LOQ 4.8 – 6.4 ug/L; 3 trace detections at <LOQ)
Methiocarb LOQ 7 ug/L; no detections

Appendix E-3 Drinking Water Treatment Effects on N-methyl Carbamate Pesticides

1. Drinking Water Treatment Effects on N-methyl Carbamate Pesticides

Based on available data, this section provides an analysis of the effects of water treatment methods on N-methyl carbamates, including aldicarb, aldicarb sulfone, aldicarb sulfoxide, carbaryl, carbofuran, formetanate HCL, methiocarb, methomyl, oxamyl, pirimicarb, propoxur, and thiodicarb. This current review of data is an update to the previous literature review, which was used to support OPP's Water Treatment Science Policy (USEPA, 2000; USEPA 2001)

An evaluation of laboratory and field monitoring data indicate that N-methyl carbamates may be effectively removed from drinking water by lime softening and activated carbon. With the exception of aldicarb, lime softening processes degrade N-methyl carbamates through alkaline-catalyzed hydrolysis. Abiotic hydrolysis studies conducted in pH 9 buffer solutions indicate that carbamates are susceptible to degradation during lime softening. In addition to lime softening, sorption on activated carbon using granular activated carbon (GAC) or powdered activated carbon (PAC) appears to be effective in removing N-methyl carbamates from drinking water. Other treatment methods, such as chlorination, chloramination, chlorine dioxide, and potassium permanganate, appear tp be only effective in oxidation of N-methyl carbamate compounds containing a methylthio group (CH3-S-), e.g., methiocarb and aldicarb. These compounds are expected to oxidize to sulfoxide and sulfone.

Available USGS water treatment plant monitoring data indicate that N-methyl carbamates and their degradation products have a low detection frequency in raw and finished water samples. The low detection frequency, coupled with sample handling issues, prevent an estimate of pesticide removal through typical water treatment plants. However, an analysis of occurrence for carbamate degradation products in the monitoring study and the laboratory studies suggest they were formed through both environmental and water treatment processes.

2. Environmental Fate Data Pertinent to Treatment Effects

With the exception of aldicarb, the N-methyl carbamates are rapidly degraded through alkaline catalyzed hydrolysis. As a group, they are generally non-persistent and mobile in aerobic soil and form oxidative degradation products. Table II.E.3.1 provides a summary of the environmental properties of the n-methyl carbamate pesticides. Based on environmental fate data, N-methyl carbamates are expected to degrade via base-catalyzed hydrolysis during lime softening as well as by oxidation when water is treated with oxidative disinfectants.

Table II.E.3.1: Environmental Fate Data for Selected N-methylcarbamates1

Pesticide	Abiotic Hydrolysis (pH=9) at 25°C		Aerobic Soil Metabolism		Soil Partitioning Coefficient Kf
	Half-life (days)	Degradation Products	Half-life (days)	Degradation Products	
Aldicarb	197		2.3	aldicarb sulfoxide aldicarb sulfone	< 1
Aldicarb sulfoxide	2.3		Stable		<1
Aldicarb sulfone			Stable		<1
Carbaryl	0.13	1-naphthol	4	1-naphthol	2-3
Carbofuran	0.63	carbofuran phenol	150-321	3-ketocarbofuran carbofuran phenol	0.72 (median)
Forme-tanate Hydro-chloride	1	N'-(3-hydroxy phenol) -N,N-dimethyl formamide hydrochloride	6.4	3-formaminophenyl methylcarbamate, 3-dimethylamino-methylene-iminophenol hydrochloride, 3-aminophenylcarbamate, 3-aminophenol	< 3.43
		3-formamido-phenyl methyl-carbamate			
Methiocarb	< 1	Mesurel phenol Mesurel sulfoxide phenol	No Data	No Data	
Methomyl	30	S-methyl-N-hydroxythioacetimidate	30-45	No Data	< 1.5
Oxamyl	0.125	Oxime	11-27	Oxime Dimethyl oxamic acid	< 1
Pirimicarb	Stable		7-294	5,6-dimethyl-2-methylamino-4'-hydroxypyrimidine; 5,6-dimethyl-2-methylamino-4'-hydroxypyrimidin-carbamate	
Propoxur	1.6		112-180		<1
Thiodicarb	0.5	Methomyl	1.5	methomyl	2-14

1- Data were obtained from most recent Re-registration Eligability Document assessments or EFED One-Liner Database

3. Review of Available EPA Studies

a. Preliminary Water Treatment Effects for Selected N-methyl Carbamates (Miltner, R.J. June, 2005. Status Report: Summary of ORD/WSWRD Studies to Control N-methyl Carbamates in Drinking Water. USEPA/ORD/ WSWRD. Cincinnati, OH) determination of Timing of Carbamate Applications

Background / Purpose

EPA's Office of Research and Development / Water Supply and Water Research Division (ORD/WSWRD) conducted bench-scale screening-level water treatment studies to assess the effect of common water treatment processes on removal of selected N-methyl carbamates. Screening-level treatment processes included coagulation/clarification, lime softening, adsorption to PAC, and oxidation with chlorine, chloramines, chlorine dioxide, and potassium permanganate. The data are considered preliminary because they have not been subject to a formal peer review process. A qualitative summary of the preliminary data is presented in a summary report, which will be followed by a more comprehensive final report.

Materials and Methods

Bench-scale water treatment studies were conducted at room temperature.

Non-radiolabeled carbamates were spiked into these waters at concentrations ranging from 44 to 88 µg/L. Concentrations of carbamates were determined using GC/MS. Degradation (transformation) products were not identified. In all studies, control samples were held for the duration of the process reaction times to ensure that there was no background loss of the carbamates that could be attributed to the treatment.

Coagulation, Clarification and PAC Adsorption

Coagulation/clarification studies were conducted in jar tests using raw surface water from the Winton Woods Lake with alum coagulant doses adjusted to control turbidity under typical full-scale drinking water treatment conditions. These studies also were conducted with and without PAC to assess the impact of activated carbon on pesticide adsorption. Alum (aluminum sulfate) is the most commonly used coagulant. Winton Woods Lake is not a source of drinking water, but is typical of surface waters with regard to levels and fluctuations in turbidity and total organic carbon (TOC). Prior to spiking carbamates into these waters, preliminary studies were conducted to determine proper alum doses for control of turbidity. Hydrodarco B, a commonly employed PAC, was used. PAC doses spanned from 10 mg/L, which is typical of doses used for taste and odor (T&O) control, to 60 mg/L, which is relatively atypical and high. 30 mg/L is representative of high-end doses of PAC.

Softening

Lime softening studies were conducted in jar tests using Great Miami Aquifer water. Lime doses raised pH according to typical full-scale conditions. In addition to pH, alkalinity, turbidity, calcium hardness, magnesium hardness and total hardness were monitored. The Great Miami Aquifer is the source of drinking water for the Cincinnati Water Works' Bolton Water Treatment Plant. Prior to spiking carbamates into these waters, preliminary studies were conducted to determine the conditions that would control calcium hardness, magnesium hardness and total hardness. Although lime softening was used in these studies, it was found that lime/soda softening would be required to control calcium hardness and turbidity at the higher pHs required for control of magnesium hardness. Settling took place for one hour. To prevent loss of the carbamates at the high pHs of softening, samples were acidified upon collection.

Oxidation

Oxidation studies using chlorine, chloramine, chlorine dioxide, and potassium permanganate were conducted in laboratory waters. For chlorine, chloramine and chlorine dioxide, studies were conducted over 24 hours and at doses that would be high for drinking water treatment. Doses were Recommended Maximum Disinfection Residuals (RMDLs) as defined in the Disinfectant/Disinfection Byproduct (D/DBP) Rule. For permanganate, studies were conducted over 6 hours and the dose was 1 mg/L. Six hours is representative of time through a water treatment plant in the presence of permanganate, and doses beyond 1 mg/L may impart undesired color in finished drinking water. These oxidation studies were designed to assess the extent of these reactions at relatively high doses and in lab waters (very low TOC, very low ionic strength) offering no significant demand on the oxidant. These studies were controlled by sampling non-oxidant treated samples held to assess background stability during the reaction time. Where these reactions are significant, follow up studies will examine reaction rates.

QA / QC Studies

These studies were conducted at ORD's laboratories in Cincinnati under contract 68-C-00-159 with the University of Cincinnati (UC). Battelle Laboratories in Columbus OH, a subcontractor to UC, performed the GC/MS analyses after developing methods for the combination of carbamates (aldicarb, carbaryl, methiocarb, oxamyl and propoxur). Significant QA/QC was a part of this effort. A stability study was conducted to define sample holding times and required preservatives. All samples were acidified upon collection. A study was conducted to find the reducing agent (sulfite) that would not cause analytic interference. Dilution series in the various waters were submitted as blinds. The QA/QC program required recovery checks, replication and analyses of blanks with each sample set. Replication included both bench-scale treatment samples and laboratory splits of submitted treatment samples.

b. Softening and Chlorination Screening Studies for Select Pesticides (Speth and Pisigan. 2001. Softening and Chlorination Screening Studies for Selected Pesticides. USEPA/ORD/ WSWRD. Cincinnati, OH)

Background / Purpose

The Office of Pesticide Programs (OPP) requested that the ORD/WSWRD generate drinking water treatment data for a select group of pesticides. Specifically, OPP requested data on lime softening and chlorination processes and chose ten pesticides to study for each process. Methomyl was the only N-methyl carbamate studied with softening. Aldicarb was the only N-methyl carbamate studied with chlorination.

These studies were conducted at ORD's laboratories in Cincinnati under contract 68-C-99-211 with the IT Corporation. IT Corp subcontracted the analytical measurements to Environmental Health Laboratories (EHL) and Environmental Micro Analysis, Inc. (EMA). EHL analyzed aldicarb and EMA analyzed methomyl.

Materials and Methods

Based on analytical methods, pesticides were broken into four groups for the softening study, and three groups for the chlorination study. Aldicarb and methomyl were measured by EPA Method 531.1. Pesticides were spiked into the ground water at concentrations near 100 ug/L. In all studies, control samples were held for the duration of the process reaction times to ensure that there was no background loss of the carbamates that could be attributed to the treatment. Degradation (transformation) products were not searched for.

These studies were conducted with Great Miami Aquifer water collected from the Cincinnati Water Works' Bolton Water Treatment plant.

QA/QC Studies

Prior to conducting the softening and chlorination studies, QA/QC studies were completed. The pesticides were spiked into the water at concentrations near 100 µg/L in several analytic groupings and analyzed to confirm that the groundwater matrix did not interfere with the analyses, the spiking procedure was adequate, the grouping of pesticides did not cause analytical interferences, and the analytical precision was acceptable. Preservation, shipping and stability were also defined. Thiosulfate was determined to be the dechlorinating agent that would not cause analytic interference. All samples for carbamates were acidified upon collection.

Lime softening

The softening screening-level studies consisted of jar tests with Great Miami Aquifer water. The lime pellets used in the study were also obtained from the Bolton plant. In preliminary studies, varying amounts of lime were added to a series of jars to determine the lime dose that matched the effluent pH of the Bolton plant's lime contactor basin (calcium softening) and to achieve a pH of 11 (magnesium softening). Soda ash was not considered for this limited study because elevated calcium levels were not important in the final magnesium-softened water. Floc would be present for any possible pesticide/floc complexation, and the pH would be elevated for base catalyzed reactions.

From preliminary studies, the calcium-softening dose was determined to be 150 mg/L. This was the same dose as that used in the Bolton Waterworks and resulted in the same final pH as that seen in the Bolton plant. The magnesium-softening dose was determined to be 300 mg/L.

All jars were allowed to settle for two hours before the softened samples were collected. Softening samples were acidfied upon collection to prevent base catalyzed loss of the carbamates. Two hours of settling was chosen because it resulted in adequate settling, and it gave a reasonable amount of time at a high pH to observe base-catalyzed degradation.

Chlorination

In the chlorination studies, chlorine was dosed under added at uniform formation conditions (UFC) (Summers et al., 1996) to pesticide-spiked Bolton water. UFC represents mean national distribution system conditions for chlorination and were developed for studies examining the formation and control of disinfection byproducts in drinking water. They are: a chlorine residual of 1 mg/L at 20 degrees C, 24 hours and pH 8. A chlorine demand study was conducted to determine the appropriate chlorine dose to give this residual under these conditions.

Data Analyses

For both the softening and chlorination studies, a one-way analysis of variance (anova) model was used to determine whether the pesticide was lost through treatment. Treatments were compared at the 5% significance level using a t-test. Control samples were also evaluated to determine whether the pesticide naturally degraded, or was lost, over the process reaction time.

c. EPA/ORD Monitoring Data (Miltner et al., 1989, Treatment of Seasonal Pesticides in Surface Waters, Journal AWWA)

In full-scale water plant treatment studies, Miltner et al. (1989) monitored a number of pesticides through three full-scale water treatment plants following pesticide application and Spring-time runoff. Conventional treatment (coagulation, clarification and filtration, lime or lime/soda softening, adsorption onto PAC, adsorption onto GAC, and oxidation by chlorine were monitored at the full-scale. Samples were collected before and after treatment processes with the downstream sample always collected after the upstream sample based on the utility's expertise with time of travel through the plants, and their experience with responding to Spring-time runoff events. PAC doses ranged up to the maximum fed for T&O control in order to assess adsorption capacities. The N-methyl carbamate carbofuran was one of the monitored pesticides.

Miltner et al. supplemented the full-scale monitoring with bench-scale studies wherein pesticides, including carbofuran, were spiked into field waters in EPA's laboratories in Cincinnati. Field waters included those from the monitored full-scale plants and Ohio River water. Coagulation/clarification, adsorption onto PAC, and oxidation by chlorine and chlorine dioxide were studied at the bench-scale. Coagulant doses, chlorine doses and chlorine dioxide doses were representative of full-scale treatment. Coagulation was by alum. PAC doses ranged from those typical of T&O control to those relatively atypical and high in order to assess adsorption capacities. Hydrodarco B and WPH PACs were studied; both are commonly used in drinking water treatment. Bench-scale studies were conducted at room temperatures.

Additionally, adsorption isotherms were conducted at the bench scale; the isotherms for carbofuran are also reported in Speth and Miltner (1990).

d. EPA/ORD Adsorption Isotherm Studies (Speth and Miltner, 1998, Technical Note: Adsorption Capacity of GAC for Synthetic Organics, Journal AWWA; Speth and Miltner, 1990, Technical Note: GAC Adsorption Capacity for SOCs, Journal AWWA)

Adsorption isotherms measure the maximum capacity of activated carbon to remove contaminants from water. In these studies, Filtrasorb 400, a GAC commonly used in drinking water treatment, was employed. The studies were conducted at room temperature. Two waters were studied: laboratory water to assess maximum capacities without competition from organics in field waters, and Ohio River water to assess lowered capacities in the presence of competing organics. These studies included the N-methyl carbamates aldicarb, carbofuran, methomyl and oxamyl. Control samples were reacted without carbon for the duration of the process reaction times to ensure that there was no background loss of the carbamates that could be attributed to the adsorption. All carbamate samples were acidified upon collection.

e. Results and Discussion

A qualitative summary of water treatment data is shown in Table II.E.3.2. A "No" designation indicates no control was observed for the particular treatment process. A "YES" designation indicates that pesticide control was observed. For the process-specific discussions that follow, the appropriate references are as given in Table II.E.3.2.

Table II.E.3.2: Qualitative Assessment of Water Treatment Data for N-methyl Carbamates

Pesticide	Coagu-lation	Soften-ing	Activated Carbon		Oxidation			
			GAC	PAC	Chlorine	Chloramine	KMnO4	ClO2
Aldicarb	No (a)	No (a)	Yes (b)	Yes (a)	Yes (a,c)	Yes (a)	Yes (a)	Yes (a)
Carbaryl	No (a)	Yes (a)	X	Yes (a)	No (a)	X	No (a)	No (a)
Carbofuran	No (d)	Yes (d)	Yes (b,d)	Yes (d)	No (d)	X	X	No (d)
Methiocarb	No (a)	Yes (a)	X	Yes (a)	Yes (a)	Yes (a)	Yes (a)	Yes (a)
Methomyl	X	Yes (c)	Yes (e)	X	X	X	X	X
Oxamyl	No (a)	Yes (a)	Yes (b)	Yes (a)	No (a)	X	No (a)	No (a)
Propoxur	No (a)	Yes (a)	X	Yes (a)	No (a)	No (a)	No (a)	No (a)

X - Indicates no data were available to assess treatment process.
(a) Miltner, 2005; (b) Speth and Miltner, 1990; (c) Speth and Pisigan, 2001; (d) Miltner et al., 1989; (e) Speth and Miltner, 1998

Coagulation and Clarification

Coagulation and clarification was not found to be effective for the control of N-methyl carbamates. They are water soluble and not-well sorbed to the particulates that are targeted for removal by coagulation and clarification. Given analytic precision, coagulated and clarified N-methyl carbamate concentrations could not be differentiated from raw water N-methyl carbamate concentrations. Coagulation and clarification provided expected results with a drop in the pH in clarified waters and control of turbidity to levels below 2 ntu in clarified waters.

Adsorption onto PAC

Table II.E.3.3 summarizes the control provided by PAC giving the approximate percent removal at 10 mg/L, a common PAC dose for T&O control, and at 30 mg/L, an upper-end dose for T&O control. These results indicate good removal at typical T&O control doses and better removal when doses approach the upper end of what treatment plants may be able to feed. Carbofuran, carbaryl, methiocarb and propoxur have higher molecular weights and rings structures that may account for their better control than oxamyl and aldicarb with lower molecular weights and branched structures.

Table II.E.3.3. Adsorption of N-methyl Carbamates onto PAC

Pesticide	Percent Removal	
	10 mg/L PAC	30 mg/L PAC
Carbaryl	62	75
Methiocarb	61	74
Carbofuran	57	83

Propoxur	44	57
Oxamyl	25	39
Aldicarb	20	38

Adsorption onto GAC

Aldicarb, oxamyl, carbofuran and methomyl were found to be strongly adsorbed onto GAC. The data were regressed using the Freundlich adsorption model. The Feundlich K value gives the adsorption capacity when the equilibrium concentration (concentration in water) is 1 ug/L. The resulting order of adsorbability was carbofuran (16830 ug adsorbed per gram of carbon) > aldicarb (8270) > methomyl (4780) > oxamyl (1740). Although adsorbability depends on several factors, carbofuran's higher molecular weight and included ring structure may account for its higher adsorption capacity. Aldicarb and carbofuran were also studied in coagulated and clarified Ohio River water where adsorption capacities would be expected to be lower as other organics would compete with the carbamates for adsorption sites. The resulting order of adsorbability was carbofuran (13065) > aldicarb (4160).

A K value of 300 ug/gram is generally considered a cost effective measure of adsorbability indicating several years of GAC bed life at typical full-scale operating conditions. These K values suggest control of carbamates to non-detect levels for several years before GAC replacement when GAC contactors would be utilized downstream of coagulated and clarified Ohio River water. GAC is a designated Best Available Technology for many pesticides regulated in drinking water, including the N-methyl carbamates carbofuran and oxamyl.

Softening

With the exception of aldicarb, all the N-methyl carbamates degraded during lime softening (Table II.E.3.4). One exception was aldicarb, which only degraded 22 percent at pH 11.25. Because aldicarb does not undergo rapid alkaline catalyzed hydrolysis (t1/2=197 days at pH 9, Table1), this observation was expected.

For studies with Great Miami Aquifer water, the calcium concentration decreased to the greatest extent under calcium-softening conditions. The percent removal of magnesium was less than 10 percent under calcium-softening conditions. Under magnesium-softening conditions, the magnesium was reduced to greater than 90 percent. The increased calcium in the magnesium-softening samples as compared to the calcium-softening samples was not surprising because of the water's initial alkalinity, indicating that this water requires lime soda ash softening to control calcium at magnesium-softening conditions. This was confirmed in other ORD/WSWRD studies.

During calcium softening, removal of N-methyl carbamates ranged from 87 to 99 percent, with the exception of aldicarb. During magnesium softening, their removal ranged 99 to 100 percent, with the exception of aldicarb. In studies by Speth and Pisigan (2001) thiodicarb demonstrated 90 percent removal during magnesium softening 1, although no removal during calcium softening. The similarity in structure between methomyl and thiodicarb may have resulted in their similar behavior under higher-pH magnesium-softening conditions. Thiodicarb is not an N-methyl carbamate, but is a dimer of methomyl and degrades to methomyl (Table II.E.3.1). Its larger structure may have prevented it from being degraded under calcium-softening conditions.

Although the studies for most of these N-methyl carbamates were done at the bench-scale in jar tests, carbofuran was monitored in full-scale treatment plants practicing magnesium softening (Miltner et al., 1989). Results were similar to those of the other N-methyl carbamates.

Although the mechanism of pesticide removal was not incorporated into these studies, base-catalyzed degradation likely explains the results. Possible transformation products are given in Table II.E.3.1.

Table II.E.3.4. Control of N-methyl Carbamates by Lime Softening

Carbamate	Ref.	Calcium Softening			Magnesium Softening		
		pH	Lime Dose, mg/L	% R	pH	Lime Dose, mg/L	% R
aldicarb	(a)	10.26	130	6	11.25	220	22
carbaryl	(a)	10.26	130	99	11.25	220	99
carbofuran	(d)				10.9,		100
methiocarb	(a)	10.26	130	99	11.1	220	99
methomyl	(c)	10.15	150	87	11.25	300	99
oxamyl	(a)	10.26	130	99	11.2	220	99
propoxur	(a)	10.26	130	99	11.25	220	99
					11.25		

% R = percent removal
(a) Miltner, 2005, Great Miami Aquifer
(c) Speth and Pisigan, 2001, Great Miami Aquifer
(d) Miltner et al., 1989, Maumee River, Sandusky River

Oxidation

Oxidation studies with chlorine, chloramine, chlorine dioxide, and potassium permanganate showed that aldicarb and methiocarb degraded through chemical oxidation with each oxidant. Generally, control of aldicarb and methiocarb by chlorine, chloramine and chlorine dioxide exceeded 95 percent removal, where as control by permanganate was only 31 and 23 percent respectively. This would be expected as permanganate is a weaker oxidant than the others and generally used for T&O control and manganese control rather than for disinfection. In contrast, carbofuran, carbaryl, oxamyl, and propoxur were not oxidized when treated with the various oxidants. Given analytic precision, oxidized N-methyl carbamate concentrations could not be differentiated from control N-methyl carbamate concentrations. One possible explanation is that methiocarb and aldicarb contain a methylthio group (CH3-S-)

which is prone to oxidize during oxidative disinfection processes. Although not identified in these studies, sulfoxide and sulfone are the expected transformation products of aldicarb and methiocarb.

Aldicarb's reaction with chlorine was examined under different conditions in two studies. Both studies utilized pH 8, room temperature and 24-hour reaction times. Results were similar in laboratory water with a higher 4 mg/L chlorine dose (Miltner, 2005) and in Great Miami Aquifer water under UFC conditions with a lower chlorine dose of 1.6 mg/L (Speth and Pisigan, 2001).

In studies by Speth and Pisigan (2001) under UFC conditions, molinate, a related carbamate, also showed 99 percent removal when oxidized by chlorine. Because molinate has an ethylthio group, the oxidation process is expected to yield sulfoxide and sulfone transformation products.

f. Other Treatment Processes

Although these studies did not include membranes, these are expected to be effective in removing N-methyl carbamates. Reverse osmosis membranes, and likely ultrafiltration membranes, would physically remove these carbamates from drinking water.

4. Open Literature: Oxidation Studies

a. Chlorine

Miles et al. (1988) studied the fate of carbaryl and propoxur, at 1.0 mg/L, in phosphate-buffered water treated with 10 mg/L of hypochlorite at pH 7 in the dark. The chlorine degradation of carbaryl was slightly faster than that for propoxur. The first-order kinetic half-lives of carbaryl were 3.5 days at pH 7.0 and 0.05 days at pH 8.0. For propoxur, the half-lives were 9.2 days at pH 7.0 and 0.29 days at pH 8.0. Structural elucidation of the chlorination products was not performed.

In another separate laboratory experiment, Miles and Oshiro (1990) monitored the degradation of 0.1 uM of methomyl by 1 uM chlorine. Methomyl, which contains a methylthio group, was transformed to methomyl sulfoxide and N-chloromethomyl, which were eventually converted to acetic acid, methanesulfonic acid, and dichloromethyl amine.

Miles (1991) found that 0.01mM of aldicarb in 0.1 mM phosphate buffered solution reacted with 0.1 - 10 mM hypochlorite at pH 6 - 9. Aldicarb initially underwent oxidation to form aldicarb sulfoxide and upon further chlorine oxidation, aldicarb sulfoxide was converted to aldicarb sulfone. An additional chlorine addition reaction led to the formation of N-chloroaldicarb sulfone, which can decompose to an acid and dichlorodimethylamine. Mason et al (1990) also found that chlorination of aldicarb led to formation of ten degradation products.

Four of the degradation products were identified as aldicarb sulfoxide, aldicarb sulfoxide oxime, aldicarb sulfone, and aldicarb oxime. Both aldicarb sulfoxide and aldicarb sulfone were also found by Miles (1991). A summary of the chlorination degradation products of methomyl and aldicarb are shown in Table II.E.3.5.

Table II.E.3.5. Chlorination Products of Methomyl and Aldicarb

Carbamate	Chlorine Transformation Products	Reference
Methomyl	methomyl sulfoxide, N-chloromethomyl, acetic acid, methanesulfonic acid, dichloromethylamine	Miles and Oshiro, 1990
Aldicarb	aldicarb sulfoxide, aldicarb sulfone, N-chloroaldicarb sulfone, aicd form, dichloromethylamine	Miles, 1991
	aldicarb sulfoxide, aldicarb sulfoxide oxime, aldicarb sulfone, aldicarb oxime	Mason et al, 1990

b. Ozone and Advanced Oxidation Processes

Advanced oxidation processes (AOPs) are those which utilize hydroxyl radicals for chemical oxidation. Ozone has a higher oxidation potential (2.07 V) than does an oxidant like chlorine. The hydroxyl radical produced by AOPs has an oxidation potential of 2.8 V. Therefore, contaminants in drinking water like carbamates can be oxidized by the ozone molecule or by the hydroxyl radical. The hydroxyl radical can be created by AOPs combining processes (ozone/UV, ozone/H2O2, ozone/H2O2/UV). Ozonation at higher pH (greater than pH 8) also creates hydroxyl radicals. With the inclusion of UV, photolysis can also contribute to the reaction mechanism. Because these are very reactive processes, the concentrations of pesticides like carbamates can be significantly lowered in drinking water, but a significant number of transformation products can be created. Ozonation and AOPs, however, are used by less than 2 percent of drinking water treatment plants.

Ikehata and Gamal El-Din (2005) reviewed the literature for ozonation and advanced oxidation processes for their control of pesticides, including the N-methyl carbamates aldicarb, carbaryl, carbofuran, fenobucarb, isoprocarb, methomyl, metolcarb, oxamyl and propoxur. Where conditions were similar to those of drinking water treatment, the following may be summarized as follows:

- ❑ Ozonation at 1 mg/L of applied ozone at pH 8.3 resulted in complete conversion of aldicarb at 9.5 ug/L , with aldicarb sulfoxide identified as a byproduct. In the ozonation of river water at pH 7.2, the order of reactivity of N-methyl carbamates was: carbaryl > propoxur > fenobucarb > isoprocarb > metolcarb. It was proposed that the isopropoxy group on propoxur was more susceptible to ozone attack than the sec-butyl or isopropyl groups on fenobucarb and isoprocarb, respectively.

- In ozone/UV reactions with propoxur, the hydroxyl radical accounted for over half the reaction, whereas the ozone molecule accounted for less than one-fifth, and photolysis for less than one-third.

- Ozonation byproducts of carbaryl were found to be: 1-naphthol, naphthoquinone, phthalic anhydride and N-formylcarbamate of 1-naphthol.

- Ozonation of carbofuran was improved when combined with UV (ozone/UV).

- Fast reaction kinetics were reported for the ozonation of oxamyl and methomyl.

- Mineralization of n-methyl carbamates by ozone or AOPs under drinking water treatment conditions has not been demonstrated.

5. D. Field Monitoring Data

a. Pesticide Occurrence Data from the USGS/EPA Pilot Reservoir Monitoring Program (Bloomquist et al., 2001)

EPA's Office of Pesticide Programs (OPP) analyzed USGS/EPA pilot reservoir monitoring data to assess concentrations of carbamates and their degradation products in raw and finished waters and to examine trends, when possible, in whole plant water treatment effects on pesticide removal and transformation (Blomquist et al, 2001). Reservoir ("outfall") samples, although collected, were not considered. Analysis and summary statistics for carbamates are discussed below:

Factors Affecting Interpretation of Reservoir Monitoring Data

- The USGS/EPA pilot reservoir monitoring study was designed to provide pesticide occurrence data in raw and finished water (Blomquist et al., 2001). Data analysis objectives included the following: provide pesticide data for human and ecological exposure assessment; assessment of sampling frequency for capturing peak pesticide concentrations in community water system (CWS); assessment of general relationships of pesticide concentrations in finished drinking water in relation to source water and overall understanding of whole system water treatment effects; establishment of relationships of pesticide concentrations in reservoirs to watershed and reservoirs characteristics; and validation and testing of watershed and reservoir models.

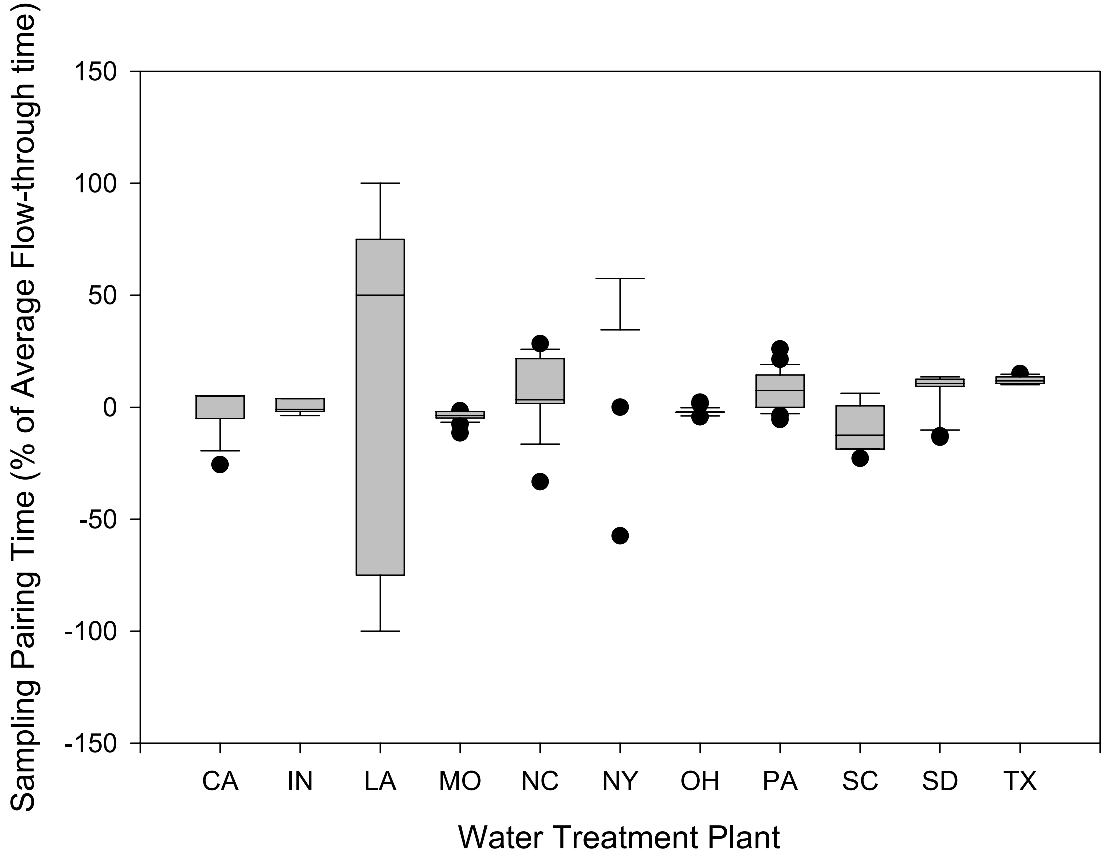
- Raw and finished water were not temporally paired to account for travel time of the pesticide and its transformation products through the water treatment plant. (The lack of temporal pairing limits a direct linkage of pesticide removal by treatment and degradation and formation of degradation products during water treatment.) Although the water samples were not temporally-paired, the results were expected to show a general relationship in concentration differences between raw and finished water samples. Temporal variability in pesticide concentrations was expected to be lower when compared to flowing water bodies because the source water was derived from reservoirs. Additionally, water samples were taken on the same time scale (hours) as the water treatment cycles for the water utilities.

  An analysis of sample pairing time, expressed as a percentage of the reservoir flow-through time, indicated that timing and sequencing of pairing were not consistent among the reservoirs (Figure II.E.2.1). The quality assurance plan (QAP) for the pilot reservoir monitoring program did not specify a pairing sampling strategy of raw and finished water samples. The water sampling time and sequence were at the discretion of the person(s) sampling the water treatment plants.

  In some cases, finished water samples were taken before the "paired" raw water samples. This situation indicates that the slug of sampled finished water was ahead of the "paired" raw water sample, which leads to negative percentage in sample pair times relative to average water plant flow time. Negative sample pair times were found in all the treatment plants except TX.

  Raw water samples were also taken prior to the finished water samples. Under these conditions, the percentage in sample pairing time relative to average water plant flow time would be positive. The mean percentage of sampling pairing time typically accounted for less than 20% of the water flow through time in the plant. An exception to this observation is was the NY reservoir where the mean percentage of sample pairing time accounted for 57% of water treatment flow through time. Exact raw and finished water sample pairing (100%) was found for three water samples at the LA water treatment plant.

Figure II.E.2. 1 - Range of Sample Pairing Time (expressed as a percent of average water treatment plant flow-through time) Among the Water Treatment Plants. Box represents 90th and 10th percentiles; whiskers represent 95th and 5th percentiles; bar in box is median; points are outliers.



There were high deviations in the sample pairing time among the water treatment plants. The most variable sampling pairing times were associated with the LA water treatment plant. In most cases, the standard deviation was equal to or higher than the mean percentage of sample pairing time.

- Pesticide concentrations in finished water samples were determined in "unquenched" water samples. The lack of quenching of free chlorine in finished water samples does not eliminate the possibility of continued chemical oxidation during storage and analysis. Water treatment plant processes in the reservoir monitoring study employ pre- and post- disinfection treatment processes, using chlorine as the disinfectant. Hence, the absence of quenching may limit the detection and definitive quantification of pesticides and transformation products prone to oxidation during storage. Recoveries in matrix-spiked finished water samples and sample storage times are presented to assess the impact of non-quenching pesticide stability (Table II.E.3.8).

- Ancillary data on weather, pesticide use, and watershed vulnerability need to be considered when interpreting occurrence data. Sampling was extended through 2000 because of extreme drought conditions in the northeastern United States and California during the 1999 sampling season. Lower than average rainfall may have impacted pesticide runoff and resulted in fewer detections of pesticides.

- Three analytical methods (2001, 9002, and 9060) were used in the reservoir monitoring study. Method 2001 was conducted using C-18 solid phase extraction and gas chromatography/mass spectrometry (GC/MS) (Zaugg et al., 1995). This method has been validated and is approved for use in the National Water Quality Assessment (NAWQA) program. Methods 9002 and 9060 were provisional (under development and validation) during the course of the study, but are now currently approved by USGS. Method 9002 (now referred to as method 2002) is was conducted using C-18 solid phase extraction and GC/MS (Sandstrom et al., 2001). Method 9060 (now referred 2060) is was conducted using solid phase extraction and high performance liquid chromatography/mass spectrometry (HPLC/MS) (Furlong et al., 2001). These methods were used to expand information on occurrence of pesticides and degradation products.

- For Method 9060, the data from March 1, 1999 to December 31,1999 have been flagged with supplemental USGS data quality (Written Communications from Joel Blomquist, USGS 9/23/02). The flagging was performed because, in 1999, the analytical demand for Method 9060 exceeded the instrumental analysis capacity. This delay led to long-storage times (180 days) in refrigerators of unextracted samples. Interpretation of the 1999 data requires careful consideration of median half-life of the pesticides during storage of unquenched samples with respect to sample holding times.

- The qualified “estimate” designation, according to USGS protocol, has been extended for data from USGS Method 9060 to account for background concentrations of pesticides in blank water samples (Verbal Communication J. Blomquist, 10/7/02). Because background concentrations in blank water samples approached minimum reporting limits (<0.003 ug/L) for several compounds, the qualified estimate designation (E) is limited to concentrations greater than or equal to 0.003 ug/L. Concentrations below 0.003 ug/L are not considered as estimated concentrations. This designation was adopted to ensure reliable estimates of detections above background concentrations.

Methods of Data Analysis

Data from USGS/EPA Reservoir Monitoring Data (Blomquist et al., 2001) were reformatted in an a spreadsheet to accommodate formatting requirements for Statistical Analysis Systems (SAS is a Trademark of SAS Institute. Inc., Cary NC). Sampling dates in the original data set were modified to facilitate translation of date variables. After the modification step, EXCEL data sets for USGS schedules 2001, 9060, and 9002 were merged into a common data set using a SAS program.

Summary Statistics

Summary statistics, including the mean, median, standard deviation, minimum, and maximum pesticide concentrations in raw and finished water samples, were determined using Statistical Analysis Systems (SAS) procedures.

Pesticide Concentration Difference for Raw and Finished Water Samples

Raw water removal percentages were not calculated because of their known instability in finished water, low detection frequencies, and low concentrations in raw and finished water samples.

Assessment Criteria for Assessing Pesticide Transformation

A set of criteria were used to identify possible pesticide transformation during water treatment.

- ❑ Pesticide degradation products detected in only finished water samples.
- ❑ Parent pesticides in only raw water samples.
- ❑ Co-occurrence of parent pesticides in only raw water samples and detection of degradation product in only finished water samples for the same paired water sample.
- ❑ Low recoveries of matrix spikes from finished water in combination with high recoveries in matrix spikes from raw water.

The premise is that at least one of these conditions may indicate possible pesticide transformation during water treatment.

Water Treatment Trains and Basic Water Quality Data

Although the water quality parameters, including pH, hardness, and total organic carbon, varied among the 12 reservoirs (Table II.E.3.6), the physical construct of the treatment train processes was similar.

Source Water → Prechlorination (Preoxidation) → Coagulation and Clarification → Filtration → Post Oxidation → Clear well

Table II.E.3.6: Average Water Quality Parameters for Raw Water at Candidate Reservoirs

Water Systems	Avg Flow Through Time (hr)	Water Quality Properties			
		pH	Alkalinity mg/L as CaCO3)	Hardness (mg/L as CaCO3)	TOC* (mg/L)
MO	26	7.9 - 9.2	63-120	90 - 145	4.7
TX	10	7.7	100	108	4-8
OH	23	7.7	95	126	5.2
OK	NA	7.9-8.8	137	150	5.8
CA	3.25	7.5	91	250	6-8
IN	8.75	8.2	128	200	4
SD	12-13	9.2	32	NA	NA
SC	4	6.9	17	15	3.8
NC	NA	7	12	NA	NA
LA	NA	NA	NA	NA	NA
NY	0.29	7.8-9.0	40-100	140	4.4
PA	7-9	7.2	7.2	172	2-3

NA-Not available
* TOC= Total Organic Carbon

The average water flow-through time at each treatment plant was less than 24 hours. The most common treatment practices included prechlorination and post disinfection, coagulation, and pH adjustment processes. Chlorine and chlorine dioxide were the most common disinfectants used in the prechlorination process, while chlorine and chloramines were the most common disinfectants used in the post disinfection process. The most common coagulants used in the treatment trains were aluminum salts and polymers. The data also shows that pH was adjusted by adding lime and sodium hydroxide. Several of the treatment plants used activated carbon in the treatment train. Powdered activated carbon was used in the PA, NY, SC and , IN water utilities, while GAC was used at the MO, OK and OH water utilities.

Monitoring Results for Carbamate Pesticides

Twenty-eight carbamates pesticides and their degradation products were analyzed in the reservoir monitoring study (Table II.E.3.7).

Table II.E.3.7. Selected carbamate pesticides and their degradation products included in the reservoir study, USGS Analytical Schedules.

Pesticide	IUPAC Name	Degradates
Alidcarb	2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxim	Aldicarb sulfone, Aldicarb sulfoxide
Carbaryl	1-naphthyl methylcarbamate	1-naphthol, 1,4-naphthoquinone
Molinate	S-ethyl azepane-1-carbothioate	

Table II.E.3.7. Selected carbamate pesticides and their degradation products included in the reservoir study, USGS Analytical Schedules.

Pesticide	IUPAC Name	Degradates
Methomyl	S-methyl-(EZ)-N – (methyl-carbamoyloxy)thioacetimidate	Methomyl oxime
Triallate	S-2,3,3-trichloroallyl di-isopropylthiocarbamate	
Butylate	S-ethyl di-isobutylthiocarbamate	
Oxamyl	N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide	Oxamyl oxime
Pebulate	S-propyl butyl(ethyl)thiocarbamate	
Methiocarb	4-methylthio-3,5-xylyl methylcarbamate	
Propoxur	2-isopropoxyphenyl methylcarbamate	
Bendiocarb	2,3-isopropylidenedioxyphenyl methylcarbamate	
Thiobencarb	S-4-chlorobenzyl diethyl(thiocarbamate)	
Cycloate	S-ethyl cyclohexyl(ethyl)thiocarbamate	
Benomyl	methyl-1-[(butylamino)carbonyl]-H-benzimidazol-2-ylcarbamate	
Propham	isopropyl phenylcarbamate	
Carbufuran	2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate	3-hydroxycarbofuran

Quality Assurance and Quality Control Assessment

The carbamate pesticides and their degradation products were analytes on the 2001, 9002, and 9060 USGS analytical schedules. Methods 9002 and 9060 were undergoing QA/QC testing during the monitoring program.

In 1999, water samples for Method 9060 were stored for extremely long periods of time (median holding time of 90 days) prior to extraction (Written Communications from Joel Blomquist, USGS 9/23/02). The USGS conducted a comparison of storage times with median half-lives in organic blank water, ground water, and surface water. The data indicated that the carbamate pesticides and their degradation products measured by Method 9060 have median half-lives ranging from 4.5 days for methomyl oxime to 28.9 days for propham, which are much shorter than the median sample holding time of 90 days in 1999. This long median storage time relative to the median half-lives is expected to create a systematic bias toward lower concentrations. Any detections in raw and finished water samples, however, should be considered as strong evidence of pesticide occurrence. Reliable quantification of carbamate concentrations in finished water may be compromised if carbamate pesticides undergo oxidation and hydrolysis in finished drinking water.

For the carbamate pesticides, the mean recovery in raw water, ranged from 2% - 140%, the maximum recovery ranged from 17% - 194%, and the minimum recovery ranged from 0% - 96% (Table II.E.3.8). For finished water, the mean recovery ranged from 1% - 134%, the maximum recovery ranged from 9% - 195%, and the minimum recovery ranged from 0% - 72%. The mean recovery values for the carbamate pesticides in finished water samples were significantly lower (P□0.05; t-test) than the mean recovery values for the raw water samples.

Table II.E.3.8: Summary statistics of fortified laboratory set and matrix samples for carbamate pesticides from USGS methods 2001 and 9060 (decimal percentage)

Compound	No. of Samples	Mean % recovery	Standard Deviation	Maximum Recovery	Median Recovery	Minimum Recovery	Schedule Number
Raw Water Samples							
Propoxur	31	78%	19%	103%	82%	29%	9060
3-Hydroxy-carbofuran	32	78%	23%	116%	83%	28%	9060
Aldicarb	32	11%	15%	49%	2%	0%	9060
Aldicarb sulfone	32	23%	31%	179%	17%	0%	9060
Aldicarb sulfoxide	32	36%	23%	83%	40%	0%	9060
Bendiocarb	32	69%	30%	123%	80%	0%	9060
Benomyl	32	73%	37%	148%	77%	0%	9060
Butylate	34	124%	30%	192%	115%	86%	2001
Carbaryl	23	139%	30%	185%	142%	88%	2001
Carbofuran	23	140%	28%	194%	142%	96%	2001
Carbofuran	32	84%	21%	124%	91%	29%	9060
Imidacloprid	31	124%	37%	193%	131%	29%	9060
Methomyl	32	77%	30%	144%	78%	0%	9060
Molinate	34	106%	22%	190%	100%	86%	2001
Oxamyl	32	62%	31%	116%	68%	0%	9060
Oxamyl oxime	31	2%	4%	17%	0%	0%	9060
Triallate	33	105%	17%	174%	104%	82%	2001
Finished Water Samples							
Propoxur	28	74%	22%	101%	80%	0%	9060
3-Hydroxy-carbofuran	30	71%	28%	117%	79%	0%	9060
Aldicarb	30	4%	11%	56%	0%	0%	9060
Aldicarb sulfone	30	12%	12%	39%	6%	0%	9060
Aldicarb sulfoxide	30	29%	40%	142%	10%	0%	9060
Bendiocarb	30	63%	31%	109%	77%	0%	9060
Benomyl	30	35%	45%	122%	3%	0%	9060
Butylate	31	31%	50%	153%	0%	0%	2001
Carbaryl	21	122%	41%	163%	135%	26%	2001
Carbofuran	26	134%	32%	189%	132%	63%	2001
Carbofuran	30	75%	24%	104%	81%	0%	9060
Imidacloprid	30	113%	36%	148%	123%	0%	9060
Methomyl	30	27%	34%	100%	7%	0%	9060
Molinate	31	26%	42%	111%	0%	0%	2001
Oxamyl	30	48%	32%	99%	54%	0%	9060
Oxamyl oxime	28	1%	3%	9%	0%	0%	9060
Triallate	31	41%	43%	117%	18%	0%	2001

Summary Statistics

The carbamate pesticides and their degradation products exhibited extremely low detection frequencies in raw and finished water samples (Table II.E.3.9). Out of the 28 compounds analyzed by USGS Methods 2001, 9002, 9060, 18 carbamate pesticides or degradation products were detected. The summary statistics were identified by analytical schedules because several carbamate pesticides are analytes on the Method 9060 analytical schedule. As previously mentioned, the data for Method 9060 in 1999 should be considered as minimum concentrations. Additionally, the lack of a detection is not conclusive evidence that the compound was not present because carbamates are unstable in finished water samples.

Other considerations are associated with analytical recoveries of the carbamates. There was a difference in analytical recovery of carbamate pesticides between raw and finished water, with lower recoveries lower in the finished water. For USGS Method 2001, carbaryl and carbofuran were considered permanently qualified estimates because of variable recoveries (Zaugg, et al. 1995). Aldicarb, aldicarb sulfone, aldicarb sulfoxide, and oxamyl oxime were classified as qualified estimates for Method 9060 because recoveries were biased outside the acceptable range of median recoveries (< 60% and >120%) (Furlong et al., 2001) The USGS defines estimated concentrations when low analytical recoveries are observed or when qualitative detections of concentrations are less than the statistically determined limit of detection (LOD).

Table II.E.3.9: Summary Table for Detections of Carbamates and their Degradation Products

Pesticide	schedule	Raw Water					Finished Water				
		N	No. detects	Pct detects	Max Conc. (ug/L)	Mean Conc. (ug/L)	N	No. detects	Pct detects	Max Conc. (ug/L)	Mean Conc. (ug/L)
1,4-Naptho-quinone	9002	316	3	0.95%	0.0054	0.0036	220	1	0.45%	0.0025	0.0025
1-Napthol	9002	316	3	0.95%	0.2280	0.0806	220	0			
3-Hydroxy-carbofuran	9060	311	0				224	1	0.45%	0.0094	0.0094
3-keto-carbofuran	9060	311	0				224	0			
4-Chlorobenzyl-methyl sulfo	9002	316	0				220	0			
Aldicarb	9060	311	0				224	0			
Aldicarb sulfone	9060	311	1	0.32%	0.0074	0.0074	224	0			
Aldicarb sulfoxide	9060	311	0				224	0			
Bendiocarb	9060	311	0				224	1	0.45%	0.0042	0.0042
Benomyl	9060	309	20	6.47%	0.0382	0.0247	223	2	0.90%	0.2150	0.1102
Butylate	2001	323	1	0.31%	0.0022	0.0022	227	0			
Carbaryl	2001	323	7	2.17%	0.0465	0.0137	227	2	0.88%	0.0041	0.0035
	9060	311	2	0.64%	0.0063	0.0059	224	0			
Carbofuran	2001	323	2	0.62%	0.0188	0.0155	227	3	1.32%	0.0095	0.0082
	9060	311	2	0.64%	0.0100	0.0074	224	1	0.45%	0.0041	0.0041
Cycloate	9002	316	0				220	0			
	9060	311	0				224	0			
EPTC	2001	323	25	7.74%	0.0373	0.0154	227	11	4.85%	0.0286	0.0135

Table II.E.3.9: Summary Table for Detections of Carbamates and their Degradation Products

Pesticide	schedule	Raw Water					Finished Water				
		N	No. detects	Pct detects	Max Conc. (ug/L)	Mean Conc. (ug/L)	N	No. detects	Pct detects	Max Conc. (ug/L)	Mean Conc. (ug/L)
Methiocarb	9060	311	0				224	0			
Methomyl	9060	311	0				224	0			
Methomyl oxime	9060	311	0				224	0			
Molinate	2001	323	1	0.31%	0.0023	0.0023	227	0			
Oxamyl	9060	311	0				224	0			
Oxamyl oxime	9060	307	0				220	2	0.91%	0.0139	0.0135
Pebulate	2001	323	0				227	0			
Propham	9060	311	0				224	0			
Propoxur	9060	307	1	0.33%	0.0048	0.0048	220	1	0.45%	0.8230	0.8230
Thiobencarb	2001	323	0				227	0			
Triallate	2001	323	1	0.31%	0.0022	0.0022	227	0			

Parent carbamate compounds found in raw water samples included benomyl, butylate, carbaryl, carbofuran, EPTC, molinate, propoxur, and triallate. EPTC had the highest detection frequency, 7.74% (25 detections in 323 samples) in raw water and 4.85% (11 detections in 227 samples) in finished water. With the exception of benomyl and EPTC, the reported concentrations for parent carbamates and their degradation products were considered qualified estimates.

Parent carbamate detections were found in the raw water of the OK, PA, SC, MO, NC, LA, NY, and SD water treatment plants (Table II.E.3.10). In finished water, parent carbamate detections were found in OK for bendiocarb, MO and NY for benomyl, MO and PA for carbaryl, PA for carbofuran (Method 2001 and 9060), and PA and SD for EPTC. No carbamate detections were found in the TX water treatment plant.

Table II.E.3.10: Summary statistics for water type, year, and water utility for carbamate pesticides and their degradation products (ug/L)

Chemical	schedule	State	Year	Water Type	Nondetects		Conc. Estimated		Conc. Measured	
					No.	LOD Range	No.	Range	No.	Range
1,4-Napthoquinone	9002	OK	2000	Raw	19	0.008	1	0.0054	.	.
	9002	PA	2000	Finish	10	0.008	1	0.0025	.	.
	9002	PA	2000	Raw	10	0.008	1	0.0037	.	.
	9002	SC	2000	Raw	23	0.008	1	0.0017	.	.
1-Napthol	9002	MO	1999	Raw	19	0.005	1	0.228	.	.
	9002	PA	2000	Raw	10	0.005	1	0.006	.	.
	9002	SC	1999	Raw	19	0.005	1	0.0077	.	.
3-Hydroxy-carbofuran	9060	NC	1999	Finish	9	0.0623	1	0.0094	.	.
Aldicarb sulfone	9060	NY	1999	Raw	9	0.16	1	0.0074	.	.
Bendiocarb	9060	OK	1999	Finish	9	0.0612	1	0.0042	.	.
Benomyl	9060	MO	2000	Finish	15	0.0219	1	0.215	.	.
	9060	NY	2000	Finish	9	0.0219	1	0.0053	.	.

Table II.E.3.10: Summary statistics for water type, year, and water utility for carbamate pesticides and their degradation products (ug/L)

Chemical	schedule	State	Year	Water Type	Nondetects		Conc. Estimated		Conc. Measured	
					No.	LOD Range	No.	Range	No.	Range
	9060	OK	1999	Raw	13	0.0219	7	0.0187-0.0382	.	.
	9060	OK	2000	Raw	12	0.0219	6	0.0243-0.0363	1	0.0242
	9060	PA	1999	Raw	11	0.0219	2	0.0259-0.0301	.	.
	9060	PA	2000	Raw	8	0.0219	3	0.0089-0.0163	.	.
	9060	SC	2000	Raw	23	0.0219	1	0.006	.	.
Butylate	2001	NY	2000	Raw	10	0.002	1	0.0022	.	.
Carbaryl	2001	MO	1999	Finish	10	0.003	1	0.0041	.	.
	2001	MO	2000	Raw	18	0.003-0.041	1	0.008	.	.
	2001	NC	1999	Raw	9	0.003	1	0.0039	.	.
	2001	OH	2000	Raw	9	0.003	1	0.012	.	.
	2001	PA	2000	Finish	10	0.003-0.041	1	0.0028	.	.
	2001	PA	2000	Raw	7	0.003-0.041	4	0.0054-0.0465	.	.
	9060	PA	2000	Raw	10	0.0628	1	0.0054	.	.
	9060	SC	1999	Raw	19	0.0628	1	0.0063	.	.
Carbofuran	2001	PA	2000	Finish	8	0.003-0.03	3	0.0075-0.0095	.	.
	2001	PA	2000	Raw	9	0.003-0.05	2	0.0121-0.0188	.	.
	9060	PA	2000	Finish	9	0.0566	1	0.0041	.	.
	9060	PA	2000	Raw	9	0.0566	2	0.0048-0.01	.	.
EPTC	2001	LA	2000	Raw	10	0.002-0.03	1	0.011	.	.
	2001	NY	1999	Raw	6	0.002-0.01	.	.	5	0.0101-0.0373
	2001	NY	2000	Raw	3	0.002-0.007	3	0.0021-0.0033	5	0.0057-0.0132
	2001	PA	2000	Finish	10	0.002	1	0.0015	.	.
	2001	PA	2000	Raw	10	0.002	1	0.0017	.	.
	2001	SD	1999	Finish	6	0.002	.	.	4	0.0128-0.0286
	2001	SD	1999	Raw	6	0.002	.	.	4	0.0134-0.0362
	2001	SD	2000	Finish	5	0.002	.	.	6	0.0048-0.0186
	2001	SD	2000	Raw	5	0.002-0.01	.	.	6	0.0093-0.0302
Molinate	2001	SC	1999	Raw	20	0.004	1	0.0023	.	.
Oxamyl oxime	9060	OK	1999	Finish	8	0.0644	2	0.0131-0.0139	.	.
Propoxur	9060	IN	1999	Finish	10	0.0594	.	.	1	0.823
	9060	MO	1999	Raw	18	0.0594	1	0.0048	.	.

Table II.E.3.10: Summary statistics for water type, year, and water utility for carbamate pesticides and their degradation products (ug/L)

Chemical	schedule	State	Year	Water Type	Nondetects		Conc. Estimated		Conc. Measured	
					No.	LOD Range	No.	Range	No.	Range
Triallate	2001	CA	1999	Raw	7	0.001	1	0.0022	.	.

With the exception of 1,4-napthoquinone, the degradation products of carbamates were detected in finished or raw water samples. There was no evidence of co-occurrence of parent carbamate pesticides and degradation products in raw and finished water samples. Although 3-hydroxycarbofuran and oxamyl oxime were detected in finished water samples, there are no concurrent detections of carbofuran or oxamyl in “paired” raw water samples to conclude transformation during treatment. Although 1,4-napthoquinone was detected in a finished and raw water at the PA site. There was no co-occurrence of carbaryl in the paired finished or raw water sample to associate 1,4-napthoquione formation to carbaryl degradation. Because aldicarb sulfone (an oxidative degradation product of aldicarb) and 1-napthol (hydrolysis degradate of carbaryl) were only detected in raw water, they are most likely environmental degradation products.

Results and Discussion

The USGS monitoring data for selected drinking water treatment plants on reservoirs indicates a low detection frequency (<1% of samples) of carbamate pesticides in raw and finished drinking water. The carbamates with the highest detection frequencies (6.5 to 7% of samples) in raw water samples were benomyl and EPTC. In finished water samples, carbofuran and EPTC had the highest detection frequencies (1 to 4% of samples). Because the monitoring program was not targeted to carbamate use areas and sample handling issues, the reported detection frequencies and concentrations may underestimate the occurrence for carbamates in raw and finished drinking water.

Because carbamate degradation products were detected in both raw and finished water samples, carbamate degradation products were formed through environmental processes. However, laboratory studies indicate that degradation products can be formed through water treatment processes.

The uncertainties associated with monitoring data limit a clear definitive analysis of water treatment effects.

6. LITERATURE CITED

Bloomquist, J.D., J. M. Denis, J. K. Cowles, J. A. Hetrick, R. D. Jones, and N. B. Birchfield. 2001. Pesticides in Selected Water-Supply Reservoirs and Finished Drinking Water, 1999-2000: Summary of Results from a Pilot Monitoring Program. USGS Open-File Report 01-456.

Blomquist, J. D., 2001. Transmittal of Preliminary Digital Data Sets From the USGS-USEPA Program “Pesticides in Water-Supply Reservoirs and Finished Drinking Water-A Pilot Monitoring Program.” USGS, Baltimore, MD.

Blomquist, J.D., Personal Communications on April 28, 2000.

Furlong, E. T., D. B. Anderson, S. L. Werner, P. P. Soliven, L. J. Coffey, and M. R. Burkhardt. 2001. Methods of analysis by the U. S. Geological Survey National Water Quality Laboratory-Determination of pesticides in water by graphitized carbon-based solid-phase extraction and high-performance liquid chromatography/mass spectrometry. USGS Water Resource Investigations Report 01-4134.

Ikehata, K. and M. Gamal El-Din, 2005. Aqueous Pesticide Degradation by Ozonation and Ozone-Based Advanced Oxidation Processes: A Review (Part 1). Ozone Science and Engineering. 27:83.

Mason, Yael, E. Choshen, and C. Chaim Rav-Acha. 1990. Carbamate Insecticides: Removal from Water by Chlorination and Ozonation. Wat Res. 24:11-21.

Miles, C., Oshiro. 1990. Environ. Toxicol. Chem. 9:535.

Miles, Carl. J, M. L. Trehy, and R. A. Yost. 1988. Degradation of N-methylcarbamate and Carbamoyl Oxime Pesticides in Chlorinated Water. Bull. Environ. Contam. Toxicol. 41:838-843.

Miles, Carl J. 1991. Degradation of Aldicarb, Aldicarb Sulfoxide, and Aldicarb sulfone in Chlorinated Water. Environ. Sci. Technol. 25:1774-1779.

Miltner, R. J., D. B. Baker, T. F. Speth, and C.A. Fronk. 1989. Treatment of Seasonal Pesticides in Surface Waters. Jour. AWWA. 81:43.

Miltner, Richard.J. June, 2005. Status Report: Summary of ORD/WSWRD Studies to Control n-methyl Carbamates in Drinking Water. USEPA/ORD/ WSWRD. Cincinnati, OH

Sandstrom, M. W., M. E. Stroppel, W. T. Foreman, M. P. Schroeder, 2001. Methods of analysis by the U. S. Geological Survey National Water Quality Laboratory-Determination of moderate use pesticides and selected degradates in water by C-18 solid phase extraction and gas chromatography/mass spectrometry. USGS Water Resource Investigations Report 01-4098.

Speth, Thomas F. and R. Pisigan. 2001. Softening and Chlorination Screening Studies for Selected Pesticides. USEPA/ORD/ WSWRD. Cincinnati, OH.

Speth, T.F. and R.J. Miltner. 1998. Technical Note: Adsorption Capacity of GAC for Synthetic Organics, Jour. AWWA. 90:171.

Speth, T.F. and R.J. Miltner. 1990. Technical Note: GAC Adsorption Capacity for SOCs. Jour. AWWA. 82:72.

Summers, R.S., S.M. Hooper, H.M. Shukairy, G. Solarik, and D.M. Owen. 1994. Assessing DBP Yield under Uniform Conditions. Jour. AWWA. 88:6:80.

U.S. EPA, 2000. Progress Report on Estimating Pesticide Concentrations in Drinking Water and Assessing Water Treatment Effects on Pesticide Removal and Transformation: A Consultation. FIFRA Scientific Advisory Panel (SAP), September 29,2000. http://www.epa.gov/ scipoly/2000/september/sept-00–sap-dw-0907.pdf).

U.S. EPA., 2001. Office of Pesticide Programs Science Policy: The Incorporation of Water Treatment Effects on Pesticide Removal and Transformations in Food Quality Protection Act (FQPA) Drinking Water Assessments. USEPA/OPP, Washington, DC. http://www.epa.gov/oppfead1/trac/science/water_treatment.pdf

Zaugg, S. D. , M. W. Sandstrom, S. G. Smith, and K. M. Fehlberg. 1995. Methods of analysis by the U. S. Geological Survey National Water Quality Laboratory-Determination of pesticides in water by C-18 solid phase extraction and capillary-column gas chromatography/mass spectrometry with selected ion monitoring. USGS Open File Report 95-181.

Appendiex E-4 N-methyl Carbamate Usage Estimates

The Biological and Economic Analysis Division (BEAD) of the USEPA Office of Pesticide Programs compiled information on key aspects of the typical usage and timing of application of selected carbamate insecticides, as part of EPA's ongoing cumulative risk assessment of these pesticides. The Environmental Fate and Effect Division (EFED) requested this information in order to more realistically model drinking water risks posed by the carbamates.

The drinking water model requires the following information for each unique crop treated with one or more carbamates in the geographic area being modeled: acres planted; and for each carbamate used on the crop, total pounds, percent of crop treated, application rate, number of applications, and application timing. The carbamate pesticides included in this analysis are aldicarb, carbaryl, carbofuran, formetanate, methiocarb, methomyl, oxamyl, pirimicarb, propoxur, and thiodicarb.

Much of this information is not easily available, or does not exist at the geographic scale (i.e., the county level) required by the drinking water model. BEAD used the best available information, and substantial effort to compile and develop these data. The general method followed is described below.

Methods

In general, data were collected and developed sequentially in three steps. First, geographic areas of interest were identified. Next, target crops were identified and carbamate usage was estimated in each area. Finally, the timing of carbamate applications was determined. Each of these steps are described in detail below.

Identification of Geographic Areas of Interest

Chemical use information, developed from agricultural surveys, is uneven in its geographical distribution. Often counties within a given state do not appear in surveys because of the relatively small number of samples used in the surveys. Therefore to overcome this problem, data from geographic areas larger than these counties were used in this analysis to extrapolate usage from areas with data to the areas of interest that lack carbamate use data.

Thirteen subregions (comprised of 28 counties) were identified by EFED as geographic areas where this class of pesticides appeared to pose significant risks to drinking water. Next, additional geographic areas were identified in preparation to estimate carbamate usage. Counties adjacent to the 13 subregions were identified to form a "county cluster" and corresponding Crop Reporting Districts (CRD) were identified. The final result was a series of geographic areas of increasing size (Number) as follows: County (28), Subregion

(13), County Cluster (13), Crop Reporting District (13), State (12), Region (8). The Subregion is the geographical unit that will be used by EFED in its analysis.

Determination of Crops and Carbamate Usage

The determination of the crop/carbamate combination, and the associated usage information, in each subregion was a multi-step process. After compiling the available information, adjustments were made for uneven survey coverage, multiple data sources, multiple years of data, and chemical toxicity. These adjustments are described in detail below.

1. Compile Available Usage Data – For each of the geographic areas identified above available information compiled for the following parameters: acres planted; and for each carbamate used on the crop, total pounds, percent of crop treated, application rate, and number of applications.

2. Adjust Usage for Limited Survey Coverage – Carbamate usage at the county cluster, CRD and state levels (for those crops reporting usage in the counties of interest) were adjusted by multiplying by the proportion of these crops that was grown in the counties within the regions of concern.

   For example, if 10,000 acres were grown in the counties of interest and 50,000 acres in the CRD then the usage reported for the CRD would be divided by 5 before being averaged with the acreage estimates from the other three levels. This ensured that figures were adjusted to more accurately reflect what was being used within these regions. Acres treated data were obtained from Doane's databases for all states involved, and also weighted by multiplying the proportion of crops grown within the specific regions of concern.

Table II.E.4.1. Example of estimated carbamate usage adjusted for limited survey area.

Parameter	Acres grown	Pounds used	Acreage ratio	Adjusted pounds
Subregion	10,000	5,000	1.00	5,000
County cluster	20,000	15,000	0.50	7,500
CRD	30,000	30,000	0.333	10,000
State	100,000	100,000	0.10	10,000
Estimated Usage for Subregion				8,125

3. Adjust Usage for Multiple Data Sources – USDA NASS data for state-level usage was also compiled for pounds of each carbamate used as well as application rates (in lbs applied/acre). Following this, the Doane's and NASS data on pounds of carbamate used

were averaged for the state-level estimates of usage. After usage estimates were obtained from Doane, NASS data where available, was used to adjust the estimates, using equal weights for the Doane and NASS state usage estimates.

For example, if the procedure above estimated use in the counties of interest of 10,000 pounds, then - based on Doane's reported state-level use of 100,000 pounds and NASS's reported state-level use of 120,000 pounds - the estimated use in the counties of interest would be adjusted to 11,000 pounds.

4. Average Usage Data Over Multiple Years – Carbamate usage (in lbs of each carbamate applied) was averaged for the years 1998 - 2002 for the following geographic areas: State, Crop Reporting District, County Cluster, and Subregion.

5. Determine Crop / Carbamate Combinations of Interest – The resulting carbamate usage (in lbs of each carbamate applied) was multiplied by the Relative Potency Factor to adjust for the differing toxicities of each carbamate. The final crop/carbamate list that resulted from the above analysis was then ranked according to the "toxicity-adjusted" pounds of carbamates used.

   Those combinations comprising 95 % of the cumulative carbamate usage were selected for the tables included in this document. The complete list of all crops/chemicals identified by the usage analysis, along with all usage figures, is available in the Excel spreadsheet in Appendix 1.

6. Final Adjustments – Data from the California Department of Pesticide Regulation (CDPR) indicated that in California, tangerines and nectarines were also crop sites where some carbamates were applied. Therefore, BEAD added these sites to the final crop/carbamate list. Finally, crops with no identified carbamate use in the California data base were dropped from the analysis.

Determination of Timing of Carbamate Applications

Once the crop / chemical combinations were identified in a given subregion, the period of the crop cycle when each carbamate is typically applied, and the dates of application were identified. Where the information was available, dates of application were further characterized as being those when carbamate applications were likely to be most frequent (or "active") and those for the total time period when the carbamate could reasonably be used (essentially, the time period when the target pests were present in the crop). It should be noted that typically, all the carbamates discussed here target multiple pests or ones that can occur multiple times during a given crop's growing season, so applications often occur over a broad time period. Where possible, the number of applications that might occur and the type of formulation that is likely to be used has been noted in the "Comments" column. It should also be noted that the number of carbamate applications for all crop/chemical combinations was also estimated using available databases. These estimates are also included in the tables that follow. For the crop/chemical combinations of interest, BEAD analysts used a variety of methods to determine most likely application dates for each chemical on each crop in each location. Biologists frequently combined information from several sources and used their best professional judgement to estimate dates of application.

For the California carbamate/crop use patterns, actual application dates from the California Department of Pesticide Regulation Pesticide Information Portal (CalPIP) for the counties of interest were used. In other states, biologists relied on a wide variety of references, including those listed in the table below:

Table II.E.4.2. Data Sources Used to Determine Carbamate Dates of Application.

Data Source	Use
Usage Data	Used to determine major pests and approximate time of application (e.g., preplant, at plant, at cultivation, pinhead to squaring). Doane data and various state surveys were frequently used.
Efficacy Data	Dates of application from efficacy studies used as surrogates for actual application dates. Efficacy studies were frequently obtained from Arthropod Management Tests
USDA Planting, Bloom, and Harvest Dates	Used to define limits of application dates. Often used in conjunction with crop phenology information to approximate dates of application and to extrapolate the dates of application from one state to another.
Crop Profiles	Used to identify major pests and approximate timing of applications.
Crop Timelines	Used to approximate timing of applications.
Crop Weather Reports	Used to estimate dates of phenological events (e.g., planting, squaring) for localized areas.
Pest Biology Information	Dates of pest emergence used to estimate timing of applications.

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
1a: Southest Region: NC East - Edgecombe, Halifax and Northampton Counties											
Cotton	**Aldicarb**	**40,000**	**40,000**	**110,000**	**42.7**	0.73	**1.00**	**56.9%**	**54.6%**	May1-15	Apr21-Jun8
Peanuts	**Aldicarb**	**30,000**	**30,000**	**40,000**	**62.1**	**1.08**	**1.00**	**42.6%**	**40.9%**	Apr10-Apr20	Apr10-May10
Peanuts	Oxamyl	800	177	40,000	1.6	1.25	1.00	0.3%	1.1%		
Tobacco	Aldicarb	100	100	8,600	0.6	1.64	1.03	0.1%	0.1%		
Peanuts	Methomyl	500	33	40,000	3.0	0.38	1.00	0.0%	0.7%	May30-Sep15	May30-Oct15
Tobacco	Carbofuran	100	24	8,600	0.1	4.00	2.00	0.0%	0.1%		
Beans, Snap	Methomyl	100	7	1,100	39.7	0.23	1.37	0.0%	0.1%	Apr15-Jun30	Mar30-Jun30
Tobacco	Methomyl	100	7	8,600	2.4	0.35	1.32	0.0%	0.1%	Apr30-Aug15	Apr15-Sep30
Cucumber	Carbaryl	700	6	3,600	6.7	1.00	2.89	0.0%	1.0%	Apr25-Jun1; May30-Jul15	Apr25-Jun1; May30-Jul15
Cotton	Carbaryl	300	2	110,000	0.4	0.75	1.00	0.0%	0.4%		
Beans, Snap	Carbaryl	200	2	1,100	19.2	1.00	0.84	0.0%	0.3%		
Peanuts	Carbaryl	200	2	40,000	0.7	0.57	1.00	0.0%	0.3%		
Cotton	Thiodicarb	100	1	110,000	0.2	0.60	1.00	0.0%	0.1%		
Tobacco	Carbaryl	100	1	8,600	0.5	1.09	2.49	0.0%	0.1%		
1b: Southest Region: Georgia East - Burke County											
Cotton	**Aldicarb**	**4,500**	**4,500**	**40,000**	**21.9**	**0.59**	**1.00**	**69.2%**	**65.2%**	May1-15	Apr21-Jun8
Peanuts	**Aldicarb**	**2,000**	**2,000**	**5,800**	**33.5**	**0.99**	**1.03**	**30.8%**	**29.0%**	Apr10-Apr20	Apr10-May10
Pecans	**Carbaryl**	400	3	1,500	7.7	1.84	1.80	0.0%	**5.8%**	Aug1-Sep20	Aug1-Sep20
2a: Florida Region: South Florida - Palm Beach County											
Oranges	**Aldicarb**	20,000	20,000	20,000	14.3	3.85	1.46	**73.4%**	**27.4%**	Bloom-fruit maturity	Apr-Nov
Grapefruit	**Aldicarb**	2,700	2,700	5,200	8.7	3.89	1.50	**9.9%**	**3.7%**	Bloom-fruit maturity	Apr-Nov
Sweet Corn	**Methomyl**	20,000	1,300	20,000	40.4	0.35	7.63	**4.8%**	**27.4%**	Apr1-Jul30; Nov15-Dec30	Apr1-Jul30; Nov15-Dec30

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Sugarcane	**Carbofuran**	3,800	912	280,000	1.9	0.72	1.00	**3.3%**	**5.2%**	Jun20-Aug20	May22-Oct12
Peppers	**Oxamyl**	2,900	641	6,000	14.9	0.51	6.42	**2.4%**	**4.0%**	Mar-Jun	Feb-Nov
Cucumber	**Oxamyl**	2,000	442	4,600	50.4	0.55	1.58	**1.6%**	**2.7%**	Oct-May	Oct-May
Cucumber	**Carbofuran**	1,700	408	4,600	30.5	1.20	1.00	1.5%	**2.3%**	Oct20-Mar15	Sep1-Apr30
Sweet Corn	**Carbofuran**	1,100	264	20,000	6.7	1.00	1.00	1.0%	1.5%	Aug1-Apr30	Aug1-Apr30
Peppers	**Methomyl**	3,700	241	6,000	15.7	0.62	6.20	0.9%	**5.1%**	Apr1-Jun15	Jan15-Jun30
Cucumber	**Methomyl**	2,600	169	4,600	21.5	0.58	4.48	0.6%	**3.6%**	Apr15-Jun15	Jan30-Jun15
Sweet Corn	**Thiodicarb**	9,700	116	20,000	23.4	0.58	4.38	0.4%	**13.3%**	Apr1-Jul30; Nov15-Dec30	Apr1-Jul30; Nov15-Dec30
Oranges	Oxamyl	100	22	20,000	0.2	0.96	2.53	0.1%	0.1%	Apr,Jun,Aug, Oct	Apr-Aug,Oct
Oranges	Carbaryl	1,300	10	20,000	1.2	3.54	1.44	0.0%	**1.8%**	Mar1-Jun1	Feb1-Dec1
Grapefruit	Carbaryl	1,200	10	5,200	7.0	3.13	1.02	0.0%	1.6%	Mar1-Dec30	can't narrow
Tomatoes	Methomyl	100	7	2,500	2.0	0.48	2.97	0.0%	0.1%		
Cucumber	Carbaryl	200	2	4,600	1.5	0.58	4.70	0.0%	0.3%		
2b: Florida Region: Central Florida - Polk County											
Oranges	**Aldicarb**	30,000	30,000	80,000	7.8	3.85	1.46	**91.0%**	**75.6%**	Bloom-fruit maturity	Apr-Nov
Grapefruit	**Aldicarb**	2,400	2,400	5,800	7.0	3.89	1.50	**7.3%**	**6.0%**	Bloom-fruit maturity	Apr-Nov
Oranges	**Oxamyl**	1,400	309	80,000	0.7	0.96	2.53	0.9%	**3.5%**	Apr,Jun,Aug, Oct	Apr-Aug,Oct
Potatoes	**Aldicarb**	200	200	1,000	6.5	2.55	1.01	0.6%	0.5%	Oct1-Mar1	Sep15-Mar1
Oranges	**Carbaryl**	5,100	41	80,000	1.3	3.54	1.44	0.1%	**12.8%**	Mar1-Jun1	Feb1-Dec1
Grapefruit	Carbaryl	500	4	5,800	2.8	3.13	1.02	0.0%	1.3%	Mar1-Dec30	can't narrow
Watermelon	Carbaryl	100	1	1,600	1.8	0.76	2.64	0.0%	0.3%		
3: Midsouth Region: Louisiana Northeast - Franklin, Madison, and Tensas Counties											

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Cotton	**Aldicarb**	40,000	40,000	280,000	25.2	0.53	1.00	**96.2%**	**76.9%**	May1-15	Apr21-Jun8
Cotton	**Carbofuran**	4,100	984	280,000	3.1	0.44	1.08	2.4%	**7.9%**	Jun24-Aug6	Apr12-Aug21
Cotton	**Oxamyl**	1,000	221	280,000	1.8	0.19	1.11	0.5%	1.9%	May4-Jul20	Apr15-Aug15
Corn	**Carbofuran**	800	192	50,000	1.8	0.85	1.00	0.5%	1.5%	Mar31-Apr21	Mar24-Apr28
Sorghum	**Carbofuran**	500	120	70,000	1.3	0.50	1.00	0.3%	1.0%	Apr20-May22	Apr6-Jun23
Rice	Carbaryl	3,900	31	20,000	15.2	1.45	1.00	0.1%	**7.5%**		
Rice	Carbofuran	100	24	20,000	0.4	0.83	1.00	0.1%	0.2%		
Cotton	**Thiodicarb**	1,600	19	280,000	0.8	0.53	1.42	0.0%	**3.1%**	Jun1-Sep15	May15-Oct1
4: Lower Midwest Region: Texas tip - Cameron and Hidalgo Counties											
Grapefruit	**Aldicarb**	80,000	80,000	20,000	73.1	4.69	1.17	**77.0%**	**52.4%**	Jan1-Apr1	Jan1-Apr1
Cotton	**Aldicarb**	10,000	10,000	130,000	18.6	0.49	1.00	**9.6%**	**6.5%**	Mar10-Jun6	Mar10-Jun30
Grapefruit	**Formetanate**	6,700	4,020	20,000	35.0	0.92	1.00	**3.9%**	**4.4%**	Apr20-May30	Apr1-Jul30
Cotton	**Oxamyl**	10,000	2,210	130,000	18.6	0.23	2.12	**2.1%**	**6.5%**	Mar15-Aug1	Feb20-Sep20
Carrots	**Oxamyl**	8,700	1,923	3,400	91.1	1.25	2.28	**1.9%**	**5.7%**	Aug10-Jan15	Aug10-Jan15
Cotton	**Carbofuran**	7,500	1,800	130,000	8.8	0.55	1.18	**1.7%**	**4.9%**	May28-Jul10	Mar16-Jul25
Peppers	**Oxamyl**	4,300	950	2,800	77.3	1.00	2.00	0.9%	**2.8%**	Jan1-Jun1, Jul1-Oct1	Jan1-Jul1, Jun15-Dec1
Onions	**Oxamyl**	2,500	553	10,000	26.8	0.48	1.42	0.5%	**1.6%**	Oct1-31, Nov1-Apr1	Sep20-Nov30, Oct1-May1
Onions	**Methomyl**	6,200	403	10,000	32.9	0.49	2.83	0.4%	**4.1%**		
Cantaloupe	**Oxamyl**	1,600	354	3,500	22.5	1.76	1.17	0.3%	**1.0%**	Feb15-May15	Feb1-May30
Watermelon	**Oxamyl**	1,600	354	10,000	25.1	0.51	1.04	0.3%	**1.0%**	Jan15-Mar15	Jan15-Apr1

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Cucumber	**Oxamyl**	1,100	243	5,200	31.1	0.66	1.00	0.2%	**0.7%**	Feb1-Mar15, Jul15-Aug15	Jan15-Mar15, Jul1-Aug31
Corn	**Carbofuran**	1,000	240	120,000	1.2	0.71	1.00	0.2%	**0.7%**	Feb10-Mar10; Apr11-May5	Feb1-Mar20; Apr4-May12
Cucumber	**Methomyl**	2,500	163	5,200	34.0	0.47	3.06	0.2%	**1.6%**		
Spinach	**Methomyl**	2,400	156	3,100	85.5	0.45	2.00	0.2%	**1.6%**		
Grapefruit	Oxamyl	700	155	20,000	4.2	0.59	1.39	0.1%	0.5%		
Sorghum	Carbofuran	300	72	250,000	0.3	0.50	1.00	0.1%	0.2%		
Cantaloupe	Methomyl	1,100	72	3,500	47.7	0.39	1.67	0.1%	**0.7%**		
Cabbage	Methomyl	800	52	5,400	13.7	0.57	1.86	0.1%	0.5%		
Peppers	Methomyl	800	52	2,800	3.0	0.60	15.00	0.1%	0.5%		
Carrots	Methomyl	500	33	3,400	33.2	0.45	1.00	0.0%	0.3%		
Watermelon	Carbofuran	100	24	10,000	1.9	0.49	1.00	0.0%	0.1%		
Beans, Snap	Methomyl	300	20	400	51.7	0.49	3.07	0.0%	0.2%		
Watermelon	Methomyl	300	20	10,000	2.2	0.41	2.63	0.0%	0.2%		
Cotton	Methomyl	100	7	130,000	0.2	0.36	1.00	0.0%	0.1%		
Cotton	Carbaryl	700	6	130,000	1.0	0.53	1.01	0.0%	0.5%		
Peppers	Carbaryl	400	3	2,800	3.8	1.00	4.00	0.0%	0.3%		
Watermelon	Carbaryl	200	2	10,000	1.9	0.86	1.25	0.0%	0.1%		
Cotton	Thiodicarb	100	1	130,000	0.1	0.32	1.29	0.0%	0.1%		
Cantaloupe	Carbaryl	100	1	3,500	0.6	0.94	5.24	0.0%	0.1%		
Squash	Carbaryl	100	1	200	35.5	0.78	1.00	0.0%	0.1%		
5a: North/North Central Region: Pennsylvania Central - Adams, Lancaster and York Counties											
Corn	**Carbofuran**	2,200	528	370,000	0.7	0.89	1.00	**32.6%**	**11.7%**	May10-May25; Jun30-Aug26	Apr30-Jun15; Jun15-Sep10
Apples	**Methomyl**	4,700	306	20,000	26.1	0.39	2.86	**18.9%**	**25.0%**	May30-Aug15	May15-Aug30

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Alfalfa	Carbofuran	1,200	288	70,000	2.8	0.61	1.00	17.8%	6.4%	Mar15-Apr15; Mar9-May15; Jun16-Aug8	Mar15-Sep15; Mar1-Jul20; Apr1-Nov10
Sweet Corn	Methomyl	2,200	143	3,800	33.9	0.38	4.47	8.8%	11.7%	Jul15-Sep30	Jun15-Oct15
Pumpkin	Carbofuran	300	72	1,500	24.8	0.81	1.01	4.4%	1.6%	Jun15-Jul1	Jun10-Jul6
Sweet Corn	Carbofuran	300	72	3,800	7.8	1.00	1.00	4.4%	1.6%	Apr25-Jun5	Apr15-Jun15
Apples	Oxamyl	300	66	20,000	2.9	0.60	1.19	4.1%	1.6%	Apr20-Aug30	Apr10-Aug30
Apples	Formetanate	100	60	20,000	0.7	0.85	1.15	3.7%	0.5%	Apr24-May20	Apr16-May24
Apples	Carbaryl	4,700	38	20,000	17.3	1.12	1.52	2.3%	25.0%	Apr20-Aug30	Apr10-Aug30
Peaches	Methomyl	200	13	1,800	9.4	0.43	3.33	0.8%	1.1%	Apr15-Sep5	Apr15-Sep10
Potatoes	Methomyl	200	13	1,900	3.8	0.45	5.00	0.8%	1.1%	Jun15-Sep30	Apr30-Oct30
Sweet Corn	Carbaryl	700	6	3,800	7.4	0.98	2.45	0.3%	3.7%	Jun15-Sep15	Jun15-Oct15
Peaches	Carbaryl	500	4	1,800	9.8	1.33	2.35	0.2%	2.7%	Jun15-Sep30	Apr1-Oct15
Sweet Corn	Thiodicarb	300	4	3,800	5.5	0.58	2.34	0.2%	1.6%	Jul15-Sep30	Jun15-Oct15
Grapes, Wine	Carbaryl	400	3	200	106.9	1.34	1.83	0.2%	2.1%		
Pumpkin	Carbaryl	300	2	1,500	7.5	0.86	3.17	0.1%	1.6%		
Potatoes	Carbaryl	200	2	1,900	9.4	0.75	1.77	0.1%	1.1%		
5b: North/North Central Region: Illinios Central - LaSalle, Livingston and McLean Counties											
Corn	Carbofuran	2,700	648	940,000	0.4	0.67	1.04	86.5%	40.3%	Jun20-Aug16	Jun1-Aug30
Alfalfa	Carbofuran	100	24	10,000	0.6	0.71	1.00	3.2%	1.5%	Apr15-May15	Apr1-Jun1
Sweet Corn	Carbofuran	100	24	4,600	6.2	0.35	1.00	3.2%	1.5%	May1-Jun15	Apr20-Jul1
Beans, Lima	Methomyl	300	20	1,800	13.3	1.05	1.00	2.6%	4.5%	Jun15-Sep30	May20-Oct10
Corn	Carbaryl	2,200	18	940,000	0.2	1.00	1.00	2.3%	32.8%	May15-	May15-

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
										Sep30	Sep30
Sweet Corn	**Carbaryl**	1,100	9	4,600	6.4	1.49	2.61	1.2%	**16.4%**	Jul15-Sep15	Jun15-Oct15
Sweet Corn	Methomyl	100	7	4,600	1.8	0.37	3.00	0.9%	1.5%		
Alfalfa	Carbaryl	100	1	10,000	1.1	0.78	1.16	0.1%	1.5%		
6: North Great Plains Region: Red River Valley - Polk (Minnesota), and Grand Forks and Walsh (North Dakota) Counties											
Potatoes	**Aldicarb**	3,200	3,200	70,000	2.0	2.30	1.00	**44.4%**	**14.7%**	1-Jun	May15-Jun1
Sugar Beets	**Aldicarb**	2,900	2,900	190,000	1.0	1.50	1.00	**40.2%**	**13.4%**	Apr30-Jul20	Apr22-Jul30
Sugar Beets	**Carbofuran**	1,900	456	190,000	1.0	1.00	1.00	6.3%	**8.8%**	Jun1-30	May15-Jul15
Potatoes	**Carbofuran**	1,100	264	70,000	1.0	0.80	2.00	**3.7%**	**5.1%**	May13-24; Jun14-Aug23	May5-Jun1; Jun1-Sep7
Potatoes	**Oxamyl**	800	177	70,000	1.0	0.60	2.00	2.5%	**3.7%**	May30-Aug30	MAy15-Sep15
Sunflowers	**Carbofuran**	500	120	90,000	1.0	0.60	1.00	1.7%	2.3%	May23-Jun4; Jun15-Aug15	May15-Jun13; Jun1-Sep1
Wheat, Spring	**Carbaryl**	11,000	88	690,000	2.0	0.80	1.00	1.2%	**50.7%**	Jun1-Jul15	May15-Jul30
Sunflowers	Carbaryl	100	1	90,000	#N/A	#N/A	#N/A	0.0%	0.5%		
Alfalfa	Carbaryl	100	1	80,000	#N/A	#N/A	#N/A	0.0%	0.5%		
Sugar Beets	Carbaryl	100	1	190,000	#N/A	#N/A	#N/A	0.0%	0.5%		
7: Northwest Region: Washington Central - Franklin and Grant Counties											
Potatoes	**Aldicarb**	120,000	120,000	110,000	36.1	2.89	1.08	**90.3%**	**63.0%**	1-Jun	May15-Jun1
Dry Beans/Peas	**Aldicarb**	6,600	6,600	30,000	17.2	1.20	1.00	**5.0%**	**3.5%**	Apr1-Jul20	beans May10-Jul20; peas Apr1-Jun20
Potatoes	**Carbofuran**	6,100	1,464	110,000	6.9	0.66	1.28	1.1%	**3.2%**		
Onions	**Oxamyl**	6,500	1,437	8,800	36.5	0.97	2.09	1.1%	**3.4%**	Mar15-Apr30; Jun15-Aug30	Mar15-Apr30; May30-Sep30

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Apples	**Formetanate**	1,900	1,140	30,000	5.1	0.97	1.20	0.9%	1.0%		
Potatoes	**Oxamyl**	5,000	1,105	110,000	1.7	1.04	2.65	0.8%	**2.6%**	Apr10-May5; MAy30-Oct15	Mar15-May15; May30-Oct30
Carrots	**Oxamyl**	2,100	464	6,500	8.8	0.99	3.68	0.3%	**1.1%**	Apr1-Jun15	Apr1-Jun15
Beans, Lima	**Methomyl**	3,800	247	4,900	43.3	0.90	2.00	0.2%	**2.0%**	May30-Sep30	May15-Oct15
Apples	**Carbaryl**	20,000	160	30,000	42.1	1.22	1.41	0.1%	**10.5%**	Apr15-Aug31	Apr1-Oct1
Sweet Corn	**Methomyl**	1,100	72	60,000	0.6	0.44	6.91	0.1%	0.6%	Jun30-Sep30	Jun10-Sep25
Cherries	**Carbaryl**	7,500	60	4,900	50.3	1.82	1.68	0.0%	**3.9%**	Mar20-Aug10	Mar20-Aug10
Onions	Methomyl	900	59	8,800	7.2	0.90	1.53	0.0%	0.5%		
Asparagus	Carbaryl	5,400	43	8,300	47.2	1.18	1.17	0.0%	**2.8%**		
Alfalfa	Carbofuran	100	24	70,000	0.3	0.50	1.00	0.0%	0.1%		
Corn	Carbofuran	100	24	7,200	1.3	1.00	1.00	0.0%	0.1%		
Apples	Oxamyl	100	22	30,000	0.2	1.20	1.07	0.0%	0.1%		
Potatoes	Carbaryl	1,400	11	110,000	0.5	0.95	3.07	0.0%	0.7%		
Pears	Carbaryl	1,100	9	1,100	28.7	1.10	3.11	0.0%	0.6%		
Asparagus	Methomyl	100	7	8,300	2.3	0.60	1.00	0.0%	0.1%		
Carrots	Methomyl	100	7	6,500	6.0	0.30	1.00	0.0%	0.1%		
Beans, Lima	Carbaryl	200	2	4,900	2.7	1.37	1.00	0.0%	0.1%		
Peaches	Carbaryl	200	2	300	15.1	2.07	1.85	0.0%	0.1%		
Grapes, Wine	Carbaryl	100	1	2,200	2.3	1.13	1.44	0.0%	0.1%		
8: Southwest Region: Fresno, Kern, Kings and Tulare Counties											
Cotton	**Aldicarb**	270,000	270,000	670,000	29.6	1.13	1.21	**81.6%**	**44.0%**	15-Apr	Jan1-Jul31
Nectarine	**Formetanate**	30,000	18,000	40,000	46.0	0.70	1.00	**5.4%**	**4.9%**		

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Cotton	Oxamyl	60,000	13,260	670,000	12.5	0.66	1.08	4.0%	9.8%	Jun1-Aug28	Apr2-Sep21
Oranges	Formetanate	10,000	6,000	170,000	5.8	1.02	1.15	1.8%	1.6%	Apr22-Jun30	Apr2-Oct10
Cotton	Carbofuran	20,000	4,800	670,000	5.1	0.48	1.30	1.5%	3.3%	Aug14-Sep21	Jul20-Nov16
Potatoes	Aldicarb	2,700	2,700	8,800	10.1	3.00	1.00	0.8%	0.4%	n/a	n/a
Tomatoes	Methomyl	40,000	2,600	100,000	40.1	0.70	1.53	0.8%	6.5%	May15-Sep30	May5-Oct20
Alfalfa	Carbofuran	9,200	2,208	270,000	5.6	0.60	1.00	0.7%	1.5%	Feb18-Mar29	Dec28-May27
Garlic	Oxamyl	6,200	1,370	20,000	13.6	2.00	1.00	0.4%	1.0%	Mar24-29	Feb7-May8
Cantaloupe	Oxamyl	4,700	1,039	30,000	16.1	0.95	1.00	0.3%	0.8%	Apr19-Jun1	Feb27-Sep25
Peaches	Formetanate	1,500	900	30,000	5.5	0.80	1.02	0.3%	0.2%	Mar6-23	Mar6-Jul27
Grapes, Wine	Carbofuran	3,000	720	110,000	0.4	6.03	1.18	0.2%	0.5%	na	na
Dry Beans/Peas	Aldicarb	700	700	30,000	2.7	0.95	1.00	0.2%	0.1%		
Cantaloupe	Methomyl	10,000	650	30,000	35.8	0.62	1.70	0.2%	1.6%	Jul1-Sep15	Jun16-Oct6
Lettuce	Methomyl	10,000	650	10,000	73.1	0.70	1.76	0.2%	1.6%	Jun15-NOv30	Jun15-NOv30
Grapes, Table	Methomyl	9,500	618	70,000	16.8	0.75	1.01	0.2%	1.5%	May1-Aug15	Mar3-Oct9
Grapes, Raisin	Carbofuran	2,400	576	290,000	0.3	2.80	1.00	0.2%	0.4%		
Nectarine	Methomyl	5,500	358	40,000	12.0	0.75	2.00	0.1%	0.9%		
Tangerine	Formetanate	500	300	4,000	14.0	0.81	1.10	0.1%	0.1%		
Lemons	Formetanate	500	300	9,300	3.2	1.06	1.60	0.1%	0.1%	May1-4	Apr26-Aug12
Plums/Prunes	Formetanate	500	300	50,000	0.9	1.15	1.00	0.1%	0.1%	Mar1-22	Feb12-MAr24
Grapefruit	Formetanate	400	240	3,400	6.3	1.13	1.82	0.1%	0.1%	Apr26-May5	Apr26-May24
Oranges	Carbaryl	30,000	240	170,000	3.2	4.40	1.24	0.1%	4.9%	May17-Nov3	Jan1-Dec21

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Sugar Beets	**Methomyl**	3,100	202	9,200	53.7	0.52	1.19	0.1%	**0.5%**	Jun15-Oct10	May30-Oct18
Oranges	**Oxamyl**	700	155	170,000	0.2	0.50	4.01	0.0%	0.1%	Feb3-16; May27-Jun23; Aug15-Sep22	Feb3-Sep22
Tomatoes	**Oxamyl**	700	155	100,000	1.2	0.59	1.00	0.0%	0.1%	Apr20-Jul7	Mar27-Aug18
Peaches	**Oxamyl**	600	133	30,000	0.5	2.00	2.00	0.0%	0.1%	Jan3-Feb15	Jan3-Feb15
Carrots	**Methomyl**	1,900	124	50,000	4.1	0.57	1.56	0.0%	**0.3%**	Aug15-Sep25	May31-Oct12
Garlic	**Methomyl**	1,600	104	20,000	5.5	0.45	2.90	0.0%	**0.3%**	Apr29-May19	Apr29-May19
Watermelon	**Methomyl**	1,600	104	5,700	21.9	0.62	2.05	0.0%	**0.3%**	Jun10-Aug31	May19-Sep11
Peaches	**Carbaryl**	10,000	80	30,000	5.4	4.02	1.39	0.0%	**1.6%**	May15-Sep4	Jan2-Oct19
Asparagus	**Methomyl**	1,200	78	3,900	36.5	0.82	1.05	0.0%	0.2%	Jun30-Aug30	Jun30-Sep14
Pistachios	**Carbaryl**	9,100	73	70,000	3.0	4.00	1.15	0.0%	**1.5%**	Feb5-Jul4	Jan22-Sep30
Alfalfa	**Methomyl**	1,100	72	270,000	1.4	0.29	1.00	0.0%	0.2%	Jun15-Sep5	Mar14-Sep27
Grapes, Raisin	**Methomyl**	1,100	72	290,000	0.4	0.74	1.42	0.0%	0.2%	May1-Aug15	Mar3-Oct9
Onions	**Methomyl**	1,000	65	20,000	3.8	0.72	1.58	0.0%	0.2%	May11-Jul20	Mar30-Aug14
Broccoli	**Methomyl**	800	52	8,200	11.2	0.57	1.63	0.0%	0.1%	Aug1-Oct30	Mar24-Nov8
Oranges	**Methomyl**	800	52	170,000	0.8	0.61	1.00	0.0%	0.1%	Apr20-Jun15; Nov4-30	Mar2-Dec29
Potatoes	**Methomyl**	700	46	8,800	8.6	0.71	1.33	0.0%	0.1%	May7-Jun28	Mar25-Oct19
Onions	Oxamyl	200	44	20,000	0.3	1.00	2.00	0.0%	0.0%		

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Cotton	**Carbaryl**	4,900	39	670,000	1.5	0.50	1.00	0.0%	**0.8%**	Apr4-Jul8	Mar24-Oct8
Peaches	**Methomyl**	600	39	30,000	2.4	0.66	1.22	0.0%	0.1%	Apr10-Sep15	Mar4-Oct10
Plums/Prunes	**Carbaryl**	4,800	38	50,000	3.3	2.97	1.00	0.0%	**0.8%**	Jan13-Aug28	Jan2-Oct23
Lettuce	Thiodicarb	2,900	35	10,000	19.4	0.63	1.66	0.0%	**0.5%**		
Cantaloupe	**Carbaryl**	4,300	34	30,000	17.5	0.78	1.04	0.0%	**0.7%**	Apr9-Aug21	Apr4-Jul8
Nectarine	**Carbaryl**	4,200	34	40,000	4.0	3.20	1.00	0.0%	**0.7%**		
Apples	Carbaryl	4,200	34	7,900	20.4	1.81	1.45	0.0%	**0.7%**		Apr10-Sep15
Grapes, Wine	Methomyl	500	33	110,000	0.4	0.74	1.22	0.0%	0.1%		Jan13-Aug28
Cotton	Methomyl	400	26	670,000	0.1	0.48	1.00	0.0%	0.1%		
Peppers	Methomyl	400	26	4,500	9.9	0.56	1.70	0.0%	0.1%		Apr9-Aug21
Plums/Prunes	Methomyl	400	26	50,000	0.8	0.78	1.35	0.0%	0.1%		
Walnuts	Methomyl	400	26	50,000	0.7	0.83	1.50	0.0%	0.1%		
Tomatoes	Carbaryl	3,200	26	100,000	3.2	0.95	1.02	0.0%	**0.5%**		
Potatoes	Oxamyl	100	22	8,800	1.1	0.73	1.00	0.0%	0.0%		
Grapes, Wine	Carbaryl	2,500	20	110,000	0.8	1.56	1.72	0.0%	**0.4%**		
Watermelon	Carbaryl	2,500	20	5,700	30.7	0.96	1.46	0.0%	**0.4%**		
Beans, Snap	Methomyl	300	20	1,900	15.6	0.46	1.99	0.0%	0.0%		
Cucumber	Methomyl	300	20	1,200	28.3	0.59	1.79	0.0%	0.0%		
Grapefruit	Carbaryl	2,300	18	3,400	8.4	6.46	1.25	0.0%	**0.4%**		
Almonds	Carbaryl	1,800	14	210,000	0.2	3.13	1.39	0.0%	0.3%		
Almonds	Methomyl	200	13	210,000	0.1	0.62	1.00	0.0%	0.0%		
Apricots	Carbaryl	1,300	10	4,900	7.8	2.85	1.16	0.0%	0.2%		
Lemons	Carbaryl	1,200	10	9,300	2.6	4.78	1.00	0.0%	0.2%		
Grapes, Raisin	Carbaryl	1,100	9	290,000	0.3	1.28	1.00	0.0%	0.2%		
Grapes, Table	Carbaryl	1,000	8	70,000	1.1	1.21	1.00	0.0%	0.2%		
Dry Beans/Peas	Methomyl	100	7	30,000	1.3	0.33	1.09	0.0%	0.0%		
Strawberries	Methomyl	100	7	800	6.5	0.67	2.89	0.0%	0.0%		
Corn	Carbaryl	800	6	110,000	1.2	0.60	1.00	0.0%	0.1%		
Walnuts	Carbaryl	800	6	50,000	0.8	2.26	1.00	0.0%	0.1%		
Carrots	Carbaryl	400	3	50,000	0.6	0.52	2.41	0.0%	0.1%		

Carbamate Usage from 1998-2002 Doanes & NASS usage data (10/20/04, BEAD)

Crop	Active Ingredient	lb A.I.	RPF-adj lb ai	Planted acres	% crop treated	App Rate	No. apps	% rpf-adj lb	% non-adj lb	Most active app dates	Ttl Range
Sugar Beets	Carbaryl	400	3	9,200	5.4	0.70	1.08	0.0%	0.1%		
Asparagus	Carbaryl	200	2	3,900	3.0	1.51	1.15	0.0%	0.0%		
Cherries	Carbaryl	200	2	1,700	2.9	2.63	1.17	0.0%	0.0%		
Strawberries	Carbaryl	200	2	800	8.1	1.21	2.38	0.0%	0.0%		
Beans, Lima	Carbaryl	100	1	600	8.2	1.42	1.00	0.0%	0.0%		
Beans, Snap	Carbaryl	100	1	1,900	4.5	1.20	1.00	0.0%	0.0%		
Lettuce	Carbaryl	100	1	10,000	0.5	0.95	1.43	0.0%	0.0%		
Onions	Carbaryl	100	1	20,000	0.3	0.75	1.00	0.0%	0.0%		
Peppers	Carbaryl	100	1	4,500	0.8	1.10	1.80	0.0%	0.0%		
Squash	Carbaryl	100	1	500	7.2	0.95	1.99	0.0%	0.0%		

Appendiex E-5 Chemical-Specific Fate and Transport Properties Used For the Water Exposure Models

Table II.E.5.1: Aldicarb (total residues including the sulfone and sulfoxide degradates) fate and transport properties

Property/ Parameter	Variable Name	Value	Units	References
Molecular weight	mwt	190.2	g/mol	MRID 00152095
Henry's Law Const.	henry	1.70E-10	atm-m^3/mol	Acc 255979
Vapor Pressure	vapr	1.00E-06	torr	MRID 00152095
Solubility	sol	6000.0	mg/L	Acc 255979
Kd or Koc	Kd	0.12	mL/g	Minimum non-sand value for aldicarb sulfone (MRID 43560302)
Photolysis half-life	kdp	4	days	MRID 42498201
Aerobic Aquatic Metabolism	kbacw	4 (x3) = 12	days	MRID 44592107. Single acceptable guideline study for (parent/sulfoxide/sulfone) x 3; corresponds w/ DT90
Anaerobic Aquatic Metabolism	kbacs	24	days	No data; use 2X aerobic aquatic half-life
Aerobic Soil Metabolism	asm	55	days	Revised from 2001 Aldicarb RED (Carleton); Upper 90th pct bound on mean for combined parent+sulfoxide+sulfone half-life from 19 soils in x studies (.
Hydrolysis:	pH 5	stable	days	Hydrolyzed only at pH9 (MRID 00102065).
Hydrolysis:	pH 7	stable	days	
Hydrolysis:	pH 9	>30 da	days	
Application Type	granular			
NOTES:	Modeled total aldicarb residues			Half-life values used in inputs based on combined aldicarb + sulfone + sulfoxide residues; lowest Kd of the 3 chemicals used for mobility. Assumes equal toxicity of parent, degradates
	App adjusted for granular, 15% left on surface			Assumed 15% granules left on surface. Adjusted rate to 15% of reported rate, assumed no incorporation, no drift

Table II.E.5.2. Carbaryl fate and transport properties

Property/ Parameter	PRZM Variable Name	Value	Units	Comments / References
Molecular weight	mwt	201.22	g/mol	
Henry's Law Const.	henry	1.28E-08	atm-m^3/mol	
Vapor Pressure	vapr	1.36E-07	torr	
Solubility	sol	32	mg/L	
Koc	Koc	196	mL/g	
Photolysis half-life	kdp	21	days	
Aerobic Aquatic Metabolism	kbacw	29.6	days	
Anaerobic Aquatic Metabolism	kbacs	216.6	days	
Aerobic Soil Metabolism	asm	12	days	
Hydrolysis:	pH 5	na	days	Stable
Hydrolysis:	pH 7	12	days	
Hydrolysis:	pH 9	0.13	days	
Method:	CAM	2	integer	
Incorporation Depth:	DEPI	0	cm	
Foliar Degradation Rate	PLDKRT	3.71	days	90% upper CI from mean of 30 studies (MRID 45860501)
Foliar Washoff Coefficient	FEXTRC	0.91		

Table II.E.5.3. Carbofuran fate and transport properties

Property/ Parameter	PRZM Variable Name	Value	Units	Comments / References
Molecular weight	mwt	221.5	g/mol	
Henry's Law Const.	henry	2.20E-10	atm-m^3/mol	
Vapor Pressure	vapr	6.00E-07	torr	
Solubility	sol	7	mg/L	
Koc	Koc	36	mL/g	mean = 36 (n= 23, stdev =31)
Photolysis half-life	kdp	6	days	
Aerobic Aquatic Metabolism	kbacw	642	days	No data; 2X aer soil metabolism half-life
Anaerobic Aquatic Metabolism	kbacs		days	
Aerobic Soil Metabolism	asm	321	days	1 value on an acidic soil
Hydrolysis:	pH 5		days	
Hydrolysis:	pH 7	28	days	
Hydrolysis:	pH 9		days	

Table II.E.5.4. Formetanate HCL fate and transport properties

Property/ Parameter	PRZM Variable Name	Value	Units	Comments / References
Molecular weight	mwt	258	g/mol	1997 EFED RED
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	1.60E-06	torr	1997 EFED RED
Solubility	sol	500000	mg/L	1997 EFED RED
Koc	Koc	340	mL/g	1997 EFED RED
Photolysis half-life	kdp	0.33	days	8 hr/24 hr; 1997 EFED RED
Aerobic Aquatic Metabolism	kbacw	12.8	days	No data; 2X aer soil metabolism data
Anaerobic Aquatic Metabolism	kbacs		days	
Aerobic Soil Metabolism	asm	6.4	days	1997 EFED RED
Hydrolysis:	pH 5	1515	days	1997 EFED RED
Hydrolysis:	pH 7	24	days	1997 EFED RED
Hydrolysis:	pH 9	24	days	1997 EFED RED
Method:	CAM	2	integer	
Incorporation Depth:	DEPI	0	cm	

Table II.E.5.5. Methomyl fate and transport properties

Property/ Parameter	PRZM Variable Name	Value	Units	Comments / References
Molecular weight	mwt	162	g/mol	
Henry's Law Const.	henry	1.80E-10	atm-m^3/mol	
Vapor Pressure	vapr	5.00E-05	torr	
Solubility	sol	58000	mg/L	
Koc	Koc	24	mg/L	average of range 19-34; MRID 00161884
Photolysis half-life	kdp	3	days	MRID 00161885
Aerobic Aquatic Metabolism	kbacw	7	days	MRID 43325401; 90th c.b. 4, 5
Anaerobic Aquatic Metabolism	kbacs	28	days	MRID 41384301, supported by supplemental data; 2x anaerobic soil metabolism
Aerobic Soil Metabolism	asm	79	days	90% upper c.b. of 2 studies (14, 46) (MRIDs 008568, 43217901)
Hydrolysis:	pH 5	stable (0)	days	MRID 00131249
Hydrolysis:	pH 7	stable (0)	days	MRID 00131249
Hydrolysis:	pH 9	30	days	MRID 00131249
Method:	CAM	2	integer	aerial/foliar
Incorporation Depth:	DEPI	0	cm	

Table II.E.5.6. Oxamyl fate and transport properties

Property/ Parameter	PRZM Variable	Value	Units	Comments / References

	Name			
Molecular weight	mwt	219	g/mol	
Henry's Law Const.	henry	2.38E-07	atm-m^3/mol	
Vapor Pressure	vapr	3.80E-07	torr	
Solubility	sol	280000	mg/L	
Koc	Koc	6	mL/g	Mean Koc of 9 soils (Acc. No. 154748 (s), 40494(s)
Photolysis half-life	kdp	11	days	MRID 406065-15; Acc. No. 40494
Aerobic Aquatic Metabolism	kbacw	40	days	No data; assume 2X aer soil met half-life
Anaerobic Aquatic Metabolism	kbacs	7	days	MRID 428200-01 (c), 413462-01 (s), Acc. No. 4094 (s), 113366 (s)
Aerobic Soil Metabolism	asm	20	days	MRID 428200-01 (c), 413462-01 (s), Acc. No. 63012 (c), 40494 (s), 154748 (s)
Hydrolysis:	pH 5	stable	days	MRID 40605-16(c), ACC No. 40494 (s)
Hydrolysis:	pH 7	8	days	MRID 40605-16(c), ACC No. 40494 (s)
Hydrolysis:	pH 9	0.13	days	MRID 40605-16(c), ACC No. 40494 (s)
Method:	CAM	2	integer	
Incorporation Depth:	DEPI	0	cm	

Table II.E.5.7. Thiodicarb fate and transport properties

Property/ Parameter	PRZM Variable Name	Value	Units	Comments / References
Molecular weight	mwt	354.46	g/mol	
Henry's Law Const.	henry	1.10E-06	atm-m^3/mol	
Vapor Pressure	vapr	4.30E-05	torr	
Solubility	sol	19	mg/L	
Koc	Koc	485	mL/g	average
Photolysis half-life	kdp	8	days	
Aerobic Aquatic Metabolism	kbacw	3	days	No data available; 2X aer soil met half-life
Anaerobic Aquatic Metabolism	kbacs	0.375	days	
Aerobic Soil Metabolism	asm	1.5	days	
Hydrolysis:	pH 5	78	days	
Hydrolysis:	pH 7	32	days	
Hydrolysis:	pH 9	0.50	days	
Method:	CAM	2	integer	
Incorporation Depth:	DEPI	0	cm	
NOTES	Model methomyl as degradate w/ 80% conversion			Take thiodicarb app rate * 0.80 (conversion based on soil metabolism studies). Shift app date + 2 days (asm half-life); no drift since this is transformation after app only

Appendix E-6 NMC Surface Water Exposure Assessment Methods

This appendix provides details on the regional surface water exposure assessments conducted in support of the N-methyl carbamate (NMC) cumulative exposure assessment. A description of the conceptual model and a summary of the analytical plan and results, focusing on the southeastern region, are found in Section I.E. This appendix provides details of the analytical methods, results for each of the regions, and documentation for the modeling inputs and scenarios used for the regional surface water exposures.

1. Conceptual Model

For surface water exposure, the Agency focused on vulnerable surface water supplies. These vulnerable systems were defined as

- small reservoirs in agricultural areas
- with high NMC use (adjusted for relative potency)
- and watersheds that are particularly prone to pesticide movement to water (by runoff and/or sedimentation)

The Agency used 1997 county-level usage data (Thelin and Gianessi, 2000), with pounds of active ingredient adjusted by the relative potency for the pesticide, to identify high carbamate use areas. Because the usage data represented agricultural usage of the pesticide (of the NMC pesticides that have the potential to reach drinking water sources, only carbaryl has non-agricultural uses), this usage data identified predominantly agricultural areas. Once the regional surface water exposure sites were identified, the Agency used pesticide use surveys from USDA National Agricultural Statistics Service (NASS) and Doane's to estimate NMC usage in more recent years.

Surface water sources of drinking water were identified using two sources:

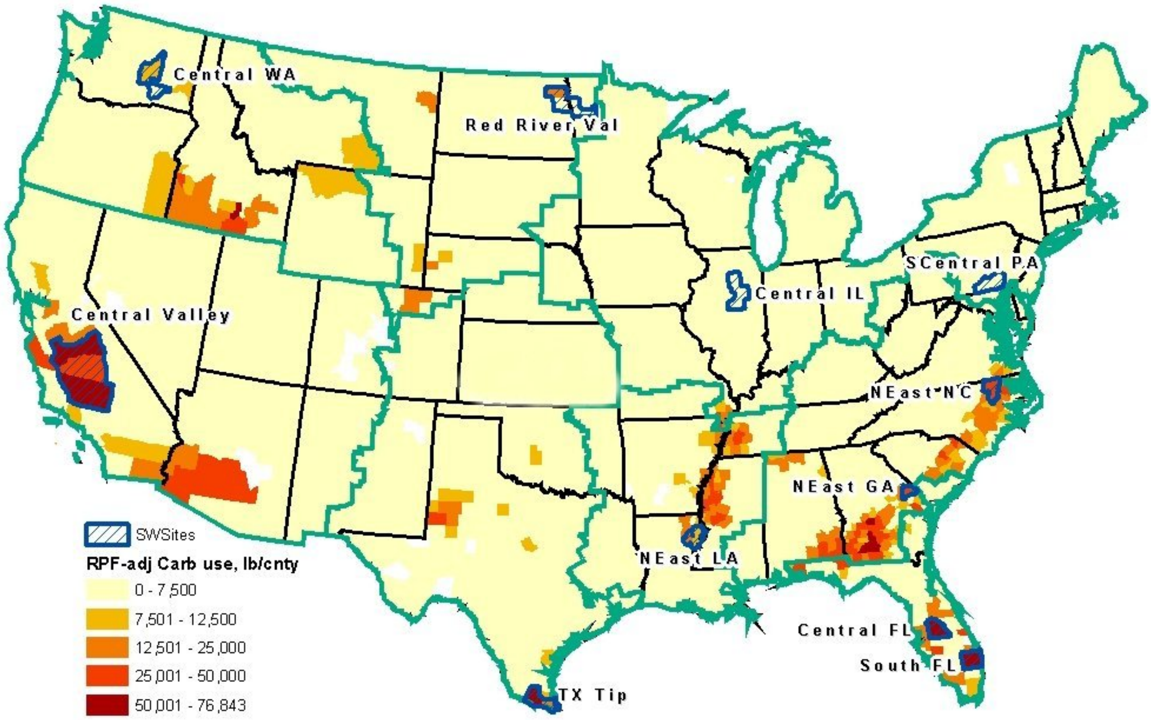
- A spatial dataset that identifies the population, by county, that gets its drinking water from public surface water supplies (USGS, 1998);

- A spatial dataset showing the location of drinking water intakes for CWS in the U.S. This information was based on the Agency's SDWIS database.

The Agency compared relative vulnerabilities of the areas based on average-annual runoff, average 2-month runoff (beginning of the growing season), and average soil loss, as developed by the USDA Natural Resources Conservation Service (Kellogg et al, 1997).

The resulting regional surface water scenario sites are shown in Figure II.E.6.1. This approach follows the same conceptual model used for the organophosphate (OP) CRA.

II.E.6. 1 - NMC cumulative risk assessment regions for drinking water exposure assessment showing high NMC use areas and regional surface water exposure sites.



The Agency used estimated NMC residues from the vulnerable surface water supplies to represent potential NMC exposure from surface water in each region. The Agency assumed that concentrations in the water at the intake represented concentrations found in treated water. This assumption is protective, but not unreasonable, considering the state of published literature on drinking water treatment impacts on NMC pesticides (Appendix II.E.3). If NMC levels in water from these vulnerable sites are not major contributors to the total regional cumulative exposure, then the Agency can reasonably conclude that drinking water exposures will not be a concern in other, less vulnerable, areas. If drinking water exposure from one or more of these vulnerable sites is a significant contributor to the total cumulative exposure, then additional refinements may be necessary to characterize the extent of the potential exposure.

2. Estimating Daily Cumulative NMC Concentrations in Surface Water

The NMC assessment focused on the likelihood of concurrent exposure to multiple pesticides from food, water, and residential use. For surface water sources of drinking water, the Agency determined the potential for co-occurrence by considering the potential for more than one NMC pesticide to be used in the same watershed (on the same or different crops that may be grown in the watershed). The Agency determined the potential for co-occurrence at each of the regional surface water exposure sites using USDA National Agricultural Statistics Service (USDA NASS) and Doane's databases. OPP considered NMC usage on agricultural crops for a multi-county area surrounding each of the vulnerable surface water exposure sites shown in Figure II.E.6.1, identifying those NMC-crop uses that accounted for at least 95% of the total NMC usage in the scenario area. Details of the methods used to collect the usage data can be found in Appendix II.E.4.

PRZM is a field-scale model, while the cumulative water assessment focused on watershed-scale impacts (i.e., the contributions of multiple NMC uses on multiple crops occurring in multiple fields in a watershed). The Agency used PRZM to model multiple fields in a watershed, adjusting the estimated exposure concentrations for each NMC-crop use in the watershed by an adjustment factor that reflected the potential area treated (Figure II.E.6.2).

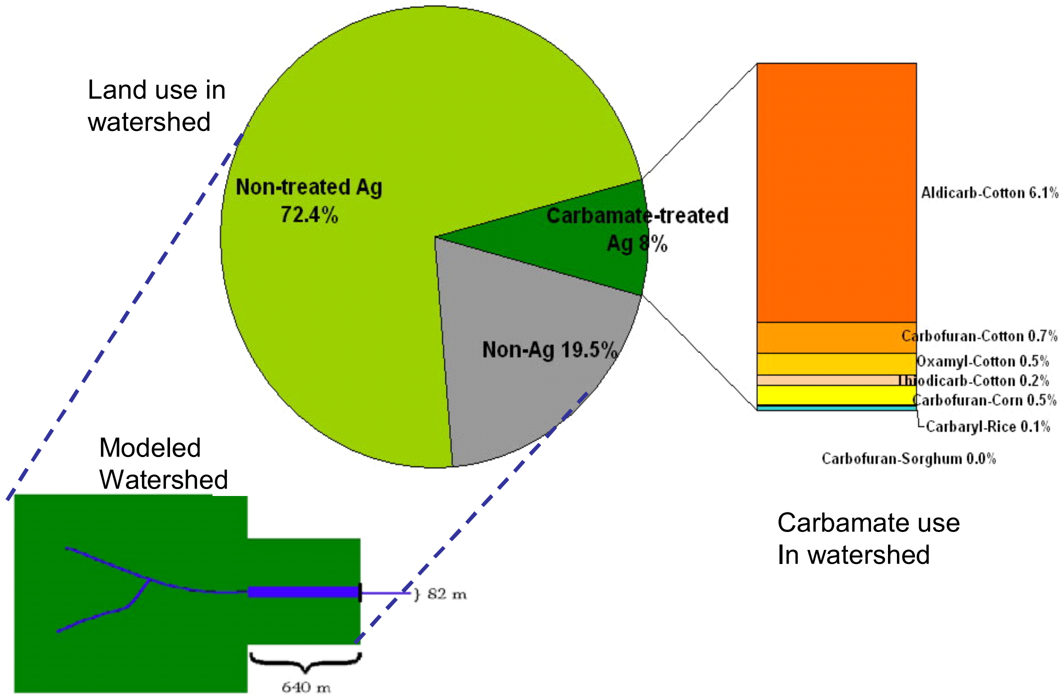
This cumulative adjustment factor (CAF) followed a three step process:

- The NMC-crop combination was modeled with PRZM/EXAMS, using the region-specific usage, application timing, soil, site, and weather data. The result is a time-series of daily pesticide concentrations in a reservoir spanning a 30-year period.

- Each daily concentration was adjusted by the fraction of the watershed that in the crop being modeled. This was done by dividing the acres of crop grown in the multi-county region by the total acres in that region (percent crop area).

- The daily concentrations were then adjusted by the fraction of acres of the crop treated by the particular NMC pesticide. This was done by dividing the acres of crop treated by the total crop acres in the multi-county region (percent crop treated).

II.E.6. 2- Conceptual model for surface water sources of drinking water illustrating how multiple NMC uses are proportioned in the watershed.



The adjustments to the estimated daily concentrations for each NMC-crop combination are shown in the following equation:

$$[\text{C-adj}]_{(NMC1,CROPa)} = [\text{C-init}]_{(NMC1,CROPa)} \times \text{RegCA}_{(CROPa)} \times \text{FractTrt}_{(NMC1,CROPa)} \times \text{RPF}_{(NMC1)} \times \text{SF-UF}_{(NMC1)}$$

where

$[\text{C-adj}]_{(NMC1,CROPa)}$ is the adjusted concentration for NMC1 on CROPa (a concentration is estimated for each day over the 30-year period)

$[\text{C-init}]_{(NMC1,CROPa)}$ is the initial (unadjusted) concentration for NMC1 on CROPa (a concentration is estimated for each day over the 30-year period)

$\text{RegCA}_{(CROPa)}$ is the regional percent crop area, expressed as a fraction = (Acres of crop planted / total acres ag crops) x regional PCA

$\text{FracTrt}_{(NMC1,CROPa)}$ is the percent of CROPa acres treated with NMC1

$\text{RPF}_{(NMC1)}$ is the relative potency factor for NMC1

$\text{SF-UF}_{(NMC1)}$ is the combined FQPA safety and data uncertainty factors for NMC1

The resulting adjusted concentrations for each crop-NMC combination are summed across each day to provide a cumulative daily time series, in oxamyl equivalents, over 30 years.

The temporal component of co-occurrence of NMC pesticide residues in surface water sources of drinking water is addressed by modeling pesticide applications within the most likely window of application for each crop in each region. Appendix II.E.4 describes the methods used to estimate the windows of application. The Agency systematically selected the beginning of the most active window for the initial application date of each NMC. Where multiple applications were identified, the Agency spread those evenly over the most active window.

3. Regional NMC Exposure Estimates from Surface Water Sources

The Agency estimated drinking water concentrations for individual NMC pesticides and for the cumulative NMC load for each of the regional surface water scenario sites shown in Figure II.E.6.1. Table II.E.6.1 gives the crop-NMC combinations modeled for each region, along with the application-related inputs for each combination. More detailed usage information used for the application parameters can be found in Appendix II.E.4. Chemical-specific model inputs are described in Appendix II.E.5. Documentation of the scenario inputs are provided in Section II.E.6.D.

The dietary baseline analysis assumes that all carbofuran uses other than import tolerances are removed, as indicated in the 2006 carbofuran IRED. The impacts of currently registered domestic uses of carbofuran on drinking water sources were modeled for this assessment. Results are presented in the appendices for all NMCs modeled, but are summarized in the main assessment in a sensitivity analysis.

Table II.E.6-1 Regional crop-NMC combinations and application-related inputs used in the surface water exposure assessment.

Crop/Use	Chemical	PRZM scenario	App. Rate, kg/ha	App Date	No Apps / Interv. (da) (+)	Frac. Trt	CAM	Spray Drift
Southeast/ NC Coastal Plain (Regional PCA = 0.61; NMC-use PCA = 0.40)								
Cotton	Aldicarb	NCcottonC	0.81 *	1-May	1	0.43	1	0 [grn]
Cotton	Carbaryl	NCcottonC	0.83	1-Jun	1	<0.01	2	0.055
Peanut	Aldicarb	NCpeanutC	1.20 *	10-Apr	1	0.62	1	0 [grn]
Peanut	Carbaryl	NCpeanutC	0.63	30-May	1	0.01	2	0.055
Peanut	Oxamyl	NCpeanutC	1.39	30-May	1	0.02	2	0.055
Peanut	Methomyl	NCpeanutC	0.42	30-May	1	0.03	2	0.055
Cucumber	Carbaryl	NCcucumbCRA	1.11	27-Apr	3 / 14	0.07	2	0.055
Tobacco	Aldicarb	NCtobaccoC	1.82 *	30-Apr	1	0.01	1	0 [grn]
Tobacco	Carbaryl	NCtobaccoC	1.21	30-Apr	3 / 36	0.01	2	0.055
Tobacco	Carbofuran[1]	NCtobaccoC	4.44	30-Apr	2 / 53	<0.01	2	0.055
Tobacco	Methomyl	NCtobaccoC	0.39	30-Apr	1	0.03	2	0.055
Southeast/ GA Coastal Plain (Regional PCA = 0.61; NMC-use PCA = 0.21)								
Cotton	Aldicarb	NCCotton / GA met file	0.65 *	1-May	1	0.22	1	0 [grn]

Crop/Use	Chemical	PRZM scenario	App. Rate, kg/ha	App Date	No Apps / Interv. (da) (+)	Frac. Trt	CAM	Spray Drift
Peanut	Aldicarb	NCpeanutC w/ GA met file	1.10 *	10-Apr	1	0.34	1	0 [grn]
Pecans	Aldicarb	GAPecanC	3.22 *	1-May	1	0.01	1	0 [grn]
Pecans	Carbaryl	GAPecanC	2.04	1-Aug	2 / 25	0.08	2	0.055
Florida / Central (Regional PCA = 0.28; NMC-use PCA = 0.11)								
Oranges	Aldicarb	FLCitrusC	4.27 *	1-Apr	2 / 121	0.08	1	0 [grn]
Oranges	Carbaryl	FLcitrusC	3.93	1-Mar	2 / 46	0.01	2	0.055
Oranges	Oxamyl	FLCitrusC	1.07	1-Apr	3 / 61	0.01	2	0.055
Grapefruit	Aldicarb	FLCitrusC	4.32 *	1-Apr	2 / 121	0.07	1	0 [grn]
Grapefruit	Carbaryl	FLCitrusC	3.47	1-Mar	1	0.03	2	0.055
Florida / South (Regional PCA = 0.28; NMC-use PCA = 0.21)								
Sugarcane	Carbofuran[1]	FLsugarcaneC	0.80	20-Jun	1	0.02	2	0.055
Sweet Corn	Methomyl	FLsweetcornC	0.39	1-Apr	8	0.40	2	0.055
Sweet Corn	Carbofuran[1]	FLsweetcornC	1.11	1-Aug	1	0.07	2	0.055
Sweet Corn	Thiodicarb	FLsweetcornC	0.64	1-Apr	4 / 60, 168, 22	0.23	2	0.055
Sweet Corn	Methomyl from Thiodicarb	FLsweetcornC	0.52	3-Apr	4 / 60, 168, 22	0.23	2	0
Pepper	Methomyl	FLpepperC	0.69	1-Apr	6 / 12	0.16	2	0.055
Pepper	Oxamyl	FLpepperC	0.57	1-Mar	6 / 20	0.15	2	0.055
Oranges	Aldicarb	FLCitrusC	4.27 *	1-Apr	2 / 121	0.14	1	0 [grn]
Oranges	Carbaryl	FLcitrusC	3.93	1-Mar	2 / 46	0.01	2	0.055
Grapefruit	Aldicarb	FLCitrusC	4.32 *	1-Apr	2 / 121	0.09	1	0 [grn]
Grapefruit	Carbaryl	FLcitrusC	3.47	1-Mar	1	0.07	2	0.055
Cucumber	Oxamyl	FLcucumberC	0.61	30-Jan	2 / 245	0.50	2	0.055
Cucumber	Carbofuran[1]	FLcucumberC	1.33	20-Oct	1	0.31	2	0.055
Cucumber	Methomyl	FLcucumberC	0.64	15-Apr	5 / 12	0.21	2	0.055
Midsouth / LA (Regional PCA = 0.81; NMC-use PCA = 0.50)								
Cotton	Aldicarb	MScottonC	0.59 *	1-May	1	0.25	1	0 [grn]
Cotton	Carbofuran[1]	MScottonC	0.49	24-Jun	1	0.03	2	0.055
Cotton	Oxamyl	MScottonC	0.21	4-May	1	0.02	2	0.055
Cotton	Thiodicarb	MScottonC	0.59	1-Jun	2 / 106	0.01	2	0.055
Cotton	Methomyl from Thiodicarb	MScottonC	0.47	3-Jun	2 / 106	0.01	2	0
Corn	Carbofuran[1]	MScornC	0.94	31-Mar	1	0.02	2	0.055
Sorghum	Carbofuran[1]	MScornC	0.56	20-Apr	1	0.01	2	0.055
Lower Midwest / TX (Regional PCA = 0.42; NMC-use PCA = 0.20)								
Grapefruit	Aldicarb	STXgrapeftCRA	5.21 *	2-Jan	1	0.73	1	0 [grn]
Grapefruit	Formetanate	STXgrapeftCRA	1.02	20-Apr	1	0.35	2	0.0089
Cotton	Aldicarb	STXcottonCRA	0.54 *	10-Mar	1	0.19	1	0 [grn]
Cotton	Oxamyl	STXcottonCRA	0.26	15-Mar	2 / 69	0.19	2	0.055

Crop/Use	Chemical	PRZM scenario	App. Rate, kg/ha	App Date	No Apps / Interv. (da) (+)	Frac. Trt	CAM	Spray Drift
Cotton	Carbofuran[1]	STXcottonCRA	0.61	28-May	1	0.09	2	0.055
Carrots	Oxamyl	STXvegetblCRA	1.39	10-Aug	2 / 79	0.91	2	0.0049
Onions	Oxamyl	STXvegetblCRA	0.53	1-Oct	2 / 31	0.27	2	0.0049
Onions	Methomyl	STXvegetblCRA	0.54	16-Mar	3 / 213, 76	0.33	2	0.0049
Cucumber	Oxamyl	STXmelonCRA	0.73	1-Feb	2 / 151	0.31	2	0.0049
Cucumber	Methomyl	STXmelonCRA	0.52	15-Apr	3 / 20	0.34	2	0.055
Cantaloupe	Oxamyl	STXmelonCRA	1.95	15-Feb	1	0.23	2	0.0049
Spinach	Methomyl	STXvegetblCRA	0.50	30-Sep	2 / 83	0.86	2	0.0049
Watermelon	Oxamyl	STXmelonCRA	0.57	15-Jan	1	0.25	2	0.0049
Peppers	Oxamyl	STXvegetblCRA	1.11	1-Jan	2 / 182	0.77	2	0.0049
Corn	Carbofuran[1]	STXcornCRA	0.89	16-Mar	2 / 26	0.08	2	0.0049
North/northcentral / PA (Regional PCA = 0.42; NMC-use PCA = 0.16)								
Alfalfa	Carbofuran[1]	PAalfalfaC	0.67	9-Mar	1	0.03	2	0.055
Apples	Methomyl	PAappleC	0.44	30-May	3 / 26	0.26	2	0.0087
Apples	Oxamyl	PAappleC	0.67	20-Apr	1	0.03	2	0.0087
Apples	Formetanate	PAappleC	0.94	24-Apr	1	0.01	2	0.0087
Apples	Carbaryl	PAappleC	1.24	20-Apr	2 / 66	0.17	2	0.0087
Corn	Carbofuran[1]	PAcornC	0.99	10-May	1	0.01	2	0.055
Peaches	Methomyl	PAappleC	0.47	15-Apr	3 / 48	0.09	2	0.0087
Peaches	Carbaryl	PAappleC	1.47	15-Jun	3 / 36	0.10	2	0.0087
Potatoes	Methomyl	PAvegetblCRA	0.50	15-Jun	5 / 21	0.04	2	0.055
Pumpkin	Carbofuran[1]	PAvegetblCRA	0.90	15-Jun	1	0.25	1	0.0049
Sweet Corn	Methomyl	PAcornC	0.42	15-Jul	5 / 15	0.34	2	0.055
Sweet Corn	Carbofuran[1]	PAcornC	1.11	25-Apr	1	0.08	1	0.0049
Sweet Corn	Carbaryl	PAcornC	1.09	15-Jun	3 / 31	0.07	2	0.055
Sweet Corn	Thiodicarb	PAcornC	0.64	15-Jul	3 / 38	0.05	2	0.055
Sweet Corn	Methomyl from Thiodicarb	PAcornC	0.51	17-Jul	3 / 38	0.05	2	0
North/northcentral / IL (Regional PCA = 0.87; NMC-use PCA = 0.45)								
Alfalfa	Carbofuran[1]	ILalfalfaCRA	0.79	15-Apr	1	0.01	2	0.055
Beans, Lima	Methomyl	ILbeanCRA	1.17	15-Jun	1	0.13	2	0.055
Corn	Carbaryl	ILCornC	1.11	15-May	1	0.00	2	0.055
Corn	Carbofuran[1]	ILCornC	0.74	20-Jun	1	0.00	2	0.055
Sweet Corn	Carbaryl	ILCornC	1.66	15-Jul	3 / 21	0.06	2	0.055
Sweet Corn	Carbofuran[1]	ILCornC	0.39	1-May	1	0.06	2	0.0049
Northern Great Plains / MN-ND (Regional PCA = 0.83; NMC-use PCA = 0.52)								
Potatoes	Aldicarb	MNpotatoCRA	2.55 *	15-May	1	0.02	1	0 [grn]
Potatoes	Carbofuran[1]	MNpotatoCRA	0.89	13-May	2 / 32	0.01	2	0.0049
Potatoes	Oxamyl	MNpotatoCRA	0.67	30-May	2 / 46	0.01	2	0.055
Sugar Beets	Aldicarb	MNsugarbeetC	1.67 *	30-Apr	1	0.01	1	0 [grn]
Sugar Beets	Carbofuran[1]	MNsugarbeetC	1.11	1-Jun	1	0.01	2	0.0049
Wheat	Carbaryl	NDwheatC	0.89	1-Jun	1	0.02	2	0.055

Crop/Use	Chemical	PRZM scenario	App. Rate, kg/ha	App Date	No Apps / Interv. (da) (+)	Frac. Trt	CAM	Spray Drift
Northwest / WA (Regional PCA = 0.42; NMC-use PCA = 0.23)								
Apples	Carbaryl	WAorchardCRA	1.35	15-Apr	2 / 69	0.42	2	0.0087
Apples	Formetanate	WAorchardCRA	1.08	31-Mar	1	0.05	2	0.0087
Beans, Lima	Methomyl	WAbeansCRA	1.00	30-May	2 / 61	0.43	2	0.055
Dry Beans/Peas	Aldicarb	WAbeansCRA	1.33 *	1-Apr	1	0.17	1	0 [grn]
Carrots	Oxamyl	WAbeansCRA	1.09	1-Apr	4 / 19	0.09	2	0.055
Cherries	Carbaryl	WAorchardCRA	2.03	20-May	2 / 41	0.50	2	0.0087
Onions	Oxamyl	WAonionsCRA	1.07	15-Mar	2 / 92	0.37	2	0.055
Potatoes	Aldicarb	WApotatoCRA	3.21 *	15-May	1	0.36	1	0 [grn]
Potatoes	Carbofuran[1]	WApotatoCRA	0.74	10-Apr	2 / 36	0.07	2	0.055
Potatoes	Oxamyl	WApotatoCRA	1.16	10-Apr	3 / 50, 69	0.02	2	0.055
Sweet Corn	Methomyl	WAswcornCRA	0.49	30-Jun	7 / 13	0.01	2	0.055
Southeast / CA (Regional PCA = 0.56; NMC-use PCA = 0.33)								
Alfalfa	Carbofuran[1]	CAalfalfa0C	0.67	18-Feb	1	0.06	2	0.055
Alfalfa	Methomyl	CAalfalfa0C	0.33	15-Jun	1	0.01	2	0.055
Asparagus	Methomyl	CAtomato0C	0.91	30-Jun	1	0.36	2	0.055
Broccoli	Methomyl	CAbroccCVcra	0.63	1-Aug	2 / 45	0.11	2	0.055
Cantaloupe	Carbaryl	CAtomato0C	0.86	9-Apr	1	0.17	2	0.055
Cantaloupe	Methomyl	CAtomato0C	0.69	1-Jul	2 / 38	0.36	2	0.055
Cantaloupe	Oxamyl	CAtomato0C	1.05	19-Apr	1	0.16	2	0.055
Carrots	Methomyl	CAcarrotCra	0.63	15-Aug	2 / 20	0.04	2	0.055
Cotton	Aldicarb	CAcotton0C	1.26 *	15-Apr	1	0.30	1	0 [grn]
Cotton	Carbaryl	CAcotton0C	0.55	4-Apr	1	0.01	2	0.055
Cotton	Carbofuran[1]	CAcotton0C	0.54	14-Aug	2 / 19	0.05	2	0.055
Cotton	Oxamyl	CAcotton0C	0.73	1-Jun	1	0.13	2	0.055
Dry Beans/Peas	Aldicarb	CAtomato0C	1.06 *	20-Apr	1	0.03	1	0 [grn]
Garlic	Methomyl	CAgarlic0Cra	0.50	29-Apr	3 / 7	0.05	2	0.055
Garlic	Oxamyl	CAgarlic0Cra	2.22	24-Mar	1	0.14	2	0.055
Grapefruit	Formetanate	CAcitrus0C	1.25	26-Apr	2 / 4	0.06	2	0.0087
Grapes	Carbofuran[1]	CAgrapesC	3.11	1-May	1	0.00	2	0.0087
Lemons	Formetanate	CAcitrus0C	1.17	1-May	2 / 4	0.03	2	0.0087
Lettuce	Methomyl	CAbroccCVcra	0.77	15-Jun	2 / 84	0.73	2	0.055
Nectarine	Carbaryl	CAfruit0C	3.55	19-May	1	0.04	2	0.0087
Nectarine	Formetanate	CAfruit0C	0.78	18-Feb	1	0.46	2	0.0087
Nectarine	Methomyl	CAfruit0C	0.83	20-Feb	2 / 81	0.12	2	0.0087
Onions	Methomyl	CAonion0C	0.80	11-May	2 / 35	0.04	2	0.0087
Oranges	Carbaryl	CAcitrus0C	4.89	17-May	1	0.03	2	0.0087
Oranges	Formetanate	CAcitrus0C	1.14	22-Apr	1	0.06	2	0.0087
Oranges	Methomyl	CAcitrus0C	0.67	20-Apr	1	0.01	2	0.0087
Oranges	Oxamyl	CAcitrus0C	0.56	3-Feb	4 / 13, 101, 80	0.00	2	0.0087
Peaches	Carbaryl	CAfruit0C	4.46	15-May	2 / 56	0.05	2	0.0087

Crop/Use	Chemical	PRZM scenario	App. Rate, kg/ha	App Date	No Apps / Interv. (da) (+)	Frac. Trt	CAM	Spray Drift
Peaches	Formetanate	CAfruit0C	0.88	6-Mar	1	0.05	2	0.0087
Peaches	Methomyl	CAfruit0C	0.74	10-Apr	1	0.02	2	0.0087
Peaches	Oxamyl	CAfruit0C	2.22	3-Jan	2 / 21	0.00	2	0.0087
Pistachios	Carbaryl		4.44	5-Feb	1	0.03	2	0.0087
Plum/Prune	Carbaryl	CAfruit0C	3.30	13-Jan	1	0.03	2	0.0087
Plum/Prune	Formetanate	CAfruit0C	1.28	1-Mar	1	0.01	2	0.0087
Potatoes	Aldicarb	CAtomato0C	3.33 *	7-May	1	0.10	1	0 [grn]
Potatoes	Methomyl	CAtomato0C	0.79	7-May	2 / 26	0.09	2	0.055
Sugar Beets	Methomyl	CAsugarbeet0C	0.58	15-Jun	1	0.54	2	0.055
Tangerine	Formetanate	CAcitrus0C	0.90	24-Apr	1	0.14	2	0.055
Tomatoes	Methomyl	CAtomato0C	0.77	15-May	2 / 69	0.40	2	0.055
Tomatoes	Oxamyl	CAtomato0C	0.66	20-Apr	1	0.01	2	0.055
Watermelon	Methomyl	CAtomato0C	0.69	10-Jun	2 / 41	0.22	2	0.055

+ For multiple applications, intervals are uniform between applications except where varying intervals are indicated.
* Because of irregularities in the way PRZM models banded in-furrow applications, OPP assumed 15% of applied aldicarb was available in the upper 4-cm of the soil for runoff, reducing the application rate accordingly.
1 EPA proposed to cancel all domestic uses of carbofuran; carbofuran model results are presented as separate sensitivity analysis in the assessment.

Table II.E.6.2 summarizes the distributions of each NMC chemical for each regional exposure site. Estimated peak concentrations of the individual NMC pesticides were in the sub-parts per billion range, except for aldicarb, which had estimated peaks as high as a single part per billion in the northeast NC site. The regional surface water distributions were generally higher in the southeastern part of the United States, where high NMC use and high rainfall drove the transport of NMC residues into surface water sources of drinking water. Aldicarb tended to be the major contributor in most of the regional surface water exposures.

Table II.E.6-2 Estimated concentration percentiles, in ug/L (ppb), of individual NMC pesticides in each region.

	Aldicarb	Carbaryl	Carbo-furan[1]	Formetan-ate HCl	Metho-myl	Oxamyl	Thiodi-carb
Southeast / NC							
Crops	cotton, peanut, tobacco	cotton, peanut, tobacco, cucumber	tobacco		peanut, tobacco	peanut	
Maximum	1.26	0.04	0.002		0.03	0.23	
99th %ile	0.28	0.02	0.001		0.004	0.01	
95th %ile	0.06	0.01	<0.001		0.001	0.002	
90th %ile	0.02	0.004	<0.001		<0.001	<0.001	
80th %ile	0.004	0.002	<0.001		<0.001	<0.001	
75th %ile	0.001	0.002	<0.001		<0.001	<0.001	
Southeast / GA							

	Aldicarb	Carbaryl	Carbo-furan[1]	Formetan-ate HCl	Metho-myl	Oxamyl	Thiodi-carb
Crops	cotton, peanut, pecan	pecan					
Maximum	0.37	0.05					
99th %ile	0.09	0.01					
95th %ile	0.02	0.004					
90th %ile	0.006	0.002					
80th %ile	0.001	<0.001					
75th %ile	<0.001	<0.001					
Florida / South							
Crops	oranges, grapefruit	oranges, grapefruit	Sugar-cane, swt corn, cucumber		swt corn, pepper, cucumber	pepper, oranges, cucumber	sweet corn
Maximum	0.02	0.01	0.82		0.63	0.14	0.06
99th %ile	0.004	0.002	0.18		0.18	0.02	0.007
95th %ile	0.001	0.001	0.08		0.08	0.006	0.003
90th %ile	<0.001	<0.001	0.04		0.04	0.003	0.001
80th %ile	<0.001	<0.001	0.01		0.02	0.001	<0.001
75th %ile	<0.001	<0.001	0.007		0.01	0.001	<0.001
Florida / Central							
Crops	oranges, grapefruit	oranges, grapefruit				oranges	
Maximum	0.46	0.11				0.05	
99th %ile	0.07	0.03				0.008	
95th %ile	0.01	0.009				0.002	
90th %ile	0.004	0.005				0.001	
80th %ile	0.001	0.002				<0.001	
75th %ile	<0.001	0.001				<0.001	
Mid-South / LA							
Crops	Cotton		cotton, corn, sorghum		degr of thiodicarb (cotton)	cotton	cotton
Maximum	0.70		0.33		0.34	0.19	0.07
99th %ile	0.14		0.15		0.05	0.01	0.003
95th %ile	0.02		0.07		0.009	0.001	0.001
90th %ile	0.003		0.04		0.003	<0.001	<0.001
80th %ile	<0.001		0.02		0.001	<0.001	<0.001
75th %ile	<0.001		0.01		<0.001	<0.001	<0.001
North-Northcentral / PA							
Crops		apple, peach, swt corn	alfalfa, corn, pumpkin, swt corn	apple	apple, peach, potato, swt corn	apple	swt corn
Maximum		0.02	0.09	0.001	0.07	0.003	<0.001
99th %ile		0.003	0.02	<0.001	0.02	<0.001	<0.001
95th %ile		0.001	0.008	<0.001	0.006	<0.001	<0.001
90th %ile		0.001	0.004	<0.001	0.003	<0.001	<0.001
80th %ile		<0.001	0.002	<0.001	0.002	<0.001	<0.001

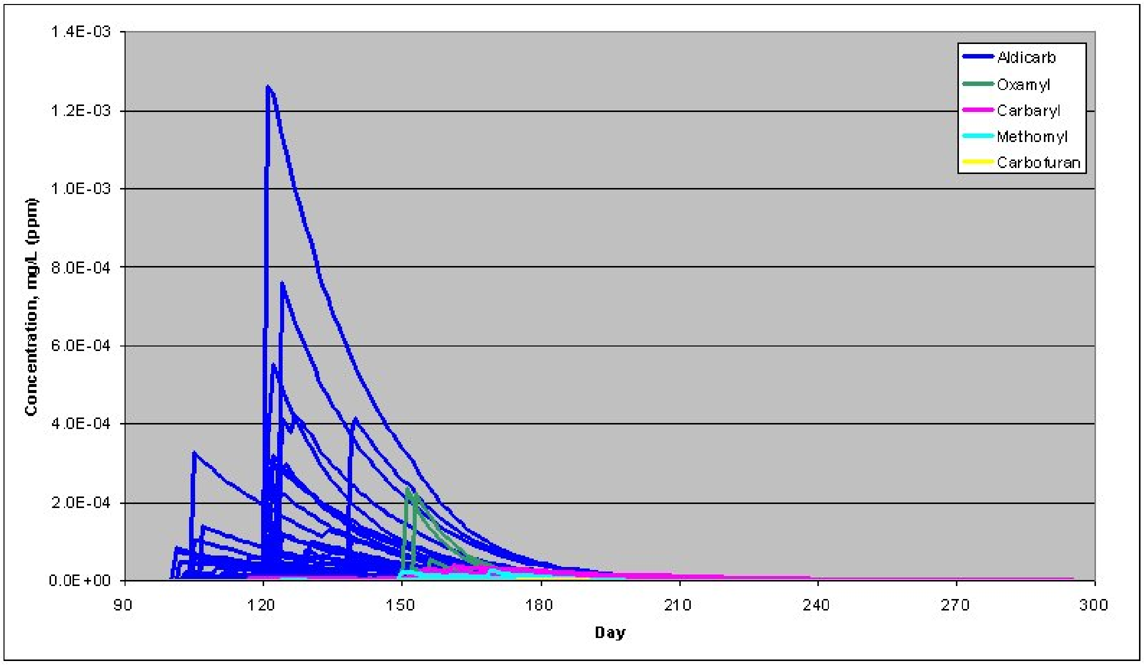
	Aldicarb	Carbaryl	Carbo-furan[1]	Formetan-ate HCl	Metho-myl	Oxamyl	Thiodi-carb
75th %ile		<0.001	0.001	<0.001	0.001	<0.001	<0.001
North- NorthCentral / IL							
Crops		corn, swt corn	alfalfa, corn, swt corn		lima beans		
Maximum		0.04	0.11		0.02		
99th %ile		0.01	0.04		0.002		
95th %ile		0.003	0.01		0.001		
90th %ile		0.001	0.008		<0.001		
80th %ile		0.001	0.003		<0.001		
75th %ile		<0.001	0.002		<0.001		
Lower Midwest / TX							
Crops	Cotton, grapefruit		Cotton, corn	Grapefruit	Onions, spinach, cucumber	Cotton, carrots, onions, melons, peppers, cucumber	
Maximum	0.07		0.35	0.04	0.21	0.19	
99th %ile	0.02		0.17	0.008	0.03	0.07	
95th %ile	0.005		0.07	0.001	0.01	0.02	
90th %ile	0.002		0.04	<0.001	0.006	0.01	
80th %ile	<0.001		0.02	<0.001	0.003	0.004	
75th %ile	<0.001		0.02	<0.001	0.002	0.003	
Northern Great Plains / Red River Valley							
Crops	Potatoes, sugar beets	Spring wheat	Potatoes, sugar beets, sunflower			Potatoes	
Maximum	0.004	0.10	0.008			0.003	
99th %ile	0.001	0.02	0.003			0.001	
95th %ile	<0.001	0.007	0.001			<0.001	
90th %ile	<0.001	0.003	0.001			<0.001	
80th %ile	<0.001	<0.001	<0.001			<0.001	
75th %ile	<0.001	<0.001	<0.001			<0.001	
Northwest / Central Washington							
Crops	Beans, potatoes	Apples, Cherries	Potatoes	Apples	Beans, sweet corn	Carrots, onions, potatoes	
Maximum	0.03	0.04	0.04	<0.001	0.09	0.02	
99th %ile	0.01	0.004	0.02	<0.001	0.01	0.005	
95th %ile	0.002	0.003	0.005	<0.001	0.006	0.003	
90th %ile	0.001	0.002	0.004	<0.001	0.004	0.002	
80th %ile	<0.001	0.001	0.002	<0.001	0.001	0.001	
75th %ile	<0.001	<0.001	0.002	<0.001	0.001	0.001	
Southwest / CA Central Valley							

	Aldicarb	Carbaryl	Carbo-furan[1]	Formetan-ate HCl	Metho-myl	Oxamyl	Thiodi-carb
Crops	Cotton, beans/ peas, potato	Apples, melons, cotton, nectarine, oranges, peaches, plums, pistachios	Alfalfa, cotton, grapes	grapefruit, lemons, nectarine, oranges, plums, tangerines	Alfalfa, asparagus, broccoli, melons, carrots, garlic, lettuce, nectarine, onions, oranges, peaches, potato, sugar beets, tomatoes	Melons, cotton, garlic, oranges, peaches, tomatoes	
Maximum	0.08	0.02	0.08	0.03	0.40	0.02	
99th %ile	0.02	0.005	0.04	0.004	0.08	0.01	
95th %ile	0.001	0.002	0.02	0.001	0.03	0.005	
90th %ile	<0.001	0.001	0.01	<0.001	0.02	0.002	
80th %ile	<0.001	0.001	0.006	<0.001	0.007	0.001	
75th %ile	<0.001	<0.001	0.005	<0.001	0.005	0.001	

1 EPA proposed to cancel all domestic uses of carbofuran; carbofuran model results are presented as separate sensitivity analysis in the assessment.

Surface water exposure in each of the regions reflects a distinct seasonal pattern, with greatest exposure coming during the dominant pesticide use season. Figure II.E.6.3 illustrates this pattern for the Southeast Region (North Carolina), with the greatest exposures from drinking water occurring in late spring and summer (May-July), dropping to negligible levels during the rest of the year. In contrast, the cumulative ground water exposures showed a less-pronounced seasonal trend, with estimated exposures remaining at elevated concentrations for prolonged periods. Similar pattern occur in each of the regions.

II.E.6. 3- Seasonal pattern in estimated concentrations of carbamates in the Southeast / North Carolina exposure site.



4. Southeast Region Scenario Documentation

a. North Carolina Cotton (NCcottonC)

The field used to represent cotton production in North Carolina is located in the Piedmont/Coastal Plain. According to the 1997 Census of Agriculture, North Carolina is ranked 5th among the major cotton producing states in the U.S. Most cotton is grown in the coastal plain region and approximately 3 percent in the Piedmont. Cotton is planted in the early spring (mid-April) and harvested beginning in October. Continuous cotton is practice is much of the region and cotton is gradually replacing land once cultivated in tobacco. Row spacing is generally 38-inches with 3-4 plants per foot row. Row canopies tend to be very close to 100 percent, while the canopy between rows is much less. All cotton is defoliated in North Carolina prior to harvesting. Conventional tillage is the dominant practice, but, conservation tillage, no-till and strip-till practices are gaining in popularity in the region. The crop is rarely grown under irrigation, approximately 5 percent. The soil selected to simulate the field is a Boswell fine sandy loam. Boswell fine sandy loam is a fine, mixed, active, thermic Vertic Paleudalfs. Very little of the soil is in cotton and most remains in woodland or pasture. Boswell fine sandy loam is a deep, moderately well drained, moderate to rapid runoff, very slowly permeable soils formed in marine fluviatile deposits of acid clayey sediments. These soils have a high shrink-swell potential. They are located on nearly level to steep uplands of the Southern Coastal Plain. Slopes are generally between 1 to 17 percent. The soils are of large extent in the Southern Coastal Plain region. Boswell fine sandy loam is a Hydrologic Group D soil.

Table II.E.6-3 PRZM 3.12 Scenario Input Parameters for Coastal Plain, North Carolina - Cotton

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Raleigh, NC (W13722)
Ending Date	December 31, 1990	Meteorological File - Raleigh, NC (W13722)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	15.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.34 tons EI-1*	FARM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	1.3	Haan and Barfield, 1978.
USLE P Factor (USLEP)	1.00	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to default for fallow surface prior to planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Raleigh, NC (W13722)
Maximum rainfall interception storage of crop (CINTCP)	0.2	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	60 cm	PRZM Input Collator; (Burns, 1992); PRZM Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	98	PRZM Input Collator, PIC (Burns, 1992)
Soil Surface Condition After Harvest (ICNAH)	3	Residues left on field until following year or cover crop is planted.
Date of Crop Emergence (EMD, EMM, IYREM)	01/06	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/08	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/11	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	92, 89, 90	Gleams Manual Table; Fallow SR/CT/poor, Cropping and Residue = Row Crop SR/CT/poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project, PB8CTCTC, actually for Columbia, SC cotton, conventional till (USDA, 2000)
USLE C Factor (USLEC)	0.228 - 0.748	RUSLE Project; PB8CTCTC, actually for Columbia, SC cotton, conventional till (USDA, 2000)
Soil Parameters: Boswell series		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	NRCS, National Soils Characterization Database (NRCS, 2001)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 2 cm (HORIZN = 2) 88 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.8 g cm-3 (HORIZN = 1,2) 1.7 g cm-3 (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Initial Water Content (THETO)	0.213 cm3-H2O cm3-soil (HORIZN =1, 2) 0.354 cm3-H2O cm3-soil (HORIZN =3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3)	
Field Capacity (THEFC)	0.213 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.354 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Wilting Point (THEWP)	0.063 cm3-H2O cm3-soil (HORIZN = 1,2) 0.213 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Organic Carbon Content (OC)	2.32% (HORIZN = 1,2) 0.29% (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)

b. North Carolina Peanuts (NCpeanutC)

The field used to represent peanut production in North Carolina is located in Eastern Pitt County in the Coastal Plain. According to the 1997 Census of Agriculture, North Carolina is ranked 3rd among the major peanut producing states in the U.S., accounting for approximately 10 percent of the total U.S. crop. Peanuts are produced mainly on the northeastern coastal plain and a small amount is produced in the southeastern region. The crop is generally planted in the spring (mid-April to early May) and harvested beginning in September. Crop rotation is the most important cultural practice, with a long rotation (3 years) followed by two years of a grass-type crop being among the most effective management practices for nematode, diseases, and weed control. Most plantings occur on raised beds. Row spacing is generally 30 to 48 inches. Conventional tillage is practiced in the region, but strip-tillage and no-tillage practices are becoming more popular. The crop is rarely grown under irrigation, approximately 10 percent. The soil selected to simulate the field is a Craven silt loam. Craven silt loam is a fine, mixed, subactive, thermic Aquic Hapludults. Approximately one-half of the series is used for the production of row crops such as corn, tobacco, cotton, small grain, peanuts and pasture. Craven silt loam is a deep, moderately well drained, medium to rapid runoff, slowly permeable soils formed in clayey Pleistocene sediments. They are located on nearly level to sloping Coastal Plain Uplands. Slopes are generally between 0 to 12 percent. The soils are extensive throughout the Coastal Plain region. Craven silt loam is a Hydrologic Group C soil.

Table II.E.6-4 PRZM 3.12 Scenario Input Parameters for Coastal Plain, North Carolina - Peanuts

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Raleigh, NC (W13722)
Ending Date	December 31, 1990	Meteorological File - Raleigh, NC (W13722)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	15.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.24 tons EI-1*	FARM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	1.34	Haan and Barfield, 1978.
USLE P Factor (USLEP)	1.00	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)

Parameter	Value	Source
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	3	American Peanut Council http://peanutsusa.com/what/growing.html
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Raleigh, NC (W13722)
Maximum rainfall interception storage of crop (CINTCP)	0.1	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	45 cm	PRZM Input Collator; (Burns, 1992); PRZM Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	80	PRZM Input Collator, PIC (Burns, 1992)
Soil Surface Condition After Harvest (ICNAH)	3	American Peanut Council http://peanutsusa.com/what/growing.html
Date of Crop Emergence (EMD, EMM, IYREM)	11/04	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Date of Crop Maturity (MAD, MAM, IYRMAT)	28/08	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Date of Crop Harvest (HAD, HAM, IYRHAR)	12/09	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	89, 84, 86	Gleams Manual Table; close seeded legume, C soil, fallow = fallow SR/CT poor; cropping and residue = legumes SR poor condition (USDA, 1990)
Manning’s N Value (MNGN)	0.014	RUSLE Project, PB9PRPRC_ runner peanuts, Augusta GA (nearest peanut) (USDA, 2000)
USLE C Factor (USLEC)	0.047 - 0.668	RUSLE Project; PB9PRPRC_ runner peanuts, Augusta GA (nearest peanut) (USDA, 2000)
Soil Parameters: Craven series		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	NRCS, National Soils Characterization Database (NRCS, 2001)

Parameter	Value	Source
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 2 cm (HORIZN = 2) 88 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.8 g cm-3 (HORIZN = 1,2) 1.7 g cm-3 (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Initial Water Content (THETO)	0.213 cm3-H2O cm3-soil (HORIZN =1, 2) 0.354 cm3-H2O cm3-soil (HORIZN =3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3)	
Field Capacity (THEFC)	0.213 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.354 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Wilting Point (THEWP)	0.063 cm3-H2O cm3-soil (HORIZN = 1,2) 0.213 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Organic Carbon Content (OC)	2.32% (HORIZN = 1,2) 0.29% (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)

c. North Carolina Tobacco (NCtobaccoC)

The field used to represent tobacco (flue-cured) production in North Carolina is located in Pitt and Johnston Counties, in Eastern North Carolina. According to the 1997 Census of Agriculture, North Carolina is the major producer of tobacco (first overall) in the U.S. Tobacco is grown on a wide variety of soils, however, maximum yields are typically seen on sandy loam soils with low organic matter content. In addition, tobacco roots do not tolerate “wet” soils for prolong periods of time. Approximately 90 percent of the crop is grown in two-year rotation. Row spacing is generally from 40 to 48 inches. Tobacco is transplanted from greenhouse or plastic-covered outdoor plant beds in early spring after frost pressures (mid-April). Flower heads are removed to induce growth of lateral shoots. Harvesting is done in stages from lowest to highest leaves on the plant as the leaves ripen. Nearly all (99 percent) of tobacco is grown with conventional tillage. No-till production is used mostly for burley tobacco grown in western North Carolina. The soil selected to simulate the field is a benchmark soil, Norfolk loamy sand. Norfolk loamy sand is a fine-loamy, kaolinitic, thermic, Typic Kandiudults. Most of these soils are under cultivation in corn, cotton, peanuts, tobacco and soybeans. Norfolk loamy sand is a very deep, well drained, moderately permeable soil with slow to medium runoff. These soils formed in loamy marine sediments of the Coastal Plain. They are found on level to gently sloping uplands of the Coastal Plain. Slopes range from 0 to 10 percent. The series is of large extent throughout the Coastal Plan. Norfolk loamy sand is a Hydrologic Group B soil.

Table II.E.6-5 PRZM 3.12 Scenario Input Parameters for Coastal Plain, North Carolina - Tobacco

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Raleigh, NC (W13722)
Ending Date	December 31, 1990	Meteorological File - Raleigh, NC (W13722)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	15.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.17 tons EI-1*	GLEAMS Table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.192	GLEAMS Table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	0.5	PRZM Table 5.6 value for contour plowing on 5% slope (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	5%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to default for fallow surface prior to planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Raleigh, NC (W13722)
Maximum rainfall interception storage of crop (CINTCP)	0.2	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	60 cm	PRZM Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	80	NCSU Crop Profile http://ipmwww.ncsu.edu/ncpmip/
Soil Surface Condition After Harvest (ICNAH)	3	Residues left on field until following year or cover crop is planted.

Parameter	Value	Source
Date of Crop Emergence (EMD, EMM, IYREM)	11/04	PRZM Table 5.9 and NCSU Crop Profile http://ipmwww.ncsu.edu/ncpmip/
Date of Crop Maturity (MAD, MAM, IYRMAT)	07/07	PRZM Table 5.9 and NCSU Crop Profile http://ipmwww.ncsu.edu/ncpmip/
Date of Crop Harvest (HAD, HAM, IYRHAR)	16/07	PRZM Table 5.9 and NCSU Crop Profile http://ipmwww.ncsu.edu/ncpmip/
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	84, 79, 83	Gleams Manual Table A.3, Fallow SR/CT/poor, Cropping and Residue = Row Crop SR/CT/poor; B soil (USDA, 1990)
Manning’s N Value (MNGN)	0.014	RUSLE Project, PB6TBHGC; Tobacco, conventional tillage; Greensboro, NC (USDA, 2000)
USLE C Factor (USLEC)	0.071 - 0.500	RUSLE Project; PB6TBHGC; Tobacco, conventional tillage; Greensboro, NC (USDA, 2000)
Soil Parameters: Norfolk series		
Total Soil Depth (CORED)	150 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (Top horizon split in two)	NRCS, National Soils Characterization Database (NRCS, 2001)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 35 cm (HORIZN = 2) 55 cm (HORIZN = 3) 50 cm (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.55 g cm-3 (HORIZN = 1,2) 1.3 g cm-3 (HORIZN = 3) 1.1 g cm-3 (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Initial Water Content (THETO)	0.199 cm3-H2O cm3-soil (HORIZN =1,2) 0.406 cm3-H2O cm3-soil (HORIZN =3) 0.396 cm3-H2O cm3-soil (HORIZN =4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5.0 cm (HORIZN = 2,3,4)	
Field Capacity (THEFC)	0.199 cm3-H2O cm3-soil (HORIZN = 1,2) 0.406cm3-H2O cm3-soil (HORIZN = 3) 0.396 cm3-H2O cm3-soil (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)

Parameter	Value	Source
Wilting Point (THEWP)	0.089 cm3-H2O cm3-soil (HORIZN = 1,2) 0.206 cm3-H2O cm3-soil (HORIZN = 3) 0.246 cm3-H2O cm3-soil (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Organic Carbon Content (OC)	0.29% (HORIZN = 1,2) 0.116 (HORIZN = 3) 0.058% (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)

d. North Carolina Cucumbers (NCcucumbCRA)

This scenario has been developed for use in the carbamate cumulative drinking water assessment (2005). The scenario was adapted from the NC Sweet Potato scenario, which is located in the same area. Soil conditions are the same; crop-specific parameters have been adjusted to reflect cucumbers rather than sweet potatoes.

The field used to represent cucumber production in North Carolina is located in the Southern Coastal Plains in Nash County. Nash County has ~6,400 acres in cucumber/pickle production, the highest among NC counties (USDA Ag Census, 2002). According to the USDA Crop Profile for cucumbers in North Carolina, is ranked 2nd among US states in cucumber production, accounting for ~20% of pickling cucumbers (27-30,000 acres) and ~10% of slicing cucumber production (5-8,000 acres) in 1999 (USDA Crop Profile, Nov 1999; http://www.ipmcenters.org/cropprofiles/docs/nccucumbers.html). Most of the cucumber production is in eastern North Carolina. Cucumbers are adapted to a wide range of soils. The crop is grown in two production seasons (spring and summer), with the average time from seeding to first harvest of 36 to 45 days. An April 15th planting date was used to reflect the spring production period. This date is based on BEAD research for the carbamate cumulative assessment (estimation method and references provided for the carbamate cumulative document).

The soil selected to simulate the field is a Craven silt loam. Craven silt loam is a fine, mixed, subactive, thermic Aquic Hapludults. Approximately one-half of the series is used for the production of row crops such as corn, tobacco, cotton, small grain, peanuts and pasture. Craven silt loam is a deep, moderately well drained, medium to rapid runoff, slowly permeable soil formed in clayey Pleistocene sediments. They are located on nearly level to sloping Coastal Plain Uplands. Slopes are generally between 0 to 12 percent. The soils are extensive throughout the Coastal Plain region. Craven silt loam is a benchmark soil and a Hydrologic Group C soil.

Table II.E.6-6 PRZM 3.12 Scenario Input Parameters for Coastal Plain, North Carolina - Cucumbers

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Raleigh, NC (W13722)
Ending Date	December 31, 1990	Meteorological File - Raleigh, NC (W13722)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	15.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.42 tons EI-1*	FARM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	1.34	Haan and Barfield, 1978.
USLE P Factor (USLEP)	1.00	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Mid-point of series range for Craven silt loam
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2005)
Initial Surface Condition (ISCOND)	1	Pickling cucumbers are generally planted on bare ground; slicing cucumbers are produced on plastic (USDA Crop Profile, 1999)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Raleigh, NC (W13722)
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	50 cm	D.C. Sanders, NCSU extension hort specialist. On-line publication on vegetable irrigation characterizing cucumber as shallow (12-18 in) to moderate (18-24 in) rooting depth (http://www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html)

Parameter	Value	Source
Maximum Canopy Coverage (COVMAX)	80	Estimated based on est for sweet potatoes; consistent w/ range for vegetable crops (70-90%) in Table A-1 of scenario input guidance (EPA, 2005)
Soil Surface Condition After Harvest (ICNAH)	3	residues remain on field until winter cover crop is planted.
Date of Crop Emergence (EMD, EMM, IYREM)	27/04	Based on planting dates of 4/15-5/15 for slicing cukes, 4/20-5/20 for pickling cukes (SE Commercial Vegetable Guide, 2005), estimated emergence 1 week after planting
Date of Crop Maturity (MAD, MAM, IYRMAT)	4/06	Assumed 1 week between crop maturity and harvest
Date of Crop Harvest (HAD, HAM, IYRHAR)	11/06	Added 45 days from planting to first harvest, based on USDA Crop Profile for NC cucumber (http://www.ipmcenters.org/cropprofiles/docs/nccucumbers.html)
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	89, 86, 87	Gleams Manual Table A.3,Fallow SR/CT/poor, Cropping and Residue = Row Crop SR/CT/poor (USDA, 1990)
Manning’s N Value (MNGN)	0.011	Pb6BGBGC Green Beans, conventional tillage, Cover Code 7 (clean tilled, smooth or fallow), Greensboro, N.C. These values re-ordered from RUSLE project so that first value is for the planting date.
USLE C Factor (USLEC)	0.160 - 0.923	Pb6BGBGC Green Beans, conventional tillage, Cover Code 7 (clean tilled, smooth or fallow), Greensboro, N.C.
Soil Parameters: Craven series		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	NRCS, National Soils Characterization Database (NRCS, 2001)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 12 cm (HORIZN = 2) 78 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1,2,3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Initial Water Content (THETO)	0.194 cm3-H2O cm3-soil (HORIZN =1, 2) 0.321 cm3-H2O cm3-soil (HORIZN =3)	NRCS, National Soils Characterization Database (NRCS, 2001)

Parameter	Value	Source
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Field Capacity (THEFC)	0.194 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.321 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Wilting Point (THEWP)	0.074 cm3-H2O cm3-soil (HORIZN = 1,2) 0.201 cm3-H2O cm3-soil (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001)

e. Georgia Cotton

This scenario is a modification of the North Carolina cotton scenario. All of the crop and soil input parameters are the same as that used for the NC scenario. Only the weather station and weather-related parameters were changed. For this scenario, OPP used the meteorological file for Augusta, GA (W3820), which was the closest site within the same MLRA to the GA scenario (Burke County, GA).

f. Georgia Peanuts

This scenario is a modification of the North Carolina peanut scenario. All of the crop and soil input parameters are the same as that used for the NC scenario. Only the weather station and weather-related parameters were changed. For this scenario, OPP used the meteorological file for Augusta, GA (W3820), which was the closest site within the same MLRA to the GA scenario (Burke County, GA).

g. Georgia Pecans

The field used to represent peach production in Georgia is located in Mitchell or Dougherty County in Southwest Georgia (MLRA133) and the weather station representing the orchard's weather is located in Macon, GA. However, for the carbamate cumulative, OPP used the weather station for Augusta, GA, which was closest to the cumulative exposure site (in the adjacent county). Pecans are grown throughout the southwestern part of the state. Georgia and Texas generally compete from year to tear for status as the top U.S. producer. As such, production varies significantly from year to year. Trees are very large, growing up to 100 feet tall and living 80 or more years, although production declines as the trees reach the end of its life span. Tree are initially planted at a rate of 27 trees per acre and thinned to 8 trees per acre over an 18-20 year period;

approximately 60 feet by 60 feet spacing. Pollinizers are generally planted every 9th or 11th row to facilitate adequate pollination and increases profitability of the stand. Pecan trees require approximately 50 percent foliar canopy for optimal light penetration and crop yield. Proper tree density also allows for better pesticide application. Pecan trees typically produce nuts for 40 or more years. Most (approximately 65 percent) Georgia pecans are irrigated via drip irrigation systems. Soil characteristics have a significant influence on tree development, fruit bearing capacity, and tree life. Pecan trees prefer light to medium textured soils, pH 5.5-6.0, but can grow on higher clay content and slightly higher pH soils. Soil depth should be several feet or more and water table below the primary root zone. Pecans are native to floodplains and river-bottoms having inherently high water requirements. Maturity is reached when the shuck loosens or splits from the shell - harvest then begins. Pecans are harvested with trunk or limb shakers depending on tree age. The soil selected to simulate the field is Williston loamy fine sand. Williston loamy fine sand is a fine, mixed, superactive, hyperthermic Typic Hapludalfs. Williston loamy fine sand loam is a moderately deep, well drained, moderately rapid runoff, moderately slowly permeable soil that formed in moderately thick beds of clayey marine sediments overlying soft limestone. These soils are generally found on nearly level to sloping landscapes in the Coastal Plain. Slopes are dominantly less than 5 percent but ranges up to 8 percent on hillsides. The soil is of small extent in the Coastal Plains of the South. Williston loamy fine sand is a Hydrologic Group C soil.

Table II.E.6-7 PRZM 3.12 Scenario Input Parameters for Mitchell, Co. Georgia Pecans

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – Augusta, GA (W3820)
Ending Date	December 31, 1990	Meteorological File – Augusta, GA (W3820)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation ANETD)	25.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.42 tons EI-1*	FARM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	0.35 tons EI-1*	Haan and Barfield, 1978.
USLE P Factor (USLEP)	1.067	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	5%	Mid-point of series range for Williston

Parameter	Value	Source
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2005)
Initial Surface Condition (ISCOND)	3	Residues remain in field between tree rows, area under trees
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Augusta, GA (W3820)
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	100 cm	Set to soil horizon depth; main root cluster may grow in excess of 2 meters deep. Tap root will grow to first confining layer. http://www.uga.edu/fruit/pecan.htm
Maximum Canopy Coverage (COVMAX)	50	Based or optimal light penetration and yield. http://www.uga.edu/fruit/pecan.htm
Soil Surface Condition After Harvest (ICNAH)	3	Residues remain in field between tree rows, area under trees.
Date of Crop Emergence (EMD, EMM, IYREM)	21/04	Estimated date of canopy leaf-out; http://www.uga.edu/fruit/pecan.htm
Date of Crop Maturity (MAD, MAM, IYRMAT)	21/09	Estimated date (based on 180-220 day required growing season) for fruit maturity; http://www.uga.edu/fruit/pecan.htm
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/10	Estimated date of harvesting; http://www.uga.edu/fruit/pecan.htm
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table A.3,Meadow, conditions good for Hydrologic Soil C;
Manning's N Value (MNGN)	0.07	RUSLE EPA Pesticide Project; Tb7WWSBC; Savannah, GA; Winter Wheat, Cover Code 3 (residues), Conventional Tillage (USDA, 2000)
USLE C Factor (USLEC)	0.021 - 0.259	RUSLE EPA Pesticide Project; Tb7WWSBC; Savannah, GA; Winter Wheat, Cover Code 3 (residues), Conventional Tillage (USDA, 2000)
Soil Parameters: Craven series		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (Top horizon split in two)	NRCS, National Soils Characterization Database (NRCS, 2001)

Parameter	Value	Source
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 20 cm (HORIZN = 2) 16 cm (HORIZN = 3) 54 cm (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1,2) 1.7 g cm-3 (HORIZN = 3,4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Initial Water Content (THETO)	0.149 cm3-H2O cm3-soil (HORIZN =1,2) 0.245 cm3-H2O cm3-soil (HORIZN =3) 0.332 cm3-H2O cm3-soil (HORIZN =4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN =2) 4 cm (HORIZN =3) 6 cm (HORIZN =4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Field Capacity (THEFC)	0.149 cm3-H2O cm3-soil (HORIZN = 1,2) 0.245 cm3-H2O cm3-soil (HORIZN = 3) 0.332 cm3-H2O cm3-soil (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Wilting Point (THEWP)	0.069 cm3-H2O cm3-soil (HORIZN = 1,2) 0.125 cm3-H2O cm3-soil (HORIZN = 3) 0.192 cm3-H2O cm3-soil (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3) 0.116% (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)

5. Florida Region Scenario Documentation

a. Florida Citrus

The field used to represent citrus production in Florida is located in Collier or Hendry Counties in Southwest Florida, although citrus production areas cover a substantial portion of the state. Citrus production has been moving southward in an attempt to avoid frost damage that has occurred in recent years. According to the 1997 Census of Agriculture, Florida is the major producer of citrus (oranges) for the juice market and among the highest for the fresh market. Florida is also among the highest producers in other citrus (grapefruit, tangerines, tangelos, and mandarins). Citrus is generally grown in double rows of trees (beds) with swales between to move water off site. Areas under and between rows of trees are generally non-cultivated/non-maintained except for the occasional mowing. Row spacing (pairs or rows) is approximately 20 to 25 feet (paired beds may be less than 20 feet) and between tree spacing is approximately 12 to 15 feet. Row canopies tend to be 100 percent, while the canopy between rows is less to permit the operation of maintenance and harvest equipment. Irrigation is mostly by low-volume drip or micro-sprinkler systems. The soil selected to simulate the field is Wabasso fine sand. Wabasso fine sand, is a sandy, siliceous, hyperthermic Alfic Alaquods. These soils are often used for citrus production and truck crops. Wabasso fine sand is a deep to very deep, poorly to very poorly drained, slow to ponded runoff, rapidly permeable in the top horizon and slow to very slowly permeable in the lower horizons soil that formed in sandy and loamy marine sediments. These soils are generally found on flatwoods, flood plains, and depressions and have slopes of 0 to 2 percent. The soil is extensive in Florida. Wabasso fine sand is a Hydrologic Group D soil.

Table II.E.6-8 PRZM 3.12 Scenario Input Parameters for Florida Citrus

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – West Palm Beach, FL (W12844)
Ending Date	December 31, 1990	Meteorological File – West Palm Beach, FL (W12844)
Pan Evaporation Factor (PFAC)	0.78	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	Does not snow in Southern Florida such that accumulation is expected
Minimum Depth of Evaporation (ANETD)	33.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.1 tons EI-1*	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.093	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	1.0	Assume no practice under trees.
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to represent fallow field
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. West Palm Beach, FL (W12844)

Parameter	Value	Source
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for orchards (EPA, 2001)
Maximum Active Root Depth (AMXDR)	100 cm	Set to maximum of soil profile. Trees may root from 7-18 feet http://edis.ifas.ufl.edu
Maximum Canopy Coverage (COVMAX)	60	http://edis.ifas.ufl.edu
Soil Surface Condition After Harvest (ICNAH)	3	Default, material under trees and between rows is generally left alone
Date of Crop Emergence (EMD, EMM, IYREM)	15/02	Date represent early to mid_season flower bloom for various varieties of citrus http://edis.ifas.ufl.edu
Date of Crop Maturity (MAD, MAM, IYRMAT)	15/10	Date represent late season maturation for various varieties of citrus http://edis.ifas.ufl.edu
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/12	Date represents late season harvest http://edis.ifas.ufl.edu
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	87, 85, 86	Gleams Manual Table A.3, Meadows, no fallow conditions (USDA, 1990)
Manning’s N Value (MNGN)	0.014	RUSLE Project; UC0CBCBC; Citrus bare ground; conventional tillage; Tampa, FL (USDA, 2000)
USLE C Factor (USLEC)	0.324 - 0.488	RUSLE Project; Variable with date, UC0CBCBC; Citrus bare ground; conventional tillage; Tampa, FL (USDA, 2000)
Wabasso Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 90 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.75 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.066 cm3-H2O cm3-soil (HORIZN =1) 0.178 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2)	

Parameter	Value	Source
Field Capacity (THEFC)	0.066 cm3-H2O cm3-soil (HORIZN = 1) 0.178 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.036 cm3-H2O cm3-soil (HORIZN = 1) 0.078 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	2.32% (HORIZN = 1) 0.29% (HORIZN = 2)	

b. Florida Cucumber

The field used to represent cucumber (vegetable) production in Florida is located in Collier and Hendry Counties in Southwest Florida, although vegetable production areas include other regions of Florida such as the Everglades Agricultural Area, west-central and south-eastern regions. According to the 1997 Census of Agriculture, Florida is a major producer of truck crops and is the highest producer of cucumbers. Cucumbers and other truck crops are generally grown on “muck soils,” but cucumbers do as well on sandy soils which require less cleaning before marketing. All cucumbers are planted by direct seeding in Florida. Typical planting distances for slicing cucumbers are 48 to 60 inches between rows and 6 to 12 inches between plants. Pickling cucumbers are typically planted at 36 to 48 inches between rows and 2 to 4 inches between plants. When grown using plastic mulch, slicing cucumbers are planted in one or two rows per bed, with 10 to 18 inches between the rows on the bed, 48 to 72 inches between beds, and 8 to 12 inches between holes with one or two plants per hole. Pickling cucumbers are planted at a distance of 3 to 4 inches between plants. At the closest spacing, the plant population is 21,780 per acre. Seeds are planted at a depth of 0.5 to 0.75 inches. Between 35 and 65 days are required from seeding to maturity (first pick). Cucumbers in Florida are produced using several types of irrigation systems. In mulched production, drip, overhead, and seepage irrigation are used. By raising the water table, seepage irrigation restricts root growth to the bed area. Water is maintained approximately 15 to 18 inches below the soil surface, allowing seepage into the root zone. The soil selected to simulate the field is Riviera sand. Riviera sand is a loamy, siliceous, active, hyperthermic Arenic Glossaqualfs. These soils are often used for truck crop and citrus production. Riviera sand is a deep, poorly drained, slow runoff, slowly to very slowly permeable soil that formed in stratified marine sandy and loamy sediments on the Lower Coastal Plain. These soil are generally found on broad, low flats and in depressions and have slopes generally less than 2 percent. The soil is of moderate extent. Riviera sand is a Hydrologic Group C soil.

Table II.E.6-9 PRZM 3.12 Scenario Input Parameters for Florida Cucumbers

Parameter	Value	Source

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - West Palm Beach, FL (W12844)
Ending Date	December 31, 1990	Meteorological File - West Palm Beach, FL (W12844)
Pan Evaporation Factor (PFAC)	0.78	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	No appreciable snow accumulation occurs in this part of Florida
Minimum Depth of Evaporation (ANETD)	33.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.03 tons EI-1*	PRZM Input Collator (Burns, 1992) and FARM Manual (EPA, 1985)
USLE LS Factor (USLELS)	0.2	Haan and Barfield, 1979
USLE P Factor (USLEP)	1.0	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Field are fallow prior to planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - West Palm Beach, FL (W12844)
Maximum rainfall Interception storage of crop (CINTCP)	0.15	PIC; confirmed using Table 5.4 from PRZM Manual (Burns, 1992 and EPA, 1985)
Maximum Active Root Depth (AMXDR)	50 cm	Florida Cucumber Crop Profile, USDA
Maximum Canopy Coverage (COVMAX)	80	PIC (Burns, 1992)
Soil Surface Condition After Harvest (ICNAH)	3	Plant residues are left behind until later in the year when tilled for next series of crops; rarely cucumbers.
Date of Crop Emergence (EMD, EMM, IYREM)	10/10	Florida Cucumber Crop Profile, USDA http://pestdata.ncsu.edu/cropprofiles/cropprofiles.cfm
Date of Crop Maturity (MAD, MAM, IYRMAT)	05/12	Florida Cucumber Crop Profile, USDA http://pestdata.ncsu.edu/cropprofiles/cropprofiles.cfm

Parameter	Value	Source
Date of Crop Harvest (HAD, HAM, IYRHAR)	10/12	Florida Cucumber Crop Profile, USDA http://pestdata.ncsu.edu/cropprofiles/cropprofiles.cfm
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = SR poor, Cropping and Residue = Row Crop SR/poor (USDA, 1990)
Manning's N Value (MNGN)	0.011	RUSLE Project; UC0BGBGC; Green Beans, conventional tillage; Tampa, FL (USDA, 2000)
USLE C Factor (USLEC)	0.162 - 0.938	RUSLE Project; UC0BGBGC; Green Beans, conventional tillage; Tampa, FL, Variable with date (USDA, 2000)
Riviera Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 62 cm (HORIZN = 2) 28 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/) Ed Russell (USDA_NRCS, Fresno)
Bulk Density (BD)	1.65 g cm-3 (HORIZN = 1,2) 1.7 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.073 cm3-H2O cm3-soil (HORIZN =1,2) 0.211 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN =2,3)	
Field Capacity (THEFC)	0.073 cm3-H2O cm3-soil (HORIZN = 1,2) 0.211 cm3-H2O cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.023 cm3-H2O cm3-soil (HORIZN = 1,2) 0.091 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3)	

c. Florida Peppers - Bell

The field used to represent pepper (bell peppers) production in Florida is located in Collier and Hendry Counties in Southwest Florida, although vegetable production areas include other regions of Florida such as the Everglades Agricultural Area, west-central and south-eastern regions. According to the 1997

Census of Agriculture, Florida is a major producer of truck crops and is the highest producer of bell peppers. Peppers and other truck crops are generally grown on “muck soils,” but peppers do as well on sandy soils which require less cleaning before marketing. Peppers (bell peppers) are planted mainly by transplant, but some direct seeding in does occur in Florida. Typical planting distances for most peppers are 36 to 42 inches between rows and 12 to 16 inches between plants in a row. When grown using plastic mulch, which is a common practice in Florida, planting distances change very little. Peppers are generally harvested two or more times during the course of the growing season and in Southern Florida, where frost pressures are minimal, they are planted and harvested throughout the year. Peppers in Florida are produced using several types of irrigation systems. In mulched production, drip irrigation is highly recommended because of less water use, lower weed production, and some evidence of increased yields. Various forms of sprinkler irrigation may also be used. The soil selected to simulate the field is a Riviera sand. Riviera sand is a loamy, siliceous, active, hyperthermic Arenic Glossaqualfs. These soils are often used for truck crop and citrus production. Riviera sand is a deep, poorly drained, slow runoff, slowly to very slowly permeable soil that formed in stratified marine sandy and loamy sediments on the Lower Coastal Plain. These soils are generally found on broad, low flats and in depressions and have slopes generally less than 2 percent. The soil is of moderate extent. Riviera sand is a Hydrologic Group C soil.

Table II.E.6-10 PRZM 3.12 Scenario Input Parameters for Florida Peppers

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - West Palm Beach, FL (W12844)
Ending Date	December 31, 1990	Meteorological File - West Palm Beach, FIL(W12844)
Pan Evaporation Factor (PFAC)	0.78	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	No appreciable snow accumulation occurs in this part of Florida
Minimum Depth of Evaporation (ANETD)	33.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.03 tons EI-1*	PRZM Input Collator (Burns, 1992) and FARM Manual (EPA, 1985)
USLE LS Factor (USLELS)	0.2	Haan and Barfield, 1979
USLE P Factor (USLEP)	1.0	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)

Parameter	Value	Source
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Field are fallow prior to planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - West Palm Beach, FL (W12844)
Maximum rainfall Interception storage of crop (CINTCP)	0.15	PIC; confirmed using Table 5.4 from PRZM Manual (Burns, 1992 and EPA, 1985)
Maximum Active Root Depth (AMXDR)	45 cm	http://www.ces.uga.edu/pubcd/b1027_w.html #Transplant
Maximum Canopy Coverage (COVMAX)	70	Based on estimates from aerial photography; specific to peppers, other vegetable crops will require a different value
Soil Surface Condition After Harvest (ICNAH)	3	Plant residues are left behind until later in the year when tilled for next series of crops
Date of Crop Emergence (EMD, EMM, IYREM)	09/01	Florida Peppers (Bell) Crop Profile, USDA, http://pestdata.ncsu.edu/cropprofiles/docs/FL peppers_bell.html
Date of Crop Maturity (MAD, MAM, IYRMAT)	11/15	http://edis.ifas.ufl.edu/BODY_CV130#TABLE _2
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/12	Florida Peppers (Bell) Crop Profile, USDA, http://pestdata.ncsu.edu/cropprofiles/docs/FL peppers_bell.html
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = SR poor, Cropping and Residue = Row Crop SR/poor (USDA, 1990)
Manning's N Value (MNGN)	0.011	RUSLE Project; UC0BGBGC; Green Beans, conventional tillage; Tampa, FL (USDA, 2000)
USLE C Factor (USLEC)	0.162 - 0.938	RUSLE Project; UC0BGBGC; Green Beans, conventional tillage; Tampa, FL, Variable with date (USDA, 2000)
Riviera Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 62 cm (HORIZN = 2) 28 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)

Parameter	Value	Source
Bulk Density (BD)	1.65 g □cm-3 (HORIZN = 1,2) 1.7 g □cm-3 (HORIZN = 3)	Ed Russell (USDA_NRCS, Fresno)
Initial Water Content (THETO)	0.073 cm3-H2O □cm3-soil (HORIZN =1,2) 0.211 cm3-H2O □cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN =2,3)	
Field Capacity (THEFC)	0.073 cm3-H2O □cm3-soil (HORIZN = 1,2) 0.211 cm3-H2O □cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.023 cm3-H2O □cm3-soil (HORIZN = 1,2) 0.091 cm3-H2O □cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3)	

d. Florida Sugarcane

The field used to represent sugarcane production in Florida is located in Hendry County in Southwest Florida, although sugarcane production areas cover an area extending east to the Everglades Agricultural Area. According to the 1997 Census of Agriculture, Florida is the major producer (yield) of sugarcane. Most sugarcane is grown on high organic “muck” soils; approximately 10 percent is grown on mineral soils. Sugarcane is grown on laser-leveled fields by placing short seed “stalks” horizontally in the prepared field. Sugarcane is produced in a three to four year cycle with the first year planting referred to as the “plant cane” crop and successive years referred to as “stubble” or “ratoon” crops which are harvested from re-growth. Yields diminish with each successive crop. At the end of the third or fourth year, sugarcane is rotated to another crop before replanting. Row spacing is approximately 60 inches. Irrigation, when needed, may be accomplished by raising the ground water level through the use of “lateral” drainage systems controlled by locks and spaced from 100 feet to 300 feet apart. The soil selected to simulate the field is Wabasso fine sand. Wabasso fine sand is a sandy, siliceous, hyperthermic Alfic Alaquods. These soils are used for sugarcane production, but mainly citrus production and truck crops. Wabasso fine sand is a deep to very deep, poorly to very poorly drained, slow to ponded runoff, rapidly permeable in the top horizon and slow to very slowly permeable in the lower horizons soil that formed in sandy and loamy marine sediments. These soil are generally found on flatwoods, flood plains, and depressions and have slopes of 0 to 2 percent. The soil is extensive in Florida. Wabasso fine sand is a Hydrologic Group D soil.

Table II.E.6-11 PRZM 3.12 Scenario Input Parameters for Florida Sugarcane

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Miami, FL (W12839)
Ending Date	December 31, 1990	Meteorological File - Miami, FL (W12839)
Pan Evaporation Factor (PFAC)	0.78	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	Does not snow in Southern Florida such that accumulation is expected
Minimum Depth of Evaporation (ANETD)	33.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.1 tons EI-1*	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.093	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	1.0	Assume no practice under trees.
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to represent fallow field
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Miami, FL (W12839)
Maximum rainfall interception storage of crop (CINTCP)	0.1	Set similar to LA Sugarcane; sugarcane is a grass PIC (Burns, 1998)
Maximum Active Root Depth (AMXDR)	100 cm	Set to maximum of soil profile.http://edis.ifas.ufl.edu
Maximum Canopy Coverage (COVMAX)	100	Set to default for row crops (EPA, 2001)
Soil Surface Condition After Harvest (ICNAH)	3	Default for sugarcane while under 3-4 yr cycle. After cycle, rotate to new crop..
Date of Crop Emergence (EMD, EMM, IYREM)	01/01	typically planted August thru January, See Sugarcane Handbook http://edis.ifas.ufl.edu/
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/06	typically harvested October thru March, See Sugarcane Handbook http://edis.ifas.ufl.edu/

Parameter	Value	Source
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/12	dates were chosen such that cycle would remain in a single calendar year and still remain within the typical range. See Sugarcane Handbook http://edis.ifas.ufl.edu/
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	94, 91, 92	Gleams Manual Table A.3, Fallow = SR/poor; Cropping and Residue = Row Crop, SR/poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project; UC0SCSCC; Sugarcane, conventional tillage, Tampa (USDA, 2000)
USLE C Factor (USLEC)	0.194 - 0.717	RUSLE Project; Variable with date, UC0SCSCC; Sugarcane, conventional tillage, Tampa (USDA, 2000)
Wabasso Soil Parameters		
Parameter	Value	Verification Source
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 90 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.75 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.066 cm3-H2O cm3-soil (HORIZN =1) 0.178 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2)	
Field Capacity (THEFC)	0.066 cm3-H2O cm3-soil (HORIZN = 1) 0.178 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.036 cm3-H2O cm3-soil (HORIZN = 1) 0.078 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	2.32% (HORIZN = 1) 0.29% (HORIZN = 2)	

e. Florida Sweet Corn

The field used to represent sweet corn production in Florida is located in Palm Beach County in Southeast Florida, although sweet corn production occurs throughout Florida. According to the 1997 Census of Agriculture, Florida is the major producer of fresh market sweet corn in the U.S. Sweet corn is extensively grown on "muck soils" (approximately 75%). Typical planting distances are 30 inches between rows and 6 to 8 inches between plants. Sweet corn in Florida is produced using several types of irrigation systems. The soil selected to simulate the field is Riviera sand. Riviera sand is a loamy, siliceous, active, hyperthermic Arenic Glossaqualfs. These soils are often used for truck crop (including sweet corn) and citrus production. Riviera sand is a deep, poorly drained, slow runoff, slowly to very slowly permeable soil that formed in stratified marine sandy and loamy sediments on the Lower Coastal Plain. These soils are generally found on broad, low flats and in depressions and have slopes generally less than 2 percent. The soil is of moderate extent. Riviera sand is a Hydrologic Group C soil.

Table II.E.6-12 PRZM 3.12 Scenario Input Parameters for Florida Sweet Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - West Palm Beach, FL (W12844)
Ending Date	December 31, 1990	Meteorological File - West Palm Beach, FL (W12844)
Pan Evaporation Factor (PFAC)	0.78	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	No appreciable snow accumulation occurs in this part of Florida
Minimum Depth of Evaporation (ANETD)	33.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.03 tons EI-1*	PRZM Input Collator (Burns, 1992) and FARM Manual (EPA, 1985)
USLE LS Factor (USLELS)	0.2	Haan and Barfield, 1979
USLE P Factor (USLEP)	1.0	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Field are fallow prior to planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File

Parameter	Value	Source
Maximum rainfall interception storage of crop (CINTCP)	0.15	PIC; confirmed using Table 5.4 from PRZM Manual (Burns, 1992 and EPA, 1985)
Maximum Active Root Depth (AMXDR)	100 cm	Set to profile depth. Roots can exceed 150 cm.
Maximum Canopy Coverage (COVMAX)	90	PIC (Burns, 1992)
Soil Surface Condition After Harvest (ICNAH)	3	Plant residues are left behind until later in the year when tilled for next series of crops; rarely cucumbers.
Date of Crop Emergence (EMD, EMM, IYREM)	15/10	http://ipmwww.ncsu.edu/opmppiap/subcrp.htm southern sweet corn cultivation cycle is generally between January and June; Maturation 64_90 days from seeding to harvest; Harvest occurs over a period of weeks to several months. Values set to cover rainy season Oct _ Feb.
Date of Crop Maturity (MAD, MAM, IYRMAT)	05/01	
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/01	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = SR/poor; Cropping and Residue = Row Crop, SR/poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.011	RUSLE Project; UC0BGBGC; Green Beans, conventional tillage; Tampa, FL (USDA, 2000)
USLE C Factor (USLEC)	0.162 - 0.938	RUSLE Project; Variable with date, UC0BGBGC; Green Beans, conventional tillage; Tampa, FL (USDA, 2000)
Riviera Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 62 cm (HORIZN = 2) 28 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/) Ed Russell (USDA_NRCS, Fresno)
Bulk Density (BD)	1.65 g □cm-3 (HORIZN = 1,2) 1.7 g □cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.073 cm3-H2O □cm3-soil (HORIZN =1,2) 0.211 cm3-H2O □cm3-soil (HORIZN =3)	

Parameter	Value	Source
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN =2,3)	
Field Capacity (THEFC)	0.073 cm3-H2O cm3-soil (HORIZN = 1,2) 0.211 cm3-H2O cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.023 cm3-H2O cm3-soil (HORIZN = 1,2) 0.091 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3)	

6. Mid-South Region Scenario Documentation

a. Mississippi Cotton (MScottonC)

The field used to represent cotton production in Mississippi is located in Yazoo County. According to the 1997 Census of Agriculture, Mississippi is ranked 4th in production and acreage of cotton in the U.S. The crop is generally planted in Spring (late April) and harvested beginning in September. Row spacing is generally 38-inches with 3-4 plants per foot row. Row canopies tend to be very close to 100 percent, while the canopy between rows is much less. The crop may be grown under irrigation by furrow or canal systems. Most crops are planted by stale seedbed, no-till, or conventional methods. The soil selected to simulate the field is a Loring silt loam. Loring silt loam is a fine-silty, mixed, active, thermic, Qxyaquic Fragiudalfs. Nearly all soils are cleared and used to grow cotton, small grains, soybeans, hay and pasture. Loring silt loam is a moderately well drained with a fragipan, medium to rapid runoff, and moderate permeability above the fragipan and moderately slowly permeable in the fragipan soils formed in loess. They are located on level to strongly sloping uplands and stream terraces. Slopes are generally between 0 to 20 percent. The soils are extensive in the lower Mississippi drainage basin. Loring silt loam is a Hydrologic Group C soil.

Table II.E.6-13 PRZM 3.12 Scenario Input Parameters for Mississippi Cotton

Parameter	Value	Source

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – Jackson, MS (W03940)
Ending Date	December 31, 1990	Meteorological File – Jackson, MS (W03940)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.15 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Pan Factor Flag (IPEIND)	2	PAN Evaporation data read from file
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.49 tons EI-1*	PRZM Manual Table 5.3 (EPA, 1998)
USLE LS Factor (USLELS)	0.4	PRZM Manual Table 5.5 (EPA, 1998)
USLE P Factor (USLEP)	0.75	PRZM Manual Table 5.6 (EPA,1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	PRZM Input Collator (Burns, 1992)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File – Jackson, MS (W03940)
Maximum rainfall interception storage of crop (CINTCP)	0.2	PRZM manual Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	125 cm	Value developed from field specific data.
Maximum Canopy Coverage (COVMAX)	98	Value developed from field specific data.
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Input Collator (Burns, 1992)
Date of Crop Emergence (EMD, EMM, IYREM)	01/05	Verified with Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	07/09	
Date of Crop Harvest (HAD, HAM, IYRHAR)	22/09	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	99, 93, 32	PRZM Manual Table 5.10_5.14 and Fig. 5.4; Field specific data.
Manning's N Value (MNGN)	0.014	RUSLE Project, PA6CTCTC: Cotton, conventional tillage, Holly Springs, MS (USDA, 2000)
USLE C Factor (USLEC)	0.223 - 0.718	RUSLE Project; PA6CTCTC: Cotton, conventional tillage, Holly Springs, MS (USDA, 2000)
Loring Soil Parameters		
Total Soil Depth (CORED)	155 cm	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	6	
Horizon Thickness (THKNS)	13 cm (HORIZN = 1) 23 cm (HORIZN = 2) 33 cm (HORIZN = 3) 30 cm (HORIZN = 4) 23 cm (HORIZN = 5) 33 cm (HORIZN = 6)	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.4 g cm-3 (HORIZN = 1,2,3) 1.45 g cm-3 (HORIZN = 4) 1.49 g cm-3 (HORIZN = 5) 1.51 g cm-3 (HORIZN = 6)	
Initial Water Content (THETO)	0.385 cm3-H2O cm3-soil (HORIZN =1) 0.370 cm3-H2O cm3-soil (HORIZN =2,3) 0.340 cm3-H2O cm3-soil (HORIZN =4) 0.335 cm3-H2O cm3-soil (HORIZN =5) 0.343 cm3-H2O cm3-soil (HORIZN =6)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2) 11 cm (HORIZN = 3) 10 cm (HORIZN = 4) 23 cm (HORIZN = 5) 33 cm (HORIZN = 6)	

Parameter	Value	Source
Field Capacity (THEFC)	0.385 cm3-H2O cm3-soil (HORIZN =1) 0.370 cm3-H2O cm3-soil (HORIZN =2,3) 0.340 cm3-H2O cm3-soil (HORIZN =4) 0.335 cm3-H2O cm3-soil (HORIZN =5) 0.343 cm3-H2O cm3-soil (HORIZN =6)	
Wilting Point (THEWP)	0.151 cm3-H2O cm3-soil (HORIZN = 1) 0.146 cm3-H2O cm3-soil (HORIZN = 2,3) 0.125 cm3-H2O cm3-soil (HORIZN = 4) 0.137 cm3-H2O cm3-soil (HORIZN = 5) 0.147 cm3-H2O cm3-soil (HORIZN = 6)	
Organic Carbon Content (OC)	1.28% (HORIZN = 1) 0.49% (HORIZN = 2) 0.16% (HORIZN = 3) 0.12% (HORIZN = 4) 0.07% (HORIZN = 5) 0.06% (HORIZN = 6)	

b. Mississippi Corn (MScornC)

The field used to represent corn production in Mississippi is located in the Southern Mississippi Valley Uplands. According to the 1997 Census of Agriculture, Mississippi is not a major corn producing state in the U.S. (not among the top 20 states) with approximately 600,000 acres in production. The crop is generally planted in the early spring (April) and harvested beginning in August. Continuous corn is practice is much of the region; however, rotation with other crops such as soybean is the practiced as well. Most of the corn is planted for feed grain. Planting depth and row spacing (generally 30 inches) follows general practices for the U.S. Conventional tillage dominates with more than 50 percent of the practice, followed by conservation tillage, no tillage, and ridge tillage. The crop is rarely grown under irrigation. The soil selected to simulate the field is a benchmark soil, Grenada silt loam. Grenada silt loam is a fine-silty, mixed, active, thermic Oxyaquic Fraglossudalfs. Most of the soil is used for the production of row crops such as corn, cotton, and soybeans, the principal crops. Grenada silt loam is a very deep, moderately well drained, medium to slow runoff, moderately permeable above a fragipan and slow in the fragipan soil. The fragipan is at a depth of about two feet. The soils formed in loess. They are located on uplands and stream terraces of low relief in the Southern Mississippi Valley Silty Uplands. Slopes are generally between 0 to 8 percent, but may range to 12 percent. The soils are extensive throughout the region. Grenada silt loam is a Hydrologic Group C soil.

Table II.E.6-14 PRZM 3.12 Scenario Input Parameters for Mississippi Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – Jackson, MS (W03940)
Ending Date	December 31, 1990	Meteorological File – Jackson, MS (W03940)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.25 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	25.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.43 tons EI-1*	GLEAMS Table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.221	GLEAMS Table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	1.00	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	4	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Mid-point of series range. Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	PRZM Input Collator (Burns, 1992)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File – Jackson, MS (W03940)
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	90 cm	PRZM Input Collator; (Burns, 1992); PRZM Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	100	PRZM Input Collator (Burns, 1992); Set to default for most row crops (EPA, 2001)
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Input Collator, PIC (Burns, 1992)

Parameter	Value	Source
Date of Crop Emergence (EMD, EMM, IYREM)	11/04	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984)
Date of Crop Maturity (MAD, MAM, IYRMAT)	22/08	
Date of Crop Harvest (HAD, HAM, IYRHAR)	02/09	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = SR/poor, Cropping and Residue = Row Crop, SR/Poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project, OA6CGSBC; Corn, grain, conventional tillage, Natchez, MS (USDA, 2000)
USLE C Factor (USLEC)	0.024 - 0.848	RUSLE Project; OA6CGSBC; Corn, grain, conventional tillage, Natchez, MS (USDA, 2000)
Grenada Soil Parameters		
Total Soil Depth (CORED)	100 cm	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (3 Base, Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 44 cm (HORIZN = 2) 8 cm (HORIZN = 3) 38 cm (HORIZN = 4)	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.7 g □cm-3 (HORIZN = 1, 2) 1.8 g □cm-3 (HORIZN = 3,4)	
Initial Water Content (THETO)	0.309 cm3-H2O □cm3-soil (HORIZN =1, 2) 0.304 cm3-H2O □cm3-soil (HORIZN =3) 0.216 cm3-H2O □cm3-soil (HORIZN =4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3,4)	
Field Capacity (THEFC)	0.309 cm3-H2O □cm3-soil (HORIZN = 1, 2) 0.304 cm3-H2O □cm3-soil (HORIZN = 3) 0.216 cm3-H2O □cm3-soil (HORIZN = 4)	

Parameter	Value	Source
Wilting Point (THEWP)	0.109 cm3-H2O cm3-soil (HORIZN = 1,2) 0.104 cm3-H2O cm3-soil (HORIZN = 3) 0.116 cm3-H2O cm3-soil (HORIZN = 4)	
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174% (HORIZN = 3) 0.116% (HORIZN = 4)	

7. Lower Midwest Region Scenario Documentation

a. South Texas Grapefruit (STXgrapefrtCRA)

The field used to represent grapefruit production in South Texas is representative of a field in Hildago and Cameron counties, located in the Lower Rio Grande Valley region. The meteorological file, Brownsville, TX, represents the MLRA region 83D. In 2004, Texas ranked second behind Florida in acres producing Grapefruit. Texas contained 16 percent of the total acres of grapefruit production (USDA 2004). Grapefruit trees are planted in rows 24-25 feet apart. Crops are irrigated (Texas A&M 2002) and pruned to maintain a height of approximately 15 feet. In the Lower Rio Grande Valley region of Texas, grapefruit trees bloom from March 10-20. Fruit matures between October and December and is harvested from October to May (Personal communication 2004). The soil in Hidalgo and Cameron counties is alluvial, being derived from the Rio Grande (USDA 1997). Thus there is no dominant soil type (range of coverages: 0.1-13.2%). In the Lower Rio Grande Valley region, several soil types support citrus production (Brennan, Delfinia, Hidalgo, and Willacy) (Texas A&M 2002). For this scenario, Hidalgo sandy clay loam was selected as a representative soil type because it has significant yields of citrus and was recommended by an extension agent as being the most commonly associated soil with citrus (Personal communication 2004). Hidalgo sandy clay loam is a hydrologic group B soil that is classified as fine-loamy, mixed, active, hyperthermic typic calciustolls. The Hidalgo series of soils is deep, well drained, moderately permeable and formed in calcareous loamy sediments. These soils occur on nearly level to gently sloping uplands with slopes of 0-5 percent. This soil type occurs on the Rio Grande Plain of Texas and Mexico (possibly). This soil is mostly used for irrigated crop production including cotton, grain sorghum, vegetables, sugar cane and citrus (USDA1997).

Table II.E.6-15 PRZM 3.12 Scenario Input Parameters for South Texas Grapefruit

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Brownsville, Cameron County, Texas: W12919

Parameter	Value	Source
Ending Date	December 31, 1990	Meteorological File - Brownsville, Cameron County, Texas: W12919
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.37	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 2.5% slope
USLE P Factor (USLEP)	1	contour plowing is not common due to 0-5% slope (consulted with extension agent)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	2.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-5%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA 2004)
Initial Surface Condition (ISCOND)	3	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.

Parameter	Value	Source
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	PRZM Manual (Carsel et al., 1998)
Maximum Active Root Depth (AMXDR)	243.8 cm	Consulted extension agent (Max rooting depth = 5 - 8 ft)
Maximum Canopy Coverage (COVMAX)	75%	Consulted extension agent
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Manual (Carsel et al., 1998), 3 = residue
Date of Crop Emergence (EMD, EMM, IYREM)	16/3/61	Consulted extension agent
Date of Crop Maturity (MAD, MAM, IYRMAT)	1/11/61	Consulted extension agent
Date of Crop Harvest (HAD, HAM, IYRHAR)	1/2/61	Consulted extension agent
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	67, 74, 78	Gleams Manual Table A.3, (Hydrological soil B) meadow (USDA, 1990)
Manning’s N Value (MNGN)	.014 .	RUSLE Project, TX Galveston, Citrus, (T95CBCBC)
USLE C Factor (USLEC)	.374 .385 .383 .391 .407 .422 .423 .437 .458 .456 .464 .475 .442 .424 .434 .439 .442 .325 .340 .352 .363 .371 .378 .384 .389 .362	RUSLE Project, TX Galveston, Citrus, (T95CBCBC)
Soil Parameters		
Total Soil Depth (CORED)	160 cm	http://soils.usda.gov/ (63 inches)
Number of Horizons (NHORIZ)	4 (top HORIZN split in 2)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 21 cm (HORIZN = 2) 25 cm (HORIZN = 3) 104 cm (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/

Parameter	Value	Source
Bulk Density (BD)	1.5g cm-3 (HORIZN = 1) 1.5 g cm-3 (HORIZN = 2) 1.325 g cm-3 (HORIZN = 3) 1.35 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.30 cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2) 1 cm (HORIZN = 3) 2 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.30 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.18 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.2% (HORIZN = 1) 1.2% (HORIZN = 2) 0.45% (HORIZN = 3) 0.18% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

b. South Texas Cotton (STXcottonCRA)

The field used to represent cotton production in South Texas is representative of a field in Hildago and Cameron counties, located in the Lower Rio Grande Valley region. The meteorological file, Brownsville, TX, represents the MLRA region 83D. Texas ranks first in production of cotton in the U. S. Cotton is the leading cash crop in Texas with a total economic impact of 5.2 billion dollars in the state (NSF 1999). Agricultural methods (irrigation, planting times, cotton type, harvesting methods) vary significantly from region to region. The Northern High Plains grows approximately 64 percent of Texas corn with 3 percent being grown in the Lower Rio Grande Valley region. In the Lower Rio Grande Valley region of Texas, cotton is planted between February and March. Corn is generally irrigated. Cotton is harvested in Texas between August and December (NSF 1999). The soil in Hildago and Cameron counties is alluvial, being derived from the Rio Grande (USDA 1997). Thus there is no dominant soil type (range of coverages: 0.1-13.2%). For this scenario, Harlingen Clay was selected as a representative soil type because it has significant yields of cotton and has the largest percent coverage of a hydrologic group C or D soil for Hildago (4.8 %) and Cameron (6.6 %) counties (USDA 2004). Harlingen Clay is a hydrologic group D soil that is classified as very-fine, smectitic, hyperthermic sodic haplusterts. The Harlingen series of soils is deep, moderately well drained, very slowly permeable soils that formed in clayey sediments. These soils have slopes of 0-1 percent and occur on stream terraces and deltas along the lower portions of the Rio Grande River and its tributaries in south Texas and Mexico. This soil is mostly used for irrigated crop land including cotton and cool season vegetables (USDA1997).

Table II.E.6-16 PRZM 3.12 Scenario Input Parameters for South Texas Cotton

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Brownsville, Cameron County, Texas: W12919
Ending Date	December 31, 1990	Meteorological File - Brownsville, Cameron County, Texas: W12919
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.15	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 0.5% slope
USLE P Factor (USLEP)	1	contour plowing is not common due to 0-1% slope (consulted with extension agent)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-1%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA 2004)
Initial Surface Condition (ISCOND)	2	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one

Parameter	Value	Source
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.20 cm	PRZM Manual (Carsel et al., 1998)
Maximum Active Root Depth (AMXDR)	60 cm	PRZM Manual (Carsel et al., 1998)
Maximum Canopy Coverage (COVMAX)	100%	PRZM Manual (Carsel et al., 1998)
Soil Surface Condition After Harvest (ICNAH)	2	PRZM Manual (Carsel et al., 1998), 2 = cover crop consulted with extension agent, crops are rotated
Date of Crop Emergence (EMD, EMM, IYREM)	16/3/61	corn is planted late January-Late February (TX extension crop profile) + emergence of 5-15 days (PRZM manual)
Date of Crop Maturity (MAD, MAM, IYRMAT)	20/7/61	mature 110-130 days from planting (PRZM manual)
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/10/61	harvest from August 1 to December 20 (PRZM manual, Table 5-9)
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	88, 89, 90	Gleams Manual Table A.3, (Hydrological soil D) Row Crop, SR, good hydrologic condition (USDA, 1990)
Manning's N Value (MNGN)	.014.	RUSLE Project, TX Galveston Cotton, (T95CTCTC)
USLE C Factor (USLEC)	.628 .654 .678 .697 .712 .727 .743 .784 .809 .808 .776 .639 .506 .384 .299 .295 .337 .412 .432 .358 .442 .494 .542 .585 .621	RUSLE Project, TX Galveston Cotton, (T95CTCTC)
Soil Parameters		
Total Soil Depth (CORED)	180 cm	http://soils.usda.gov/
Number of Horizons (NHORIZ)	4 (top HORIZN split in 2)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 18 cm (HORIZN = 2) 61 cm (HORIZN = 3) 91 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/

Parameter	Value	Source
Bulk Density (BD)	1.45g cm-3 (HORIZN = 1) 1.45g cm-3 (HORIZN = 2) 1.40 g cm-3 (HORIZN = 3) 1.55 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.39 cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2) 1 cm (HORIZN = 3) 1 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.39 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.28 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.2% (HORIZN = 1) 1.2% (HORIZN = 2) 0.9% (HORIZN = 3) 0.45% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

c. South Texas Vegetables (STXvegetblCRA)

The field used to represent vegetable production in South Texas is representative of a field in Hidalgo and Cameron counties, located in the Lower Rio Grande Valley region. The meteorological file, Brownsville, TX, represents the MLRA region 83D. Specifically, the vegetable scenario represents carrot, onion and cabbage production in the state. Texas produces 3 percent of the U.S. commercially grown carrots. The Lower Rio Grande Region produces approximately 50 percent of Texas carrots. Carrot seed is often precision planted at 1/8-1/4 inches deep between July and November. They are mechanically harvested from December to May (NSF 2003 a). Texas produces 7 percent of the U.S. commercially grown onions. The Lower Rio Grande Region produces approximately 80 percent of Texas onions. Onion seed is often precision planted at 1/4-3/4 inches deep, on 38-40 inch raised beds in October. Mechanical harvest begins 120-210 days after planting, when the tops 50-80% of the tops fall over. They are mechanically harvested from December to May (NSF 2003 b). Texas produces 15 percent of the U.S. commercially grown cabbage. The Lower Rio Grande Region produces approximately 50 percent of Texas cabbage. Cabbage seed is often planted at 6-15 inches apart (NSF 2003 c). The soil in Hidalgo and Cameron counties is alluvial, being derived from the Rio Grande (USDA 1997). Thus there is no dominant soil type (range of coverages: 0.1-13.2%). For this scenario, Harlingen Clay was selected as a representative soil type because it supports vegetable production and has the largest percent coverage of a hydrologic group C or D soil for Hidalgo (4.8 %) and Cameron (6.6

%) counties (USDA 2004). Harlingen Clay is a hydrologic group D soil that is classified as very-fine, smectitic, hyperthermic sodic haplusterts. The Harlingen series of soils is deep, moderately well drained, very slowly permeable soils that formed in clayey sediments. These soils have slopes of 0-1 percent and occur on stream terraces and deltas along the lower portions of the Rio Grande River and its tributaries in south Texas and Mexico. This soil is mostly used for irrigated crop land including cotton and cool season vegetables (USDA 1997).

Table II.E.6-17 PRZM 3.12 Scenario Input Parameters for South Texas Vegetable

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Brownsville, Cameron County, Texas: W12919
Ending Date	December 31, 1990	Meteorological File - Brownsville, Cameron County, Texas: W12919
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.15	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 0.5% slope
USLE P Factor (USLEP)	1	contour plowing is not common due to 0-1% slope (consulted with extension agent)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-1%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	

Parameter	Value	Source
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	2	Consulted extension agent, crops are rotated
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	PRZM Manual (Carsel et al., 1998)
Maximum Active Root Depth (AMXDR)	38.1 cm	Consulted extension agent
Maximum Canopy Coverage (COVMAX)	80%	Consulted extension agent
Soil Surface Condition After Harvest (ICNAH)	2	PRZM Manual (Carsel et al., 1998)
Date of Crop Emergence (EMD, EMM, IYREM)	1/10/61	Consulted extension agent
Date of Crop Maturity (MAD, MAM, IYRMAT)	1/3/61	Consulted extension agent
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/3/61	Consulted extension agent
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	88, 89, 90	Gleams Manual Table A.3, (Hydrological soil D), Row crop, SR, good hydrologic conditions (USDA, 1990)
Manning's N Value (MNGN)	.011 .	RUSLE Project, TX Galveston, Onion (T95ONONC)
USLE C Factor (USLEC)	.623 .673 .715 .746 .760 .698 .813 .816 .806 .785 .760 .726 .692 .590 .666 .729 .782 .824 .857 .801 .902 .901 .885 .842 .786 .742 .699 .697 .712 .574	RUSLE Project, TX Galveston, Onion (T95ONONC)
Soil Parameters		
Total Soil Depth (CORED)	180 cm	http://soils.usda.gov/ (71 inches)
Number of Horizons (NHORIZ)	4 (top HORIZN split in 2)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)

Parameter	Value	Source
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 18 cm (HORIZN = 2) 61 cm (HORIZN = 3) 91 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45g cm-3 (HORIZN = 1) 1.45g cm-3 (HORIZN = 2) 1.40 g cm-3 (HORIZN = 3) 1.55 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.39 cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2) 1 cm (HORIZN = 3) 1 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.39 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.28 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.2% (HORIZN = 1) 1.2% (HORIZN = 2) 0.9% (HORIZN = 3) 0.45% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

d. South Texas Melon (STXmelonCRA)

The field used to represent melon production in South Texas is representative of a field in Hidalgo and Cameron counties, located in the Lower Rio Grande Valley region. The meteorological file, Brownsville, TX, represents the MLRA region 83D. Specifically, the melon scenario represents cantaloupe, honeydew melon and watermelon production in the state. Texas produces 9 percent and 10 percent of the U.S. commercially grown cantaloupe and honeydew melon, respectively (NSF 1999). Approximately 50 percent of the state's cantaloupe and honeydew melon is grown in the Lower Rio Grande Region. Seeds are planted ½ -1 inch deep 8-12 inches apart in 78-80 inch beds or 12-24 inches apart in 2 lines on 78-80 inch beds. Planting is from the third week in January to the second week of February. Second and third plantings are done two weeks after the previous plantings. Cantaloupe and honeydew melon are harvested 85-95 days after planting (NSF 2000). Texas produces 20 percent of the U.S. commercially grown watermelons, ranking number one in the country (NSF 1999). Hidalgo is the number one county in Texas for watermelon production. Seeds are planted 3/4 -1 inch deep 3 feet apart on 6 foot beds (NSF 2003). The soil in Hidalgo and Cameron counties is alluvial, being derived from the Rio Grande (USDA 1997). Thus there is no dominant soil type (range of coverages: 0.1-13.2%). For this scenario, Harlingen Clay was selected as a representative soil type because it supports melon growth and has the largest percent coverage of a hydrologic group C or D soil for Hidalgo (4.8 %) and Cameron (6.6 %) counties (USDA 2004). Harlingen Clay is a hydrologic group D soil that is classified as very-fine, smectitic, hyperthermic sodic haplusterts. The Harlingen series of soils is deep, moderately well drained, very slowly permeable soils that formed in clayey sediments. These soils have slopes of 0-1 percent and occur on stream terraces and deltas along the lower portions of the Rio Grande River and its tributaries in south Texas and Mexico. This soil is mostly used for irrigated crop land including cotton and cool season vegetables (USDA1997).

Table II.E.6-18 PRZM 3.12 Scenario Input Parameters for South Texas Melon

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Brownsville, Cameron County, Texas: W12919
Ending Date	December 31, 1990	Meteorological File - Brownsville, Cameron County, Texas: W12919
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.15	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 0.5% slope
USLE P Factor (USLEP)	1	contour plowing is not common due to 0-1% slope (consulted with extension agent)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-1%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	

Parameter	Value	Source
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA. 2001)
Initial Surface Condition (ISCOND)	2	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	PRZM Manual (Carsel et al., 1998)
Maximum Active Root Depth (AMXDR)	61 cm	Consulted extension agent
Maximum Canopy Coverage (COVMAX)	100%	Consulted extension agent
Soil Surface Condition After Harvest (ICNAH)	2	PRZM Manual (Carsel et al., 1998)
Date of Crop Emergence (EMD, EMM, IYREM)	1/2/61	Consulted extension agent
Date of Crop Maturity (MAD, MAM, IYRMAT)	1/5/61	Consulted extension agent
Date of Crop Harvest (HAD, HAM, IYRHAR)	7/5/61	Consulted extension agent
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	88, 89, 90	Gleams Manual Table A.3, (Hydrological soil D), Row crop, SR, good hydrologic conditions (USDA, 1990)
Manning’s N Value (MNGN)	.011	RUSLE Project, TX Galveston, Citrus, Bare Ground (T95CBCBC)
USLE C Factor (USLEC)	.715 .746 .760 .698 .813 .816 .806 .785 .760 .726 .692 .590 .666 .729 .782 .824 .857 .801 .902 .901 .885 .842 .786 .742 .699 .697 .712 .574 .623 .673	RUSLE Project, TX Galveston, Onion, Bare Ground (T95ONONC)
Soil Parameters		

Parameter	Value	Source
Total Soil Depth (CORED)	180 cm	http://soils.usda.gov/ (71 inches)
Number of Horizons (NHORIZ)	4 (top HORIZN split in 2)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 18 cm (HORIZN = 2) 61 cm (HORIZN = 3) 91 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45g cm-3 (HORIZN = 1) 1.45g cm-3 (HORIZN = 2) 1.40 g cm-3 (HORIZN = 3) 1.55 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.39 cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2) 1 cm (HORIZN = 3) 1 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.39 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.28 cm3 H20 cm3 soil	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.2% (HORIZN = 1) 1.2% (HORIZN = 2) 0.9% (HORIZN = 3) 0.45% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

e. South Texas Corn (STXcornCRA)

The field used to represent corn production in South Texas is representative of a field in Hidalgo and Cameron counties, located in the Lower Rio Grande Valley region. The meteorological file, Brownsville, TX, represents the MLRA region 83D. Texas produces 2 percent of the U.S. commercially grown corn (NSF 1999). The Northern High Plains grows approximately 66 percent of Texas corn with less than 12 percent being grown in the Lower Valley region. In the Lower Valley region of Texas, corn is planted between late January and Late February. In the Northern parts of the state, planting dates are significantly different, being mid April to early May. Corn is generally planted in 30 inch rows at rates of 28,000 - 34,000 seeds/ acre. Corn is generally irrigated and harvested in the lower valley between late June and Mid July (NSF 1999). The soil in Hidalgo and Cameron counties is alluvial, being derived from the Rio Grande (USDA 1997). Thus there is no dominant soil type (range of coverages: 0.1-13.2%). For this scenario, Harlingen Clay was selected as a representative soil type because it has significant yields of corn and has the largest percent coverage of a hydrologic group C or D soil for Hidalgo (4.8 %) and Cameron (6.6 %) counties (USDA 2004). Harlingen Clay is a hydrologic group D soil that is classified as very-fine, smectitic, hyperthermic sodic haplusterts. The Harlingen series of soils is deep, moderately well drained, very slowly permeable soils that formed in clayey sediments. These soils have slopes of 0-1 percent and occur on stream terraces and deltas along the lower portions of the Rio Grande River and its tributaries in south Texas and Mexico. This soil is mostly used for irrigated crop land including cotton and cool season vegetables (USDA1997).

Table II.E.6-19 PRZM 3.12 Scenario Input Parameters for South Texas Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Brownsville, Cameron County, Texas: W12919
Ending Date	December 31, 1990	Meteorological File - Brownsville, Cameron County, Texas: W12919
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.0 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	32.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.15	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 0.5% slope
USLE P Factor (USLEP)	1	contour plowing is not common due to 0-1% slope (consulted with extension agent)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-1%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	

Parameter	Value	Source
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	2	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	Maximum recommended value for grass (Carsel et al. 1998)
Maximum Active Root Depth (AMXDR)	90 cm	PRZM Manual (Carsel et al., 1998)
Maximum Canopy Coverage (COVMAX)	100%	PRZM Manual (Carsel et al., 1998)
Soil Surface Condition After Harvest (ICNAH)	2	PRZM Manual (Carsel et al., 1998), 2 = cover crop consulted with extension agent, crops are rotated
Date of Crop Emergence (EMD, EMM, IYREM)	1/3/61	corn is planted late January-Late February (TX extension crop profile) + emergence of 5-15 days (PRZM manual)
Date of Crop Maturity (MAD, MAM, IYRMAT)	15/6/61	mature 110-130 days from planting (PRZM manual)
Date of Crop Harvest (HAD, HAM, IYRHAR)	1/7/61	corn is harvested between late June and mid July (http://pestdata.ncsu.edu/cropprofiles)
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	88, 89, 90	Gleams Manual Table A.3, (Hydrological soil D) Row Crop, SR, good hydrologic condition (moderately well drained soil) (USDA, 1990)
Manning's N Value (MNGN)	.014	RUSLE Project, TX Galveston Corn, (T95CGSBC)
USLE C Factor (USLEC)	.536 .581 .622 .654 .680 .705 .800 .829 .843 .821 .774 .602 .452 .371.311.282 .285 .287 .288 .307 .369 .388 .039 .042 .133 .173 .215 .257	RUSLE Project, TX Galveston Corn, (T95CGSBC)
Soil Parameters		
Total Soil Depth (CORED)	180 cm	http://soils.usda.gov/ (71 inches)
Number of Horizons (NHORIZ)	4 (top HORIZN split in 2)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)

Parameter	Value	Source
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 18 cm (HORIZN = 2) 61 cm (HORIZN = 3) 91 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45g cm-3 (HORIZN = 1) 1.45g cm-3 (HORIZN = 2) 1.40 g cm-3 (HORIZN = 3) 1.55 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.39 cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2) 1 cm (HORIZN = 3) 1 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.39 cm3 H20 cm3 soil (HORIZN = 1-4)	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.28 cm3 H20 cm3 soil (HORIZN = 1-4)	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.2% (HORIZN = 1) 1.2% (HORIZN = 2) 0.9% (HORIZN = 3) 0.45% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

8. North / Northcentral Scenario Documentation

a. Pennsylvania Apples (PAappleC)

The field used to represent apple production in Pennsylvania is located in Lancaster County, in south-eastern Pennsylvania. According to the 1997 Census of Agriculture, Pennsylvania is ranked 5th in apple production in the U.S. Within row tree spacing depends on the root stock and cultivation method. Spacing ranges from as little as 5 feet to 25 feet. Row spacing may be as much as twice the within row spacing to allow for maintenance and harvesting equipment. The soil selected to simulate the field is a benchmark soil, Elioak silt loam. Elioak silt loam is a clayey, kaolinitic, mesic, Typic Hapludults. The soil is used for pastures, orchards, general local crops and non-agricultural uses. Elioak silt loam is a very deep, well drained, moderately permeable soil with medium to rapid runoff. These soils formed in residuum weathered from mica schists and phyllites, and to a minor extent from granitized schist and micaeous gneiss. They are found on summits and upper slopes in northern portions of the Piedmont Plateau. Most slopes are less than 15 percent, but can range from 0 to

30 percent. The series is of moderate extent in the mid-Atlantic Piedmont Plateau. Elioak silt loam is a Hydrologic Group C soil.

Table II.E.6-20 PRZM 3.12 Scenario Input Parameters for Pennsylvania Apples

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Allentown, PA (W14737)
Ending Date	December 31, 1990	Meteorological File - Allentown, PA (W14737)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.2 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.42 tons EI-1*	PRZM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	3.60	Haan and Barfield, 1978
USLE P Factor (USLEP)	1.0	PRZM Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12%	Value set to maximum for crop (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	3	Orchard _ material is largely left in place
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	36	Set to weather data. Allentown, PA (W14737)
Maximum rainfall interception storage of crop (CINTCP)	0.25	Set to default for orchards (EPA, 2001)
Maximum Active Root Depth (AMXDR)	100 cm	Set to maximum soil depth. Roots may grow to 20 feet.
Maximum Canopy Coverage (COVMAX)	90	http://caf.wvu.edu/kearneyville/fruitloop.html Ross Byers, Horticultural Specialist VPI _ canopy somewhat open between rows; 90% reasonable upper end estimate.
Soil Surface Condition After Harvest (ICNAH)	3	Orchards floor maintained similar to a meadow
Date of Crop Emergence (EMD, EMM, IYREM)	20/04	Personal communication w/ Ross Byers, VA Tech Fruit Horticulturalist (540) 869_2560 x19 Emergence based on leaf emergence,

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	10/05	Maturation based on canopy maturity, Harvest based on average leaf fall. Dates based on central VA and modified by: 1 day added for every 100 miles north or 100 feet higher elevation or 1day subtracted for every 100 miles south or 100 feet lower elevation.
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/10	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table A.3, meadow; condition good (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project, SB5OBOBC; Orchards, bare ground; conventional tillage; York, PA (USDA, 2000)
USLE C Factor (USLEC)	0.103 - 0.515	RUSLE Project; SB5OBOBC; Orchards, bare ground; conventional tillage; York, PA (USDA, 2000)
Elioak Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 28 cm (HORIZN = 2) 62 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.70 g cm-3 (HORIZN = 1,2) 1.80 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.218 cm3-H2O cm3-soil (HORIZN =1,2) 0.243 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2) 2 cm (HORIZN = 3)	
Field Capacity (THEFC)	0.218 cm3-H2O cm3-soil (HORIZN = 1,2) 0.243cm3-H2O cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.098 cm3-H2O cm3-soil (HORIZN = 1,2) 0.163 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	1.16% (HORIZN = 1,2) 0.174 (HORIZN = 3)	

b. Pennsylvania Alfalfa (PAalfalfaC)

The field used to represent alfalfa production in Pennsylvania is located in York County in south-central Pennsylvania. According to the 1997 Census of Agriculture, Pennsylvania is ranked 15th overall in the production of alfalfa in the U.S. Alfalfa is a perennial crop, grown on a variety of soils, planted early in the year and maintained under continuous cultivation on a 3- to 5-year cycle at which time a new crop is planted. Planting depths range from 0.25 to 1.0 inches, depending on soil texture, on level seed beds. Row spacing is approximately 30 inches; alfalfa is not irrigated in Pennsylvania. Cuttings range from 2 to 4 per year. Most farmers take the last cutting of the season in September. Alfalfa prefers well-drained soils with a pH near neutral (pH 6.7-6.9). The soil selected to simulate the field is a benchmark soil, Glenville silt loam. Glenville silt loam is a fine-loamy, mixed, active, mesic, Aquic Fragiudults. These soils are in general crop production, but mostly grain, hay and pasture. Glenville silt loam is a very deep, moderately well drained or somewhat poorly drained, medium to slowly permeable soil with medium to slow runoff and consists of a fragipan at approximately 2 feet. In the fragipan, permeability is slow to moderately slow. These soils formed in residuum weathered from mica acid schist and crystalline rock containing mica. They are found on nearly level to strongly sloping upland flats, foot-slopes, or near the heads of drainage ways. Slopes range from 0 to 15 percent. These soils are extensive in the mid-Atlantic Piedmont. Glenville silt loam is a Hydrologic Group C soil.

Table II.E.6-21 PRZM 3.12 Scenario Input Parameters for Pennsylvania Alfalfa

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Allentown, PA (W14737)
Ending Date	December 31, 1990	Meteorological File - Allentown, PA (W14737)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.3 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	12.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.33 tons EI-1*	FARM Manual, Table 3.1 (EPA, 1985)
USLE LS Factor (USLELS)	0.123	Haan and Barfield, 1978.
USLE P Factor (USLEP)	0.60	Leon Restler, Ag. Extension Agent, Lancaster Co. (717) 394_6851 8/14/01)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12%	Leon Restler, Ag. Extension Agent, Lancaster Co. (717) 394_6851 8/14/01)

Parameter	Value	Source
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to fallow prior to new crop planting.
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Allentown, PA (W14737)
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM, Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	120 cm	Leon Restler, Ag. Extension Agent, Lancaster Co. (717) 394_6851 8/14/01)
Maximum Canopy Coverage (COVMAX)	100	Leon Restler, Ag. Extension Agent, Lancaster Co. (717) 394_6851 8/14/01)
Soil Surface Condition After Harvest (ICNAH)	3	Set to residue for winter months after last harvest during multi-year growth and during winter of last years of growth.
Date of Crop Emergence (EMD, EMM, IYREM)	15/04	Leon Restler, Ag. Extension Agent, Lancaster Co. (717) 394_6851 8/14/01)
Date of Crop Maturity (MAD, MAM, IYRMAT)	31/10	
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/10	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	87, 83, 86	Gleams Manual Table A.3, pasture/range, non_CNT, poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.110	RUSLE Project, SB5HLHLC; Hay, legume, conventional till, York (USDA, 2000)
USLE C Factor (USLEC)	0.001 - 0.017	RUSLE Project; SB5HLHLC; Hay, legume, conventional till, York (USDA, 2000)
Glenville Soil Parameters		
Total Soil Depth (CORED)	120 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 12 cm (HORIZN = 2) 98 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.4 g cm-3 (HORIZN = 1,2) 1.8 g cm-3 (HORIZN = 3)	

Parameter	Value	Source
Initial Water Content (THETO)	0.254 cm3-H2O cm3-soil (HORIZN =1,2) 0.201 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3)	
Field Capacity (THEFC)	0.254 cm3-H2O cm3-soil (HORIZN = 1,2) 0.201cm3-H2O cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.094 cm3-H2O cm3-soil (HORIZN = 1,2) 0.121 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	1.74% (HORIZN = 1,2) 0.174 (HORIZN = 3)	

c. Pennsylvania Corn (PAcornC)

The field used to represent corn production in Pennsylvania is located in Lancaster County in the south-east portion of the state. According to the 1997 Census of Agriculture, Pennsylvania is ranked 15th among major producers of corn in the U.S. The crop is generally planted in the spring (April) and harvested beginning in September. Continuous corn is practice is much of the region. However, rotation with other crops such as soybeans is also practiced. Most of the corn is planted for feed grain. Planting depth and row spacing (generally 30 inches) follows general practices for the U.S. Conventional tillage dominates management practices, followed by no-tillage. However, conservation tillage is continuing to grow. The soil selected to simulate the field is a benchmark soil, Hagerstown silt loam. Hagerstown silt loam, is a fine, mixed, semiactive, mesic Typic Hapludalfs. These soils are used fro general crops, pastures, orchards and truck crops. Large portions are in non-farm uses. Hagerstown silt loam is a very deep, well drained, moderately permeable soil with moderate to rapid runoff. These soils formed in materials weathered from hard grey limestone of rather high purity. They are found on valley floors and the adjacent hills. In some areas rock outcrops are common surface features. Slopes are generally less than 15 percent, but may range up to 45 percent. Hagerstown silt loam is a Hydrologic Group C soil.

Table II.E.6-22 PRZM 3.12 Scenario Input Parameters for Pennsylvania Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Allentown, PA (W14737)
Ending Date	December 31, 1990	Meteorological File - Allentown, PA (W14737)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998.)
Snowmelt Factor (SFAC)	0.20m C- 1	PRZM Manual Table 5.1 (EPA, 1998)

Parameter	Value	Source
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	1.042	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	0.5	Set according to guidance (EPA, 2001)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Maximum value for row crop. (EPA, 2001). Most slopes for soil series are around 2 percent.
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set fallow prior to new crop planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Allentown, PA (W14737)
Maximum rainfall interception storage of crop (CINTCP)	0.17	PRZM, Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	90 cm	PRZM Manual, Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	100	QA/QC Guidance (EPA, 2001)
Soil Surface Condition After Harvest (ICNAH)	3	Winter cover crop planted in most areas.
Date of Crop Emergence (EMD, EMM, IYREM)	20/04	Usual Planting and Harvesting Dates for U.S. Field Crops and Penn. State Coop. Extension
Date of Crop Maturity (MAD, MAM, IYRMAT)	04/07	Usual Planting and Harvesting Dates for U.S. Field Crops and Penn. State Coop. Extension
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/10	Usual Planting and Harvesting Dates for U.S. Field Crops and Penn. State Coop. Extension
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	89, 83, 85	Gleams Manual Table A.3, Fallow SR/CT; Cropping and Residue = Row crop, Conservation tillage, Contour plowing" (USDA, 1990)

Parameter	Value	Source
Manning's N Value (MNGN)	0.014	RUSLE Project, SB5CGSBC, Corn, grain, conventional tillage, York, PA (USDA, 2000)
USLE C Factor (USLEC)	0.025 - 0.701	RUSLE Project; SB5CGSBC, Corn, grain, conventional tillage, York, PA (USDA, 2000)
Hagerstown Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 40 cm (HORIZN = 2) 50 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.6 g cm-3 (HORIZN = 1) 1.7 g cm-3 (HORIZN = 2) 1.8 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.282 cm3-H2O cm3-soil (HORIZN =1) 0.2942cm3-H2O cm3-soil (HORIZN =2) 0.245 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5.0 cm (HORIZN = 2,3)	
Field Capacity (THEFC)	0.282 cm3-H2O cm3-soil (HORIZN = 1) 0.242cm3-H2O cm3-soil (HORIZN = 2) 0.245 cm3-H2O□cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.122 cm3-H2O cm3-soil (HORIZN = 1) 0.142 cm3-H2O cm3-soil (HORIZN = 2) 0.145 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	2.9% (HORIZN = 1) 0.174% (HORIZN = 2) 0.116% (HORIZN = 3)	

d. Pennsylvania Vegetables (PAvegetblCRA)

The Pennsylvania Vegetable crop/field scenario represents the typical potato and pumpkin crop/field conditions in southeastern Pennsylvania. Potatoes are grown in Pennsylvania from mid-July to September and mid-September to mid-May. Potato seeds are placed 7 to 12 inches apart in rows. Soil is ridged over the seed rows or hilling in order to prevent greening and to control weeds before seedlings bloom. Potatoes are fertilized twice, during planting using a band treatment along side the seedling rows and during cultivation or hilling. Potatoes are typically harvested from mid-July to October in Pennsylvania. 80% of the potato crop production occurs in Erie, Cambria, Schuylkill, Lancaster, and Potter counties (IPM, 2004a). Pennsylvania is ranked 2nd in the United States for pumpkin production in the United States, making up 10% of total pumpkin production in the United States. The majority of pumpkin production in Pennsylvania occurs in the southeastern region. Pumpkins are mostly direct seeded with conventional tillage preparation. Pumpkins are grown in silts, gravely loams, and clays. Planting typically occurs between early June and July (IPM, 2004b).

The Clarksburg soil series was selected to represent the Pennsylvania Vegetable scenario. Clarksburg soils are silt loams, the soil type where potato and pumpkin crops are typically grown. The Clarksburg soil series is a very deep, moderately well-drained soil formed in colluvium, glacial till or residuum from limestone, calcareous and non-calcareous shale and sandstone. This soil series is located on uplands with slopes ranging from 0 to 25 percent. Soil permeability is slow to moderately slow. This taxonomic class is described as fine-loamy, mixed, super-active, mesic Oxyaquic Fragiudalfs. The typical pedon is a silt loam located on a 5 percent northeast facing slope in a cultivated field. The Harrisburg, Pennsylvania weather record is selected to represent meteorological conditions for the Pennsylvania Vegetable scenario. This is the MLRA 148 region (USDA, 2004).

Table II.E.6-23 PRZM 3.12 Scenario Input Parameters for Pennsylvania Vegetable

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Harrisburg, PA, W14751
Ending Date	December 31, 1990	Meteorological File - Harrisburg, PA, W14751
Pan Evaporation Factor (PFAC)	0.79	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.36 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.37 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), Lancaster County, Pennsylvania - Vegetable: Clarksburg silt loam
USLE LS Factor (USLELS)	0.44	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), Lancaster County, Pennsylvania - Vegetable: Clarksburg silt loam

Parameter	Value	Source
USLE P Factor (USLEP)	1	From PRZM Scenario Guidance (2004) and ID potato scenario
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12.5%	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), Lancaster County, Pennsylvania - Vegetable: Clarksburg silt loam
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	1	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Lancaster, PA
Maximum rainfall interception storage of crop (CINTCP)	0.1cm	Maximum recommended value for grass (Carsel et al. 1998)
Maximum Active Root Depth (AMXDR)	60 cm	PRZM Manual (Carsel et al., 1998)
Maximum Canopy Coverage (COVMAX)	40%	PRZM Manual (Carsel et al., 1998)
Soil Surface Condition After Harvest (ICNAH)	3	From ID potato scenario
Date of Crop Emergence (EMD, EMM, IYREM)	10/5/61	From ID potato scenario
Date of Crop Maturity (MAD, MAM, IYRMAT)	1/10/61	From ID potato scenario
Date of Crop Harvest (HAD, HAM, IYRHAR)	10/10/61	From ID potato scenario

Parameter	Value	Source
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	89, 86, 87	Gleams Manual Table A.3, Pasture/Range, Non-CNT, Poor (USDA, 1990)
Manning’s N Value (MNGN)	.014	RUSLE Project , PA Potato (Irish), York County, File Code: S65P1PC
USLE C Factor (USLEC)	.694 .698 .701 .705 .713 .728 .746 .767 .736 .842 .870 .872 .809 .568 .392 .282 .118 .057 .052 .213 .534 .593 .635 .663 .679 .689	RUSLE Project , PA Potato (Irish), York County, File Code: SB5P1PC
Clarksburg Soil Parameters		
Total Soil Depth (CORED)	152 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	4	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 12 cm (HORIZN = 2) 34 cm (HORIZN = 3) 96 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.3 g cm-3 (HORIZN = 1) 1.3 g cm-3 (HORIZN = 2) 1.4 g cm-3 (HORIZN = 3) 1.6 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.32cm3 H20 cm3 soil (HORIZN = 1-4)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3) 4 cm (HORIZN = 4)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.32 cm3 H20 cm3 soil (HORZIN = 1-4)	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.21 cm3 H20 cm3 soil (HORZIN = 1-4)	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	1.8% (HORIZN = 1) 0.24% (HORIZN = 2) 0.09% (HORIZN = 3) 0.09% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

e. Illinois Corn (ILcornC)

The field used to represent corn production in Illinois is located in McLean County, although the crop is grown extensively throughout the state. According to the 1997 Census of Agriculture, Illinois is ranked second among the major corn producing states in the U.S. The crop is generally planted the early Spring (April) in the south, early May in the north and harvested beginning in August. Continuous corn is practice is much of the region (approximately 30 percent is continuous), however, rotation with other crops such as soybean, wheat, sorghum, and alfalfa is the dominant practice. Most of the corn is planted for feed grain, but may also be planted for oil, sweetener, and for export. Planting depth and row spacing (generally 30 inches) follows general practices for the U.S. Conservation tillage practices are regularly used for field corn with no till practiced on about 20 percent of the corn acreage annually. About 50 percent of the acreage is cultivated with a row cultivator and an estimated 40 percent is rotary hoed annually. The crop is rarely grown under irrigation. The soil selected to simulate the field is an Adair clan loam. Adair clay loam is a fine, smectitic, mesic Aquertic Argiudolls. More than 50 percent of the soil is used for the production of grains with the balance in meadow and pasture. Adair clay loam is a deep, somewhat poorly drained, medium to rapid runoff, slowly permeable soil formed on uplands in a thin mantle of loess or loess and pedisediments and a paleosol formed in glacial till. They are on convex summits of narrow interfluves and on convex side slopes at slightly lower elevations. Slopes are generally between 2 to 18 percent, but may range to 30 percent. The soils are extensive in MLRA 108 and found in many MLRA in the region. Adair clay loam is a Hydrologic Group C soil.

Table II.E.6-24 PRZM 3.12 Scenario Input Parameters for Illinois Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – Peoria, IL (W14842)
Ending Date	December 31, 1990	Meteorological File – Peoria, IL (W14842)
Pan Evaporation Factor (PFAC)	0.77	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.36 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	16.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.32 tons EI-1*	GLEAMS Table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	1.126	GLEAMS Table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	1.00	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	6%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	3	PRZM Input Collator (Burns, 1992); Lyle Paul of U of Illinois indicates residues are typically chiseled in

Parameter	Value	Source
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File – Peoria, IL (W14842)
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for grass
Maximum Active Root Depth (AMXDR)	90 cm	PRZM Input Collator (Burns, 1992)
Maximum Canopy Coverage (COVMAX)	100	PRZM Input Collator (Burns, 1992); Lyle Paul of U of Illinois
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Input Collator (Burns, 1992); Lyle Paul of U of Illinois
Date of Crop Emergence (EMD, EMM, IYREM)	01/05	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984) & Updated Crop Stage Information from HED (Bernard Schneider)
Date of Crop Maturity (MAD, MAM, IYRMAT)	21/09	
Date of Crop Harvest (HAD, HAM, IYRHAR)	20/10	
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = SR/poor; Cropping and Residue = Row Crop, SR/poor condition (USDA, 1990)
Manning’s N Value (MNGN)	0.014	RUSLE Project, MA3CGSBC; Corn, grain, Conventional tillage, Springfield, IL (USDA, 2000)
USLE C Factor (USLEC)	0.017 - 0.638	RUSLE Project; MA3CGSBC; Corn, grain, Conventional tillage, Springfield, IL, variable with date (USDA, 2000)
Adair Soil Parameters		
Total Soil Depth (CORED)	100 cm	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 34 cm (HORIZN = 2) 44 cm (HORIZN = 3) 12 cm (HORIZN = 4)	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.5 g cm-3 (HORIZN = 1, 2) 1.6 g cm-3 (HORIZN = 3) 1.7 g cm-3 (HORIZN = 4)	

Parameter	Value	Source
Initial Water Content (THETO)	0.355 cm3-H2O cm3-soil (HORIZN =1, 2) 0.338 cm3-H2O cm3-soil (HORIZN =3) 0.307 cm3-H2O cm3-soil (HORIZN =4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2,3,4)	
Field Capacity (THEFC)	0.355 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.338 cm3-H2O cm3-soil (HORIZN = 3) 0.307 cm3-H2O cm3-soil (HORIZN = 4)	
Wilting Point (THEWP)	0.185 cm3-H2O cm3-soil (HORIZN = 1,2) 0.208 cm3-H2O cm3-soil (HORIZN = 3) 0.167 cm3-H2O cm3-soil (HORIZN = 4)	
Organic Carbon Content (OC)	2.32% (HORIZN = 1,2) 0.174% (HORIZN = 3) 0.116% (HORIZN = 4)	

f. Illinois Alfalfa (ILalfalfaCRA)

Alfalfa production in Illinois represents 2.2% of the alfalfa production in the United States. Alfalfa is harvested in late May to mid-June with successive cuttings occurring every 28 to 34 days until September or October (IPM, 2004). The Varna soil series was selected to represent the Illinois Alfalfa crop scenario. This soil type is a silt loam with the largest spatial extent in McLean County, Illinois, the region selected to represent alfalfa production in Illinois. The Varna soil is very deep, moderately well drained, slowly permeable soil located on till plains. It is a fine, illitic, mesic Oxyaquic Argiudolls soil. The typical pedon is located on a northwest-facing convex slope of 3 percent at an elevation of 722 feet. The weather record from Peoria, Illinois located in the MLRA region of 108 (USDA 2004).

Table II.E.6-25 PRZM 3.12 Scenario Input Parameters for Illinois Alfalfa

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Peoria, Illinois (W14842)
Ending Date	December 31, 1990	Meteorological File - Peoria, Illinois (W14842)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998)

Parameter	Value	Source
Snowmelt Factor (SFAC)	0.36 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), McLean County, Illinois: Varna Silt Loam
USLE LS Factor (USLELS)	0.44	PRZM Manual, Table 5-5 (EPA 1998), Default slope length = 400 ft.
USLE P Factor (USLEP)	1	From PRZM Scenario Guidance (2004)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), McLean County, Illinois: Varna Silt Loam
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	1	PRZM Scenario Guidance (EPA, 2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Peoria, Illinois (W14842)
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	Maximum recommended value for grass (Carsel 1998)
Maximum Active Root Depth (AMXDR)	100 cm	Taken from Minnesota Alfalfa scenario

Parameter	Value	Source
Maximum Canopy Coverage (COVMAX)	100%	Taken from Minnesota Alfalfa scenario
Soil Surface Condition After Harvest (ICNAH)	3	Taken from Minnesota Alfalfa scenario
Date of Crop Emergence (EMD, EMM, IYREM)	1/6/61	Taken from Minnesota Alfalfa scenario
Date of Crop Maturity (MAD, MAM, IYRMAT)	25/8/61	Taken from Minnesota Alfalfa scenario
Date of Crop Harvest (HAD, HAM, IYRHAR)	30/8/61	Taken from Minnesota Alfalfa scenario
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	82, 85, 87	Gleams Manual Table H-4, Close-seeded legumes or rotation meadow, straight row, poor (USDA, 1990)
Manning’s N Value (MNGN)	.110 .	RUSLE Project, File Code: MA5HLHLC (Carbondale, IL, Hay legume)
USLE C Factor (USLEC)	.015 .015 .015 .016 .016 .018 .012 .006 .002 .007 .004 .002 .007 .006 .003 .001 .005 .003 .003 .005 .009 .013 .014 .014 .015 .015	RUSLE Project, File Code: MA5HLHLC (Carbondale, IL, Hay legume)
Varna Soil Parameters		
Total Soil Depth (CORED)	152 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	5 (top horizon split in 2)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 20 cm (HORIZN = 2) 38 cm (HORIZN = 3) 31 cm (HORIZN = 4) 53 cm (HORIZN = 5)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.5 g cm-3 (HORIZN = 1) 1.5 g cm-3 (HORIZN = 2) 1.45 g cm-3 (HORIZN = 3) 1.6 g cm-3 (HORIZN = 4) 1.8 g cm-3 (HORIZN = 5)	
Initial Water Content (THETO)	0.32 cm3 H20 cm3 soil (HORIZN = 1 -5)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2,3,4,5)	PRZM Scenario Guidance (2004)

Parameter	Value	Source
Field Capacity (THEFC)	0.32 cm3 H20 cm3 soil (HORIZN = 1 -5)	GLEAMS Table H-3 (1990) (Silt loam)
Wilting Point (THEWP)	0.12 cm3 H20 cm3 soil (HORIZN = 1 -5)	GLEAMS Table H-3 (1990) (Silt loam)
Organic Carbon Content (OC)	1.5% (HORIZN = 1) 1.5% (HORIZN = 2) 0.6% (HORIZN = 3) 0.18% (HORIZN = 4) 0.15% (HORIZN = 5)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

g. Illinois Beans (ILbeanCRA)

The Illinois Bean scenario represents the environmental conditions for snap bean, green pea, and lima bean production in Illinois. Lima beans are typically planted in June or July after a pea crop. Lima beans may be planted between May and July (IPM, 2004 a). Snap bean seedlings are started in the greenhouse in March and April, then transplanted to the field in June. Snap beans prefer well drained soils and a soil pH ranging from 5.5 to 6.0. Snap beans are planted 3/4 to 1 inch deep at the end of the frost season for harvest in the spring. Snap beans may also be planted in early summer for harvest in late fall before the first frost. Snap bean seedlings are planted in rows 2 inches wide with 18 to 36 inches between the rows (IPM, 2004 b). Green peas are planted in rows 6 to 7 inches apart. Planting occurs in early spring. Green peas must be harvested prior to hot, dry weather of mid to late summer (IPM, 2004 c). The Varna soil series was selected to represent the Illinois Beans crop scenario. This soil type is a silt loam with the largest spatial extent in McLean County, Illinois, the region selected to represent bean production in Illinois. The Varna soil is very deep, moderately well drained, slowly permeable, and located on till plains. It is a fine, illitic, mesic Oxyaquic Argiudolls soil. The typical pedon is located on a northwest-facing convex slope of 3 percent at an elevation of 722 feet. The weather record from Peoria, Illinois is located in the MLRA region of 108 (USDA, 2004).

Table II.E.6-26 PRZM 3.12 Scenario Input Parameters for Illinois Beans

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Peoria, Illinois (W14842)
Ending Date	December 31, 1990	Meteorological File - Peoria, Illinois (W14842)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.36 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		

Parameter	Value	Source
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), McLean County, Illinois: Varna Silt Loam
USLE LS Factor (USLELS)	0.44	PRZM Manual, Table 5-5 (EPA 1998), Default slope length = 400 ft.
USLE P Factor (USLEP)	1	From PRZM Scenario Guidance (2004)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/), McLean County, Illinois: Varna Silt Loam
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (. EPA 2004)
Initial Surface Condition (ISCOND)	1	PRZM Scenario Guidance (2004)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Peoria, Illinois (W14842)
Maximum rainfall interception storage of crop (CINTCP)	0.1 cm	Taken from Oregon Snapbeans scenario
Maximum Active Root Depth (AMXDR)	18 cm	Taken from Oregon Snapbeans scenario
Maximum Canopy Coverage (COVMAX)	80%	Taken from Oregon Snapbeans scenario
Soil Surface Condition After Harvest (ICNAH)	1	Taken from Oregon Snapbeans scenario
Date of Crop Emergence (EMD, EMM, IYREM)	16/6/61	Taken from Oregon Snapbeans scenario

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	18/8/61	Taken from Oregon Snapbeans scenario
Date of Crop Harvest (HAD, HAM, IYRHAR)	2/9/61	Taken from Oregon Snapbeans scenario
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	92, 89, 90	Gleams Manual Table H-4, Close-seeded legumes, fallow, ST/CT, poor (USDA, 1990)
Manning's N Value (MNGN)	.023	RUSLE Project, File Code: MaISBCGC Chicago, IL, Soybean
USLE C Factor (USLEC)	.086 .089 .092 .095 .100 .109 .124 .145 .168 .278 .292 .342 .372 .395 .381 .326 .199 .067 .072 .054 .073 .093 .046 .047 .193 .219 .242 .258 .270	RUSLE Project, File Code: MaISBCGC Chicago, IL, Soybean
Varna Soil Parameters		
Total Soil Depth (CORED)	152 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	5 (top horizon split in 2)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 20 cm (HORIZN = 2) 38 cm (HORIZN = 3) 31 cm (HORIZN = 4) 53 cm (HORIZN = 5)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.5 g cm-3 (HORIZN = 1) 1.5 g cm-3 (HORIZN = 2) 1.45 g cm-3 (HORIZN = 3) 1.6 g cm-3 (HORIZN = 4) 1.8 g cm-3 (HORIZN = 5)	
Initial Water Content (THETO)	0.32 cm3 H20 cm3 soil (HORIZN = 1 -5)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2,3,4,5)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.32 cm3 H20 cm3 soil (HORIZN = 1 -5)	GLEAMS Table H-3 (1990) (Silt loam)
Wilting Point (THEWP)	0.12 cm3 H20 cm3 soil (HORIZN = 1 -5)	GLEAMS Table H-3 (1990) (Silt loam)
Organic Carbon Content (OC)	1.5% (HORIZN = 1) 1.5% (HORIZN = 2) 0.6% (HORIZN = 3) 0.18% (HORIZN = 4) 0.15% (HORIZN = 5)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship % OC = 0.6 x % Organic Matter (Doucette 2000)

9. Northern Great Plains Region Scenario Documentation

a. Minnesota Potatoes (MNpotatoCRA)

The field used to represent potato production in Minnesota is located in Polk County, in the Red River Valley. However, the scenario should be considered as representative of the major potato producing region of the Red River Valley, which included counties in both Minnesota and North Dakota. According to the USDA Crop Profile for Potatoes in Minnesota (USDA, 2002), Minnesota ranked 7^{th} nationally in potato production, with the largest producing regions in the northwest (Polk, Clay, Kittson, Marshall, and Red Lake counties) and the central (Sherburne, Morrison, Todd counties). Because this scenario is being developed for the N-methyl carbamate cumulative risk assessment, a scenario site in the northwest (Red River Valley) was selected to coincide with the regional cumulative assessment area. The site may still be of value as a regional potato scenario since it does represent an area of the country with relatively high potato production (North Dakota, on the other side of the Red River, is 6^{th} in potato production, with the main producing area in ND being the Red River Valley [USDA, 2000b]). The Red River Valley MLRA (56) includes the North Dakota counties along the eastern border (Pembina, Walsh, Grand Forks, Traill, Cass, and Richland) and the Minnesota counties along the northwestern border (Kittson, Marshall, Polk, Pennington, Red Lake, Norman, Clay, Wilkin, and Traverse).

Planting begins in late April (after soil temperatures reach 45^{o}F) through the end of May. Potatoes are harvested roughly 90 days after planting, beginning in late August and continuing through October (USDA, 2002). Row spacing is generally 32 to 36 inches, with rows 8-16 inches apart. Potatoes are generally grown once every three years on the same field to limit disease pressures (Willem Schrage, Minnesota Dept. of Agriculture). While a “significant portion” of MN potato acres are irrigated (USDA, 2002), irrigation generally occurs on coarse-textured (sandy loams or loamy sands) soils low in organic matter (USDA, 2000b). Potatoes and sugar beets may be grown on the same soils, but do not follow each other in a rotation because of the depletion of moisture (USDA, 2000b).

While the ideal potato soils are sandy-loam textured, fertile fine- to medium-textured soils are also appropriate for potato production (USDA, 2002). The soil selected to simulate the field is a benchmark soil, Bearden silty clay loam. This is the same soil used for the sugar beet scenario. Bearden silty clay loam, is a fine-silty, mixed, superactive, frigid Aeric Calciaquolls. These soils are nearly all under cultivation to small grains, especially alfalfa, and row crops (i.e., sugar beets). Bearden silty clay loam is a very deep, somewhat poorly drained, slowly permeable soil with negligible to high runoff. A seasonal high water table is at depths of 1.5 to 3.5 feet as some time during the period of April to June. These soils formed in calcareous silt loam and silty clay loam lacustrine sediments. They are generally found on glacial lake plains at elevations from 650 to 2000 feet above mean sea level on slopes of 0 to 3 percent. Bearden silty clay loam is a Hydrologic Group C soil. The series is of large extent in Minnesota, North Dakota, and South Dakota.

Table II.E.6-27 PRZM 3.12 Scenario Input Parameters for Minnesota Potatoes

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File – Fargo, ND (W14914)
Ending Date	December 31, 1990	Meteorological File - Fargo, ND (W14914)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.50 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	12.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	GLEAMS Table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.17	GLEAMS Table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	0.5	PRZM Manual (EPA,1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1.5%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	PRZM Input Collator (Burns, 1992)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File – Fargo, ND (W14914)
Maximum rainfall interception storage of crop (CINTCP)	0.1	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	60 cm	http://www.css.orst.edu/Classes/CSS322/Growing.htm
Maximum Canopy Coverage (COVMAX)	100	PRZM Input Collator (Burns, 1992); Dr. Mohamed Kahn; NDSU (701) 231_8596; Larry Smith U of MN (218) 281_8602.
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Input Collator, PIC (Burns, 1992)
Date of Crop Emergence (EMD, EMM, IYREM)	15/05	Based on beginning of most active planting dates (May 8 – May 31) and harvest dates (Sep 16 – Oct 12) for potatoes in MN, adding 7 days for

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	06/09	emergence and 10 days between maturity & harvest (USDA 1997)
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/09	
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 85, 87	Gleams Manual Table A.3, Fallow = SR/poor; Cropping and Residue = Row Crop, SR/poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project: F86PIPIC – Potatoes, Conventional tillage, Fargo, ND (USDA, 2000a)
USLE C Factor (USLEC)	.649 .774 .808 .816 .740 .441 .349 .233 .055 .056 .050 .496 .530 .565 .581 .588 .587 .586 .584 .583 .581 .579 .577 .580 .590 .612 .638 .639	RUSLE Project: F86PIPIC – Potatoes, Conventional tillage, Fargo, ND (USDA, 2000a). Order of C factors revised to follow crop emergence sequence (May 16 – 1605 – is the beginning date)
Bearden Soil Parameters		
Total Soil Depth (CORED)	100 cm	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (3 Base, Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 8 cm (HORIZN = 2) 54 cm (HORIZN = 3) 28 cm (HORIZN = 4)	PIC (Burns, 1992) Confirmed with: NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/) NOTE: Used same soil parameters as used for MN Sugar Beets scenario since the scenarios are based on the same benchmark soil
Bulk Density (BD)	1.4 g cm-3 (HORIZN 1, 2) 1.5 g cm-3 (HORIZN 3) 1.8 g cm-3 (HORIZN 4)	
Initial Water Content (THETO)	0.377 cm3-H2O cm3-soil (HORIZN 1, 2) 0.292 cm3-H2O cm3-soil (HORIZN 3) 0.285 cm3-H2O cm3-soil (HORIZN 4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN 1) 2.0 cm (HORIZN 2,3,4)	

Parameter	Value	Source
Field Capacity (THEFC)	0.377 cm3-H2O cm3-soil (HORIZN 1, 2) 0.292 cm3-H2O cm3-soil (HORIZN 3) 0.285 cm3-H2O cm3-soil (HORIZN 4)	
Wilting Point (THEWP)	0.207 cm3-H2O cm3-soil (HORIZN 1,2) 0.132 cm3-H2O cm3-soil (HORIZN 3) 0.125 cm3-H2O cm3-soil (HORIZN 4)	
Organic Carbon Content (OC)	4.06% (HORIZN = 1,2) 0.174% (HORIZN = 3) 0.116% (HORIZN = 4)	

b. Minnesota Sugar Beets (MNsugarbeetC)

The field used to represent sugar beet production in Minnesota is located in Polk County, in the Red River Valley (MLRA 56). According to the 1997 Census of Agriculture, Minnesota ranked 1st in production and acreage of sugar beets in the U.S. The crop is generally planted the late spring and harvested beginning in October. Row spacing is generally 30 inches. Row canopies tend to be very close to 100 percent, while the canopy between rows is much less. The crop may be grown under irrigation by furrow, canal, or center pivot systems. However, sugar beets grown in the Red River Valley do not need to be irrigated.

The soil selected to simulate the field is a benchmark soil, Bearden silty clay loam. Bearden silty clay loam, is a fine-silty, mixed, superactive, frigid Aeric Calciaquolls. These soils are nearly all under cultivation to small grains, especially alfalfa, and row crops (i.e., sugar beets). Bearden silty clay loam is a very deep, somewhat poorly drained, slowly permeable soil with negligible to high runoff. A seasonal high water table is at depths of 1.5 to 3.5 feet as some time during the period of April to June. These soils formed in calcareous silt loam and silty clay loam lacustrine sediments. They are generally found on glacial lake plains at elevations from 650 to 2000 feet above mean sea level on slopes of 0 to 3 percent. Bearden silty clay loam is a Hydrologic Group C soil. The series is of large extent in Minnesota, North Dakota, and South Dakota.

Table II.E.6-28 PRZM 3.12 Scenario Input Parameters for Minnesota Sugar Beets

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Fargo, ND (W14914)
Ending Date	December 31, 1990	Meteorological File - Fargo, ND (W14914)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)

Parameter	Value	Source
Snowmelt Factor (SFAC)	0.50 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	12.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	GLEAMS Table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.17	GLEAMS Table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	0.5	PRZM Manual (EPA,1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1.5%	Selected according to QA/QC Guidance (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	PRZM Input Collator (Burns, 1992)
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Fargo, ND (W14914)
Maximum rainfall interception storage of crop (CINTCP)	0.2	PRZM Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	100 cm	Set to soil profile depth. Roots can be as much as 8 feet deep. Dr. Mohamed Kahn; NDSU (701) 231_8596; Larry Smith U of MN (218) 281_8602.
Maximum Canopy Coverage (COVMAX)	100	PRZM Input Collator (Burns, 1992); Dr. Mohamed Kahn; NDSU (701) 231_8596; Larry Smith U of MN (218) 281_8602.
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Input Collator, PIC (Burns, 1992)
Date of Crop Emergence (EMD, EMM, IYREM)	11/05	Usual Planting and Harvest Dates for US Field Crops (USDA, 1984) & Updated Crop Stage Information from HED (Bernard Schneider)
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/10	
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/10	
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation

Parameter	Value	Source
SCS Curve Number (CN)	91, 85, 87	Gleams Manual Table A.3, Fallow = SR/poor; Cropping and Residue = Row Crop, SR/poor condition (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project, F86SUSUC); Sugar beets, Conventional tillage, Fargo, ND (USDA, 2000)
USLE C Factor (USLEC)	0.017 - 0.638	RUSLE Project; F86SUSUC); Sugar beets, Conventional tillage, Fargo, ND (USDA, 2000)
Soil Parameters - Bearden		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (3 Base, Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 8 cm (HORIZN = 2) 54 cm (HORIZN = 3) 28 cm (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001)
Bulk Density (BD)	1.4 g cm-3 (HORIZN = 1, 2) 1.5 g cm-3 (HORIZN = 3) 1.8 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.377 cm3-H2O cm3-soil (HORIZN =1, 2) 0.292 cm3-H2O cm3-soil (HORIZN =3) 0.285 cm3-H2O cm3-soil (HORIZN =4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2.0 cm (HORIZN = 2,3,4)	
Field Capacity (THEFC)	0.377 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.292 cm3-H2O cm3-soil (HORIZN = 3) 0.285 cm3-H2O cm3-soil (HORIZN = 4)	
Wilting Point (THEWP)	0.207 cm3-H2O cm3-soil (HORIZN = 1,2) 0.132 cm3-H2O cm3-soil (HORIZN = 3) 0.125 cm3-H2O cm3-soil (HORIZN = 4)	
Organic Carbon Content (OC)	4.06% (HORIZN = 1,2) 0.174% (HORIZN = 3) 0.116% (HORIZN = 4)	

c. North Dakota Wheat (NDwheatC)

The field used to represent wheat production in North Dakota is located in Cass County in the Red River Valley. According to the 1997 Census of

Agriculture, North Dakota is ranked first in the production of both durum and spring wheat in the U.S. The crop is generally planted in the Spring (late April to the end of May) and harvested beginning in August. Continuous wheat is practice is much of the region. Conventional tillage is used but requires greater seedbed preparation. No-till and reduced tillage systems are designed for use in high residue conditions. Row spacing ranges from 6 to 9 inches with seeds planted at a depth of 2 inches or less. The soil selected to simulate the field is a benchmark soil, Bearden silty clay loam. Bearden silty clay loam, is a fine-silty, mixed, superactive, frigid Aeric Calciaquolls. These soils are nearly all under cultivation to small grains, especially alfalfa, and row crops. Bearden silty clay loam is a very deep, somewhat poorly drained, slowly permeable soil with negligible to high runoff. These soils formed in calcareous silt loam and silty clay loam lacustrine sediments. They are generally found on glacial lake plains at elevations from 650 to 2000 feet above mean sea level on slopes of 0 to 3 percent. Bearden silty clay loam is a Hydrologic Group C soil.

Table II.E.6-29 PRZM 3.12 Scenario Input Parameters for North Dakota Wheat

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Fargo, ND (W14914)
Ending Date	December 31, 1990	Meteorological File - Fargo, ND (W14914)
Pan Evaporation Factor (PFAC)	0.75	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.5m C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	12.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE LS Factor (USLELS)	0.17	GLEAMS Manual, table of Representative Soils (USDA, 1990)
USLE P Factor (USLEP)	1.0	Set according to guidance (EPA, 2001)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1.5%	Value mid-point of series slope range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Set to fallow prior to new crop planting
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one

Parameter	Value	Source
Number of Cropping Periods (NCPDS)	30	Set to weather data. Fargo, ND (W14914)
Maximum rainfall interception storage of crop (CINTCP)	0.1	PRZM, Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	22 cm	PRZM Manual, Table 5.9 (EPA, 1998)
Maximum Canopy Coverage (COVMAX)	100	QA/QC Guidance (EPA, 2001)
Soil Surface Condition After Harvest (ICNAH)	1	Fallow conditions after harvest in preparation for winter crop
Date of Crop Emergence (EMD, EMM, IYREM)	15/05	Planting and Harvesting dates for spring wheat adjusted for ""C"" value planting and harvesting date (USDA, 1984)
Date of Crop Maturity (MAD, MAM, IYRMAT)	25/07	Planting and Harvesting dates for spring wheat adjusted for ""C"" value planting and harvesting date (USDA, 1984)
Date of Crop Harvest (HAD, HAM, IYRHAR)	08/08	Planting and Harvesting dates for spring wheat adjusted for ""C"" value planting and harvesting date (USDA, 1984)
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 85, 87	Gleams Manual Table A.3, Fallow = SR/CT poor; Cropping = Row Crop SR/CT poor (second number; Fallow = row crop SR/CT poor (3rd number) (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project, F86WSFA Fargo, ND spring wheat, fallow, conventional tillage (USDA, 2000)
USLE C Factor (USLEC)	0.036 - 0.617	RUSLE Project; F86WSFA Fargo, ND spring wheat, fallow, conventional tillage (USDA, 2000)
Bearden Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 8 cm (HORIZN = 2) 54 cm (HORIZN = 3) 28 cm (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.4 g cm-3 (HORIZN = 1,2) 1.5 g cm-3 (HORIZN = 3) 1.8 g cm-3 (HORIZN = 4)	

Parameter	Value	Source
Initial Water Content (THETO)	0.377 cm3-H2O cm3-soil (HORIZN =1,2) 0.292 cm3-H2O cm3-soil (HORIZN =3) 0.285 cm3-H2O cm3-soil (HORIZN =4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2.0 cm (HORIZN = 2,3,4)	
Field Capacity (THEFC)	0.377 cm3-H2O cm3-soil (HORIZN = 1,2) 0.292cm3-H2O cm3-soil (HORIZN = 3) 0.285 cm3-H2O cm3-soil (HORIZN = 4)	
Wilting Point (THEWP)	0.207 cm3-H2O cm3-soil (HORIZN = 1,2) 0.132 cm3-H2O cm3-soil (HORIZN = 3) 0.125 cm3-H2O cm3-soil (HORIZN = 4)	
Organic Carbon Content (OC)	1.74% (HORIZN = 1,2) 0.116% (HORIZN = 3) 0.058% (HORIZN = 4)	

10. Northwest / WA

a. Washington Apples (WAorchardsCRA)

The field used to represent orchard production in Central Washington is representative of a field in Grant county, located in the Columbia Basin. The meteorological file, Yakima, WA represents the MLRA region 7, 8. Washington produces 53 percent of U.S. apples, ranking first in the U.S. Apple production in the state of Washington occurs primarily in three regions: Yakima Basin, North Central, and Columbia Basin. Various types of apples, including red delicious, golden delicious, pink lady, granny smith, and more are grown in orchards in Washington (NSF 2001). Taunton silt loam chosen from Grant County. This soil was chosen over the Scoon silt loam even though more orchard crops are grown in the Scoon soil, since data are available for deeper depths. This is appropriate due to the large maximum rooting depth of apples and cherry trees. Taunton silt loam is a hydrologic group C soil that is classified as coarse-loamy, mixed, superactive, mesic xeric Haplodurids. The Taunton series of soils is moderately deep to duripan, well drained soils formed in alluvium. These soils occur on terraces and basalt plains, fan terraces and mesas with slopes of 0 to 45 percent. This soil type occurs in South-central Washington, north-central Oregon and

Southern Idaho where it is used for livestock grazing and irrigated crop production (USDA 2001).

Table II.E.6-30 PRZM 3.12 Scenario Input Parameters for Washington Orchards

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Yakima, Grant County, Washington
Ending Date	December 31, 1990	Meteorological File - Yakima, Grant County, Washington
Pan Evaporation Factor (PFAC)	0.71	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.20 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.55 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.70	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 4% slope
USLE P Factor (USLEP)	1.0	PRZM Manual Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	3.5%	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Hydraulic Length (HL)	464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	3	Consulted extension agent, crops are rotated

Parameter	Value	Source
Number of Different Crops (NDC)	1	Based on OR apple scenario.
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	Based on OR apple scenario.
Maximum Active Root Depth (AMXDR)	45 cm	Based on OR apple scenario.
Maximum Canopy Coverage (COVMAX)	98%	Based on OR apple scenario.
Soil Surface Condition After Harvest (ICNAH)	3	Based on OR apple scenario.
Date of Crop Emergence (EMD, EMM, IYREM)	1/5/61	Based on OR apple scenario.
Date of Crop Maturity (MAD, MAM, IYRMAT)	31/5/61	Based on OR apple scenario.
Date of Crop Harvest (HAD, HAM, IYRHAR)	7/11/61	Based on OR apple scenario.
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	79, 82, 84	Gleams Manual Table A.3, (Hydrological soil C) (USDA, 1990)
Manning's N Value (MNGN)	.040 .	RUSLE Project (B060FOFN.dat)
USLE C Factor (USLEC)	.004 .005 .006 .006 .009 .010 .011 .011 .011 .010 .009 .008 .006 .005 .005 .005 .005 .005 .005 .005 .002 .003 .003 .003	RUSLE Project (B060FOFN.dat)
Soil Parameters		
Total Soil Depth (CORED)	68 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	4	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 10 cm (HORIZN = 2) 28 cm (HORIZN = 3) 20 cm (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.25 g cm-3 (HORIZN = 1) 1.25 g cm-3 (HORIZN = 2) 1.40 g cm-3 (HORIZN = 3) 1.40 g cm-3 (HORIZN = 4)	

Parameter	Value	Source
Initial Water Content (THETO)	0.32 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2) 2 cm (HORIZN = 3)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.32 cm3 H20 cm3 soil (HORIZN = 1, 2, 3, 4)	GLEAMS Table H-3(1990)
Wilting Point (THEWP)	0.12 cm3 H20 cm3 soil (HORIZN = 1, 2, 3, 4)	GLEAMS Table H-3(1990)
Organic Carbon Content (OC)	0.45% (HORIZN = 1) 0.45% (HORIZN = 2) 0.15% (HORIZN = 3) 0.15% (HORIZN = 4)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship %OC = 0.6x% Organic Matter (Doucette 2000)

b. Washington Beans (WAbeansCRA)

The field used to represent bean production in Central Washington is located in Grant County in the Columbia Basin. The meteorological file, Yakima, WA represents the MLRA regions 7 and 8. Beans are planted in early summer and harvested in September. For this scenario, Ekrub fine sand was selected as a representative soil type because it supports bean crops. Ekrub fine sand is a hydrologic group C soil that is classified as sandy-skeletal, mixed, mesic, shallow xeric Haplodurids. The Ekrub series of soils is shallow, somewhat excessively drained, formed in eolian sands overlying a lime-silica indurated duripan. These soils occur on terraces with slopes of 0 to 25 percent. This soil type occurs in South-central Washington where it is mostly used for range (USDA 1996).

Table II.E.6-31 PRZM 3.12 Scenario Input Parameters for Washington Beans

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Yakima, Grant County, Washington
Ending Date	December 31, 1990	Meteorological File - Yakima, Grant County, Washington
Pan Evaporation Factor (PFAC)	0.71	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.20 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)

Parameter	Value	Source
USLE LS Factor (USLELS)	3.6	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 12% slope
USLE P Factor (USLEP)	0.6	PRZM Manual Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12.5%	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Hydraulic Length (HL)	464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	1	Consulted extension agent, crops are rotated
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.1 cm	Taken from OR snap beans scenario.
Maximum Active Root Depth (AMXDR)	18 cm	Taken from OR snap beans scenario.
Maximum Canopy Coverage (COVMAX)	80%	Taken from OR snap beans scenario.
Soil Surface Condition After Harvest (ICNAH)	1	Taken from OR snap beans scenario.
Date of Crop Emergence (EMD, EMM, IYREM)	61/6/61	Taken from OR snap beans scenario.
Date of Crop Maturity (MAD, MAM, IYRMAT)	18/8/61	Taken from OR snap beans scenario.

Parameter	Value	Source
Date of Crop Harvest (HAD, HAM, IYRHAR)	2/9/61	Taken from OR snap beans scenario.
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	84, 86, 87	Gleams Manual Table A.3, (Hydrological soil C), SR Conservation Tillage/poor, Cropping and Residue = Row Crop Contour/good (USDA, 1990)
Manning's N Value (MNGN)	.011	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA
USLE C Factor (USLEC)	.806 .812 .818 .822 .827 .831 .836 .786 .885 .887 .869 .829 .778 .733 .691 .666 .690 .707 .554 .582 .617 .658 .702 .735 .759 .777 .790 .799	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA
Soil Parameters		
Total Soil Depth (CORED)	45 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	8 cm (HORIZN = 1) 22 cm (HORIZN = 2) 15 cm (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.55 g cm-3 (HORIZN = 2) 1.55 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2) 5 cm (HORIZN = 3)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3(1990)
Wilting Point (THEWP)	0.03 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3(1990)
Organic Carbon Content (OC)	0.15% (HORIZN = 1, 2, 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship %OC = 0.6x%Organic Matter (Doucette 2000)

c. Washington Onions (WAonionsCRA)

The field used to represent onion production in Central Washington is representative of a field in Grant County. The meteorological file, Yakima, WA represents the MLRA region 7, 8. Washington produces 16.2 percent of the U.S. dry summer onions, ranking third in the U.S. Washington storage onion production is primarily in the central part of the state in Grant, Franklin, Benton and Adams counties. Onions are cool-season crops which can grow in a variety of soil types. Onions in Grant County are grown in 3 to 4 year rotations with carrots, sweet corn, cereals and potatoes. Onions are planted on beds in multiple rows (2-12). Seeds are planted 1/4 to ½ inch deep. Most onions are irrigated (NSF 2003). For this scenario, Ekrub fine sand was selected as a representative soil type because it supports onion crops. Ekrub fine sand is a hydrologic group C soil that is classified as sandy-skeletal, mixed, mesic, shallow xeric Haplodurids. The Ekrub series of soils is shallow, somewhat excessively drained, formed in eolian sands overlying a lime-silica indurated duripan. These soils occur on terraces with slopes of 0 to 25 percent. This soil type occurs in South-central Washington where it is mostly used for range (USDA 1996).

Table II.E.6-32 PRZM 3.12 Scenario Input Parameters for Washington Onions

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Yakima, Grant County, Washington
Ending Date	December 31, 1990	Meteorological File - Yakima, Grant County, Washington
Pan Evaporation Factor (PFAC)	0.71	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.20 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD	17 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	3.6	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 12% slope
USLE P Factor (USLEP)	0.5	PRZM Manual Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12.5%	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Hydraulic Length (HL)	464 (reservoir)	Shipman Reservoir (EPA 2004)

Parameter	Value	Source
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	1	Consulted extension agent, crops are rotated
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.5 cm	Taken from CA onion scenario.
Maximum Active Root Depth (AMXDR)	35 cm	Taken from CA onion scenario.
Maximum Canopy Coverage (COVMAX)	80%	Taken from CA onion scenario.
Soil Surface Condition After Harvest (ICNAH)	1	Taken from CA onion scenario.
Date of Crop Emergence (EMD, EMM, IYREM)	1/6/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349
Date of Crop Maturity (MAD, MAM, IYRMAT)	30/8/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349
Date of Crop Harvest (HAD, HAM, IYRHAR)	10/9/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	84, 86, 87	Gleams Manual Table A.3, (Hydrological soil C), SR Conservation Tillage/poor, Cropping and Residue = Row Crop Contour/good (USDA, 1990)
Manning’s N Value (MNGN)	.011	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA

Parameter	Value	Source
USLE C Factor (USLEC)	.806 .812 .818 .822 .827 .831 .836 .786 .885 .887 .869 .829 .778 .733 .691 .666 .690 .707 .554 .582 .617 .658 .702 .735 .759 .777 .790 .799	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA
Soil Parameters		
Total Soil Depth (CORED)	45 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	8 cm (HORIZN = 1) 22 cm (HORIZN = 2) 15 cm (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.55 g cm-3 (HORIZN = 2) 1.55 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2) 5 cm (HORIZN = 3)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.03 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	0.15% (HORIZN = 1, 2, 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship %OC = 0.6x%Organic Matter (Doucette 2000)

d. Washington Potatoes (WApotatoCRA)

The field used to represent potato production in Central Washington is located in Grant County in the Columbia Basin. The meteorological file, Yakima, WA represents the MLRA regions 7 and 8. Potatoes are planted in the spring and harvested in the summer and fall. Common potato varieties grown in Washington include russets, which are grown for french fries and fresh market. Other varieties include yellow, red and blue potatoes (WSPC 2004). For this scenario, Scoon silt loam was selected as a representative soil type because it supports potato crops in Grant County in Washington. Scoon silt loam is a hydrologic group D soil that is classified as loamy, mixed, superactive, mesic and shallow Xeric Haplodurids. The Scoon series of soils is shallow to a duripan, well drained, and formed in loess and silty alluvium over a duripan. These soils occur on terraces and alluvial fans with slopes of 0 to 30 percent. This soil type occurs in South-central Washington and Southern Idaho and is mostly used for irrigated crop production and range (USDA 2001).

Table II.E.6-33 PRZM 3.12 Scenario Input Parameters for Washington Potatoes

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Yakima, Grant County, Washington
Ending Date	December 31, 1990	Meteorological File - Yakima, Grant County, Washington
Pan Evaporation Factor (PFAC)	0.71	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.20 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Parameter	Value	Source
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.55 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
USLE LS Factor (USLELS)	0.30	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 2% slope
USLE P Factor (USLEP)	0.3	PRZM Manual Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	2.5%	From http://soils.usda.gov/ official soil series description (slope range = 0-1%)
Hydraulic Length (HL)	356 (pond) 464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA,2001)
Initial Surface Condition (ISCOND)	1	Consulted extension agent, crops are rotated

Parameter	Value	Source
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.1 cm	PRZM Manual (Carsel et al., 1998)
Maximum Active Root Depth (AMXDR)	30 cm	Consulted extension agent
Maximum Canopy Coverage (COVMAX)	40%	Consulted extension agent
Soil Surface Condition After Harvest (ICNAH)	3	PRZM Manual (Carsel et al., 1998)
Date of Crop Emergence (EMD, EMM, IYREM)	1/5/61	Consulted extension agent
Date of Crop Maturity (MAD, MAM, IYRMAT)	15/9/61	Consulted extension agent
Date of Crop Harvest (HAD, HAM, IYRHAR)	1/10/61	Consulted extension agent
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	91, 89, 90	Gleams Manual Table A.3, (Hydrological soil D) (USDA, 1990)
Manning's N Value (MNGN)	.014	RUSLE Project (A04PIPC.dat)
USLE C Factor (USLEC)	.741 .753 .764 .774 .784 .795 .805 .750 .757 .858 .880 .811 .582 .389 .290 .125 .055 .050 .188 .486 .520 .582 .630 .666 .694 .713 .729	RUSLE Project (A04PIPC.dat)
Soil Parameters		
Total Soil Depth (CORED)	40 cm	http://soils.usda.gov/ Note: Only upper 16 inches of soil had data on physical properties.
Number of Horizons (NHORIZ)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 5 cm (HORIZN = 2) 25 cm (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.25 g cm-3 (HORIZN = 1) 1.25 g cm-3 (HORIZN = 2) 1.4 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.32 cm3 H20 cm3 soil	Field Capacity values, PRZM Scenario Guidance (2004)

Parameter	Value	Source
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2) 5 cm (HORIZN = 3)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.32 cm3 H20 cm3 soil	GLEAMS Table H-3(1990), NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Wilting Point (THEWP)	0.12 cm3 H20 cm3 soil	GLEAMS Table H-3(1990), NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Organic Carbon Content (OC)	0.45% (HORIZN = 1, 2) 0.15% (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship %OC = 0.6x%Organic Matter (Doucette 2000)

e. Washington Sweet Corn (WAswcornCRA)

This scenario was developed specifically to fill in usage for the N-methyl Carbamate Cumulative assessment for total NMC use in Grant County, WA. The scenario uses the climate and soil inputs from the WA onion scenario with crop parameters specific to sweet corn. The meteorological file, Yakima, WA, represents the MLRA region 7, 8. For this scenario, Ekrub fine sand was selected as a representative soil type because it supports onion crops. Ekrub fine sand is a hydrologic group C soil that is classified as sandy-skeletal, mixed, mesic, shallow xeric Haplodurids. The Ekrub series of soils is shallow, somewhat excessively drained, formed in eolian sands overlying a lime-silica indurated duripan. These soils occur on terraces with slopes of 0 to 25 percent. This soil type occurs in South-central Washington where it is mostly used for range (USDA 1996).

Table II.E.6-34 PRZM 3.12 Scenario Input Parameters for Washington Sweet Corn

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Yakima, Grant County, Washington
Ending Date	December 31, 1990	Meteorological File - Yakima, Grant County, Washington
Pan Evaporation Factor (PFAC)	0.71	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.20 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD	17 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)

Parameter	Value	Source
USLE LS Factor (USLELS)	3.6	Based on slope taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) , PRZM manual length 400 m, 12% slope
USLE P Factor (USLEP)	0.5	PRZM Manual Table 5.6 (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA 2004)
NRCS Hyetograph (IREG)	3	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	12.5%	Taken from NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Hydraulic Length (HL)	464 (reservoir)	Shipman Reservoir (EPA 2004)
Irrigation Flag (IRFLAG)	0	From PRZM Scenario Guidance (2004)
Irrigation Type (IRTYP)	Not applicable	
Leaching Factor (FLEACH)	Not applicable	
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (.EPA 2004)
Initial Surface Condition (ISCOND)	1	Consulted extension agent, crops are rotated
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data.
Maximum rainfall interception storage of crop (CINTCP)	0.25 cm	Taken from OR sweet corn scenario.
Maximum Active Root Depth (AMXDR)	90 cm	Taken from OR sweet corn scenario.
Maximum Canopy Coverage (COVMAX)	100%	Taken from OR sweet corn scenario.
Soil Surface Condition After Harvest (ICNAH)	1	Taken from OR sweet corn scenario.
Date of Crop Emergence (EMD, EMM, IYREM)	10/5/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	21/8/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349
Date of Crop Harvest (HAD, HAM, IYRHAR)	10/9/61	Oregon State University Extension and Experiment Station http://eesc.orst.edu/agcomwebfile/edmat/html/pnw546/pnw546.html#anchor256349
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	84, 86, 87	Gleams Manual Table A.3, (Hydrological soil C), SR Conservation Tillage/poor, Cropping and Residue = Row Crop Contour/good (USDA, 1990)
Manning's N Value (MNGN)	.011	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA
USLE C Factor (USLEC)	.806 .812 .818 .822 .827 .831 .836 .786 .885 .887 .869 .829 .778 .733 .691 .666 .690 .707 .554 .582 .617 .658 .702 .735 .759 .777 .790 .799	RUSLE Project (A04ONONC.dat) Onion fields in Centralia, WA
Soil Parameters		
Total Soil Depth (CORED)	45 cm	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Number of Horizons (NHORIZ)	3	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Horizon Thickness (THKNS)	8 cm (HORIZN = 1) 22 cm (HORIZN = 2) 15 cm (HORIZN = 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.55 g cm-3 (HORIZN = 2) 1.55 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	Field Capacity values, PRZM Scenario Guidance (2004)
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN = 2) 5 cm (HORIZN = 3)	PRZM Scenario Guidance (2004)
Field Capacity (THEFC)	0.18 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3 (1990)
Wilting Point (THEWP)	0.03 cm3 H20 cm3 soil (HORIZN = 1, 2, 3)	GLEAMS Table H-3 (1990)
Organic Carbon Content (OC)	0.15% (HORIZN = 1, 2, 3)	NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/); Adjusted using the relationship %OC = 0.6x%Organic Matter (Doucette 2000)

11. Southwest Region Scenario Documentation

a. California Alfalfa (CAalfalfa0C)

The field used to represent alfalfa production in California is located in San Joaquin County in the Central Valley, although the crop is grown throughout the Central Valley and as far south as the Imperial Valley. According to the 1997 Census of Agriculture, California is ranked first in pounds of alfalfa hay harvested and among the top 10 in acres planted. Alfalfa is a perennial crop, planted early in the year and maintained under continuous cultivation on a 4- to 5-year cycle at which time a new crop is planted. Planting depths range from 0.25 to 1.0 inches, depending on soil texture, on level seed beds. Row spacing is approximately 30 inches; nearly all alfalfa is irrigated in California by flooding. Cuttings range from 3 to 5 per year under most conditions. Alfalfa prefers well-drained soil with a pH near neutral. Root systems rarely exceed 2 feet in California and cuttings occur when the plant reaches a height of approximately 30 inches. The soil selected to simulate the field is a benchmark soil, Sacramento clay. Sacramento clay is a very-fine, smectitic, thermic Cumulic Vertic Endoaquolls. These soils are often used for alfalfa cultivation providing the water table is low. Sacramento clay is a poorly to very poorly drained, slowly permeable soil with very slow to slow runoff. These soils formed in fine textured alluvium of mixed origin and are of moderate extent. They are generally found in level basins at elevations near sea level to 60 feet. The soil is typical of soils used for a variety of row crops, rice, safflower and alfalfa. Sacramento clay is a Hydrologic Group D soil.

Table II.E.6-35 PRZM 3.12 Scenario Input Parameters for California Alfalfa

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.73	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.45 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	15.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.20 tons EI-1*	NRI - Average value listed for the soil series Sacramento
USLE LS Factor (USLELS)	0.19	NRI - Average value listed for the soil series Sacramento
USLE P Factor (USLEP)	1.00	NRI - Average value listed for the soil series Sacramento
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)

Parameter	Value	Source
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	2%	Marcia Campbell-Matthews; San Joaquin County Cooperative Extension Agent. 209-468-2085
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA. 2001)
Initial Surface Condition (ISCOND)	1	Marcia Campbell-Matthews; San Joaquin County Cooperative Extension Agent. 209-468-2085
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File - Sacramento, CA (W23232)
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for grass (EPA, 2001)
Maximum Active Root Depth (AMXDR)	60 cm	Marcia Campbell-Matthews; San Joaquin County Cooperative Extension Agent. 209-468-2085
Maximum Canopy Coverage (COVMAX)	100	Marcia Campbell-Matthews; San Joaquin County Cooperative Extension Agent. 209-468-2085
Soil Surface Condition After Harvest (ICNAH)	1	Marcia Campbell-Matthews; San Joaquin County Cooperative Extension Agent. 209-468-2085
Date of Crop Emergence (EMD, EMM, IYREM)	10/01	Value set to approximate planting cycle. Alfalfa is planted one every five years with multiple cuttings in every year
Date of Crop Maturity (MAD, MAM, IYRMAT)	28/12	Value set to approximate planting cycle. Alfalfa is planted one every five years with multiple cuttings in every year
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/12	Value set to approximate planting cycle. Alfalfa is planted one every five years with multiple cuttings in every year

Parameter	Value	Source
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	90, 88, 89	Gleams Manual Table A.3, Pasture/Range, Non-CNT, Poor (USDA, 1990)
Manning’s N Value (MNGN)	0.023	RUSLE Project, A01OCOCM; Orchard, cover alley, Mulch till, Olympia, WA (USDA, 2000)
USLE C Factor (USLEC)	0.046 - 0.221	RUSLE Project; A01OCOCM; Orchard, cover alley, Mulch till, Olympia, WA. Variable with date (USDA, 2000)
Sacramento Soil Parameters		
Total Soil Depth (CORED)	176 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	4 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 8 cm (HORIZN = 2) 157 cm (HORIZN = 3) 1 cm (HORIZN = 4)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.43 g cm-3 (HORIZN = 1, 2) 1.29 g cm-3 (HORIZN = 3) 1.48 g cm-3 (HORIZN = 4)	
Initial Water Content (THETO)	0.42 cm3-H2O cm3-soil (HORIZN =1, 2) 0.44 cm3-H2O cm3-soil (HORIZN =3) 0.39 cm3-H2O cm3-soil (HORIZN =4)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 4.0 cm (HORIZN = 2) 1 cm (HORIZN = 3,4)	
Field Capacity (THEFC)	0.44 cm3-H2O cm3-soil (HORIZN = 1, 2) 0.42 cm3-H2O cm3-soil (HORIZN = 3) 0.39 cm3-H2O cm3-soil (HORIZN = 4)	
Wilting Point (THEWP)	0.36 cm3-H2O cm3-soil (HORIZN = 1,2,3) 0.3 cm3-H2O cm3-soil (HORIZN = 4)	
Organic Carbon Content (OC)	1.77% (HORIZN = 1,2) 0.84% (HORIZN = 3,4)	

b. California Citrus (CAcitrus0C)

The field used to represent citrus production in California is located in Fresno County in the Central Valley, although citrus production areas are quite extensive (San Joaquin, Coastal-Intermediate Region, Imperial Valley, Coachella Valley, and the Southern Interior Region). According to the 1997 Census of Agriculture, California is the major producer of citrus (lemons and oranges) for the fresh market, and among the highest producers in other citrus (grapefruit, tangerines, tangelos, and mandarins). Citrus is generally grown on the foothills to avoid frost damage. Areas under and between rows of trees are generally non-cultivated/non-maintained. Row spacing is approximately 22 feet and between tree spacing is approximately 18 feet. Row canopies tend to be 100 percent, while the canopy between rows is less to permit the operation of maintenance and harvest equipment. Irrigation is mostly by low-volume drip or micro-sprinkler systems, although furrow and overhead sprinklers are also used. The soil selected to simulate the field is a benchmark soil, Exeter loam. Exeter loam, is a fine-loamy, mixed, superactive, thermic Typic Durixeralfs. These soils are often used for citrus production under irrigation. Exeter loam is a moderately deep, moderately well drained, and very slow to medium runoff soil that formed in alluvium mainly from granite sources. The soil also consists of a duripan. The Exeter loam has moderately slow permeability above the duripan and very slow permeability within the duripan. These soils are generally found on alluvial fans and stream terraces at elevations of up to 700 feet above mean sea level and have slopes of 0 to 9 percent. The soil is extensive in MLRA 17. Exeter loam is a Hydrologic Group C soil.

Table II.E.6-36 PRZM 3.12 Scenario Input Parameters for California Citrus

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.7	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.55 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	NRI - Average value listed for the soil series Exeter
USLE LS Factor (USLELS)	0.21	NRI - Average value listed for the soil series Exeter
USLE P Factor (USLEP)	1.0	NRI - Average value listed for the soil series Exeter
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)

Parameter	Value	Source
Slope (SLP)	5%	Mark Freeman, Fresno County Cooperative Extension Agent.
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	3	Mark Freeman, Fresno County Cooperative Extension Agent.
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for grass (EPA, 2001)
Maximum Active Root Depth (AMXDR)	60 cm	Mark Freeman, Fresno County Cooperative Extension Agent.
Maximum Canopy Coverage (COVMAX)	80	Mark Freeman, Fresno County Cooperative Extension Agent.
Soil Surface Condition After Harvest (ICNAH)	3	Mark Freeman, Fresno County Cooperative Extension Agent.
Date of Crop Emergence (EMD, EMM, IYREM)	02/01	Value set to a default evergreen cycle with no specific crop growth milestone such as flowering of fruit set.
Date of Crop Maturity (MAD, MAM, IYRMAT)	03/01	Value set to a default evergreen cycle with no specific crop growth milestone such as flowering of fruit set.
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/12	Value set to a default evergreen cycle with no specific crop growth milestone such as flowering of fruit set.
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table A.3, Meadows, no fallow conditions (USDA, 1990)
Manning’s N Value (MNGN)	0.023	RUSLE Project; D26CCCCM for cover alley citrus (USDA, 2000)

Parameter	Value	Source
USLE C Factor (USLEC)	0.096 - 0.150	RUSLE Project; Variable with date, D26CCCCM for cover alley citrus (USDA, 2000)
Exeter Soil Parameters		
Total Soil Depth (CORED)	183 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 173 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.59 g cm-3 (HORIZN = 1) 1.76 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.16 cm3-H2O cm3-soil (HORIZN =1) 0.2 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2)	
Field Capacity (THEFC)	0.16 cm3-H2O cm3-soil (HORIZN = 1) 0.2 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.06 cm3-H2O cm3-soil (HORIZN = 1) 0.11 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	0.46% (HORIZN = 1) 0.19% (HORIZN = 2)	

c. California Cotton (CAcotton0C)

The field used to represent cotton production in California is located in Fresno County in the Central Valley, although cotton production occurs throughout the Central Valley. According to the 1997 Census of Agriculture, California is the major producer of cotton in the U.S. Cotton is generally grown on the alluvial fans and basin rims by both dry and wet seeded methods. Row spacing and planting depths are consistent with other cotton growing regions of the U.S. Both standard (30-inch) and ultra-narrow (20-inch) row spacing are used. Irrigation is mostly by flooding. The soil selected to simulate the field is Twisselman clay. Twisselman clay is a fine, mixed, calcareous, thermic Typic Torriorthents. These soils are often used for cotton production under irrigation. Twisselman clay is a deep, well drained, slow to medium runoff, slowly permeable (very slow in saline-alkali phases) soil that formed in alluvium mainly from sedimentary rock sources. These soil are generally found on alluvial fans and basin rims at elevations of 200 to 1,000 feet above mean sea level and have slopes of 0 to 5 percent. The soil is of moderate extent. Twisselman clay is a Hydrologic Group C soil.

Table II.E.6-37 PRZM 3.12 Scenario Input Parameters for California Cotton

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.7	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.5 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.21 tons EI-1*	PRZM Input Collator (Burns, 1992) and FARM Manual (EPA, 1985)
USLE LS Factor (USLELS)	0.02	Haan and Barfield, 1979
USLE P Factor (USLEP)	1.0	PRZM Manual (EPA,1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	2.5%	Mid-point of soil series range (EPA, 2001)
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Kerry Arroues USDA_NRCS
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File -

Parameter	Value	Source
Maximum rainfall interception storage of crop (CINTCP)	0.2	PIC; confirmed using Table 5.4 from PRZM Manual (Burns, 1992 and EPA, 1985)
Maximum Active Root Depth (AMXDR)	65 cm	Kerry Arroues USDA_NRCS
Maximum Canopy Coverage (COVMAX)	100	Kerry Arroues USDA_NRCS
Soil Surface Condition After Harvest (ICNAH)	3	Kerry Arroues USDA_NRCS
Date of Crop Emergence (EMD, EMM, IYREM)	05/05	Usual Planting and Harvesting Dates for U.S. Field Crops (USDA, 1984)
Date of Crop Maturity (MAD, MAM, IYRMAT)	03/01	Usual Planting and Harvesting Dates for U.S. Field Crops (USDA, 1984)
Date of Crop Harvest (HAD, HAM, IYRHAR)	11/11	Usual Planting and Harvesting Dates for U.S. Field Crops (USDA, 1984)
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	89, 86, 87	Set to MS Cotton values. Field validated curve numbers.
Manning's N Value (MNGN)	0.023	RUSLE Project; C23CTCTC; Cotton, conventional tillage, Fresno (USDA, 2000)
USLE C Factor (USLEC)	0.54 - 0.412	RUSLE Project; C23CTCTC; Cotton, conventional tillage, Fresno, Variable with date (USDA, 2000)
Twisselman Soil Parameters		
Total Soil Depth (CORED)	100 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 26 cm (HORIZN = 2) 64 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/) Ed Russell (USDA_NRCS, Fresno)
Bulk Density (BD)	1.45 g cm-3 (HORIZN = 1) 1.5 g cm-3 (HORIZN = 2) 1.6 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.36 cm3-H2O cm3-soil (HORIZN =1,2) 0.317 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 2 cm (HORIZN =2,3)	
Field Capacity (THEFC)	0.36 cm3-H2O cm3-soil (HORIZN = 1,2) 0.317 cm3-H2O cm3-soil (HORIZN = 3)	

Parameter	Value	Source
Wilting Point (THEWP)	0.22 cm3-H2O cm3-soil (HORIZN = 1,2) 0.197 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	0.29% (HORIZN = 1,2) 0.174% (HORIZN = 3)	

d. California Fruit Trees (CAfruit0C)

The field used to represent non-citrus fruit production in California is located in Fresno County in the Central Valley, although non-citrus fruit production covers most of the central portion of the state, but mainly on Eastern slopes. According to the 1997 Census of Agriculture, California is the major producer of peaches, plums/prunes, and kiwi for the fresh market, and among the highest producers in other non-citrus fruit such as pears and apples. Areas under and between rows of trees may or may not be maintained depending on the location. Row spacing varies depending on the fruit tree (from approximately 15 to 25 feet) as does the tree spacing (approximately 12 to 20 or more feet). Row canopies tend to be very close to 100 percent, while the canopy between rows is much less to permit the operation of maintenance and harvest equipment. Irrigation is by furrow and flood for most crops, but low-volume drip or micro-sprinkler systems are growing in popularity. The soil selected to simulate the field is a benchmark soil, Exeter loam. Exeter loam is a fine-loamy, mixed, superactive, thermic Typic Durixeralfs. These soils are often used for citrus production under irrigation. Exeter loam is a moderately deep, moderately well drained, very slow to medium runoff soil that formed in alluvium mainly from granite sources. The soil also consists of a duripan. The Exeter loam has moderately slow permeability above the duripan and very slow permeability within the duripan. These soils are generally found on alluvial fans and stream terraces at elevations of up to 700 feet above mean sea level and have slopes of 0 to 9 percent. The soil is extensive in MLRA 17. Exeter loam is a Hydrologic Group C soil.

Table II.E.6-38 PRZM 3.12 Scenario Input Parameters for California Fruit trees

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.73	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Snowmelt Factor (SFAC)	0.0 cm C- 1	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		

Parameter	Value	Source
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.34 tons EI-1*	NRI - Average value listed for the soil series Exeter
USLE LS Factor (USLELS)	0.018	NRI - Average value listed for the soil series Exeter
USLE P Factor (USLEP)	1.0	NRI - Average value listed for the soil series Exeter
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	2	PRZM Manual Figure 5.12 (EPA, 1998); based on crops grown on Eastern side of slopes.
Slope (SLP)	9%	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Mark Freeman, Fresno County Cooperative Extension Agent.
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for grass (EPA, 2001)
Maximum Active Root Depth (AMXDR)	30 cm	Mark Freeman, Fresno County Cooperative Extension Agent.
Maximum Canopy Coverage (COVMAX)	90	Mark Freeman, Fresno County Cooperative Extension Agent.
Soil Surface Condition After Harvest (ICNAH)	3	Mark Freeman, Fresno County Cooperative Extension Agent.
Date of Crop Emergence (EMD, EMM, IYREM)	21/01	Value set to a dates for plums based on Health Effects Division information

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	21/06	Value set to a dates for plums based on Health Effects Division information
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/08	Value set to a dates for plums based on Health Effects Division information
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table A.3, Meadows, no fallow conditions (USDA, 1990)
Manning’s N Value (MNGN)	0.023	RUSLE Project; C21OCOCM for orchards, covered alley in Sacramento (USDA, 2000)
USLE C Factor (USLEC)	0.034 - 0.221	RUSLE Project; Variable with date, C21OCOCM for orchards, covered alley in Sacramento (USDA, 2000)
Exeter Soil Parameters		
Total Soil Depth (CORED)	183 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 173 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.59 g cm-3 (HORIZN = 1) 1.76 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.16 cm3-H2O cm3-soil (HORIZN =1) 0.2 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN = 2)	
Field Capacity (THEFC)	0.16 cm3-H2O cm3-soil (HORIZN = 1) 0.2 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.06 cm3-H2O cm3-soil (HORIZN = 1) 0.11 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	0.46% (HORIZN = 1) 0.19% (HORIZN = 2)	

e. California Grapes (CAgrapesC)

The field used to represent grape production in California is located in Southern San Joaquin Valley. According to the 1997 Census of Agriculture, California is the major producer of table, wine, and raisin grapes with 85 percent of California’s production in the San Joaquin Valley and the bulk of the remainder in the Coachella Valley. Grapes need at least 3 ft of well drained soil, and are typically grown on sandy or sandy loam soils. Vine rows are usually kept weed free, but there is some growth in the winter. Surface soil around the vine row is usually sealed, but some plants can grow between vine rows. The soil between rows is usually disked. Row spacing varies depending on the terrain. Canopies between rows tend to be much less than 100 percent, while the canopy along the rows is 100 percent. Irrigation is mainly by drip irrigation, but some vineyards continue to use sprinkler systems. The soil selected to simulate the field is a benchmark soil, San Joaquin loam. San Joaquin loam is a fine, mixed, active, thermic Abruptic Durixeralfs. These soils are often used for vineyards, fruit and nut production under irrigation. San Joaquin loam is a moderately deep, well and moderately well drained, medium to very high runoff soil that formed in alluvium mainly from granite sources. The soil also consists of a duripan. The San Joaquin loam has very slow permeability above the duripan and very slow permeability within the duripan. Some areas are subject to flooding. These soil are generally found on undulating terraces at elevations from 50 to 500 feet above mean sea level and have slopes of 0 to 9 percent. The soil is extensive in MLRA 17 along the Eastern slopes of the Sacramento and San Joaquin Valleys. San Joaquin loam is a Hydrologic Group C soil.

Table II.E.6-39 PRZM 3.12 Scenario Input Parameters for California Grapes

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.7	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.55 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.28 tons EI-1*	NRI - Average value listed for the soil series San Joaquin
USLE LS Factor (USLELS)	0.2	NRI - Average value listed for the soil series San Joaquin
USLE P Factor (USLEP)	1.0	NRI - Average value listed for the soil series San Joaquin
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998); based on crops grown on Eastern side of slopes.
Slope (SLP)	2%	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)

Parameter	Value	Source
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	3	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File
Maximum rainfall interception storage of crop (CINTCP)	0.25	Maximum recommended value for grass (EPA, 2001)
Maximum Active Root Depth (AMXDR)	100 cm	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Maximum Canopy Coverage (COVMAX)	70	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Soil Surface Condition After Harvest (ICNAH)	3	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Date of Crop Emergence (EMD, EMM, IYREM)	01/02	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Date of Crop Maturity (MAD, MAM, IYRMAT)	15/08	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/08	Paul Verdegaal, San Joaquin County Cooperative Extension 209_468_9494
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	84, 79, 82	Gleams Manual Table A.3, Meadows, no fallow conditions (USDA, 1990)
Manning's N Value (MNGN)	0.023	RUSLE Project; C21GBGBC for grapes, Sacramento, bare ground (USDA, 2000)
USLE C Factor (USLEC)	0.274 - 0.517	RUSLE Project; Variable with date, C21GBGBC for grapes, Sacramento, bare ground (USDA, 2000)
San Joaquin Soil Parameters		
Total Soil Depth (CORED)	340 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	

Parameter	Value	Source
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 330 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.84 g cm-3 (HORIZN = 1) 1.6 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.21 cm3-H2O cm3-soil (HORIZN =1) 0.28 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2)	
Field Capacity (THEFC)	0.21 cm3-H2O cm3-soil (HORIZN = 1) 0.28 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.1 cm3-H2O cm3-soil (HORIZN = 1) 0.15 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	0.72% (HORIZN = 1) 0.16% (HORIZN = 2)	

f. California Vegetables: Root & Bulb crops – Carrots (CAcarrot0CRA), Garlic (CAgarlic0CRA), Onion (CAonion0C)

These scenarios were adapted for the N-Methyl Carbamate cumulative assessment, using the weather, runoff, and soil parameters from the CA onion scenario, changing the scenarios to reflect crop-specific parameters for carrots and garlic. All parameters are the same for these scenarios, except where noted in the table below.

The field used to represent onion production in California is located in Kern County in the San Joaquin Valley, although onion production areas are quite extensive (San Joaquin, Coastal-Intermediate Region, Imperial Valley, southern and central coastal regions, the high desert areas of Los Angeles County and the northern mountain valleys). According to the 1997 Census of Agriculture, California is the major producer of onions for the market. Bulb onions are planted from September through May and harvesting begins in April or May and completed by September. Onions are cools season, biennial plants that are commercially grown as an annual. Most onions are direct seeded, but transplants are used in some fall planted fields for an earlier harvest of short-day and intermediate-day varieties and to achieve uniform, jumbo-sized bulbs. Seeds are planted uniformly at 2 to 3 inches between plants in a row. Onions are most commonly grown in multiple rows on raised beds 40 to 42 inches wide, but some production areas use 36-inch wide beds or beds of 60 to 80 inches. Distribution of rows across beds varies depending on irrigation method and planter. With drip and sprinkler irrigation (most common types), rows are spaced equidistant across the bed at approximately 4-inch intervals. When furrow irrigation is used, the center of the bed is left vacant for salt accumulation with 2 or 3 rows planted on either side. Plant canopy can approach 100 percent in some narrow row fields grown under drip irrigation. Irrigation is required to avoid seed or plant dry out. Generally 24 to 36 inches of irrigated water per year is sufficient. Onions can grow on a wide range of soils.

Garlic is grown in the desert valleys, central coast, and San Joaquin Valley of California. It is typically planted in the fall (mid-September through November) and matures in late spring in the desert valleys and mid-summer in the central coast and San Joaquin Valley (UC Davis, 1976, "*Growing Garlic in California*"). Garlic is generally ready to harvest one month after maturity.

California is the top carrot-producing state in the United States and the San Joaquin Valley / Kern County is the largest carrot-producing region in the state, accounting for 75% of acreage (USDA Crop Profile for Carrots in California). Carrots may be planted in December to March or in July to September. Harvest dates are from May to July for the winter planting and from November to February for the late summer planting.

The soil selected to represent the field is Ciervo clay. Ciervo clay, is a fine, semetic, thermic Vertic Haplocambids. These soils are often used for onion and other truck crop production under irrigation. Ciervo clay is a very deep, moderately well drained, medium to high runoff soil on fan skirts that formed in alluvium mainly from sedimentary rocks at elevation of 170 to 735 feet above mean sea level. The Ciervo clay has very slow permeability. Slopes range from 0 to 2 percent. The soil is of large extent in MLRA 17. Ciervo clay is a Hydrologic Group D soil.

Table II.E.6-40 PRZM 3.12 Scenario Input Parameters for California Bulb and Root Crops

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.7	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.55 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.21 tons EI-1*	PRZM Input Collator (Burns, 1992) and FARM Manual (EPA, 1985)
USLE LS Factor (USLELS)	0.303	Haan and Barfield, 1979

Parameter	Value	Source
USLE P Factor (USLEP)	0.5	PRZM Manual (EPA, 1998)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	1%	Mid-point of the Soil Series, Ciervo
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Default
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File
Maximum rainfall interception storage of crop (CINTCP)	0.05	PRZM Input Collator (Burns, 1992)
Maximum Active Root Depth (AMXDR)	30 cm (onion)	Voss, R.E. Fresh Market Bulb Onion Production in California. U. of CA Publication 7242. 1999.
	45 cm (garlic)	Rooting depth averages 18-24 inches (USDA crop profile for Garlic in CA)
	35 cm (carrot)	Confirmed by R.E. Voss UC Publ 7242
Maximum Canopy Coverage (COVMAX)	80	Estimated based on aerial photography
Soil Surface Condition After Harvest (ICNAH)	1	Voss, R.E. 1999. Fresh Market Bulb Onion Production in California. U. fo CA Publication 7242.
Date of Crop Emergence (EMD, EMM, IYREM)	11/01 (0nion)	PIC Recommended dates adjusted according to RUSLE Project planting dates.
	01/10 (Garlic)	Garlic typically planted mid-Sept through Nov (USDA Crop Profile, 2004)
	01/08 (Carrot)	Based on Jul-Sep planting window; also planted Dec-Mar (USDA Crop Profile)

Parameter	Value	Source
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/06 (Onion)	PIC Recommended dates adjusted according to RUSLE Project planting dates.
	01/06 (Onion)	Garlic bulbs mature in late spring in desert valleys, midsummer in central coast, San Joaquin Valley (UC Davis, Growing Garlic in CA, 1976)
	01/11 (Carrot)	Maturity set to coincide with harvest window (2 weeks between)
Date of Crop Harvest (HAD, HAM, IYRHAR)	15/06 (Onion)	PIC Recommended dates adjusted according to RUSLE Project planting dates.
	01/07 (Garlic)	Typical harvest dates July-Sep (WA crop profile); generally ready to harvest 1 mo after maturity (CA crop profile)
	15/11 (Carrot)	Nov-Feb harvest window for winter planting; also May-Jul harvest (USDA Crop Profile)
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation
SCS Curve Number (CN)	92, 85, 86	Gleams Manual Table A.3, Meadows, no fallow conditions (USDA, 1990)
Manning’s N Value (MNGN)	0.011	RUSLE Project; C23ONONC; Onions, Fresno CA Conventional Tillage (USDA, 2000)
USLE C Factor (USLEC)	0.521 - 0.732	RUSLE Project; C23ONONC; Onions, Fresno CA Conventional Tillage (USDA, 2000)
Ciervo Soil Parameters		
Total Soil Depth (CORED)	150 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Base horizons)	
Horizon Thickness (THKNS)	12 cm (HORIZN = 1) 50 cm (HORIZN = 2) 88 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.40 g cm-3 (HORIZN = 1) 1.36 g cm-3 (HORIZN = 2) 1.17 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.259 cm3-H2O cm3-soil (HORIZN =1) 0.266 cm3-H2O cm3-soil (HORIZN =2) 0.345 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2) 2.0 cm (HORIZN = 3)	

Parameter	Value	Source
Field Capacity (THEFC)	0.259 cm3-H2O cm3-soil (HORIZN =1) 0.266 cm3-H2O cm3-soil (HORIZN =2) 0.345 cm3-H2O cm3-soil (HORIZN =3)	
Wilting Point (THEWP)	0.15 cm3-H2O cm3-soil (HORIZN = 1) 0.158 cm3-H2O cm3-soil (HORIZN = 2) 0.202 cm3-H2O cm3-soil (HORIZN = 3)	
Organic Carbon Content (OC)	0.91% (HORIZN = 1) 0.43% (HORIZN = 2) 0.32% (HORIZN = 3)	

g. California Sugar Beets (CAsugarbeet0C)

The field used to represent sugar beet production in California is located in the Central Valley, although sugar beet production covers diverse climates. The major production areas are in the Klamath Basin and Imperial Valley. According to 1997 Census of Agriculture, California ranked 4th among producers of sugar beets in the U.S. Sugar beets are planted almost every month somewhere in the state and are generally grown in rotation. Production is concentrated on heavy clay and clay loam soil and is irrigated by both furrow and sprinkler systems. Areas between rows of plants may or may not be maintained. Row spacing is generally 30-inches. Row canopies tend to be very close to 100 percent, while the canopy between rows is much less. The soil selected to simulate the field is a benchmark soil, Exeter loam. Exeter loam is a fine-loamy, mixed, superactive, thermic Typic Durixeralfs. These soils are often used for citrus production under irrigation. Exeter loam is a moderately deep, moderately well drained, and very slow to medium runoff soil that formed in alluvium mainly from granite sources. The soil also consists of a duripan. The Exeter loam has moderately slow permeability above the duripan and very slow permeability within the duripan. These soil are generally found on alluvial fans and stream terraces at elevations of up to 700 feet above mean sea level and have slopes of 0 to 9 percent. The soil is extensive in MLRA 17. Exeter loam is a Hydrologic Group C soil.

Table II.E.6-41 PRZM 3.12 Scenario Input Parameters for California Sugar Beets

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.75	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County

Parameter	Value	Source
Snowmelt Factor (SFAC)	0.0 cm C- 1	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.34 tons EI-1*	FARM Manual, Table A3 (EPA, 1985)
USLE LS Factor (USLELS)	0.0054	Haan and Barfield, 1979
USLE P Factor (USLEP)	1.0	Per QA/QC Guidance (EPA, 2001)
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998); based on crops grown on Eastern side of slopes.
Slope (SLP)	2%	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File
Maximum rainfall interception storage of crop (CINTCP)	0.25	PRZM, Table 5.4 (EPA, 1998)
Maximum Active Root Depth (AMXDR)	90 cm	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Maximum Canopy Coverage (COVMAX)	100	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County

Parameter	Value	Source
Soil Surface Condition After Harvest (ICNAH)	1	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Date of Crop Emergence (EMD, EMM, IYREM)	01/02	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Date of Crop Maturity (MAD, MAM, IYRMAT)	31/05	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/08	Kurt Hembree (559.456.7556), UC Cooperative Extension Office, Fresno County
Maximum Dry Weight (WFMAX)	0.0	Set to "0" Not used in simulation
SCS Curve Number (CN)	89, 86, 87	Gleams Manual Table A.3, Fallow SR/CT/poor, Cropping and Residue = Row Crop SR/CT/poor (USDA, 1990)
Manning's N Value (MNGN)	0.014	RUSLE Project; C21SUSUC Sacramento climate station, Conventional tillage, no cover (USDA, 2000)
USLE C Factor (USLEC)	0.015 - 0.769	RUSLE Project; Variable with date, C21SUSUCSacramento climate station, Conventional tillage, no cover (USDA, 2000)
Exeter Soil Parameters		
Total Soil Depth (CORED)	183 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	2 (Base horizons)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 173 cm (HORIZN = 2)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/)
Bulk Density (BD)	1.59 g cm-3 (HORIZN = 1) 1.76 g cm-3 (HORIZN = 2)	
Initial Water Content (THETO)	0.16 cm3-H2O cm3-soil (HORIZN =1) 0.2 cm3-H2O cm3-soil (HORIZN =2)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2)	
Field Capacity (THEFC)	0.16 cm3-H2O cm3-soil (HORIZN = 1) 0.2 cm3-H2O cm3-soil (HORIZN = 2)	
Wilting Point (THEWP)	0.06 cm3-H2O cm3-soil (HORIZN = 1) 0.11 cm3-H2O cm3-soil (HORIZN = 2)	
Organic Carbon Content (OC)	0.46% (HORIZN = 1) 0.19% (HORIZN = 2)	

h. California Vegetables: Other crops – Tomato (CAtomato0C), Broccoli/cole crops (CAbroccoliCVcra)

The field used to represent tomato production in California is located in San Joaquin County in the Central Valley, although tomatoes are produced throughout the Central Valley and Imperial Valley. According to the 1997 Census of Agriculture, California is ranked second in the U.S. in production; 45 percent of California's production is in Stanislaus and Merced Counties. Tomatoes are generally grown on raised beds 60-66 inches wide. Most tomato plants are from transplants grown in nurseries. Row spacing is approximately 30 to 45 inches and plants are grown close together within rows. Spaces between rows are generally kept clear, but plants often grow into these areas. The scenario has been adapted for other crops grown in the same area on the same soil by changing the crop-specific inputs as necessary. While broccoli is grown in the San Joaquin Valley, primary production is in the coastal regions. All parameters are the same for these scenarios, except where noted in the table below.

The soil selected to simulate the field is Stockton clay. Stockton clay is a fine, semectitic, thermic Xeric Epiaquerts. These soils are often used for tomato production under irrigation, but also for other row crops such as corn, beans, sugar beets, and grains. Stockton clay is a deep, somewhat poorly drained, slowly permeable, very slow to slow runoff soil that formed in alluvium of mixed igneous and sedimentary rock sources. These soils are generally found in basins and in swales of drainage ways. They are located at elevation of 0 to 100 feet above mean sea level and have slopes of 0 to 2 percent. The soil is of moderate extent. Stockton clay is a Hydrologic Group D soil.

Table II.E.6-42 PRZM 3.12 Scenario Input Parameters for California Tomato/ Cole crops

Parameter	Value	Source
Starting Date	January 1, 1961	Meteorological File - Sacramento, CA (W23232)
Ending Date	December 31, 1990	Meteorological File - Sacramento, CA (W23232)
Pan Evaporation Factor (PFAC)	0.7	PRZM Manual Figure 5.1 (EPA, 1998)
Snowmelt Factor (SFAC)	0.55 cm C- 1	PRZM Manual Table 5.1 (EPA, 1998)
Minimum Depth of Evaporation (ANETD)	17.0 cm	PRZM Manual Figure 5.2 (EPA, 1998)
Erosion and Landscape Parameters		
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.24 tons EI-1*	NRI - Average value listed for the soil series Stockton
USLE LS Factor (USLELS)	0.26	NRI - Average value listed for the soil series Stockton
USLE P Factor (USLEP)	1.0	NRI - Average value listed for the soil series Stockton

Parameter	Value	Source
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	1	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	0.25%	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
Hydraulic Length (HL)	464 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Based on current EPA guidance (2004)
Irrigation Type (IRTYP)	Not applicable	Based on current EPA guidance (2004)
Leaching Factor (FLEACH)	Not applicable	Based on current EPA guidance (2004)
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	Not applicable	Based on current EPA guidance (2004)
Maximum Rate at which Irrigation is Applied (RATEAP)	Not applicable	Based on current EPA guidance (2004)
Crop Parameters		
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2001)
Initial Surface Condition (ISCOND)	1	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
Number of Different Crops (NDC)	1	Set to crops in simulation - generally one
Number of Cropping Periods (NCPDS)	30	Set to weather data. Meteorological File
Maximum rainfall interception storage of crop (CINTCP)	0.1	PIC; confirmed using Table 5.4 from PRZM Manual (Burns, 1992 and EPA, 1985)
Maximum Active Root Depth (AMXDR)	90 cm (Tomato)	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
	30 cm (Broccoli/Cole)	Most roots in the top 3 feet
Maximum Canopy Coverage (COVMAX)	90	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
Soil Surface Condition After Harvest (ICNAH)	1	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
Date of Crop Emergence (EMD, EMM, IYREM)	01/03 (Tomato)	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
	01/08 (Broccoli/Cole)	Typical planting for SJV (USDA Crop Profile)
Date of Crop Maturity (MAD, MAM, IYRMAT)	01/07 (Tomato)	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
	20/10 (Broccoli/Cole)	Based on USDA crop profile
Date of Crop Harvest (HAD, HAM, IYRHAR)	01/09 (Tomato)	Bob Mullen, San Joaquin County Cooperative Extension. 209_468_9489
	30/10 (Broccoli/Cole)	Based on USDA crop profile
Maximum Dry Weight (WFMAX)	0.0	Set to “0" Not used in simulation

Parameter	Value	Source
SCS Curve Number (CN)	91, 87, 88	Gleams Manual Table A.3, Fallow = Fallow, SR/ poor; Cropping and Residue = Row Crops SR/poor condition
Manning's N Value (MNGN)	0.023	RUSLE Project; C23BDCGC for dry beans, 2000 lb, Fresno (USDA, 2000)
USLE C Factor (USLEC)	0.035- 0.255	RUSLE Project; C23BDCGC for dry beans, 2000 lb, Fresno Variable with date (USDA, 2000)
Stockton Soil Parameters		
Total Soil Depth (CORED)	180 cm	NRCS, National Soils Characterization Database (NRCS, 2001)
Number of Horizons (NHORIZ)	3 (Top horizon split in two)	
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 8 cm (HORIZN = 2) 162 cm (HORIZN = 3)	NRCS, National Soils Characterization Database (NRCS, 2001) http://www.statlab.iastate.edu/soils/ssl/) Ed Russell (USDA_NRCS, Fresno)
Bulk Density (BD)	1.3 g cm-3 (HORIZN = 1,2) 1.4 g cm-3 (HORIZN = 3)	
Initial Water Content (THETO)	0.38 cm3-H2O cm3-soil (HORIZN =1,2) 0.25 cm3-H2O cm3-soil (HORIZN =3)	
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1 cm (HORIZN =2) 2 cm (HORIZN = 3)	
Field Capacity (THEFC)	0.38 cm3-H2O cm3-soil (HORIZN = 1,2) 0.25 cm3-H2O cm3-soil (HORIZN = 3)	
Wilting Point (THEWP)	0.25 cm3-H2O cm3-soil (HORIZN = 1,2,3)	
Organic Carbon Content (OC)	0.95% (HORIZN = 1,2) 0.4% (HORIZN = 3)	

Appendix E-7 NMC Ground Water Exposure Assessment Methods

This appendix provides details on the ground water exposure assessment conducted in support of the N-methyl carbamate (NMC) cumulative exposure assessment. A description of the overall conceptual model for drinking water exposure and a summary of the analytical plan and results are found in Section I.E. This appendix focuses on updates to the conceptual model, analytical methods, and ground water exposure scenarios as a result of two FIFRA Scientific Advisory Panel (SAP) meetings in February and August of 2005 (FIFRA SAP, 2005a and 2005b). Details of the resulting exposure time series (chemographs), comparisons to available monitoring, identification of the extent of areas with the potential for high NMC exposures, and the modeling inputs and scenarios supporting the NMC cumulative ground water exposures estimates are documented.

Changes in the ground water exposure assessment since the preliminary NMC CRA include:

- Revised depth of ground water in shallow drinking water wells from 3.5 m (12 feet) to 9 m (30 feet)
- Selection of PRZM for exposure modeling
- Additional scenarios to represent other NMC uses in Florida, the southeastern coastal plain, and the Delmarva peninsula
- Additional comparisons of modeling results with monitoring for both model revisions and for characterization
- Expanded spatial characterization of areas with potential for high exposure from NMC

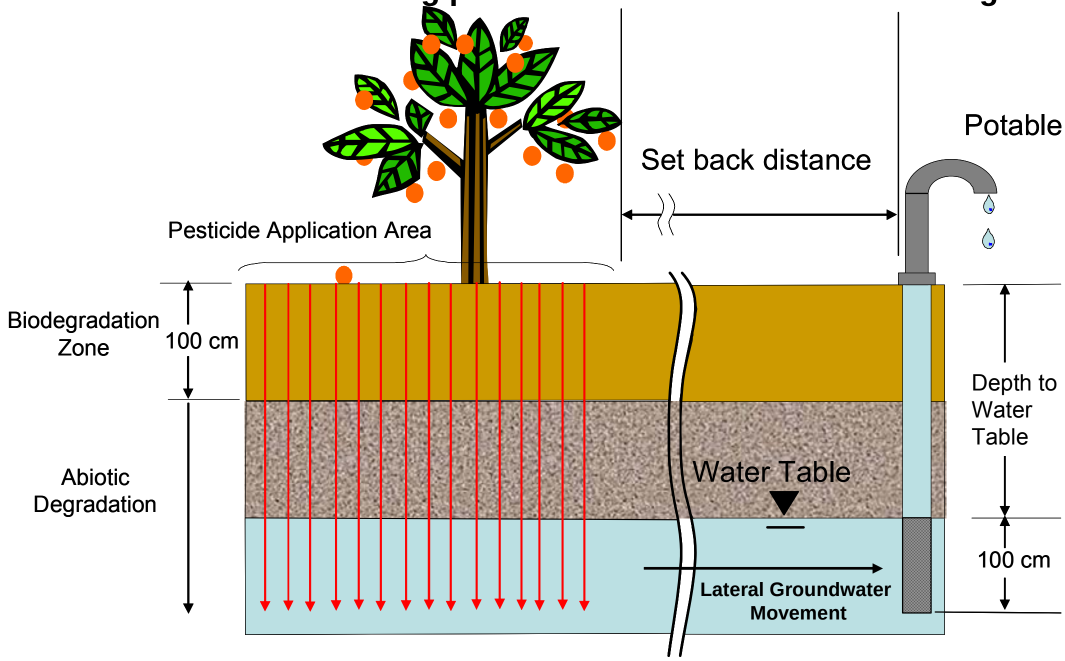
1. Conceptual Model

For ground water exposure, the Agency focused on vulnerable ground water supplies. Vulnerable ground water supplies were defined as

- private wells (generally undergo no treatment)
- the wells extended through a permeable soil and vadose zone to a shallow, unconfined aquifer
- in areas with high NMC use, taking into account relative potency and likelihood of the pesticide to leach

Figure II.E.7.1 illustrates the conceptual model for groundwater exposure which evolved from the advice of the two FIFRA SAPs (2005a and 2005b). The SAP considered this to be a reasonable representation of a potentially vulnerable ground water scenario. In this conceptualization, the pesticide is applied to the soil surface (or plant canopy) and precipitation or irrigation drives the pesticide through the soil profile and into a saturated zone. The saturated zone represents a shallow surficial aquifer with a water table depth based on the particular scenario, likely 3 to 20 meters below the surface. Well screen length is set at one meter and starts at the water table. The well depth and screen location provides a protective, but reasonable representation of an actual well.

Figure II.E.7- 3 - Depiction of general ground water scenario concept used for estimating pesticide concentrations in drinking water.



Transport processes are simulated with the Pesticide Root Zone Model (PRZM). In the earlier case study and preliminary assessment provided to the FIFRA SAP, the Agency compared the capabilities of three leaching models – PRZM, RZWQM, and LEACHP—for estimating ground water concentrations. While all three provided similar long-term average concentration estimates for highly-permeable sandy soils, short-term differences were evident (FIFRA SAP, 2005b). Based upon comparisons of model performance, functionality, and ease of use, the Agency chose PRZM to estimate ground water exposure concentrations in this revised assessment. Details on the model comparisons can be found in the preliminary assessment submitted to the August 2005 FIFRA SAP (US EPA, 2005b).

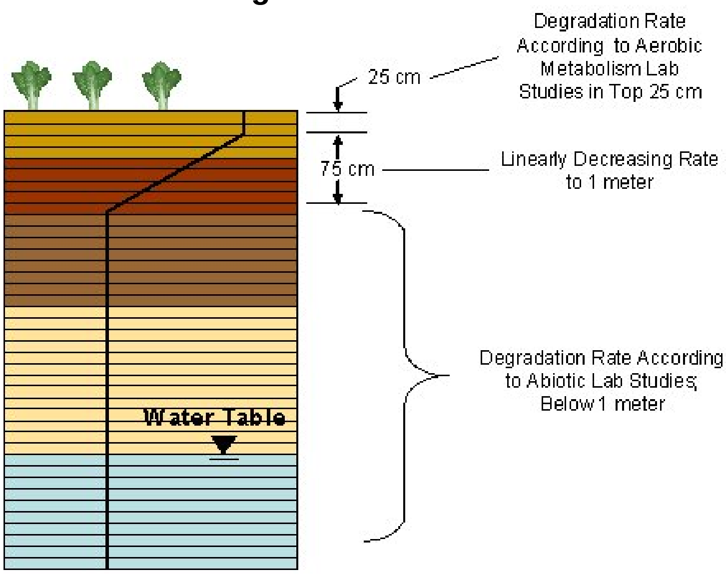
In the preliminary assessment, the Agency simulated a shallow unconfined aquifer with a water table at 3.5 m below the surface, with a well screen extending an additional 1 m below the water table to 4.5 m. This depth ensured both conservativeness in the assessment and acceptable runtimes in the models. Since then, the Agency has looked for additional data on depths to aquifers serving as private drinking water sources and depths of private wells. While such information is not readily available, sources ranging from USGS NAWQA (Berndt et al, 1998; McPherson et al, 2000) and ground water atlases (USGS, 1990) to FL water management districts suggest that 30- to 50-feet might be a more suitable depth for shallow ground water supplying private wells in FL. A subsequent monitoring study by Bayer CropScience further support the 30-50 depth to ground water as a reasonable shallow limit for private wells in

NMC use areas (USEPA, 2007a). Therefore, this revised assessment estimates NMC concentrations at a 30-foot (approximately 9 m) depth.

The well concentration is the average pore water concentration across the length of the screen. PRZM was set up to deliver the average pore water concentration in the 'saturated' soil profile in the upper meter of the ground water zone.

The modes and rates of degradation for the parent chemical (or combined toxic residues) change through the soil profile, with faster degradation in the surface 25 cm, decreasing with depth. Consistent with Health Canada and the European FOCUS group, the Agency used the pesticide aerobic soil metabolism rate for the top 25 cm, linearly decreasing the rate with depth to 1 m. Below that depth, only abiotic processes were assumed to be in effect (Figure II.E.7.2). While this can be adjusted for pesticides that behave differently than this default concept, the NMC pesticides followed this pattern.

Figure II.E.7- 4 - Conceptual model illustrating pesticide degradation through the soil and vadose zone.



For those pesticides with well setback requirements (Figure II.E.7.1), the Agency used a plug flow model to simulate the additional travel time for a pesticide to reach a drinking water well from point of application. The pesticide was degraded by abiotic processes (typically hydrolysis) during that additional travel time. For the NMC group, only aldicarb had well setback requirements on its label.

Co-occurrence of NMC residues in ground water is likely to be more localized – at a field-scale – than for surface water. Co-occurrence will result when more than one NMC pesticide is used at different times on the same crop, on different crops in rotation on the same fields, or on different crops grown on adjacent fields. Because of lags in travel time and in reported persistence of some NMC residues in ground water, EPA modeled multiple NMC uses on a crop at the same ratio of pounds used as that reported in the usage summary for the region (Section II.E.7.B.5).

2. Analysis Plan for Estimating NMC Concentrations in Ground Water

The Agency used the Pesticide Root Zone Model (PRZM) 3.12.2 to simulate pesticide leaching through the soil and vadose zone to ground water. This version was used because of its capability of simulating irrigated scenarios. Details of the model evaluation and calibration can be found in the preliminary NMC CRA (US EPA, 2005b). In comparison to the other leaching models EPA considered, PRZM is relatively simple, more stable numerically, and faster running (US EPA, 2005a). This section provides a brief synopsis of the model set-up for the conceptual model, scenario selection and development, and the methods the Agency used to generate cumulative NMC exposure estimates.

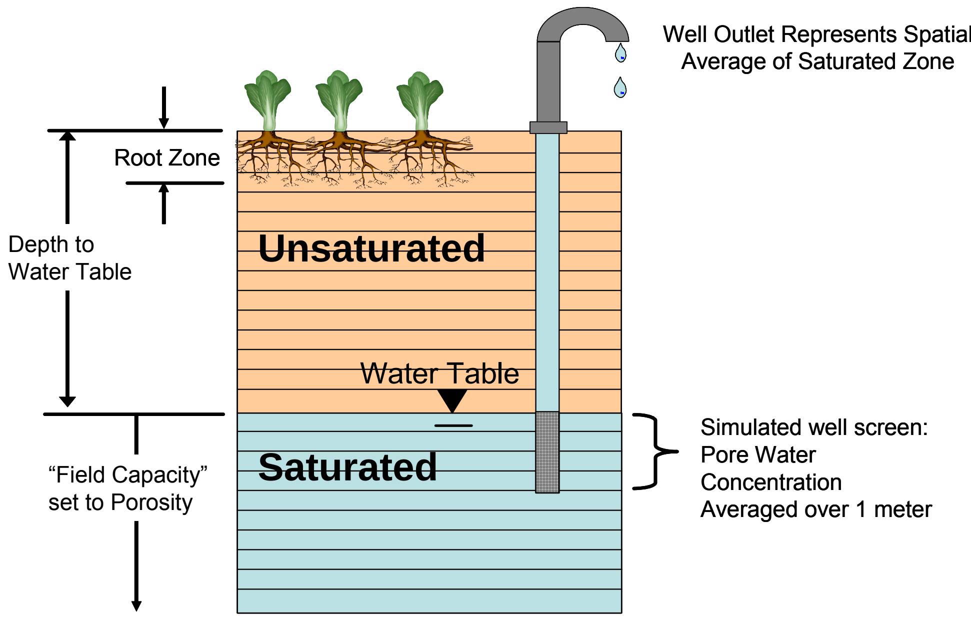
a. PRZM Model Implementation

PRZM simulates solute transport from the soil surface through the root zone and into the vadose zone. Although PRZM was not originally developed to simulate saturated conditions of a water table, saturated conditions can effectively be simulated by redefining the field capacity parameter. Since PRZM maintains water in soil compartments at “field capacity” unless losses occur by evapotranspiration, a saturated zone can be created below the root zone by setting the PRZM field capacity parameter (THEFC) equal to the soil porosity. This creates a constant water table at that depth.

PRZM simulated leaching through the the root zone and underlying vadose zone into the saturated zone (Figure II.E.7.3). The depth of leaching extended beyond the lowest depth for which the USDA NRCS measures and records soil properties. For the zone between the bottom of the root zone and the water table, the Agency extended the properties of the deepest soil horizon for which data were available.

Output concentrations represent the spatial average over the depth from the top of the saturated zone to 1 meter below the water table. Depending on the depth to the saturated zone, rainfall and evapotranspiration characteristics of the particular scenario, this spatial average effectively represents a temporal average ranging from six months (at 12 feet in the most permeable soils in FL and the southeast Coastal Plain) to more than one year.

Figure II.E.7- 5 - PRZM scenario for a fixed water table by setting field capacity to porosity to simulate a saturated zone.



Irrigation may be an important contributor to vertical pesticide transport and may be the dominant water source in some scenarios. Thus appropriate handling of irrigation is crucial. PRZM can appropriately handle irrigation applied either above the canopy or beneath the canopy. Irrigation simulation guidance in the PRZM manual may be inappropriate for deeply rooted plants such as orchard trees. PRZM attempts to satisfy water demand to the bottom of the root zone whereas, in reality, water demand would only be satisfied to several centimeters depth. Thus too much irrigation would occur unless preventative measures are taken. Because the quantity of irrigation water is coupled to root zone depth in PRZM, rooting depths were set to irrigation depths rather than actual rooting depths.

The size of the increments used for vertical spatial discretization in PRZM must be standardized because PRZM uses backwards spatial differencing for the pesticide transport finite differencing. Although this method is superior for eliminating oscillation at boundaries, it produces high amounts of numerical dispersion. Dispersion (whether numerical or explicitly modeled) affects pesticide concentrations where the degradation zone is limited over a short distance, as it is in this conceptual model. In these cases, dispersion will quickly remove pesticide from the degradation zone into areas of low or no degradation. Higher dispersion results in higher pesticide concentrations, opposite of what would be expected for a conservative non-degrading tracer (see Boesten, 2004, for examples).

Dispersion is often characterized by dispersivity, which relates pore water velocity to a dispersion coefficient, illustrated by the equation

$$D = \alpha v$$

where D is the dispersion coefficient

v is the velocity
α is the dispersivity.

In finite difference methods, backward differencing of the velocity term results in a numerical dispersion with dispersivity effectively equal to $\Delta x/2$. Thus if the desired dispersivity is known, the spatial discretization could be set to approximate it (note that the spatial component only addresses part of the numerical dispersion in PRZM). A review of vertical transport and dispersivity in agricultural-type soils shows considerable variability. Yasuda et al. (1994) reported dispersivities ranging from 0.1 to 1.5 meters at depths from 0.1 to 4 meters below surface. A preliminary EPA review of prospective ground water (PGW) monitoring studies using bromide shows dispersivities ranging from 1 to 45 cm. Costa and Prunty (2005) reported relatively small dispersivities on the order of 1 to 3.5 cm. The best approximation of dispersivity at this point appears to be around 5 cm, which is not a radical departure from the values suggested by Health Canada and Boesten (2004). Thus if spatial discretization is set at 5 cm, a dispersivity of 2.5 cm will result from the velocity component. Additional effective dispersivity will result from the temporal component depending upon rainfall.

b. Well Setbacks

In some cases, federal or state labels require well setbacks, specifying the nearest distance to a well that a pesticide can be applied. The setback distances result in additional travel time for the chemical to move laterally to the well, resulting in additional degradation over time. Reductions in concentration are calculated in these assessments by a plug flow approximation:

$$\frac{C}{C_0} = \exp\left(-\frac{L}{v}k\right)$$

where C = concentration at well [mass/volume]
C_0= concentration at point of application [mass/vol]
L = well setback distance [length]
v = lateral groundwater velocity [length/time]
k = degradation rate in aquifer [$time^{-1}$]

The travel time of the groundwater used in these scenarios is much shorter (faster) than travel time would be if only the pumping draw of a private drinking well was considered. EPA made conservative estimates regarding natural, groundwater lateral velocities. As an example, consider the travel time through a setback for unretarded chemicals without regard to additional head induced by well pumping, estimated by

$$t_n = \frac{r}{v}$$

where r = setback radius
v = natural lateral groundwater velocity
t_n = travel time of unretarded solute due to natural gradient

The travel time of an unretarded chemical when only well-induced flow is considered (see for example USEPA 1993) is determined by the following equation:

$$t_w = \frac{r^2 \pi \theta L_s}{Q}$$

where θ= aquifer porosity
L_s= screened length of well
Q = flow rate
t_w = travel time of unretarded solute

For setback estimations, EPA assumed a typical high-end lateral velocity of 0.15 m/day, as reported by Jones et al. (1987) for the Central Ridge of Florida. In a similar area, Paramasivam et al. (1999) reported velocities of 0.09 to 0.27 m/day. For a 50-ft setback, travel time is about 100 days due to the natural topographic gradient (elevation head). To determine the well-induced travel time, EPA used an American Water Works Association estimate that a typical family uses 101 gallons per day (0.28 m^3/day), a 1-m screened well, and a porosity of 30%. For a 50 foot setback, the well-induced travel time is 570 days, 57 times longer than the natural gradient travel time. For 1000-foot setbacks, the well-induced travel time is more than 100 times longer than the natural gradient travel time. Thus EPA neglected the velocity effects caused by private rural wells because of their insignificance. Depending on crop water needs, irrigation wells, however, could have an impact (FIFRA SAP, 2005b), but EPA has no information on the likelihood of such a scenario at this time.

Table II.E.7.1 provides estimated travel times and concentration reduction factors for varying well setback distances. The reduction factors are based on first-order degradation due to hydrolysis during the travel time. For the ground water exposure assessment, EPA used the reduction factor associated with the corresponding well-setback distance on the aldicarb label (1000 ft for citrus in FL; 300 ft for other crops in FL and in the southeastern coastal plain). Because none of the other NMC pesticides specified well setback distances on the label, reduction factors were not applied to those estimated concentrations.

Table II.E.7-1 Travel time and concentration reduction factors for varying well setback distances for aldicarb (based on 500-day half-life for hydrolysis @ pH5).

Setback distance (ft)	Travel time (da)	Reduction factor
50	102	0.869
100	203	0.754
200	407	0.569

300	610	0.429
400	813	0.324
500	1016	0.244
600	1220	0.184
700	1423	0.139
800	1626	0.105
900	1829	0.079
1000	2033	0.060

.

c. Scenario Selection and Development

The potential for NMC pesticides to reach ground water sources of drinking water depends on a variety of factors, including pesticide usage; physical, chemical, and hydrologic properties of the overlying soil and vadose zone that affect downward movement of water and chemicals; climate; and irrigation management practices that affect the amount of water potentially moving through the vadose zone. These factors may vary geographically and cause certain wells in one region to be more vulnerable than those in another region.

For the cumulative assessment, EPA focused first on areas with high potential NMC exposure in drinking water sources. GIS tools facilitated identifying potential high exposure scenarios by overlaying high carbamate use areas (adjusted for relative potencies) with counties for which the dominant source of drinking water is from ground water (see the Analysis Plan in Section I.E).

In the revised NMC CRA, the Agency defined areas with high potential for exposure from ground water sources of drinking water according to the following criteria:

- **Relatively high NMC use**: both total NMC use by county and relative potency-adjusted NMC use were considered; for ground water sources, EPA also looked at the areas with the highest aldicarb and carbofuran uses because both pesticides had a history of ground-water contamination;

- **Ground water source of drinking water**: EPA used the USGS report on water use in the U.S. (USGS, 1998, 1999) to identify the drinking water sources (public ground water, domestic private) by county, focusing on counties where >50% of the population (or, >20,000 people) get their water from domestic sources (dominantly private wells);

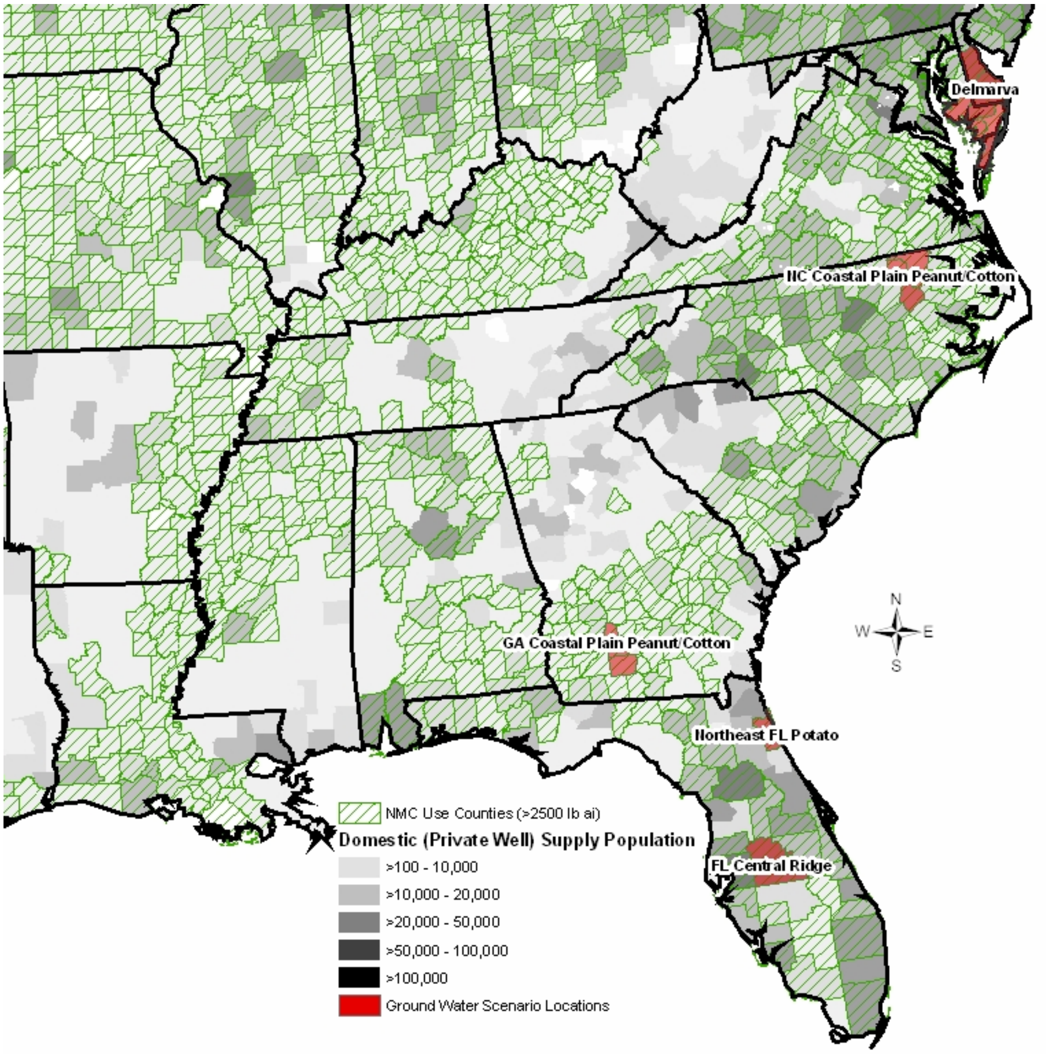
- **High leaching potential**: defined by areas where soils (using USDA SSURGO county soil survey data retrieved from the Soil Data Mart) rated as having a high leaching potential. EPA also considered depth to unconfined aquifer from a number of sources, including USGS NAWQA reports and Ground Water Atlases.

Because the NMC pesticides generally hydrolyze more rapidly under alkaline conditions than under acidic conditions, EPA also considered available information on the pH of the soil, vadose zone, and aquifer. Areas with the highest potential for high NMC exposures in shallow wells occur primarily in the southeastern US, in the Coastal Plain and Florida. Other areas with a dominance of high leaching potential soils either have low NMC use or are located in parts of the country where one or more NMC is no longer used because of groundwater concerns.

EPA developed six scenarios to represent high leaching potential areas (Figure II.E.7.4) in areas of relatively high NMC use. These groundwater scenarios for the NMC CRA represent high leaching potential soils under:

- Florida Central Ridge
- Northeastern Florida
- Coastal plain of Georgia, representing SC, GA, AL, and northern FL
- Coastal plain of North Carolina, representing NC and VA
- Delmarva peninsula
- Central Washington

Figure II.E.7. 6 - Location of ground water scenarios (red showing counties) in the southeastern US.



The Agency developed the scenarios using a consistent protocol in selecting soil characteristics, meteorological, and crop management practices. Where crops were likely to be grown on multiple soils in a region, the most vulnerable of the likely soils were chosen, as characterized by the soils hydrologic group, hydraulic conductivity and organic matter content. Soil properties were taken from the Soils Data Mart (http://soildatamart.nrcs.usda.gov/) and transformed into appropriate input parameters for each of the models.

Weather inputs represent the weather recorded at meteorological stations in closest proximity to the scenario location. These stations recorded 30 years of historical data, obtained from the EPA Office of Research and Development (http://www.epa.gov/ceampubl/tools/metdata/index.htm).

The model incorporated inputs for those specific management practices that were most likely to affect pesticide transport – pesticide application method and the application of irrigation water. Variations in tillage practices were ignored in the development of these scenarios, as characterization and parameterization of such practices are difficult and would be speculative. Irrigation and pesticide application practices were developed for the scenarios after consultation with agricultural extension agents, review of open literature, and pesticide label information.

The characteristics of each scenario are described below. The specific inputs for each scenario are provided in last section of this appendix.

i. Florida Citrus (Central Ridge)

Citrus is the dominant crop on which NMCs are used in this region. Most citrus production occurs on Florida's Central Ridge. Polk County, typical of the Ridge, has the highest acreage (101,000 acres in 2000) in citrus production in Florida (Obreza and Collins 2002). Groundwater in this region is particularly vulnerable to pesticide contamination due to the high water table and sandy soils with low organic matter content. The Polk County area includes several ground water studies (e.g., Jones et al. 1987; Hornsby et al., 1990, FL DEP 2005, USGS 2006), which allowed evaluation of the scenario modeling performance.

Soils: Citrus grows in Entisols on the Florida Central Ridge. Typical soils used for citrus production in Polk County are Candler, Tavares, and Astatula (Obreza and Collins, 2002). These soils are predominantly sandy with a low organic matter content and high permeability (Table II.E.7.2). These soils are all in the Hydrologic Group A, indicating negligible runoff.

Table II.E.7-2 Soil properties for the Chandler, Tavares, and Astatula series in Polk County, FL (USDA Soil Data Mart).

Soil Series	Depth (cm)	Org. matter 1 (%)	Sand 1 (%)	Clay1 (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct.1 in/hr	Field Capacity 1 (in/in)	Avail. Water Capacity (in/in)	pH
Candler	0 -80	0.5 - 1.0	97.5	1.25	1.35-1.55	6-50	0.025-0.058	0.04-0.08	4.5-6
Tavares	0-8	0.5-1.0	97	1.5	1.25-1.6	7-39	0.025-0.05	0.05-0.10	3.6-6
	8-80	0-0.5	97	1.5	1.40-1.70	7-39	--	0.02-0.05	3.6-6
Astatula	0-7	0.5-1.0	98.5	0.75	1.25-1.55	9-85	0.025-0.05	0.04-0.10	4.5-6.5
	7-80	0-0.5	98.5	0.75	1.45-1.60	9-85	--	0.02-0.05	4.5-6.5

1 Obreza and Collins, 2002

Irrigation: The Central Ridge has relatively high rainfall (~50 inches/year), but crops require irrigation because of rapid drainage and low water retention of its characteristic sandy soils. Irrigation water management in these conditions is difficult and micro-irrigation is commonly used, supplying only enough water to satisfy the tree demand (Smajstra and Harman, 2002; Parsons and Morgan, 2004). Microirrigation typically supplies 10-20 gallons/hour spread out over a 10- to 18-ft area, with durations of about 4 hours. Typically, this provides water in the range of 1 to 2 feet below the surface. Irrigation events occur 2 times per week in the spring and up to 3 times per week in the summer (communication L. Parsons, South Florida Agricultural Extension Office). During the spring, soil moisture depletion should be no less than 1/3 of the available water capacity, while during the remainder of the year, up to 2/3 of the available water capacity can be depleted without severe effects (Boman et al., 2002). Irrigation at 50 % of available water capacity was assumed for modeling.

Crop profile: About half of citrus in Florida is grown on deep, sandy soil using the unbedded tree row production. The remainder is grown on heavier, wetter soils in Florida Flatwoods. Citrus on the Central Ridge is planted along the natural contour. No leveling is required for the soils because of their natural drainage (Obreza and Collins, 2002). Although Ridge citrus roots can go as deep as 15 feet, most of the roots are in the top 3 feet. Because rooting depth is coupled to the depth of irrigation in PRZM, rooting depth was set to the appropriate depth of irrigation (~2 feet in this case).

Water table and aquifer characteristics: The water table in the region has an upper limit 3.5 to 6 feet below the surface (USDA Soils Data Mart), generally occurring in winter (December-January). Typical depths may be considerably deeper. For example, Hornsby et al. (1990) found water table depths greater than 20 meters while Jones et al reported depths of 12 feet in groundwater studies conducted in this area. Jones et al (1987) found typical high lateral groundwater velocities of 0.15 m/day in the Ridge area. They reported groundwater pH values ranging from 3.5 to 6 (typically 4.5), and temperatures of 20 to 25 C. The USGS Lake Wales Ground Water Monitoring Study (USGS, 2006) found pH values for the surficial aquifer in the range of 4 to 7 (median 4.9).

ii. Florida Potato (Northeastern FL)

Potatoes are the dominant crop on which NMCs are used in this region. Florida potato production occurs predominantly in the northeastern part of the state, with 47 percent of potato acreage in St. Johns County (21,000 acres), 11 percent in Putnam County, 10 percent in Dade County, and 3 percent in Flagler County. Winter and early spring potato production supplies more than 35% of the early crop for the U.S. The nearest weather station for PRZM weather data is in Jacksonville, FL (W138889.dvf).

Soils: The Pomano fine sand is typical of the potato-growing region of the Hastings/St. Johns County area. The properties of this soil (Table II.E.7.3) were obtained from the USDA Soils Data Mart.

Table II.E.7-3 Soil properties for the Pomano fine sand in St. Johns County, FL (USDA Soil Data Mart).

Depth (cm)	Organic matter (%)	Sand (%)	Clay (%)	Moist Bulk Dens., g/cm3	Saturated Hydraulic Conduct. (µm/s)	Poros-ity (in/in)	Field Capac. (in/in)	Avail. Water Capac. (in/in)	pH

Depth (cm)	Organic matter (%)	Sand (%)	Clay (%)	Moist Bulk Dens., g/cm3	Saturated Hydraulic Conduct. (µm/s)	Poros-ity (in/in)	Field Capac. (in/in)	Avail. Water Capac. (in/in)	pH
0 – 15	2.5	93	1	1.35	42-141	0.491	0.085	0.075	3.6-6
15 – 50	0.25	94	1	1.58	42-141	0.406	0.065	0.055	3.6-5.5
50 – 80	0.25	94	2	1.45	4-42	0.453	0.135	0.125	3.6-6
80 – 120	0.25	94	2	1.5	42-141	0.434	0.065	0.055	3.6-5.5
120 – 160	0.25	76	13	1.6	1.4-14	0.396	0.16	0.15	3.6-5.5
160 – 250	0.25	88	2	1.58	4-42	0.405	0.065	0.055	3.6-5.5
250 - 350	0.25	--	--	1.58	--	0.405	0.40	--	3.6-5.5

Irrigation: Irrigation is generally required during initial plant growth, when plant water requirements rapidly increase. Water requirements during the final growth period of tuber development decrease. As with other root crops, continuous moderate levels of soil moisture must be ensured.

Crop Profile: Seed pieces are planted at a maximum density of approximately 29,000 plants per acre. Approximately 110 days elapse between planting and maturity. Potato planting in this area runs from late December through early March, with harvest from late April through June. The vines are killed before harvest to prevent skinning and bruising of the mature tubers and to reduce harvest machinery interference by heavy foliage. Tuber harvest occurs 14-21 days after the vines are desiccated to allow time from the periderm to set on the tuber to reduce skinning and scuffing. Vine killing is accomplished with herbicides and occasionally by mowing. Hilling soil around plants to keep the tubers completely covered is important to prevent sunburn and greening of the tubers when the vines are killed.

Water table and aquifer characteristics: The upper limit of the water table is 1.5 feet, generally in July to September (USDA Soil Data Mart). No information on typical well depths in the area could be found. In a ground water monitoring study in the potato-growing region of Putnam and St. Johns counties, Tilden and Weigand (1998) reported ground water pH values ranging from 7 to 8.

iii. Georgia Peanut/Cotton (Southern Coastal Plain)

The southern part of Georgia is an area of prime farmland, suitable for field and row crops, including peanuts. Georgia has the highest peanut acreage in the U.S., primarily concentrated in the southwestern part of the state. This area has shallow groundwater that is susceptible to contamination (Donohue, 2001) and is used for drinking water in some cases (Crandall and Berndt, 1996). In addition, a prospective groundwater study was conducted in this area (MRID

43099601) which allowed for evaluations regarding the suitability of the scenario parameterization.

While the scenario was developed for peanuts, it can also represent cotton, which is often grown in rotation with peanuts in this region. Although pecans are also grown in this region they were not modeled because pecans are not rotated with these crops, and co-occurrence of NMC in groundwater is not expected. Also the percent of pecan crop treated with NMC is significantly lower (1-8 percent) than that of peanut and cotton crops (22 and 34 percent, respectively).

.

Soils: Based on soil data from Cook and Colquitt counties (Soil Data Mart, USDA, 2005), Tifton loamy sand is the dominant soil (24% of coverage in the region) and is also a prime farmland soil. Tifton is a very deep, well drained soil on uplands. The subsoil is loamy and extends to a depth greater than 5 feet. Plinthite occurs below a depth of 30 to 50 inches and ironstone nodules are present throughout the soil. Permeability is moderate in the upper part of the subsoil and moderately slow in the lower part. Available water capacity is moderate. Some properties of this soil that are relevant for pesticide transport modeling are listed in Table II.E.7.4. This soil falls into the Hydrologic Group B.

Table II.E.7-4 Soil properties for the Tifton loamy sand in Cook/Colquitt counties, GA (USDA Soil Data Mart).

Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (µm/s)	Wilt. Point (in/in)	Field Capac. (in/in)	Avail. Water Capacity (in/in)	pH
0 -25	0.5 - 1.0	66	10-20	1.3 - 1.55	42 - 141	0.09	0.17	0.03 – 0.08	4.5 - 6.0
25-46	0.5 - 1.0	67	13-22	1.45 - 1.65	42 - 141	0.10	0.18	0.08-0.12	4.5 - 6.
46-83	0.0 - 0.5	55	20-35	1.5 - 1.7	4 - 14	0.16	0.23	0.12-0.16	4.5 - 6.0
83-162	0.0 - 0.5	54	25-40	1.55 - 1.80	1.4 - 4	0.22	0.27	0.1-.13	4.5 - 5.5
162-216	0.0 - 0.5	53	25-45	1.65 - 1.85	1.4 - 4	0.22	0.27	0.1-0.12	4.5 - 5.5

Irrigation: Georgia peanuts are grown on both dry and irrigated land. About 50% of Georgia peanut acreage is irrigated. Typical irrigation amounts may be around 1 to 2 inch per week using center pivots. Total seasonal use could be 10 inches.

Crop Profile: Peanuts are typically rotated with cotton or a grass-type crop. Conventional tillage is used for almost all Georgia peanut crops. Planting dates range from April 23 to May 25, and harvest runs from early September to early November. Plantings are typically single rows 36 inches apart.

Water table and aquifer characteristics: The water table is typically at a high of 4 to 6 feet below the ground surface, and some domestic wells draw from this shallow aquifer. The pH of the surficial aquifer in the Southern Coastal Plain ranges from 4.1 to 7.4 (median 5.2) according to a survey by Crandall and Berndt (1996).

iv. North Carolina Cotton/Peanut (Eastern Coastal Plain)

North Carolina is ranked sixth in the nation in cotton acreage and seventh in production, generating 5 percent of the U.S. cotton crop. Most of the cotton in North Carolina is grown in the eastern half of the state in the coastal plain region. Three of the four highest cotton producing counties, Northampton [63045 acres], Halifax [61933 acres], and Edgecombe [46001 acres], in North Carolina are located in northeastern North Carolina (USDA, 2002). Other Crops grown in this region include corn, peanuts, tobacco, soybeans, small grains, cotton, and pasture. Although cucumbers and tobacco are also grown in this region they were not modeled the percent of crop treated with NMC for those two uses (<1- 7 percent) is significantly lower than that of peanut and cotton crops (62 and 43 percent, respectively).

The climate of North Carolina's coastal plain province is temperate. Average high temperature during summer months is in the mid-upper 80s, while average lows are near 70 degrees. During winter, average highs are in the mid 50s, while average lows are in the mid 30s. Temperatures tend to be more moderate in the outer coastal plain. Average rainfall is about 51 inches. Snowfall is infrequent and generally averages less than 5 inches per year in the inner coastal plain and less than 2 inches per year in the outer coastal plain.

Soils: Cotton is predominately grown on sandy loam soils of the coastal plain. These soils require subsoiling to breakup naturally occurring hardpans. Dominant cotton soils in the three counties of interest (Edgecombe, Halifax, Northampton) are the Norfolk loamy sand [Fine-loamy, kaolinitic, thermic Typic Kandiudults] and Wagram loamy sand [Loamy, kaolinitic, thermic Arenic Kandiudults]. The Norfolk loamy sand was selected as it is present in both Edgecombe and Northampton counties, is designated as prime farmland, and is an NRCS benchmark soil (National Soil Handbook, part 630). This soil is in Hydrologic Soil Group B. Properties are given in Table II.E.7.5.

Table II.E.7-5 Soil properties for the Norfolk loamy sand in eastern NC (USDA Soil Data Mart).

Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (µm/s)	Wilting Point1 (in/in)	Field Capac. (in/in)	Avail. Water Capacity (in/in)	pH
0 -23	0.5-2.0	79	2-8	1.55-1.7	42-141	0.02	0.05	0.06-0.11	3.5-6.0
23-36	0.3-0.8	90	2-10	1.55-1.7	42-141	0.02	0.05	0.06-0.11	3.5-6.0
36-178	0-0.5	60	18-35	1.3-1.65	4-14	0.08	0.12	0.1-0.18	3.5-5.5

Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (µm/s)	Wilting Point1 (in/in)	Field Capac. (in/in)	Avail. Water Capacity (in/in)	pH
178-254	0-0.5	54	20-43	1.2-1.65	4-14	0.10	0.13	0.12-0.18	3.5-5.5

1 Approximated from USDA Norfolk pedons NSSL query

Irrigation: Limited cotton acreage in North Carolina is irrigated. The USDA Ag Census 2002 estimates that about 3.4% of acreage is irrigated. Irrigation is not included in the NC cotton model scenario.

Crop Profile: The majority of cotton is located on the sandy loam soils of the coastal plain that require subsoiling to break naturally occurring hardpans. About 20 percent of the cotton is grown on heavier soils that do not require subsoiling. No-till systems are gaining in popularity in these locales. Traditionally, these soils have been heavily tilled, utilizing two disking operations followed by subsoiling/bedding. Strip-till is increasing dramatically in this area as a method of controlling sand blasting. The heavier clay soils of the piedmont do not require subsoiling, and most of this cotton is produced in no-till systems.

Planting begins in mid-April and usually is finished by the end of May (most active is May 1 to May 29). Harvesting begins at the end of September and ends mid December (most active is Oct. 15 to Nov. 15).

Water table and aquifer characteristics: The surficial aquifer is widely used for private wells throughout NC (NC DWR, 2007). In the eastern coastal plain of NC, the surficial aquifer consists of unconsolidated sand and gravel and is susceptible to contamination by human activities (USGS, 2005). In a survey of shallow ground water in the Albemarle-Pamlico Basin (covering a large portion of the NC coastal plain), the pH of the ground water in the surficial aquifer ranges from 5.1 to 6.7 (median 6.0), with a depth to the shallow water table at less than 5 meters below the surface (in the inner coastal plain (Tesoriero et al, 2004).

v. Delmarva Sweet Corn/Cucurbits

While overall this region was not one of the highest areas of total NMC use, this scenario was developed and used in a sensitivity analysis to compare with ground water monitoring data available for carbofuran.Most of the crop-related information in this section comes from the USDA crop profiles for sweet corn and cucurbits (represented by cucumbers) in Maryland and Delaware (http://cipm.ncsu.edu/CropProfiles/cplist.cfm?org=state). Sweet corn is grown throughout the Delmarva Peninsula. It is planted in small blocks, usually less than 5 acres, in successive plantings to provide a continuous supply of corn. In contrast, the processing acreage is planted in larger rotated fields, usually greater than 30 acres and ranging up to 120 acres. In the southern areas, sweet corn is often double cropped with crops such as soybeans or cucumbers. The highest cucumber production area in Maryland is along the Eastern Shore (Delmarva), with the highest production in Wicomico County.

Soils: Sweet corn grows in many types of soils; however light, sandy soils with a pH level of 6.5 are optimal. Cucumbers grow best on light-textured (sandy), well-drained soils high in organic matter with a pH between 6 and 6.5. Table II.E.7-6 gives selected properties of a typical soil in the Delmarva area.

Table II.E.7-6 Soil properties for the Evesboro soil in Delaware (USDA Soil Data Mart).

Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (µm/s)	Wilting Point (in/in)	Field Capac (in/in)	Avail. Water Capacity (in/in)	pH
0 -10	0.2-1.0	70-98	1-10	1.15-1.7	42-705	-	-	0.05-0.6	4.3-6.5
10-100	0.0-0.5	70-98	1-10	1.6-1.8	42-705	-	-	0.02-0.10	4.3-6.5
100-200	0.0-0.5	70-98	1-7	1.6-1.8	42-705	-	-	0.02-0.10	4.3-5.5

Irrigation: Sweet corn requires a continuous supply of water. Irrigation during silking, tasseling, and ear development is used by nearly all Delmarva processors and some fresh market growers. Per the USDA crop profile, fields should be irrigated if rain does not occur for more than 2 weeks during the early stages of growth. Irrigation becomes critical as corn begins to tassel. About 1 inch of water per week is needed from tasseling through harvest.

The USDA crop profile for cucumbers indicate that 50% of the cucumber crop in Maryland is grown on black plastic with drip irrigation, with the remainder grown on bare ground.

Crop Profile: Sweet corn is generally seeded one inch deep with a row spacing of 30 inches and plants separated by 8 to 12 inches within rows. Cover crops, such as rye or wheat, are typically used prior to seeding sweet corn, to reduce soil erosion and improve soil tilth and fertility. No-till is used on less than 20% of fresh market sweet corn acres and about 10% of processed corn. Sweet corn may be planted as early as the last week of March in the southern portions of Delmarva, with successive plantings into early July in the remaining regions. Fresh market sweet corn is harvested 8-21 days after silking, whereas processing corn is harvested 5-7 days later when the ears are more mature.

Cucumbers are initially seeded 9-12 inches apart in rows 3-4 feet apart between mid-April and early May in the mid-Atlantic, and successive plantings may continue through early August.

Water table and aquifer characteristics: The pH of the shallow aquifer at 3 to 20 feet below surface is typically in the range of 5 to 6 (Blaier and Baxter, 2000).

vi. Central Washington Potato

Washington is the second leading potato-growing state in the U.S. (WA Dept. of Ag, Statistics). The highest potato-producing areas within the state are located in Grant and Yakima counties, which also coincide with the highest usage of carbamates in the northwest. Grant County was the top potato-producing county in the nation in 1998 (WA Dept. of Ag, Statistics), with almost 50,000 acres in potato production in 2002 (USDA, 2002). Groundwater is generally shallow in Grant County, with little or no overlying confining layer in most places. As is typical for areas where potato production is favorable, the soils tend to be coarse-grained (sandy) and well drained (Sieczka and Thornton, 1993). Sandy, well-drained soils typical of potato production are likely to be fairly low in organic carbon. These factors make Grant County especially susceptible to groundwater pesticide contamination. Although apples, cherries, beans, onions and sweet corn are also grown in this region they were not modeled. Because apples and cherries are not rotated with these other crops co-occurrence of NMC in groundwater is not expected. Also the percent of sweet corn crop treated with NMC is significantly lower (1 percent). Several other crops did have higher percent crop treated values, but the combination of relative potency factor of specific NMCs used and the percent crop treated was highest for potatoes.

Soils: Although potatoes will grow on a wide variety of soils, optimal soils are usually deep, coarse-grained, and well-drained. Generally, soils with little or no slope are preferable, so that runoff is minimized (and less water and organic matter is lost).

Potatoes are primarily grown in Entisols (Torriorthents, Torripsamments) and Aridisols (Haplocambids, Haplodurids) in central Washington. These soils are generally well-drained and have low clay and organic matter contents. The most productive and widespread soil series cropped with potato in the central Washington region are Kennewick, Sagehill, and Wiehl (USDA Soil Data Mart). These soils tend to be coarse-grained (sand fractions typically range from 60-80%) with low organic matter content (<1%). Most of these soils are in hydrologic group B. Several relevant soil properties are listed in Table II.E.7.7.

Table II.E.7-7 Soil properties for the Kennewick, Sagehill, and Wiehl series in Grant County, WA (USDA Soil Data Mart).

Soil Series	Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (μm/s)	Field Capac. (in/in)	Avail. Water Capac. (in/in)	pH
Kenne-wick	0 -23	0.5-1.0	61-80	3.5	1.15-1.45	4-14	--	0.11-0.17	7.4-8.4
	23-152	0-0.5	---	3-18	1.3-1.5	1.4-4	--	0.18-0.21	7.9-9.0
Sagehill	0-20	0-0.5	60	5	1.2-1.4	14-42	--	0.18-0.2	6.6-8.4
	20-48	0-0.5	---	2-8	1.3-1.55	14-42	--	0.18-0.2	6.6-8.4

Soil Series	Depth (cm)	Org. matter (%)	Sand (%)	Clay (%)	Moist Bulk Density (g/cm3)	Saturated Hydraulic Conduct. (µm/s)	Field Capac. (in/in)	Avail. Water Capac. (in/in)	pH
	48-152	0-0.5	---	2-8	1.3-1.6	4-14	--	0.18-0.2	7.9-9.0
Wiehl	0-20	0.5-1.0	66	6.5	1.2-1.4	14-42	--	0.13-0.17	7.4-7.8
	20-46	0-0.5	---	5-8	1.3-1.5	4-14	--	0.15-0.19	6.6-7.8
	46-64	0-0.5	---	5-8	1.3-1.5	4-14	--	0.13-0.17	7.4-8.4
	64-89	---	---	---	1.6-1.9	---	--	---	---

Irrigation: Almost all potato crops grown in the Pacific Northwest are irrigated (2002 USDA AgCensus), because of crop water demand and low water retention in the sandy soils. Therefore irrigation water must be included in total water inputs to the system (e.g., precipitation plus irrigation water). Irrigation at 50% of available water capacity is used for this scenario.

Crop Profile: Potatoes require greater amounts of fertilizers (especially N) and pesticides than grain and feed crops, and need more intensive management (tillage, equipment, monitoring). Potatoes require consistent amounts of water throughout its growing cycle, with seasonal requirements ranging from 20 to 40 inches. It is advantageous to keep the soil near field capacity; soil should not be allowed to get below 65% of field capacity. However, soil should not be allowed to exceed field capacity, or quality and yield will become dramatically lowered. The effective rooting depth of potato is 2 feet (Sieczka and Thornton, 1993).

Water table and aquifer characteristics: The water table associated with this type of soil in this region has an upper limit of 1 to 5 feet and a lower limit greater than 6 feet (USDA Soil Data Mart). Groundwater pH for this region ranges from 6.7-7.8; typical pH for shallow ground water is generally around 7.2 (personal communication, Washington State Dept. of Ecology).

d. . NMC Chemical Inputs

Three NMC pesticides – aldicarb, carbofuran, and oxamyl – were the dominant NMCs in those areas where high carbamate use coincided with private ground water sources of drinking water in leaching-prone landscapes. The chemical properties that drive these assessments are given in Table II.E.7.8. These properties came from an evaluation of registrant-submitted studies. Other chemical properties are required as inputs, but have negligible effect on model output; these properties can be found in the model input files. Properties for aldicarb represent total residue (parent aldicarb, plus the degradates aldicarb sulfoxide and aldicarb sulfone) properties (i.e. half-lives the total toxic-relevant constituents). Chemical-specific model inputs are described in Appendix II.E.5.

Table II.E.7-8 Summary of NMC fate and transport properties for leaching.

Pesticide	Soil Metabolism half-life	Hydrolysis half-life	Mobility / Sorption
Aldicarb, including sulfoxide and sulfone degradates (USEPA, 2006c, 2006d)	55 days for total aldicarb residues	**Aldicarb**: stable @ pH5-7; degrades slowly @ pH9 **Sulfoxide**: stable @ pH7, 2-3 days @ pH9 **Suflone**: 60-63 days @ pH7, 6 days @pH8, 1 day @ pH9	Kd = 0.12 mL/g (Koc = 10 mL/g)
Carbofuran (USEPA, 2005c, 2005d)	321 days	Stable @ pH5 28 days @ pH7 9 days @ pH7.5 3 days @ pH8 <1 day @ pH9	Koc = 36 mL/g
Oxamyl (USEPA, 1999f, 2007e)	20 days	Stable @ pH5 7 days @ pH7 0.1 day @ pH9	Koc = 6 mL/g

EPA used the hydrolysis rates that best reflected soil and groundwater conditions identified for the scenario. Thus, the Agency used the acidic hydrolysis rates for the FL citrus, NC cotton/peanut, and GA peanut scenarios and neutral to alkaline hydrolysis rates for the FL potato and WA potato scenarios.

The chemicals were modeled using a unit rate of 1 kg ai/ha for each scenario. Because the exposure concentrations are linearly related to the application rate, the resulting rates were multiplied by the reported application rates (Table II.E.7.9). More detailed usage information used for the application parameters can be found in Appendix II.E.4.

Table II.E.7-9 NMC-crop application related inputs used for the GW exposure assessment.

Chemical	Crop	PRZM scenario	Typ. app. Rate, kg/ha	App Date	Well setback, ft(1)	Use adjust-ment(2)
Southeast Coastal Plain / NC cotton, peanut						
Aldicarb	Peanut, Cotton	NC Cotton	1.2 (p), 0.8 (c)	10-Apr	300	1
Oxamyl	Peanut	NC Cotton	1.39	30-May	NA	0.3
Southeast Coastal Plain / GA peanut, cotton						
Aldicarb	Peanut, Cotton	GA Peanut	1.1 (p), 0.65 (c)	10-Apr	300, 500	1
Florida / Central Ridge Citrus						
Aldicarb	Oranges / grapefruit	FL Citrus	4.27	1-Apr	1000	1
Oxamyl	Oranges	FL Citrus	1.07	1-Apr	NA	0.5
Florida / Northeast Potatoes						
Aldicarb	Potato	FL potato	0.80	20-Jun	300	1
Carbofuran	Potato	FL potato	0.39	1-Apr	NA	0.5

Chemical	Crop	PRZM scenario	Typ. app. Rate, kg/ha	App Date	Well setback, ft(1)	Use adjust-ment(2)
Delmarva / Sweet corn, cucurbits						
Carbofuran	Sweet corn	Delmarva	1.00	15-Apr	NA	1
Carbofuran	Cucurbits (Melons, cucumber, squash)	Delmarva	Range from 0.33 to 1.25	15-Apr	NA	1
Northwest / WA Potato						
Aldicarb	Potato	WA potato	3.21	15-May	300	1

1 Concentration reductions were calculated for degradation during the additional travel time from the point of application to the well based on setback distance.
2 Use adjustment is the ratio of reported amount of the specific pesticide applied in the region to the total amount of the highest reported amount of NMC (generally aldicarb) applied in that same region.

Because co-occurrence of NMC residues in ground water is likely to be localized at a field or multi-field level, EPA considered co-occurrence based on the potential for more than one NMC to be used at different times on the same crop or on different crops in rotation on the same fields. The Agency modeled multiple NMC uses on a crop at the same ratio of pounds used as that reported in the usage summary for the region. This is reflected by the use adjustment value in Table II.E.7.8, and is based on reported regional usage (total amount applied) in Appendix II.E.4.

The adjustments to the estimated daily concentrations for each NMC-crop combination are shown in the following equation:

$$[C\text{-adj}]_{(NMC1,CROP)} = [C\text{-init}]_{(NMC1,CROP\ 1kg/ha)} \times Rate_{(NMC1,CROP)} \times SetbackRed_{(NMC1,CROP)} \times UseAdj_{(NMC1,CROP)}$$

where

$[C\text{-adj}]_{(NMC1,CROP)}$ is the adjusted daily concentration for NMC_1 on the crop
$[C\text{-init}]_{(NMC1,CROP\ 1kg/ha)}$ is the initial concentration for NMC_1 on the crop with a unit (1 kg/ha) application rate
$Rate_{(NMC1,CROP)}$ is the typical application rate for NMC_1 on the crop
$SetbackRed_{(NMC1,CROP)}$ is the concentration reduction resulting from degradation during the additional travel time from application to the well
$UseAdj_{(NMC1,CROP)}$ is the ratio of the total reported amount of NMC_1 used in the area to the NMC with the highest total reported amount (which is assigned a use adjustment of 1)

The resulting adjusted concentrations for each crop-NMC combination are multiplied by the relative potency, FQPA safety and uncertainty factors and then summed across each day to provide a cumulative daily time series, in oxamyl equivalents, over 30 years.

The dietary baseline analysis assumes that all carbofuran uses other than import tolerances are removed, as indicated in the 2006 carbofuran IRED. The impacts of currently registered domestic uses of carbofuran on drinking water sources were modeled for this assessment. Results are presented in the appendices for all NMCs modeled, but are summarized in the main assessment in a sensitivity analysis.

3. Regional NMC Concentrations in Ground Water

Each of the exposure scenarios summarized below represent areas with the potential for high NMC concentrations as a result of use, leaching potential, and depth to groundwater. Four scenarios – FL citrus on the Central Ridge, NC peanuts/cotton/tobacco on the coastal plain, GA peanuts/cotton on the coastal plain, and Delmarva sweet corn/cucurbits – represent soils and aquifers with acidic pH values (conditions which favor persistence of NMC residues). One scenario – WA potatoes – represents alkaline soil and aquifer conditions, which would favor more rapid hydrolysis of the NMC residues. The FL potato scenario represents acidic soils but neutral to alkaline aquifer conditions.

In other regions of the country, anticipated exposure to NMC residues in groundwater is expected to be lower than estimated in these scenarios. In the north and north-central, groundwater exposures are expected to be lower because of low NMC use, particularly aldicarb, which is no longer used in high leaching potential areas of the north and northeast. In the mid-south, drinking water is drawn predominantly from public ground water supply from deep, protected aquifers and NMC contamination not expected. In the midwest and west, anticipated exposure is expected to be lower because of low rainfall and deeper aquifers than in the southeast and Florida.

The following sections summarize the exposure model estimates for each of the scenarios. Discussion and characterization of the results in terms of total NMC exposure can be found in the main water exposure section (I.E) of the NMC CRA.

a. FL Citrus (Central Ridge)

Aldicarb and oxamyl are the two NMC pesticides with reported use on citrus crops in the FL Central Ridge area. The estimated exposures represent high leaching potential soils and vadose zones over shallow, unconfined aquifers with acidic pH values. Table II.E.7.10 summarizes estimated exposures for aldicarb (0, 300, and 1000 foot setback distances) and oxamyl (no setback) at 3 well depths (15, 30, and 50 feet).

Table II.E.7-10 Estimated concentrations of NMC residues for the GW exposure assessment under high leaching potential conditions (1) in the citrus region of the Central Ridge of Florida.

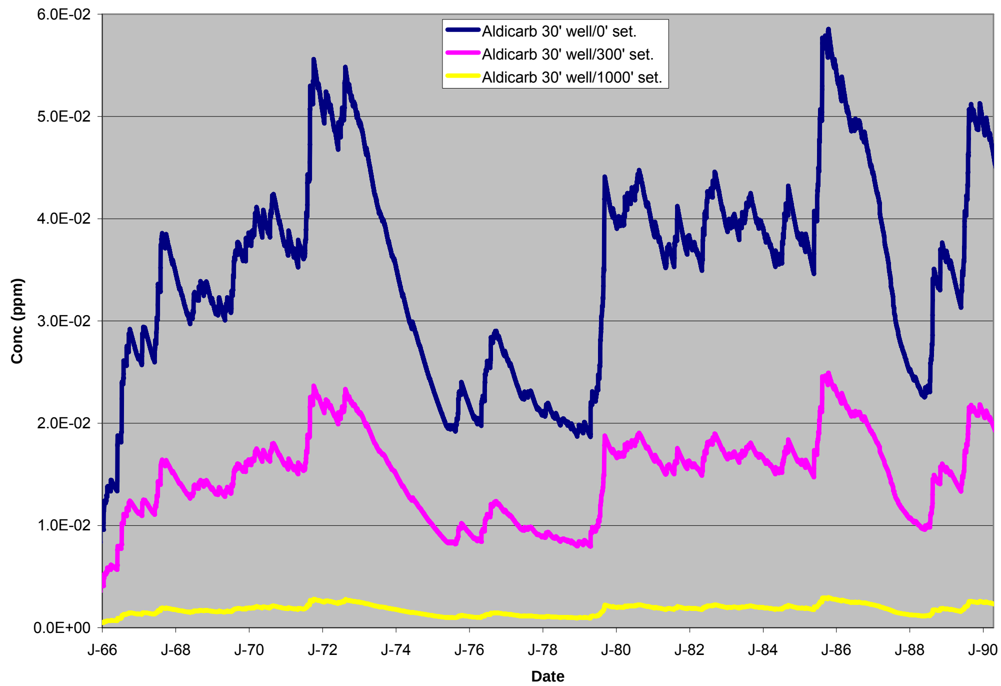
NMC pesticide	Well setback	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
30 foot well depth (used for revised NMC CRA)								
Aldicarb	0 ft	58.5	55.5	50.8	48.5	41.8	40.3	33.8
	300 ft	24.9	23.6	21.6	20.6	17.8	17.2	14.4
	1000 ft	3.0	2.8	2.6	2.5	2.1	2.0	1.7
Oxamyl	0 ft	0.7	0.7	0.5	0.4	0.4	0.3	0.2
15 foot well depth (used in preliminary NMC CRA)								
Aldicarb	0 ft	545	506	438	397	362	347	278
	300 ft	232	216	187	169	154	148	118
	1000 ft	27.6	25.6	22.2	20.1	18.3	17.5	14.0
Oxamyl	0 ft	8	7	5	3	2	2	1
50 foot well depth (used for characterization)								
Aldicarb	0 ft	14.9	14.4	13.3	11.7	10.3	10.0	7.9
	300 ft	6.4	6.1	5.6	5.0	4.4	4.2	3.4
	1000 ft	0.8	0.7	0.7	0.6	0.5	0.5	0.4
Oxamyl	0 ft	0.3	0.3	0.2	0.2	0.2	0.1	0.1

(1) High leaching potential conditions: soils with a high leaching potential rating (according to USDA NRCS ratings), shallow wells (30 ft) extending into an unconfined aquifer, and acidic groundwater.

The cumulative NMC exposure from groundwater sources of drinking water in this region (reported in Section I.E) represent the sum of total aldicarb residues in the 30-foot well with a 1000-foot setback and oxamyl concentrations from the 30-foot well. The individual chemical concentrations were adjusted for relative potency and uncertainty factors to oxamyl equivalents. The total NMC concentration was driven by total aldicarb residues. Based on existing label restrictions, the cumulative residues represent aldicarb applications with a 1000-foot setback between the well and the citrus field. The 30-foot well depth represents a reasonable approximation of the depth of shallow private wells. The additional exposure estimates are for comparison and characterization purposes, as well as for evaluating the sensitivity of the modeling assumptions regarding depth to groundwater on the estimated exposures.

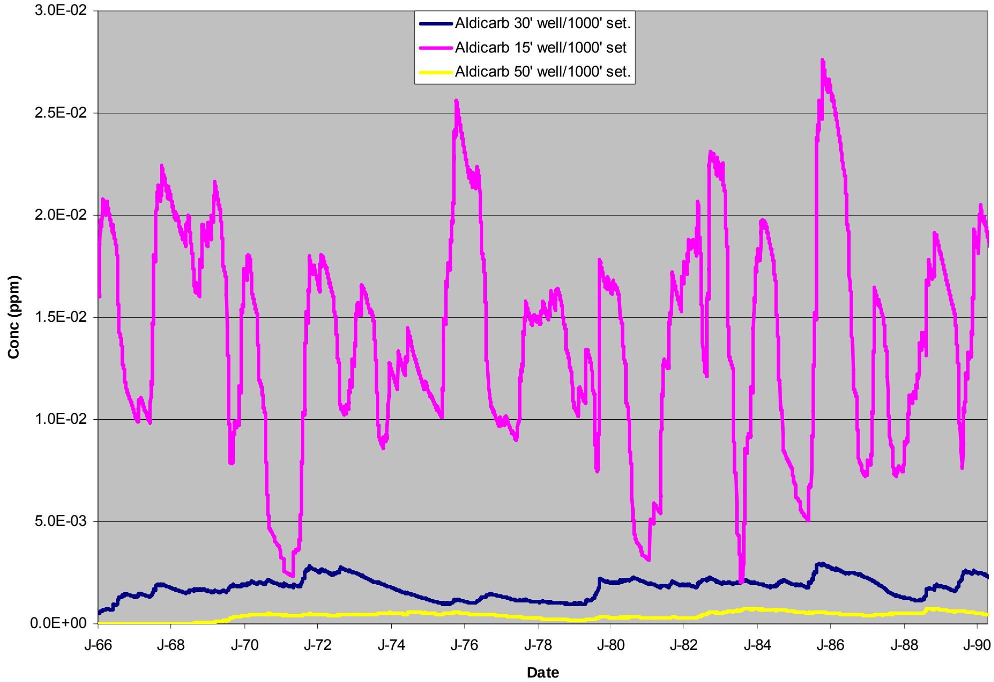
Figure II.E.7.5 shows the effect of varying well setback distances on estimated total aldicarb residues in groundwater in the Central Ridge of Florida. Estimated concentrations in the field (0-foot setback) are roughly 20X greater than estimated concentrations in a well 1000 feet from the field of application.

Figure II.E.7. 7 – Estimated concentrations of total aldicarb residues in groundwater at 30 feet under citrus in the Central Ridge of Florida with varying setback distances.



With the increased travel time allowing for more degradation, estimated NMC residues decreased by nearly an order of magnitude between 15 and 30 feet (Table II.E.7.10 and Figure II.E.7.6). Estimated concentrations at the 15-foot depth showed more variation in concentrations over time. This is consistent with monitoring data which show that mobile chemicals applied to the surface of highly permeable soils can reach shallow groundwater in the same season or year. For groundwater at 50 feet, estimated concentrations were approximately 4 times lower than those at 30 feet.

Figure II.E.7. 8 – Estimated concentrations of total aldicarb residues at different depths in groundwater near citrus in the Central Ridge of Florida (1000 foot setback from well).



b. FL Potato (Northeast FL/ St. Johns County)

Aldicarb and carbofuran are the two NMC pesticides with reported use on potatoes grown in the Hastings/St. Johns County area. The estimated exposures represent high leaching potential soils and vadose zones over shallow, unconfined aquifers under neutral (pH 7) conditions. While the leaching potential is similar to that of the soils in the Central Ridge, the NMC residues are expected to break down more rapidly in ground water because of the neutral pH conditions of the area. Thus, the estimated residues of aldicarb (Table II.E.7.11) and of the cumulative NMC residues (Section I.E) are orders of magnitude lower than what was estimated for the FL citrus/ Central Ridge scenario. The estimated concentrations are well below analytical limits of detection.

Table II.E.7-11 Estimated concentrations of NMC residues for the GW exposure assessment in the potato region of northeastern Florida.

NMC pesti-cide	Well setback	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
Aldicarb	0 ft	3.9e-05	3.0e-05	1.9e-05	1.3e-05	8.1e-06	6.2e-06	2.3e-06
	300 ft	1.7e-05	1.3e-05	8.0e-06	5.7e-06	3.5e-06	27.e-06	9.9e-07
Carbo-furan	0 ft	2.7e-11	1.7e-11	9.3e-12	4.8e-12	2.1e-12	1.5e-12	1.5e-13

c. GA Peanuts/Cotton (Southern Coastal Plain)

Aldicarb use on peanuts is the dominant NMC use in this scenario, which represents the southern end of the Coastal Plain province (spanning from South

Carolina westward into Alabama and part of northern Florida). The estimated exposures represent high leaching potential soils and vadose zones over shallow, unconfined aquifers with acidic pH values. Table II.E.7.12 summarizes estimated exposures for aldicarb over a range of well setback distances at 3 well depths (15, 30, and 50 feet). Existing label restrictions for aldicarb stipulate a 300-foot well setback for aldicarb in this area. The table shows estimated concentrations for both peanuts, at a typical application rate of 1.1 kg/ha, and cotton, at a typical application rate of 0.65 kg/ha. The differences in concentrations reflect the differences in application rates.

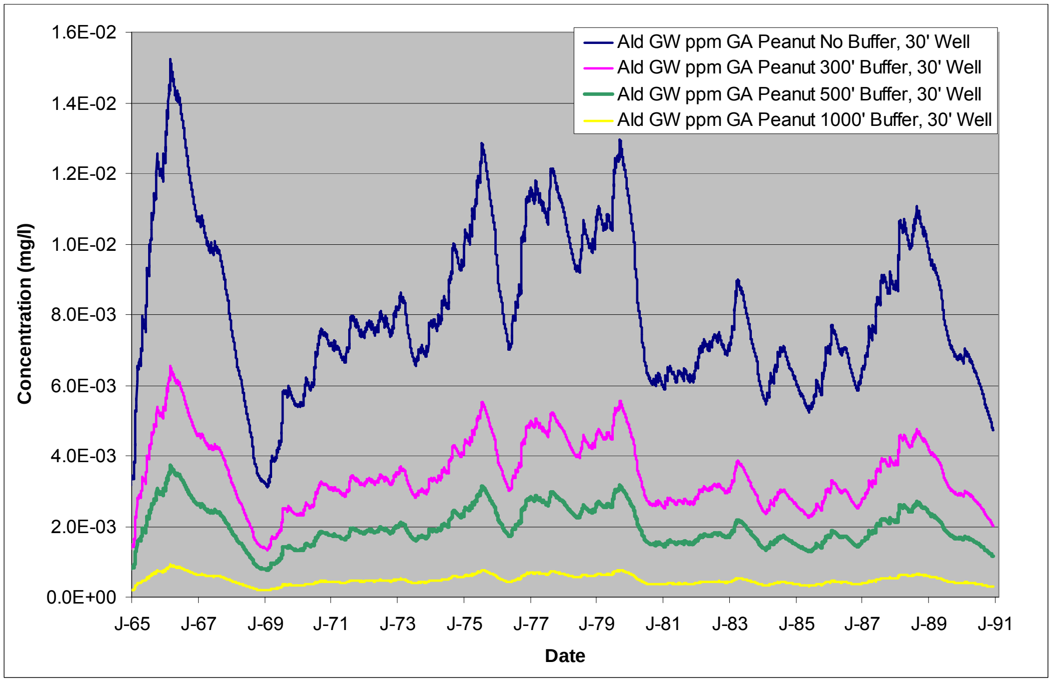
Based on the aggregate dietary exposure assessment for aldicarb, a 500-foot well setback is needed to reach a reasonable certainty of no harm. Both setback exposures are used in the cumulative NMC exposure from groundwater sources of drinking water in this region. The additional exposure estimates are for comparison and characterization purposes.

Table II.E.7-12 Estimated concentrations of NMC residues for the GW exposure assessment in the southern coastal plain of Georgia (peanuts and cotton).

NMC pesticide	Well setback	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
30 foot well depth (used for revised NMC CRA)								
Aldicarb (peanuts)	0 ft	15.2	14.1	12.0	11.2	10.1	9.6	7.2
	300 ft	6.5	6.0	5.1	4.8	4.3	4.1	3.1
	500 ft	3.7	3.4	2.9	2.7	2.5	2.4	1.8
	1000 ft	0.9	0.8	0.7	0.7	0.6	0.6	0.4
Aldicarb (cotton)	0 ft	9.1	8.4	7.2	6.7	6.1	5.7	4.3
	300 ft	3.9	3.6	3.1	2.9	2.6	2.5	1.8
	500 ft	2.2	2.1	1.8	1.6	1.5	1.4	1.1
	1000 ft	0.5	0.5	0.4	0.4	0.4	0.3	0.3
15 foot well depth (used in preliminary NMC CRA)								
Aldicarb (peanuts)	0 ft	85.6	76.3	66.6	60.2	53.9	50.3	32.7
	300 ft	36.5	32.5	28.4	25.6	22.9	21.4	13.9
50 foot well depth (used for characterization)								
Aldicarb (peanuts)	0 ft	4.7	4.5	4.1	4.0	3.5	3.3	2.5
	300 ft	2.0	1.9	1.8	1.7	1.5	1.4	1.1

Figure II.E.7.7 illustrates the effect of varying well setback distances on total aldicarb residues in the southern coastal plain of Georgia. The graph plots estimated concentrations of total aldicarb residues in a 30-foot well located adjacent to peanut fields in high leaching potential soils in the coastal plain. As with the FL Central Ridge citrus scenario, the effect of the setback distance between the well and the treated field is estimated based on the increase in lateral travel time from the point of application to the well. The Agency is not aware of any monitoring data or studies that would quantify the effect of varying setback distances on concentrations of total aldicarb residues in ground water.

Figure II.E.7. 9 – Estimated concentrations of total aldicarb residues in groundwater at 30 feet under peanuts in the Georgia Coastal Plain with varying setback distances.



At equivalent well depths and setback distances, estimated total aldicarb residues in ground water in this Georgia scenario are less than those estimated for the Florida Central Ridge scenario (Table II.E.7.10). However, because the well setback distance specified for high leaching potential soils in Georgia is less (300 feet) than that specified for citrus in Florida (1000 feet), the resulting NMC cumulative exposure from ground water in the high exposure areas of Georgia is greater than that for the Florida Central Ridge.

d. NC Peanuts/Cotton (Eastern Coastal Plain)

Aldicarb is used on peanuts and cotton in the eastern portion of the coastal plain, representing the northern portion of the coastal plain in VA and NC. Additionally, oxamyl is also used on peanuts in this same region. The estimated exposures of these NMC residues represent high leaching potential soils and vadose zones over shallow, unconfined aquifers with acidic pH values. The difference in estimated exposures for aldicarb on peanuts and cotton reflect differences in the typical application rates on these crops. Table II.E.7.13 summarizes estimated exposures for with 0 and 300 foot setback distances for a 30-ft deep well. The cumulative NMC exposure from groundwater sources of drinking water in this region are represented by exposures in the 30-foot well with a 300-foot setback for aldicarb (no well setback distance is specified for oxamyl).

Table II.E.7-13 Estimated concentrations of NMC residues in high leaching soils under peanuts for the GW exposure assessment in the eastern coastal plain of North Carolina.

NMC pesticide	Well setback	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
Aldicarb (peanuts)	0 ft	3.1	2.9	2.5	2.3	2.0	2.0	1.5
	300 ft	1.3	1.2	1.1	1.0	0.9	0.8	0.6
Aldicarb (cotton)	0 ft	2.1	2.0	1.7	1.5	1.4	1.3	1.0
	300 ft	0.9	0.8	0.7	0.7	0.6	0.6	0.4
Oxamyl (peanut)	0 ft	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01

e. Delmarva Sweet Corn/Cucurbits

Carbofuran is currently used on sweet corn and cucurbits in the Delmarva peninsula (Delaware and portions of Maryland and Virginia east of the Chesapeake Bay). However the dietary baseline analysis assumes that all carbofuran uses other than import tolerances are removed, as indicated in the 2006 carbofuran IRED The estimated exposures of carbofuran represent high leaching potential soils and vadose zones over shallow, unconfined aquifers with acidic pH values (Table II.E.7.14).

Table II.E.7-14 Estimated concentrations of NMC residues in high leaching soils under sweet corn and cucurbits for the GW exposure assessment in the Delmarva peninsula.

NMC pesticide	Crop/ rate (lb ai/ ac/ yr)	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
Carbo-furan	Sweet corn, 1 lb/a	30.8	29.1	23.0	20.5	17.3	16.5	12.4
	Cucurbit, 0.33 lb/a	10.2	9.6	7.6	6.8	5.7	5.4	4.1
	Cucurbit, 1.25 lb/a	38.5	36.4	28.8	25.6	21.6	20.6	15.5

f. Washington Potatoes

In the preliminary NMC assessment (USEPA 2005b), the Agency estimated total aldicarb residues in ground water for a 15-foot well. The resulting concentrations were well below limits of detection, consistent with an absence of detections from wells in this area (Kirk Cook, Washington State Dept. of Agriculture, Pesticide Management Division, personal communication). Results of those estimates are provided in Table II.E.7.15. Because there were no exposures of concern for this scenario in the preliminary assessment, no further exposure estimates were conducted for this NMC assessment.

Table II.E.7-15 Estimated concentrations of NMC residues in high leaching soils under potatoes for the GW exposure assessment in central Washington.

NMC pesticide	Well setback	Concentrations, ug/l						
		Max-imum	99th %ile	95th %ile	90th %ile	80th %ile	75th %ile	50th %ile
Aldicarb	300 ft	8.9e-04	5.3e-04	1.1e-04	2.7e-05	1.4e-06	6.9e-07	3.8e-08

4. Comparison of Estimated NMC Concentrations in Ground Water to Monitoring Data

The Agency compared estimated exposures from PRZM against available monitoring data for aldicarb, carbofuran, and oxamyl. Appendix II.E.2 summarizes available ground water monitoring data for the NMC pesticides. Estimated total aldicarb residues in shallow ground water were comparable to recent monitoring data in aldicarb use areas. While similar recent monitoring is not available for carbofuran, estimated carbofuran concentrations in the Delmarva Peninsula were similar to detected concentrations in older monitoring studies for that pesticide.

a. Aldicarb monitoring comparisons

The exposure estimates for total aldicarb residues in private wells were modeled at a 30-foot depth. Current label restrictions for aldicarb apply if vulnerable soils are present and the water table is less than 25 feet below the ground surface. Exposure in private wells is a function of pesticide application intensity, depth to ground water/ well screen, permeability of the overlying soil and vadose zone, the amount of precipitation in excess of evapotranspiration (to leach the chemical through the soil and vadose zone) distance between the field of application and the well, and the direction and velocity of lateral ground water flow. No single ground water depth provides a bright line between vulnerable and not vulnerable. The current label restrictions do not reflect the true range in vulnerability with depth.

EPA compared estimated aldicarb concentrations from PRZM modeling to two recent groundwater monitoring datasets from Florida and to a recent survey of aldicarb residues in private wells in high aldicarb use areas:

- The Lake Wales Ridge study conducted by the USGS and the Florida Department of Agriculture measured aldicarb concentrations in monitoring wells located in citrus groves along the Central Ridge of Florida. The wells are not drinking water wells, but reflect ambient pesticide concentrations in ground water beneath the citrus groves. Since these wells are located within the treated fields, OPP used PRZM concentrations with no well setback adjustments (0-ft well setback) for comparisons to the monitoring data.
- A dataset of private well monitoring collected by the FL Department of Environmental Protection across the state of Florida. While the data represent potable drinking water wells, no information is available on well depth, aldicarb use in the vicinity, or distance between the well and the treated field.
- A monitoring survey by Bayer CropScience provides recent monitoring of aldicarb residues in private drinking wells in other parts of the US.

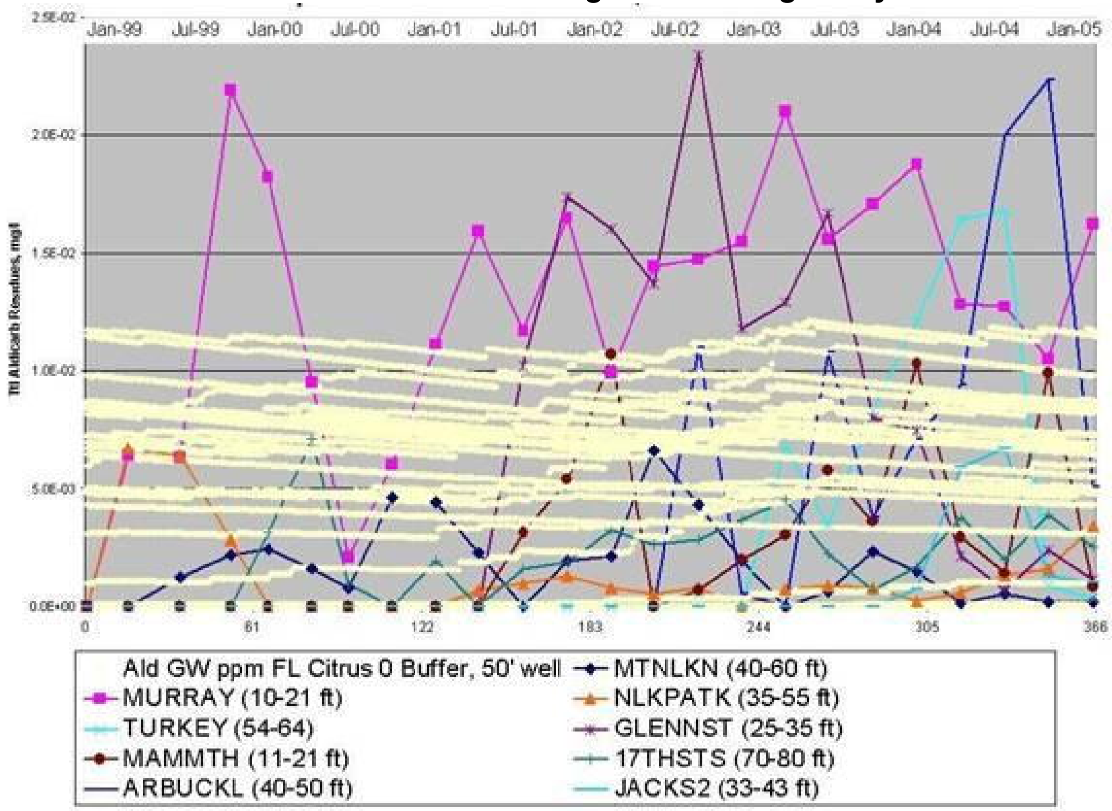
i. Lake Wales Ridge, FL, ambient groundwater monitoring

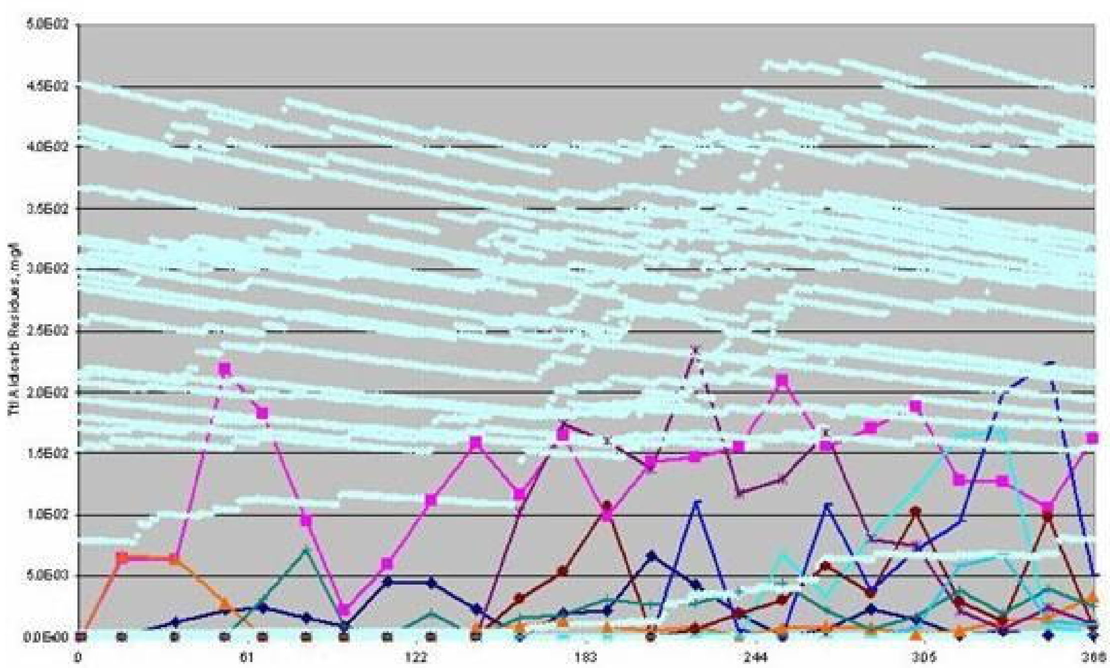
In-field concentrations (0-ft well setback) of estimated total aldicarb residues from the FL Central Ridge Citrus scenario were compared to an on-going groundwater monitoring study on the Florida Central Ridge (USGS, 2006). The USGS and the Florida Department of Agriculture monitored 31 wells within and around citrus groves on the Central Ridge. Well depths ranged from 4 to 110 feet deep (two thirds in the 20 to 60 foot range), and pH ranged from 3.9 to 6.9 (median about 5). Concentrations as high as 23 ppb have been recorded in one 26-ft well, while a 4-ft well had reported concentrations as high as 21 ppb. This study is not targeted for any specific pesticide, but rather is designed as a survey mechanism—that is, it is not known how much aldicarb was used nor is it known how far aldicarb was used from the wells.

Figure II.E.7.8 compares the monitoring results from the Lake Wales Ridge study with PRZM-modeled estimated aldicarb residues at 30- and 50-foot well depths. At 50-ft depths, the PRZM estimates are in the same concentration range when compared to wells of similar depth (TURKEY, ARBUCKL, MTNLKN, NLKPATK). While the median estimated concentrations for total aldicarb residues at a 30-foot well depth were typically greater than those found in the wells at similar depths (GLENNST, JACKS2), the measured detections were still within the range of estimated concentrations. The model estimates and the monitoring data do not reflect the same time periods, so direct comparisons are not possible. Instead, the figures illustrate the overlap between estimated concentrations over 30 years of model simulations with monitoring data collected at a different times from the Lake Wales Ridge study.

Figure II.E.7. 10 –Comparison of estimated concentrations of total aldicarb residues in groundwater at 50 feet (top, yellow) and 30 feet

(bottom, blue) with in-field monitoring from the USGS/FL Dept. of Ag. Lake Wales Ridge monitoring study.

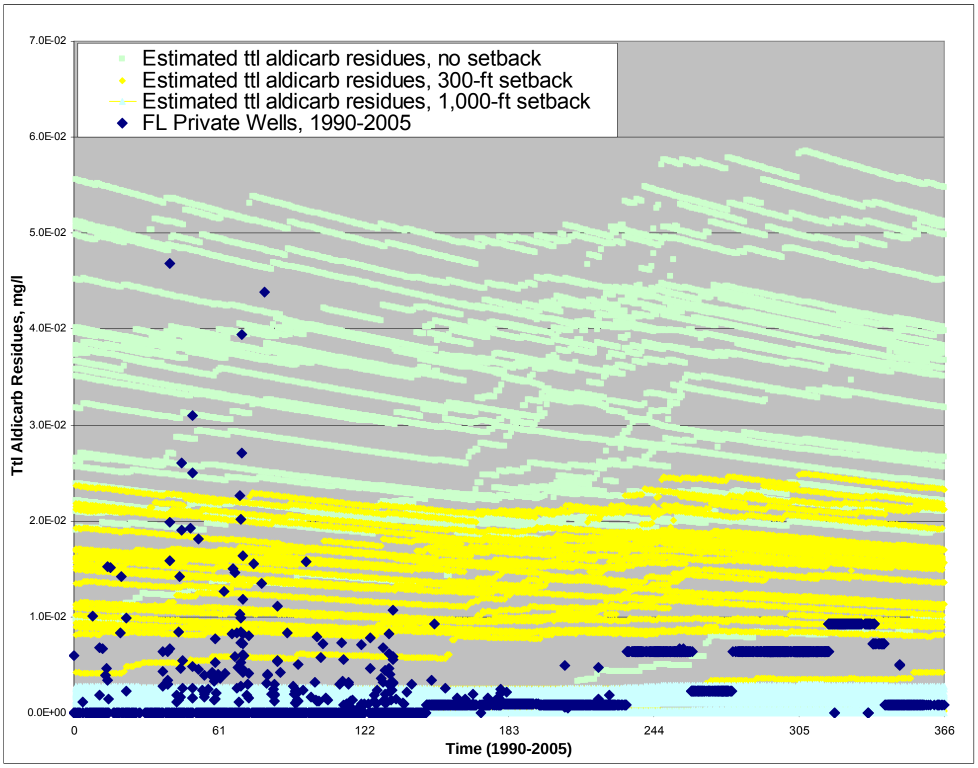




ii. Private drinking water well monitoring in FL

The Florida Department of Environmental Protection (FDEP) monitors private drinking water wells in rural areas. The monitoring is not comprehensive, but instead is instituted when there has been an indication of a problem (personal communication, FDEP). The study found total aldicarb residues (parent, sulfoxide and sulfone degradates) as high as 47 ppb in private drinking water wells in the early 1990s (FLDEP, 2006), in the same range as estimated concentrations of total aldicarb residues with no buffer (Table II.E.7.10 and Figure II.E.7.9).

Figure II.E.7. 11 – Comparison of total aldicarb detections in the FLDEP private well monitoring survey (FLDEP, 2005) with estimated concentrations from PRZM.

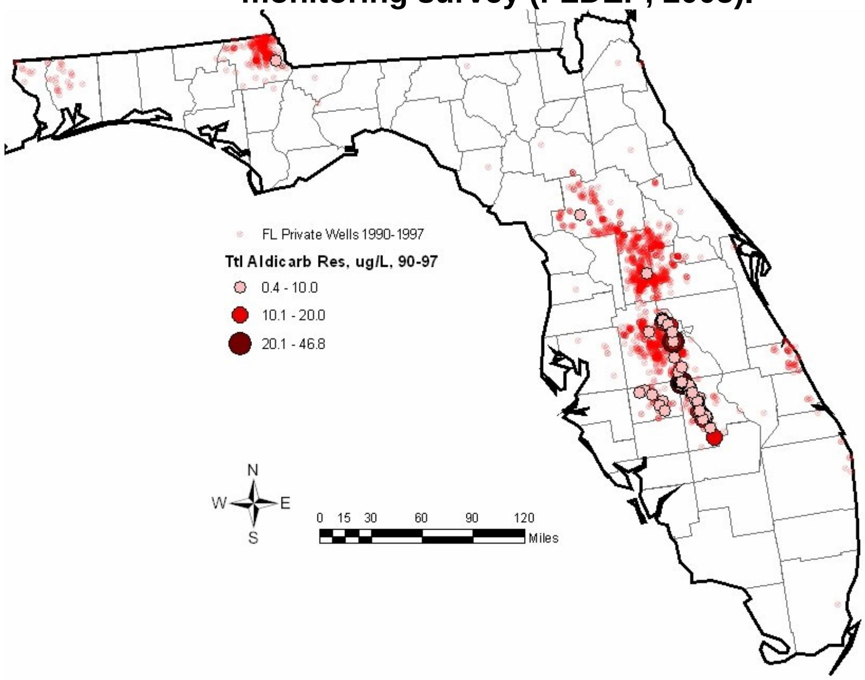


As with the Lake Wales Ridge comparisons, the model estimates and the monitoring data do not reflect the same time periods, so direct comparisons are not possible. The monitoring data (dark blue diamonds) are plotted over a time span from 1990 to 2005. The estimated concentrations from PRZM represent a range of variations over 30 years of simulations (1961-1990). The purpose of the figure is to evaluate how well the range in estimated concentrations assuming various well setback distances bound the monitoring data from the FL DEP program.

Concentrations of total aldicarb residues dropped off in subsequent years, potentially due to a combination of factors, including: (1) label changes which reduced application rates and applied well setback requirements; (2) a Florida program to install carbon filters or to pipe water in from treatment facilities when contamination was found; and (3) discontinued use of aldicarb in the vicinity of the contaminated areas (personal communication, FDEP).

Detections of aldicarb residues in the FDEP study have been concentrated largely along the Central Ridge of FL (Figure II.E.7.10). This information allowed EPA to identify conditions where aldicarb residues are likely to be found. The detections were associated with citrus production where the underlying soils had a high pesticide leaching potential (sandy, low organic matter content, high permeability).

Figure II.E.7. 12 – Location of detections in the FLDEP private well monitoring survey (FLDEP, 2005).



Method detection limits (MDL) for aldicarb residues vary over time in this monitoring study. In 1999 and earlier, the MDL for aldicarb sulfone and aldicarb sulfoxide ranged from 0.077 to 0.73 ug/L. Between 2000 and 2004, the MDL ranged from 2.1 to 3.3 ug/L for aldicarb sulfone and from 2.4 to 4.0 ug/L for aldicarb sulfoxide. Estimated concentrations for total aldicarb residues are below the high MDL for the individual degradates (Figure II.E.7.9) in those years. This further complicates interpretations regarding the effectiveness of label changes in reducing aldicarb residues in private wells. Because of the nature of this monitoring program the data are best used to identifying potential vulnerable areas in Florida.

iii. Private drinking water well monitoring by Bayer CropScience

Bayer CropScience conducted a retrospective ground water monitoring study to look for residues of aldicarb and its sulfoxide and sulfone metabolites in potable water from private wells in selected aldicarb use areas (MRIDs 46793701, 46793702, 46793703, 46793704, 46793705, 46793706). The study tested 1,673 drinking water wells and collected information on ground-water depth, well depth, casing depth, well type and age, soil types, recent aldicarb use history, crops, and distance of the well from the treated field. Although not a statistical survey, the study provided useful information on measured concentrations of aldicarb residues in drinking water wells in selected areas of the United States with recent/current aldicarb use – Southeastern US, excluding FL (800 wells), Mississippi Delta (169 wells), Pacific Northwest (303 wells), Texas (201 wells), and California (200 wells).

Aldicarb residues – predominantly the sulfoxide and sulfone metabolites – were detected in 10 percent of the wells sampled (160 out of 1,673), with the greatest frequencies of detections in the Southeastern US (16%, with a maximum detect of 2.9 ug/L) and the Mississippi Delta (9%, with a maximum detect of 2.6 ug/L) regions. Aldicarb detections showed a regional pattern, with this highest frequency of detects in Alabama (22%) and South Carolina (21%) in the Southeast region and southeastern Missouri/northeastern Arkansas (23%) in the Mississippi Delta region.

Frequency and magnitudes of detection for aldicarb residues were generally greater for wells located within 300 feet of a field (~10% of wells had detections); aldicarb residues were detected in 4-6% of wells located >300 feet from the field, although detections were < 1ug/L. Frequency and magnitudes of detection for aldicarb residues also were generally greater where the reported ground water was closer to the surface (23% detects for groundwater at <25 feet; 12% for groundwater at 25-50 feet), although residues were detected in 9% of wells where the depth to groundwater was not known or not reported, with maximum detects of up to 2.66 ug/L. Aldicarb residues were detected in 24-30% of wells with reported well depths of <100 feet. However, detects of up to 2.66 ug/L were reported for deeper or unknown well depths.

A comparison of wells located near fields with restricted soils (as identified in the TEMIK® 15G label) to those where the surrounding fields contained no restricted soils showed that, while the frequency of aldicarb detections was greater for wells near restricted soil types, the magnitude of aldicarb residues was greater for wells with no restricted soil types.

The single samples in the study are a snapshot of aldicarb residues in the well at the time of collection. While the residues in ground water are not expected to fluctuate greatly, fluctuation of residues over time occur in ground water (see USGS, 2006, for example). The Agency assumed that the single concentrations represented a median value for that particular well. The higher detects reported in the study coincided with the median values estimated in the southern coastal plain (represented by the GA peanut scenario) using PRZM with a 300-foot well setback and typical application rates at a 30-ft depth (Table II.E.7.12).

b. Carbofuran

The Agency's most recent risk assessment for carbofuran (March 7, 2006) noted that available targeted ground water monitoring, mostly from the 1980's, detected peak carbofuran concentrations ranging from 1.4 - 176 ug/l (ppb); several studies reported peak concentrations in the 50 ppb range with application rates comparable to rates currently used. More recent non-targeted ground water monitoring reports indicate fewer locations with detections in the last decade. While label changes may have impacted the reduced detections, non-targeted monitoring can also may miss important areas that could be susceptible to contamination. The most vulnerable drinking water sites appear to be shallow private wells near carbofuran use areas, where the ground water has a low pH.

The Agency used a prospective groundwater (PGW) monitoring study conducted on corn in the eastern shore of Maryland (Burt, 1982, 1983; USEPA, 1985) to estimate drinking water exposure from ground water for carbofuran. The measured peak concentration in this study was 65 ug/l, with a 95th percentile concentration of 18 ug/l and a 90-day average of 34 ug/l. This is similar to the estimated concentrations for carbofuran using PRZM (Table II.E.7.14).

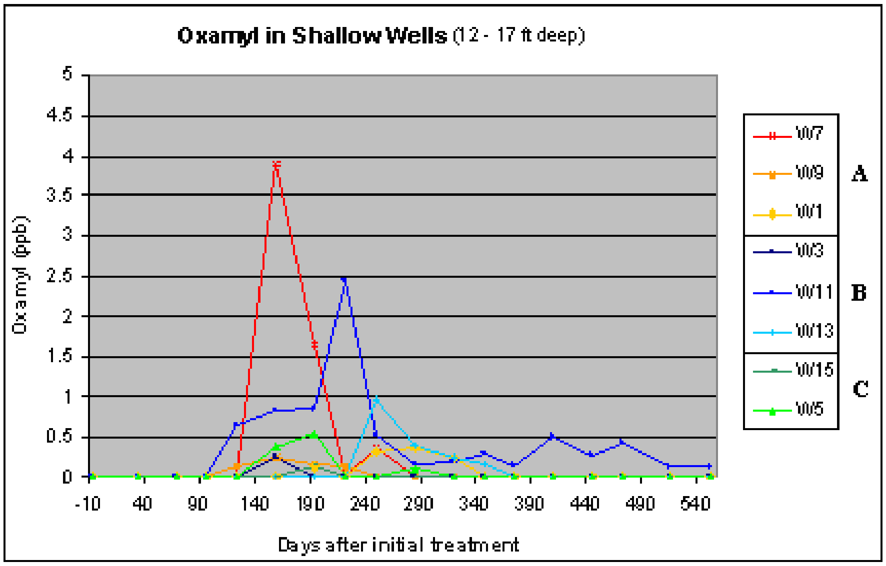
c. Oxamyl

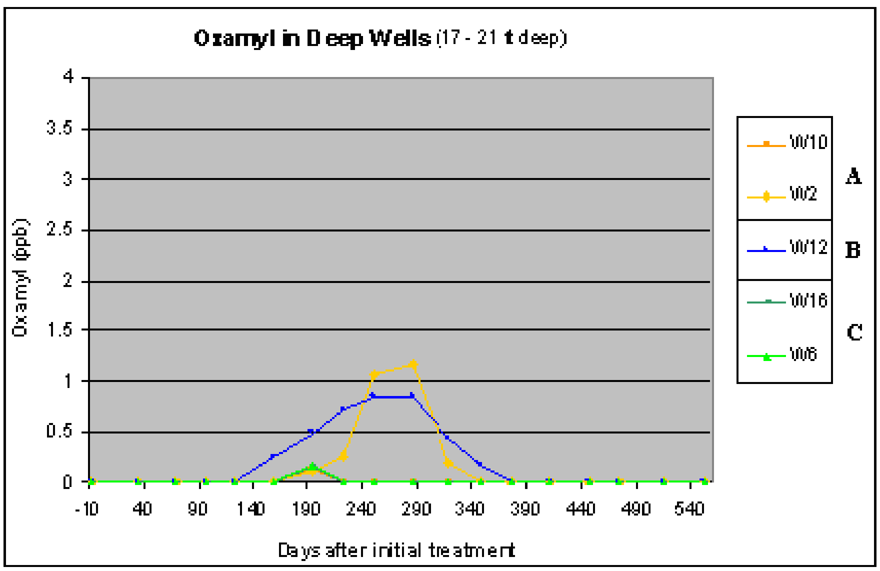
Monitoring results are much more limited for oxamyl than for aldicarb. Oxamyl has not been detected in the FDEP monitoring program (FDEP, 2005). It has only recently been included in the USGS monitoring study along the FL Central Ridge, but results are not yet available (Choquette 2005, personal communication).

A small-scale prospective groundwater (PGW) monitoring study was conducted for oxamyl and its oxime metabolite in Tarboro, North Carolina, in the coastal plain region. The study site represents highly vulnerable soil and hydrogeologic characteristics under cotton, soybeans, peanut, tobacco, and corn production. The Tarboro loamy sand soil at the site is characterized by excessive drainage and negligible runoff. It is low in organic matter content, has a sand to loamy sand texture with a layer of sandy loam to sandy clay loam at approximately two to four feet, and is acidic in pH. Details of the study can be found in Appendix II.E.2.

Oxamyl was applied in 5 ground broadcast applications at 6 to 8 day intervals. The first two applications were at a rate of 0.5 lb/A, and the rest at 1.0 lb/A, representing the maximum labeled seasonal rate using the minimum application intervals. The maximum detection in the shallow wells (12-17 feet deep) was 3.9 ppb (Figure II.E.7.11). Oxamyl was only detected in 5 deeper (17-21 feet) wells, at a range of 0.12 to 1.17 ppb. These concentrations are greater than that estimated by PRZM for oxamyl use on peanuts in the NC coastal plain (0.01 ug/l). However, the estimated exposures using PRZM represent a deeper well with the ground water surface at 30 feet and represent a typical application rate (1.25 lb/A vs 4 lb/A). The estimated concentrations for oxamyl at a 15-foot well depth in NC were similar in magnitude to the maximum detection (2.4 ppb maximum; 2.0 ppb at 95th percentile).

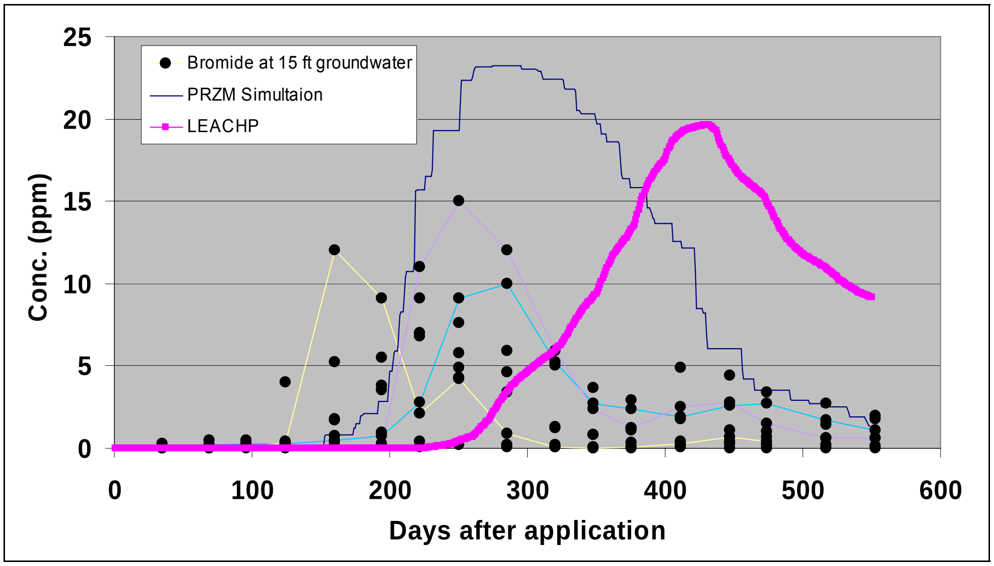
II.E.7. 13 – Oxamyl concentrations in shallow (top) and deep wells (bottom) in an Oxamyl PGW study in NC.





In the preliminary NMC CRA (USEPA, 2005b), EPA compared the movement of a conservative bromide trace modeled by PRZM and LEACHP with data from the PGW study in the shallow wells. Both models predicted higher concentrations than the data show. However, lateral groundwater velocities at the study site are high (51 feet per year). Because the groundwater flow transverses across the narrow side of the field, advection and dispersion could have caused lower concentrations than those modeled In Figure II.E.7.12.

II.E.7.14 – A comparison of modeled bromide concentrations from PRZM and LEACHP with monitoring data from the North Carolina PGW study.



5. Documentation for Spatial Extent of High Ground Water Exposure Potential Areas

For this assessment, OPP used the USDA NRCS classification for soil leaching potential for pesticides (USDA NRCS, 2003). Rating criteria are provided in Table II.E.7.16. The groundwater scenarios represent properties of soils identified as having a high soil leaching potential for pesticides. The soil leaching potential rating has been derived for all soils in the SSURGO county surveys for Florida (available for download from the USDA NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/). EPA used the criteria in Table II.E.7.16 to estimate the leaching potential for soils in counties in other states (for the NMC cumulative, OPP focused on coastal plain soils in VA, NC, SC, GA, and AL), as well as the Delmarva Peninsula (DE, MD, VA). The criteria could be used to identify soils that are vulnerable to pesticide leaching throughout the country. This list of soils should provide a more definitive list of vulnerable soils than the current list of soils based solely on soil texture and organic matter content.

Table II.E.7-16 USDA NRCS Criteria Used for Soil Leaching Potential for Pesticides (USDA NRCS, 2003).

Rating	Criteria
High	Hydrologic Group = A and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon <= 30 or Hydrologic Group = B and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon <= 9 and the K Factor is <= 0.48 or Hydrologic Group = B and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon <= 15 and the K Factor is <= 0.26
Low	Hydrologic Group = B and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon >= 35 and the K Factor is >= 0.40 or Hydrologic Group = B and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon >= 45 and the K Factor is >= 0.20 or Hydrologic Group = C and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon <= 10 and the K Factor is >= 0.28 or Hydrologic Group = C and % Surface Horizon Organic Matter Content X Depth of the First Soil Horizon >= 10
Very Low	Hydrologic Group = D
Intermediate	All other conditions

6. PRZM Scenario Input Files

a. FL Citrus (Central Ridge)

The Florida citrus scenario for the Central Ridge was used for both aldicarb and oxamyl. The *.inp is generic for both chemicals, with either “aldicarb” or “oxamyl” substituted in place of “pesticide” in the file names. Separate Record 33 lines specific to each chemical are listed below; to run the file, select the record that is applicable to the chemical being modeled. In Record 16, the timing of application is the same for both pesticides. A unit application rate of 1 kg/ha is used for the modeling runs. The resulting modeled concentrations are multiplied by the actual application rate, assuming that the concentrations are linearly proportional to the application rate.

FLCitrus_pesticide.INP

```
FL Central Ridge Citrus
Polk County;  Metfile: W12842.dvf
*** Record 3:
    0.78       0       0      33       1       2
*** Record 6 -- ERFLAG
      4
*** Record 7:
     0.1   0.093       1      10               4       1      354
*** Record 8
      1
*** Record 9
      1    0.25      30      60       3   50   50   50        0      450
*** Record 9a-d
      1      2
0101 0106
0.4   0.4
.010 .010
*** Record 10 -- NCPDS, the number of cropping periods
     01
*** Record 11
  030161  040161  311290       1
*** Record 12 -- PTITLE
wwww - 1 applications @ 01 kg/ha
*** Record 13
```

```
      30        1        0        0
*** Record 15 -- PSTNAM
wwww
*** Record 16
  010661  0 1  0.0     01     1     0
  010662  0 1  0.0     01     1     0
  010663  0 1  0.0     01     1     0
  010664  0 1  0.0     01     1     0
  010665  0 1  0.0     01     1     0
  010666  0 1  0.0      1     1     0
  010667  0 1  0.0      1     1     0
  010668  0 1  0.0      1     1     0
  010669  0 1  0.0      1     1     0
  010670  0 1  0.0      1     1     0
  010671  0 1  0.0      1     1     0
  010672  0 1  0.0      1     1     0
  010673  0 1  0.0      1     1     0
  010674  0 1  0.0      1     1     0
  010675  0 1  0.0      1     1     0
  010676  0 1  0.0      1     1     0
  010677  0 1  0.0      1     1     0
  010678  0 1  0.0      1     1     0
  010679  0 1  0.0      1     1     0
  010680  0 1  0.0      1     1     0
  010681  0 1  0.0      1     1     0
  010682  0 1  0.0      1     1     0
  010683  0 1  0.0      1     1     0
  010684  0 1  0.0      1     1     0
  010685  0 1  0.0      1     1     0
  010686  0 1  0.0      1     1     0
  010687  0 1  0.0      1     1     0
  010688  0 1  0.0      1     1     0
  010689  0 1  0.0      1     1     0
  010690  0 1  0.0      1     1     0
*** Record 17
       0        1        0
*** Record 19 -- STITLE
Astatula Hydro group A
*** Record 20
    1100            0    0    1    0    0    1    0    0    0
*** Record 26
       0        0        0
***Record 27
       4        0       .5      0.2
***Record 30
       4       10
*** Record 33 [for aldicarb]
       6
       1       25      1.3     0.06        0        0        0
          0.0126   0.0126        0
               1     0.06     0.01     0.75        0
       2       25      1.3     0.06        0        0        0
          0.0107   0.0107        0
               5     0.06     0.01     0.75        0
       3       25      1.3     0.06        0        0        0
          0.0070   0.0070        0
               5     0.06     0.01     0.75
       4       25      1.3     0.06        0        0        0
          0.0032   0.0032        0
               5     0.06     0.01     0.75
       5      200      1.3     0.06        0        0        0
          0.0014   0.0000        0
               5     0.06     0.01     0.25        0
       6      800      1.3     0.40        0        0        0
          0.0014   0.0000        0
               5      0.4     0.01     0.25        0
*** Record 33 [for oxamyl]
       6
       1       25      1.3     0.06        0        0        0
          0.0347   0.0347        0
               1     0.06     0.01     0.75        0
       2       25      1.3     0.06        0        0        0
          0.0289   0.0289        0
               5     0.06     0.01     0.75        0
       3       25      1.3     0.06        0        0        0
          0.0173   0.0173        0
               5     0.06     0.01     0.75
       4       25      1.3     0.06        0        0        0
          0.0058   0.0058        0
               5     0.06     0.01     0.75
       5      200      1.3     0.06        0        0        0
          0.0028   0.0000        0
               5     0.06     0.01     0.25        0
       6      800      1.3     0.40        0        0        0
```

```
          0.0028  0.0000       0
               5     0.4    0.01    0.25       0
***Record 40
       0
            YEAR      10            YEAR      10            YEAR      10   1
       1
       1  -----
       1    YEAR
       DCON1   TAVE 221 240  1000.0
```

b. FL Potato (Northeastern FL)

The Florida potato scenario for northeastern FL (St. John's County) was used for both aldicarb and carbofuran. The *.inp is generic for both chemicals, with either "aldicarb" or "carbofuran" substituted in place of "pesticide" in the file names. Separate Record 33 lines specific to each chemical are listed below; to run the file, select the record that is applicable to the chemical being modeled. In Record 16, the timing of application is the same for both pesticides. A unit application rate of 1 kg/ha is used for the modeling runs. The resulting modeled concentrations are multiplied by the actual application rate, assuming that the concentrations are linearly proportional to the application rate.

FLPotato_pesticide.INP

```
Florida Potato
pomona sand
*** Record 3:
    0.77       0       0      25       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.03     0.2       1   172.8              4       1     600
*** Record 8
       1
*** Record 9
       1     0.1      60      40       3   77   78   78       0      30
*** Record 9a-d
       1       3
0101 1601 0102
.164 .166 .167
.014 .014 .014
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  150261  010561  010661       1
  150262  010562  010662       1
  150263  010563  010663       1
  150264  010564  010664       1
  150265  010565  010665       1
  150266  010566  010666       1
  150267  010567  010667       1
  150268  010568  010668       1
  150269  010569  010669       1
  150270  010570  010670       1
  150271  010571  010671       1
  150272  010572  010672       1
  150273  010573  010673       1
  150274  010574  010674       1
  150275  010575  010675       1
  150276  010576  010676       1
  150277  010577  010677       1
  150278  010578  010678       1
  150279  010579  010679       1
  150280  010580  010680       1
  150281  010581  010681       1
  150282  010582  010682       1
  150283  010583  010683       1
  150284  010584  010684       1
  150285  010585  010685       1
  150286  010586  010686       1
  150287  010587  010687       1
  150288  010588  010688       1
  150289  010589  010689       1
  150290  010590  010690       1
```

```
*** Record 12 -- PTITLE
carbam - 1 applications @ 1 kg/ha
*** Record 13
      30        1        0        0
*** Record 15 -- PSTNAM
carbam
*** Record 16
  010361  0 1  0.0      1    1    0
  010362  0 1  0.0      1    1    0
  010363  0 1  0.0      1    1    0
  010364  0 1  0.0      1    1    0
  010365  0 1  0.0      1    1    0
  010366  0 1  0.0      1    1    0
  010367  0 1  0.0      1    1    0
  010368  0 1  0.0      1    1    0
  010369  0 1  0.0      1    1    0
  010370  0 1  0.0      1    1    0
  010371  0 1  0.0      1    1    0
  010372  0 1  0.0      1    1    0
  010373  0 1  0.0      1    1    0
  010374  0 1  0.0      1    1    0
  010375  0 1  0.0      1    1    0
  010376  0 1  0.0      1    1    0
  010377  0 1  0.0      1    1    0
  010378  0 1  0.0      1    1    0
  010379  0 1  0.0      1    1    0
  010380  0 1  0.0      1    1    0
  010381  0 1  0.0      1    1    0
  010382  0 1  0.0      1    1    0
  010383  0 1  0.0      1    1    0
  010384  0 1  0.0      1    1    0
  010385  0 1  0.0      1    1    0
  010386  0 1  0.0      1    1    0
  010387  0 1  0.0      1    1    0
  010388  0 1  0.0      1    1    0
  010389  0 1  0.0      1    1    0
  010390  0 1  0.0      1    1    0
*** Record 17
       0        0        0
*** Record 19 -- STITLE
pomona
*** Record 20
    1100           0    0    1    0    0    0    0    0    0
*** Record 26
       0        0        0
*** Record 30
       4       10
*** Record 33 [for aldicarb]
       9
       1       15     1.35    0.085        0        0        0
         0.01260 0.01260        0
               1    0.085     0.01     1.44        0
       2       10     1.58    0.065        0        0        0
         0.01260 0.01260        0
               5     0.01    0.065    0.144        0
       3       25     1.58    0.065        0        0        0
          .01050  .01050        0
               5     0.01    0.065    0.144        0
       4       30     1.45    0.135        0        0        0
         .005783 .005783        0
               5    0.135     0.01     1.44        0
       5       20      1.5    0.065        0        0        0
         0.00168  .00168        0
               5    0.065     0.01    0.144        0
       6       20      1.5    0.065        0        0        0
        0.011000 .000000        0
               5    0.065     0.01    0.144        0
       7       40      1.6     0.16        0        0        0
        0.011000 .000000        0
               5     0.16     0.01    0.144        0
       8       90     1.58    0.065        0        0        0
        0.011000 .000000        0
               5    0.065     0.01    0.144        0
       9      850     1.58    0.403        0        0        0
        0.001100 .000000        0
               5    0.403     0.01    0.144        0
*** Record 33 [for carbofuran]
       9
       1       15     1.35    0.085        0        0        0
         0.00217 0.00217        0
               1    0.085     0.01     1.44        0
       2       10     1.58    0.065        0        0        0
         0.00217 0.00217        0
               5     0.01    0.065    0.144        0
```

```
         3       25     1.58    0.065        0        0        0
           .001804 .001804        0
                  5     0.01    0.065    0.144        0
         4       30     1.45    0.135        0        0        0
           .001386 .001000        0
                  5    0.135     0.01     1.44        0
         5       20      1.5    0.065        0        0        0
           .001386 .000289        0
                  5    0.065     0.01    0.144        0
         6       20      1.5    0.065        0        0        0
           0.02475 .000000        0
                  5    0.065     0.01    0.144        0
         7       40      1.6     0.16        0        0        0
           0.02475 .000000        0
                  5     0.16     0.01    0.144        0
         8       90     1.58    0.065        0        0        0
           0.02475 .000000        0
                  5    0.065     0.01    0.144        0
         9      850     1.58    0.403        0        0        0
           0.02475 .000000        0
                  5    0.403     0.01    0.144        0
***Record 40
       0
            YEAR       10            YEAR       10            YEAR       10    1
       1
       1  -----
       1    YEAR
    DCON1   TAVE 213 232   1.0E3
```

c. Georgia Peanut/Cotton (Southern Coastal Plain)

The Georgia coastal plain (peanut/cotton) scenario was used for aldicarb. In Record 16, a unit application rate of 1 kg/ha is used for the modeling runs. The resulting modeled concentrations are multiplied by the actual application rate, assuming that the concentrations are linearly proportional to the application rate.

GACoaPlain_aldicarb.INP

```
Georgia Coastal Plain
Cook.txt
"Metfile: W93805.dvf (Tallahasee),"
*** Record 3:
    0.75    0.15       0      17       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.34     1.3       1      10               3       2     354
*** Record 8
       1
*** Record 9
       1     0.2      30      80       3   70   70   70       0     100
*** Record 9a-d
       1       3
0101 1601 0102
.474 .504 .532
.014 .014 .014
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  010561  010861  011061       1
  010562  010862  011062       1
  010563  010863  011063       1
  010564  010864  011064       1
  010565  010865  011065       1
  010566  010866  011066       1
  010567  010867  011067       1
  010568  010868  011068       1
  010569  010869  011069       1
  010570  010870  011070       1
  010571  010871  011071       1
  010572  010872  011072       1
  010573  010873  011073       1
  010574  010874  011074       1
  010575  010875  011075       1
  010576  010876  011076       1
  010577  010877  011077       1
  010578  010878  011078       1
```

```
  010579  010879  011079       1
  010580  010880  011080       1
  010581  010881  011081       1
  010582  010882  011082       1
  010583  010883  011083       1
  010584  010884  011084       1
  010585  010885  011085       1
  010586  010886  011086       1
  010587  010887  011087       1
  010588  010888  011088       1
  010589  010889  011089       1
  010590  010890  011090       1
*** Record 12 -- PTITLE
 - 1 applications @ 105 kg/ha
*** Record 13
      30       1       0       0
*** Record 15 -- PSTNAM
pesticide
*** Record 16
  010561  0 1  0.0  1.12    1    0
  010562  0 1  0.0  1.12    1    0
  010563  0 1  0.0  1.12    1    0
  010564  0 1  0.0  1.12    1    0
  010565  0 1  0.0  1.12    1    0
  010566  0 1  0.0  1.12    1    0
  010567  0 1  0.0  1.12    1    0
  010568  0 1  0.0  1.12    1    0
  010569  0 1  0.0  1.12    1    0
  010570  0 1  0.0  1.12    1    0
  010571  0 1  0.0  1.12    1    0
  010572  0 1  0.0  1.12    1    0
  010573  0 1  0.0  1.12    1    0
  010574  0 1  0.0  1.12    1    0
  010575  0 1  0.0  1.12    1    0
  010576  0 1  0.0  1.12    1    0
  010577  0 1  0.0  1.12    1    0
  010578  0 1  0.0  1.12    1    0
  010579  0 1  0.0  1.12    1    0
  010580  0 1  0.0  1.12    1    0
  010581  0 1  0.0  1.12    1    0
  010582  0 1  0.0  1.12    1    0
  010583  0 1  0.0  1.12    1    0
  010584  0 1  0.0  1.12    1    0
  010585  0 1  0.0  1.12    1    0
  010586  0 1  0.0  1.12    1    0
  010587  0 1  0.0  1.12    1    0
  010588  0 1  0.0  1.12    1    0
  010589  0 1  0.0  1.12    1    0
  010590  0 1  0.0  1.12    1    0
*** Record 17
       0       1       0
*** Record 19 -- STITLE
"Tifton, loamy sand,  HYDG: B"
*** Record 20
     1100          0    0    1    0    0    2    0    0    0
*** Record 26
       0       0       0
*** Record 27   allow up to 5% runoff during sprinkler
       3       0      .5      .15
*** Record 30
       4     10.
*** Record 33
       6
       1      25    1.50   0.106       0       0       0
          0.0126  0.0126       0
             1.0   0.106   0.046    0.75       0
       2      25    1.50   0.106       0       0       0
          0.0105  0.0105       0
             5.0   0.106   0.046    0.75       0
       3      25    1.60   0.156       0       0       0
          0.0063  0.0063       0
             5.0   0.156   0.046    0.25       0
       4      25    1.60   0.156       0       0       0
          0.0021  0.0021       0
             5.0   0.156   0.046    0.25       0
       5     250    1.70   0.156       0       0       0
          0.0014  0.0014       0
               5   0.156   0.046     .75       0
       6     750    1.70   0.357       0       0       0
          0.0014  0.0014       0
               5   0.357   0.085    0.75       0
***Record 40
       0
            YEAR      10          YEAR      10          YEAR      10   1
```

```
     1
     1  -----
     1    YEAR
  DCON1   TAVE 221 240  1000.0
```

d. North Carolina Cotton/Peanut (Eastern Coastal Plain)

The North Carolina scenario was used for both aldicarb and oxamyl. The *.inp is generic for both chemicals, with either “aldicarb” or “oxamyl” substituted in place of “pesticide” in the file names. Separate Record 33 lines specific to each chemical are listed below; to run the file, select the record that is applicable to the chemical being modeled. In Record 16, the timing of application is the same for both pesticides. A unit application rate of 1 kg/ha is used for the modeling runs. The resulting modeled concentrations are multiplied by the actual application rate, assuming that the concentrations are linearly proportional to the application rate.

NCCoaPlain_pesticide.INP

```
NC_gw.txt
"MLRA 133A; Metfile: W13722.dvf (old: Met133A.met),"
*** Record 3:
    0.75    0.15       0      17       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.34     1.3       1      10               3       1     354
*** Record 8
       1
*** Record 9
       1     0.2      60      98       3   60   60   60       0     100
*** Record 9a-d
       1       3
0101 1601 0102
  .2    .2    .2
 .01   .01   .01
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  010561  010861  011061       1
  010562  010862  011062       1
  010563  010863  011063       1
  010564  010864  011064       1
  010565  010865  011065       1
  010566  010866  011066       1
  010567  010867  011067       1
  010568  010868  011068       1
  010569  010869  011069       1
  010570  010870  011070       1
  010571  010871  011071       1
  010572  010872  011072       1
  010573  010873  011073       1
  010574  010874  011074       1
  010575  010875  011075       1
  010576  010876  011076       1
  010577  010877  011077       1
  010578  010878  011078       1
  010579  010879  011079       1
  010580  010880  011080       1
  010581  010881  011081       1
  010582  010882  011082       1
  010583  010883  011083       1
  010584  010884  011084       1
  010585  010885  011085       1
  010586  010886  011086       1
  010587  010887  011087       1
  010588  010888  011088       1
  010589  010889  011089       1
  010590  010890  011090       1
*** Record 12 -- PTITLE
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx kg/ha
*** Record 13
      30       1       0       0
*** Record 15 -- PSTNAM
```

```
oxamyl
*** Record 16
  010561  0 1  0.0    01    1    0
  010562  0 1  0.0    01    1    0
  010563  0 1  0.0    01    1    0
  010564  0 1  0.0    01    1    0
  010565  0 1  0.0    01    1    0
  010566  0 1  0.0     1    1    0
  010567  0 1  0.0     1    1    0
  010568  0 1  0.0     1    1    0
  010569  0 1  0.0     1    1    0
  010570  0 1  0.0     1    1    0
  010571  0 1  0.0     1    1    0
  010572  0 1  0.0     1    1    0
  010573  0 1  0.0     1    1    0
  010574  0 1  0.0     1    1    0
  010575  0 1  0.0     1    1    0
  010576  0 1  0.0     1    1    0
  010577  0 1  0.0     1    1    0
  010578  0 1  0.0     1    1    0
  010579  0 1  0.0     1    1    0
  010580  0 1  0.0     1    1    0
  010581  0 1  0.0     1    1    0
  010582  0 1  0.0     1    1    0
  010583  0 1  0.0     1    1    0
  010584  0 1  0.0     1    1    0
  010585  0 1  0.0     1    1    0
  010586  0 1  0.0     1    1    0
  010587  0 1  0.0     1    1    0
  010588  0 1  0.0     1    1    0
  010589  0 1  0.0     1    1    0
  010590  0 1  0.0     1    1    0
*** Record 17
       0       1       0
*** Record 19 -- STITLE
"xxxxxxxxxxxxxxxxx"
*** Record 20
    1100           0   0   1   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 30
       4     10.
*** Record 33 [for Aldicarb]
       6
       1      25    1.68    0.09       0       0       0
          0.0126   .0126       0
               1    0.09    0.03    0.61       0
       2      25    1.85   0.213       0       0       0
          0.0105  0.0105       0
               5   0.213   0.063     0.2       0
       3      25     1.7    0.18       0       0       0
          0.0063  0.0063       0
               5    0.18    0.12    0.05       0
       4      25     1.7    0.18       0       0       0
          0.0021  0.0021       0
               5    0.18    0.12    0.05       0
       5     150     1.6    0.31       0       0       0
          0.0014     0.0       0
               5    0.31     0.2    0.05       0
       6     850     1.6    0.37       0       0       0
          0.0014     0.0       0
               5    0.37     0.2    0.05       0
*** Record 33 [for Oxamyl]
       6
       1      25    1.68    0.09       0       0       0
          0.0347   .0347       0
               1    0.09    0.03    0.61       0
       2      25    1.85   0.213       0       0       0
          0.0289  0.0289       0
               5   0.213   0.063     0.2       0
       3      25     1.7    0.18       0       0       0
          0.0173  0.0173       0
               5    0.18    0.12    0.05       0
       4      25     1.7    0.18       0       0       0
          0.0058  0.0058       0
               5    0.18    0.12    0.05       0
       5     150     1.6    0.31       0       0       0
          0.0029     0.0       0
               5    0.31     0.2    0.05       0
       6     850     1.6    0.37       0       0       0
          0.0029     0.0       0
               5    0.37     0.2    0.05       0
***Record 40
       0
```

```
        YEAR      10            YEAR      10            YEAR      10   1
    1
    1  -----
    1    YEAR
DCON1    TAVE 221 240  1000.0
```

e. Delmarva Sweet Corn/Cucurbits

The Delmarva scenario was used for carbofuran. In Record 16, a unit application rate of 1 kg/ha is used for the modeling runs. The resulting modeled concentrations are multiplied by the actual application rate, assuming that the concentrations are linearly proportional to the application rate.

Delmarva_carbofuran.INP

```
Delmarva Corn-cucurbits, 300 day hydrolysis for carbofuran
Group A Soil
*** Record 3:
    0.77     0.5       0      10       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
       0       0       0      10               1     0.5     354
*** Record 8
       1
*** Record 9
       1    0.15     100      90       3   65   65   65       0     250
*** Record 9a-d
       1       2
0101 1601
.813 .830
.011 .011
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  150461  150761  200761       1
  150462  150762  200762       1
  150463  150763  200763       1
  150464  150764  200764       1
  150465  150765  200765       1
  150466  150766  200766       1
  150467  150767  200767       1
  150468  150768  200768       1
  150469  150769  200769       1
  150470  150770  200770       1
  150471  150771  200771       1
  150472  150772  200772       1
  150473  150773  200773       1
  150474  150774  200774       1
  150475  150775  200775       1
  150476  150776  200776       1
  150477  150777  200777       1
  150478  150778  200778       1
  150479  150779  200779       1
  150480  150780  200780       1
  150481  150781  200781       1
  150482  150782  200782       1
  150483  150783  200783       1
  150484  150784  200784       1
  150485  150785  200785       1
  150486  150786  200786       1
  150487  150787  200787       1
  150488  150788  200788       1
  150489  150789  200789       1
  150490  150790  200790       1
*** Record 12 -- PTITLE
anything - 1 applications @ 1 kg/ha
*** Record 13
      30       1       0       0
*** Record 15 -- PSTNAM
anything
*** Record 16
  150461  0 1  0.0     1    1    0
  150462  0 1  0.0     1    1    0
  150463  0 1  0.0     1    1    0
  150464  0 1  0.0     1    1    0
  150465  0 1  0.0     1    1    0
```

```
  150466  0 1  0.0     1    1    0
  150467  0 1  0.0     1    1    0
  150468  0 1  0.0     1    1    0
  150469  0 1  0.0     1    1    0
  150470  0 1  0.0     1    1    0
  150471  0 1  0.0     1    1    0
  150472  0 1  0.0     1    1    0
  150473  0 1  0.0     1    1    0
  150474  0 1  0.0     1    1    0
  150475  0 1  0.0     1    1    0
  150476  0 1  0.0     1    1    0
  150477  0 1  0.0     1    1    0
  150478  0 1  0.0     1    1    0
  150479  0 1  0.0     1    1    0
  150480  0 1  0.0     1    1    0
  150481  0 1  0.0     1    1    0
  150482  0 1  0.0     1    1    0
  150483  0 1  0.0     1    1    0
  150484  0 1  0.0     1    1    0
  150485  0 1  0.0     1    1    0
  150486  0 1  0.0     1    1    0
  150487  0 1  0.0     1    1    0
  150488  0 1  0.0     1    1    0
  150489  0 1  0.0     1    1    0
  150490  0 1  0.0     1    1    0
*** Record 17
       0       0       0
*** Record 19 -- STITLE
Hyd group A
*** Record 20
    1100          0   0   1   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 30
       4      20
*** Record 33
       7
       1      25     1.3    0.08       0       0       0
         0.00355 .002166       0
               1    0.08    0.01     0.6       0
       2      25     1.3    0.08       0       0       0
         0.00319 .001805       0
               5    0.08    0.01     0.6       0
       3      25     1.3    0.08       0       0       0
         0.00247 .001083       0
               5    0.08    0.01     0.6       0
       4      25     1.3    0.08       0       0       0
         0.00231 .000361       0
               5    0.08    0.01     0.6       0
       5      50     1.5    0.19       0       0       0
        0.002310     0.0       0
               1    0.19    0.01     0.2       0
       6     100     1.4     0.2       0       0       0
        0.002310    0.00       0
               5     0.2    0.01    0.05       0
       7     850     1.4    0.47       0       0       0
        0.002310    0.00       0
               5    0.47    0.01    0.05       0
***Record 40
       0
            YEAR       10             YEAR       10             YEAR       10    1
       1
       1  -----
       1    YEAR
    DCON1   TAVE 151 170   1.0E3
```

f. Central Washington Potato