Summary of Monitoring Activity – 2012

Sampling Details

The Agricultural Chemicals & Groundwater Protection Program sampled the following networks in 2012: Weld County monitoring (MW), domestic (DW), and irrigation (IW) wells, Lower South Platte, Arkansas River Basin, and Lincoln County. Lincoln County was a reconnaissance sampling of existing domestic and stock use groundwater wells while the other networks are dedicated networks that have been sampled several times since 1992. Results from 2012 are briefly compared to historical results in the *General Findings* along with any noteworthy discoveries. Table 1 summarizes the sampling logistics.

TABLE 1 SUMMARY OF MONITORING ACTIVITIES CONDUCTED IN 2012

Network	# Wells In Network	# Samples Collected	Sampling Period	Lab Analyses Conducted
Weld County MWs	22	50	06/19/2012 - 10/11/2012	CDA (Pesticide & Anion)
Weld County DWs	13	12	08/10/2012 - 08/16/2012	CDA (Pesticide & Anion)
Weld County IWs	33	20	8/7/2012 - 8/16/2012	CDA (Anion)
Lower South Platte MWs	22	20	8/21/2012 - 8/31/2012	CDA (Pesticide & Anion)
Arkansas River Basin MWs	19	16	9/24/2012 - 10/4/2012	CDA (Pesticide & Anion)
Lincoln County Recon	28	28	10/22/2012 - 10/30/2012	CDA (Pesticide & Anion); CSU (Cation & Dissolved Metals)
TOTAL	137	146		

Aside from the normal sampling that took place in 2012, ten of the Weld County MWs were sampled four times between June and October. This was done to determine if any considerable variability was occurring in water quality since the Program normally conducts only one sampling event of the Weld County MW network in June of every year.

The normal analysis suite for groundwater samples includes anion and 100+ pesticide compounds and nearly all samples undergo a complete analysis. Some exceptions for 2012 are that only nine of twelve Weld County DWs were run for pesticide analysis and Weld County IWs are only analyzed for anions. All samples collected in Lincoln County also underwent further analysis at Colorado State University's Soil, Plant, and Water Testing Laboratory for cations and some of them for dissolved metals. The analytes screened for at the CDA and CSU laboratories and their corresponding reporting limits are presented in Table 5 at the end of this summary.

General Findings

Overall, the nitrate values discovered in all well networks, compared with historical sampling data, are within what is expected of each respective network. In Weld County, median NO_3-N values for the MWs and DWs were near the long-term median but conversely the IW median for 2012 was a little higher than historical values. This could be

an artifact of the particular collection of IWs sampled in 2012 since different combinations of wells may be sampled every year due to a variety of reasons, or it could be evidence of year to year variability that occurs. The median NO_3-N for the Lower South Platte and Arkansas River Basin MWs are within historical findings.

TABLE 2 NITRATE-NITROGEN RESULTS FOR 2012

2012 Nitrate-Nitrogen Findings by Network			
Well Network	**# Years Sampled**	**# ≥ STD**	**2012 Median**
Weld County MWs	18	17	18.0
Weld County DWs	18	6	9.2
Weld County IWs	18	12	17.7
Lower South Platte	4	5	6.1
Arkansas River Basin	5	0	2.5
Lincoln County	1	4	4.8

 # ≥ STD is the number of samples with NO_3-N at or above the U.S. EPA Drinking Water Standard of 10.0 in 2012; All values are in units of mg L^{-1} or parts-per-million except # Years Sampled

As has been the case historically, more than 60% of samples collected in Weld County, during their normally scheduled sampling times, were above the U.S. EPA Drinking Water Standard of 10.0 mg L^{-1} or parts-per-million (ppm) in 2012. The following table shows each network's median NO_3-N values and number of wells over the U.S. EPA standard.

A few of the ten Weld County MWs that were sampled four times in 2012 showed significant temporal variability in NO_3-N concentration. More in-depth discussion of the findings of these multiple sampling events will be had in an update to the Weld County Long-Term Fact Sheet in early 2014. To briefly summarize the findings however, it was discovered that nitrate-nitrogen concentration variability ranged from a decrease of 13.7 ppm to an increase of 45.3 ppm between individual sampling events conducted in June, August, September, and October. Overall

TABLE 3 NITRATE SEASONAL VARIABILITY AND LONG-TERM MEDIAN RANGE FOR SELECT WELD COUNTY MONITORING WELLS SAMPLED MULTIPLE TIMES IN 2012

Weld County MW Nitrate-Nitrogen: 2012 and Historical Concentrations					
Well	**AT Median Range**	**June**	**August**	**September**	**October**
WL-M-003A	27.1 - 35.5	34.3	39.2	43.2	44.0
WL-M-008	16.5 - 23.2	58.8	71.8	58.1	69.4
WL-M-009	3.0 - 4.5	1.4	0.8	0.7	3.3
WL-M-011	11.2 - 23.3	4.8	18.6	4.8	1.6
WL-M-013	20.1 - 27.4	10.6	6.4	7.8	6.4
WL-M-022	8.7 - 13.2	22.3	NS	3.8	NS
WL-M-040	64.6 - 86.3	63.2	61.2	57.7	103.0
WL-M-401	2.8 - 4.5	3.2	2.6	3.5	3.5
WL-M-501	14.7 - 34.0	16.5	10.6	9.6	11.1
WL-M-901	16.7 - 25.9	11.6	16.6	15.7	16.5

AT Median Range is the median range for all years sampled; 'NA' value means trend is not available; 'NS' value means well was not sampled; All values are in units of mg L^{-1} or parts-per-million except p-val.

concentrations within these ten MWs ranged from 0.7 to 103 ppm NO_3-N across the four sampling events. These multiple events were done as part of an ongoing investigation of nitrate trend analysis of long-term Weld County data. Since all trend calculations are being based on only data collected once per year in June, the Program was curious to know if this time of year indeed represented the time of year in which the greatest impact to water quality is occurring within the irrigated agriculture land use. The results in Table 3 show that further evaluation is necessary across all 22 MWs in the network as some considerable variability was discovered.

There were a total of 180 detections of 17 different pesticide compounds. The majority (75%) of detections were of metolachlor ESA and metolachlor OA (breakdown products of metolachlor – Tradename[1] Bicep) comprising 83% of those detections and more than 60% of the total detections. The number of detections discovered in each sampled network in 2012 can be seen in Table 4. The numbers and types of pesticide detections are in line with what has been discovered historically for the various networks except for the increase in the number of thiamethoxam (Tradename Helix) detections and the first ever detection of a fenamiphos (Tradename Nemacur) breakdown product (fenamiphos sulfone) in the Weld County Monitoring network. Metolachlor ESA and metolachlor OA have seen 124 and 68 detections respectively since the program first started looking for these compounds in 2009. They have been discovered in the groundwater of every network sampled since 2009 except for the Front Range Urban and Lincoln County networks. There was a detection of atrazine in a Lower South Platte monitoring well that exceeded the U.S. EPA drinking water standard of 3.0 ppb. This is the fifth time the atrazine standard has been exceeded in the monitoring history of the program, the fourth time for wells sampling groundwater within the South Platte Basin watershed, but just the first time for this particular well.

Conclusion

The 2012 sampling year saw the continued discovery of nitrate-nitrogen above the U.S. EPA drinking water standard of 10.0 ppm in areas with historical evidence of groundwater contamination. The multiple sampling events conducted on ten Weld County MWs showed evidence that nitrate-nitrogen concentrations may have greater in season variability than was initially expected. The newly sampled Lincoln County network did not turn up any extensive groundwater contamination which falls in line with the program's classification of groundwater in the area as having low vulnerability to agrichemical contamination. The pesticide compounds detected in Weld County MWs are in line with historical discoveries, with the previously noted exceptions. A Lower South Platte MW had a detection of atrazine over the U.S. EPA drinking water standard of 3.0 ppb.

[1] Tradenames are used as example for a product that contains a particular active ingredient or pesticide compound and do not indicate that the specific product has been studied and/or detected.

All of the data seen and/or discussed in this monitoring summary can be queried and downloaded from the program's online water quality database found at: http://www.erams.com/co_groundwater.

TABLE 4 PESTICIDE DETECTION RESULTS FOR 2012 MEASURED IN PARTS-PER-BILLION (PPB)

Pesticide Compounds Detected in Various Networks in Sampling Year 2012				
Pesticide Active Ingredient	**Network**	**# Detects**	**Conc. Range [ppb]**	**Note**
Metolachlor ESA	Arkansas River Basin	3	0.35 - 1.27	No Drinking Water Standard
	Lower South Platte	15	0.13 - 1.84	
	Weld County Domestic	6	0.55 - 2.79	
	Weld County Monitoring	46	0.21 - 25.61	
Metolachlor	Lower South Platte	1	1.86	U.S. EPA Drinking Water HAL 700 ppb
	Weld County Monitoring	11	0.12 - 23.39	
Metolachlor OA	Lower South Platte	3	0.22 - 0.72	No Drinking Water Standard
	Weld County Domestic	4	0.26 - 0.79	
	Weld County Monitoring	35	0.13 - 13.50	
Dicamba	Weld County Monitoring	1	3.56	U.S. EPA Drinking Water HAL 4000 ppb
Atrazine	Lower South Platte	1	3.40	U.S. EPA Drinking Water MCL 3.0 ppb
	Weld County Monitoring	2	0.20 - 0.28	
Dimethenamid ESA	Weld County Monitoring	1	1.69	No Drinking Water Standard
Diflufenzopyr	Arkansas River Basin	2	0.11 - 0.12	U.S. EPA HHBP Chronic 1820 ppb
	Weld County Monitoring	1	1.58	
Alachlor ESA	Lower South Platte	4	0.24 - 1.31	No Drinking Water Standard
	Weld County Monitoring	3	0.33 - 0.64	
Thiamethoxam	Lower South Platte	1	0.24	U.S. EPA HHBP Chronic 84 ppb
	Weld County Domestic	1	0.22	
	Weld County Monitoring	11	0.22 - 1.27	
Desethyl Atrazine	Lower South Platte	5	0.13 - 1.23	No Drinking Water Standard
	Lincoln County	1	0.31	
	Weld County Monitoring	3	0.21 - 0.33	
Imazapyr	Arkansas River Basin	1	0.95	U.S. EPA HHBP Chronic 17500 ppb
	Weld County Monitoring	3	0.24 - 0.53	
Fenamiphos sulfone	Weld County Monitoring	1	0.77	No Drinking Water Standard
Acetochlor ESA	Lower South Platte	1	0.72	No Drinking Water Standard
MCPA	Weld County Monitoring	1	0.70	U.S. EPA Drinking Water HAL 30 ppb
Bromacil	Weld County Monitoring	1	0.60	U.S. EPA Drinking Water HAL 70 ppb
Prometon	Weld County Monitoring	7	0.23 - 0.52	U.S. EPA Drinking Water HAL 40 ppb
Desisopropyl Atrazine	Lower South Platte	1	0.36	No Drinking Water Standard
	Weld County Monitoring	3	0.10 - 0.30	

Conc. Range [ppb] is the range of concentration the detected pesticide active ingredient was discovered at; **HAL** is Health Advisory Level; **MCL** is Maximum Contaminant Level; **HHBP** is Human Health Benchmark for Pesticides

TABLE 5 REPORTING LIMITS FOR ALL LABORATORY ANALYTES MEASURED IN 2012

Analytes Measured of Groundwater Samples† Collected in 2012							
Analyte Name	**Reporting Limit**	**Units**	**Laboratory**	**Analyte Name**	**Reporting Limit**	**Units**	**Laboratory**
2,4-D	0.2	ug/L	CDA Groundwater Lab	Propazine	0.1	ug/L	CDA Groundwater Lab
2,4-DB	0.2	ug/L	CDA Groundwater Lab	Propoxur	0.1	ug/L	CDA Groundwater Lab
2,4-DP	0.1	ug/L	CDA Groundwater Lab	Prosulfuron	0.1	ug/L	CDA Groundwater Lab
3-Hydroxycarbofuran	0.5	ug/L	CDA Groundwater Lab	Pyrimethanil	0.1	ug/L	CDA Groundwater Lab
Acetochlor	0.1	ug/L	CDA Groundwater Lab	Quinclorac	0.1	ug/L	CDA Groundwater Lab
Acetochlor ESA	0.2	ug/L	CDA Groundwater Lab	Simazine	0.1	ug/L	CDA Groundwater Lab
Acetochlor OA	0.1	ug/L	CDA Groundwater Lab	Sulfentrazone	0.5	ug/L	CDA Groundwater Lab
Acifluorfen	0.1	ug/L	CDA Groundwater Lab	Sulfometuron methyl	0.1	ug/L	CDA Groundwater Lab
Alachlor	0.1	ug/L	CDA Groundwater Lab	Sulfosulfuron	0.2	ug/L	CDA Groundwater Lab
Alachlor ESA	0.2	ug/L	CDA Groundwater Lab	Tebuconazole	0.1	ug/L	CDA Groundwater Lab
Alachlor OA	0.2	ug/L	CDA Groundwater Lab	Tebufenozide	0.1	ug/L	CDA Groundwater Lab
Aldicarb	0.2	ug/L	CDA Groundwater Lab	Tebuthiuron	0.1	ug/L	CDA Groundwater Lab
Aldicarb sulfone	0.2	ug/L	CDA Groundwater Lab	Terbacil	0.5	ug/L	CDA Groundwater Lab
Aldicarb sulfoxide	0.2	ug/L	CDA Groundwater Lab	Thiamethoxam	0.2	ug/L	CDA Groundwater Lab
Aminopyralid	0.1	ug/L	CDA Groundwater Lab	Triadimefon	0.1	ug/L	CDA Groundwater Lab
Atrazine	0.1	ug/L	CDA Groundwater Lab	Triallate	0.5	ug/L	CDA Groundwater Lab
Azoxystrobin	0.1	ug/L	CDA Groundwater Lab	Triasulfuron	0.2	ug/L	CDA Groundwater Lab
Bentazon	0.5	ug/L	CDA Groundwater Lab	Trichlorfon	0.2	ug/L	CDA Groundwater Lab
Bromacil	0.5	ug/L	CDA Groundwater Lab	Triclopyr	0.5	ug/L	CDA Groundwater Lab
Carbofuran	0.1	ug/L	CDA Groundwater Lab	Triticonazole	0.1	ug/L	CDA Groundwater Lab
Chlorantraniliprole	0.1	ug/L	CDA Groundwater Lab	Chlorothalonil	0.2	ug/L	CDA Groundwater Lab
Chlorimuron ethyl	0.5	ug/L	CDA Groundwater Lab	DCPA	0.2	ug/L	CDA Groundwater Lab
Chlorsulfuron	0.5	ug/L	CDA Groundwater Lab	Dichlobenil	0.2	ug/L	CDA Groundwater Lab
Clopyralid	1.0	ug/L	CDA Groundwater Lab	Dichlorvos	0.2	ug/L	CDA Groundwater Lab
Cyanazine	0.1	ug/L	CDA Groundwater Lab	Disulfoton	0.2	ug/L	CDA Groundwater Lab
Cyproconazole	0.1	ug/L	CDA Groundwater Lab	Disulfoton sulfone	0.2	ug/L	CDA Groundwater Lab
Cyromazine	0.5	ug/L	CDA Groundwater Lab	Disulfoton sulfoxide	1.0	ug/L	CDA Groundwater Lab
Desethyl Atrazine	0.2	ug/L	CDA Groundwater Lab	Ethoprop	0.2	ug/L	CDA Groundwater Lab
Desisopropyl Atrazine	0.1	ug/L	CDA Groundwater Lab	Fenamiphos	0.5	ug/L	CDA Groundwater Lab
Dicamba	0.5	ug/L	CDA Groundwater Lab	Fenamiphos sulfone	0.5	ug/L	CDA Groundwater Lab
Diflufenzopyr	0.1	ug/L	CDA Groundwater Lab	Hexazinone	0.5	ug/L	CDA Groundwater Lab
Dimethenamid	0.1	ug/L	CDA Groundwater Lab	Lindane	0.2	ug/L	CDA Groundwater Lab
Dimethenamid ESA	0.1	ug/L	CDA Groundwater Lab	Linuron	0.5	ug/L	CDA Groundwater Lab
Dimethenamid OA	0.1	ug/L	CDA Groundwater Lab	Malathion	0.2	ug/L	CDA Groundwater Lab
Dimethoate	0.2	ug/L	CDA Groundwater Lab	Metalaxyl	0.2	ug/L	CDA Groundwater Lab
Dinotefuran	0.2	ug/L	CDA Groundwater Lab	Metribuzin	0.2	ug/L	CDA Groundwater Lab
Diuron	0.2	ug/L	CDA Groundwater Lab	Norflurazon	0.2	ug/L	CDA Groundwater Lab
Ethofumesate	0.2	ug/L	CDA Groundwater Lab	Prometon	0.2	ug/L	CDA Groundwater Lab
Florasulam	0.1	ug/L	CDA Groundwater Lab	Vinclozolin	0.2	ug/L	CDA Groundwater Lab
Flufenacet	0.1	ug/L	CDA Groundwater Lab	Br	0.05	mg/L	CDA Groundwater Lab
Flumetsulam	0.1	ug/L	CDA Groundwater Lab	Cl	0.05	mg/L	CDA Groundwater Lab
Halofenozide	0.1	ug/L	CDA Groundwater Lab	F	0.05	mg/L	CDA Groundwater Lab
Halosulfuron methyl	0.2	ug/L	CDA Groundwater Lab	Nitrate-nitrogen	0.05	mg/L	CDA Groundwater Lab
Hydroxy Atrazine	0.2	ug/L	CDA Groundwater Lab	Nitrite-nitrogen	0.05	mg/L	CDA Groundwater Lab
Imazamethabenz ester	0.1	ug/L	CDA Groundwater Lab	P (Total)	0.05	mg/L	CDA Groundwater Lab
Imazamox	0.2	ug/L	CDA Groundwater Lab	SO4	0.05	mg/L	CDA Groundwater Lab
Imazapic	0.1	ug/L	CDA Groundwater Lab	Al	0.02	mg/L	CDPHE Lab
Imazapyr	0.2	ug/L	CDA Groundwater Lab	As	0.1	ug/L	CDPHE Lab
Imazethapyr	0.2	ug/L	CDA Groundwater Lab	Cd	0.07	ug/L	CDPHE Lab
Imidacloprid	0.2	ug/L	CDA Groundwater Lab	Cr	0.01	mg/L	CSU Soil, Plant and Water Lab
Isoxaflutole	0.1	ug/L	CDA Groundwater Lab	Cu	0.01	mg/L	CSU Soil, Plant and Water Lab
Kresoxim methyl	0.2	ug/L	CDA Groundwater Lab	Fe	0.01	mg/L	CSU Soil, Plant and Water Lab
MCPA	0.2	ug/L	CDA Groundwater Lab	Pb	0.005	mg/L	CSU Soil, Plant and Water Lab
MCPP	0.2	ug/L	CDA Groundwater Lab	Mg	0.06	ug/L	CDPHE Lab
Metconazole	0.1	ug/L	CDA Groundwater Lab	Mn	0.01	mg/L	CSU Soil, Plant and Water Lab
Methomyl	0.2	ug/L	CDA Groundwater Lab	Ni	2.0	ug/L	CDPHE Lab
Metolachlor	0.1	ug/L	CDA Groundwater Lab	Se	0.17	ug/L	CDPHE Lab
Metolachlor ESA	0.1	ug/L	CDA Groundwater Lab	Ag	0.7	ug/L	CDPHE Lab
Metolachlor OA	0.1	ug/L	CDA Groundwater Lab	Na	0.1	mg/L	CDPHE Lab
Metsulfuron methyl	0.2	ug/L	CDA Groundwater Lab	Zn	0.01	mg/L	CSU Soil, Plant and Water Lab
Nicosulfuron	0.5	ug/L	CDA Groundwater Lab	Mo	0.01	mg/L	CSU Soil, Plant and Water Lab
Oxamyl	0.5	ug/L	CDA Groundwater Lab	Ba	0.01	mg/L	CSU Soil, Plant and Water Lab
Oxydemeton methyl	1.0	ug/L	CDA Groundwater Lab	CO3	0.1	mg/L	CSU Soil, Plant and Water Lab
Picloram	0.5	ug/L	CDA Groundwater Lab	HCO3	0.1	mg/L	CSU Soil, Plant and Water Lab

†, not all groundwater samples underwent analysis for all analytes listed in this table; **CDA** is Colorado Department of Agriculture; **CDPHE** is Colorado Department of Public Health & Environment; **CSU** is Colorado State University