THESIS

DEVELOPMENT OF FRAMEWORK FOR PREDICTING WATER PRODUCTION FROM OIL AND GAS WELLS IN WATTENBERG FIELD, COLORADO

Submitted by

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ABSTRACT

DEVELOPMENT OF FRAMEWORK FOR PREDICTING WATER PRODUCTION FROM OIL AND GAS WELLS IN WATTENBERG FIELD, COLORADO

Water issues in the oil and gas industry have drawn attention from various stakeholders including the public, industry and environmental groups. With the increasing demand for energy, the number of oil and gas wells has increased greatly providing 60% of the energy in the United States. Besides the large volume of fresh water required for drilling and hydraulic fracturing, wastewater from the well can also lead to serious problems. The current approach for managing wastewater from oil and gas fields is deep well injection or evaporation both of which can potentially cause environmental issues. One of the best strategies to solve water issues from oil and gas operations is to reuse wastewater as drilling and fracturing water so the volume of fresh water required and wastewater disposed can be reduced. Information on both water quantity and quality are required when designing wastewater reuse treatment facilities. This study provides a framework for understanding water production trends from oil and gas wells in the Wattenberg field in Northern Colorado by analyzing historical data from Noble Energy Inc. The Arps equations were chosen for modeling water production from oil and gas wells. After studying 1,677 vertical and 32 horizontal wells in Wattenberg field, an exponential decline function was applied to model the produced water production of all the wells and the frac flowback water of horizontal wells. An Excel based 30-year water production prediction tool was developed based on the two protocols developed for vertical and horizontal wells in the Wattenberg field. Three case studies of different subsets of oil and gas wells were examined to illustrate the function of the tool. In addition, a comparison of exponential and harmonic functions was made in the third case study, and a significant difference was observed. The harmonic decline function predicts a less aggressive decline resulting in higher production volumes. It was concluded that in the absence of long term production data, the harmonic decline function should be used since the exponential decline function may underestimate the volume of produced water.

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Chapter 1. Introduction

1.1. Origins of the problem

"Courage, determination, and hard work are all very nice, but not so nice as an oil well in the back yard."

-Mason Cooley

With the rapid growth of economies throughout the world over the past several decades, the availability of energy has become critically important. As major forms of fuel, oil and gas provide about 60 percent of the world's 6.9 billion people with their daily energy needs, while other forms of energy like coal, nuclear and hydroelectric power , wind and solar provide the other 40 percent [1]. With the economic recovery of the United States and the rest of the world, total energy demand will rise by 1.2% per annum in the next five years in the US [2], driving the need for additional oil and gas supplies. More oil and gas wells will be drilled to meet the energy demand increase; therefore, more hydraulic fracturing will be performed in the future. With heightened public knowledge and awareness of hydraulic fracturing, many people believe that the fracturing process can cause severe environmental problems, such as water shortages and pollution of both surface and ground water [3].

In order to drill a new oil and gas well, water mixed with other chemical components and sand is used for hydraulic fracturing to release oil and gas from shale formations deep beneath the ground [4]. Water usage varies depending on the type of well. Typically for vertical wells, 65,000 to 600,000 gallons of water is needed, but horizontal deep shale gas and oil wells require an average of 4.5 million gallons of water per well [4]. Fresh water is often the major water source for hydraulic fracturing. As one of the states that have large oil and gas reserves, Colorado has over 95,000 oil and gas wells in total as of February, 2012 [5]. The biggest oil and gas field in Colorado is the Wattenberg field lying northeast of Denver, and average water usage for the wells in the Wattenberg field is around 3 million gallons per well [6]. Due to the rapid growth of population and industry in Colorado, the water scarcity problem has drawn more attention than ever before [7]. Besides the large amount of water needed for hydraulic fracturing, the water pollution problem is also becoming critical with the exploration and production of oil and gas wells. Though there is no evidence that hydraulic fracturing pollutes ground and surface water, people have begun to discuss this because of the additives in the fracturing water [8]. At the same time, since water also comes out with gas and oil from a well, it is important and necessary to have a good understanding of water as well as oil and gas production.

1.2. Structure of thesis

To better understand the impact of water from oil and gas wells, an in-depth study was performed to analyze the overall water balance during the entire oil and gas production process. Protocols and models were designed to predict total water production from oil and gas wells from a given field. The thesis is divided into 4 sections: (1) review of existing literature about water production in oil and gas wells, (2) analysis of production data from sample wells in Wattenberg field and modeling of the water production trend for both vertical and horizontal wells, (3) discussion of protocols and tools designed to predict total water production for the life of the well and (4) case studies on wells in different selected regions of Wattenberg field with uncertainty analysis.

Chapter 2. Literature review

2.1. Introduction

By the end of 2009, according to the U.S. Energy Information Administration, the proven reserves of crude oil in the U.S. were 22.3 billion barrels, and natural gas reserves were 283.9 trillion cubic feet [9]. The latest report released by the U.S. EIA showed that by the end of 2010, the proved reserves of crude oil in the U.S. were 25.2 billion barrels and the natural gas reserves were 317.6 trillion cubic feet [9]. Oil and gas make up to 60% of the energy source in the U.S. and the number of oil and gas wells will increase as a result of the increased energy demand. [10]. Water problems associated with oil and gas wells have caused concern [11] including water demand for drilling and fracturing [12,13,14], water contamination [15,16] and collection and handling of frac flowback and produced water during the oil and gas production process[17,18,19].

When oil or gas is extracted from underground formations, water also comes to the surface, and it is usually called produced water [20]. Also, as the largest waste stream generated by the oil and gas industry [20], produced water is difficult to manage and treat. In the United States, approximately 21 billion barrels of produced water has been generated from nearly one million oil and gas wells in 1985 and 18 billion bbls in 1995 [21,22] and 14 billion bbls in 2002 [20,23]. In Colorado, there are roughly 49,800 active wells and with an additional 46,300 wells which have been plugged and abandoned [5]. As one of the largest natural gas deposits in the United States, Wattenberg oil and gas field is located in the Denver-Julesburg Basin. In 2009, with an estimated 195.3 billion cubic feet of natural gas production, Wattenberg field was ranked as the 10th largest source of natural gas in the United States [24]. Figure 2.1 shows the location of Wattenberg field in Colorado.

Figure 2.1. Wattenberg field in Colorado [25]

The 100 square mile geological formation located north of Denver, Colorado in Weld, Adams, Boulder, Broomfield and Larimer counties, Wattenberg field produces both crude oil and natural gas [25]. Currently there are over 18,000 wells in the Wattenberg field [26] and over 7,700 wells are operated by the Noble Energy Inc. New wells are still being drilled every year in the Wattenberg field [5], which demands a large volume of water for drilling and fracturing and results in significant frac flowback and produced water. In Colorado, most of the drilling water, known as hydraulic fracturing water, comes from fresh water.

Today, water shortages are not only a regional problem but a global consideration. The rapidly increasing population and industrial activity have led to increased water demand and use. That, together with climate change, has contributed to a world-wide water crisis. In the United States, the government projects that by 2013 at least 36 states will face water shortages due to the combined results of rising temperatures, drought, population growth, urban sprawl, waste and excess [27]. As the principal river of the southwestern United States and northwestern Mexico, the Colorado River supplies water for agricultural and urban areas as well as hydroelectric power in the southwestern desert lands of North America [28]. A study in Water Resources Research in 2007 showed Colorado River reservoirs would risk running dry by 2057, leaving many downstream cities like Las Vegas, Los Angeles and San Diego short of water [29]. The Colorado Water Conservation Board has identified potential solutions to mitigate the water shortage in Colorado. One of the key outcomes to reach the water conservation goal is to recycle and reuse waste water [30], which also applies to the oil and gas industry.

2.2. Water use in energy production

Water is very important in energy resource development. Table 2.1 shows the water use for generating 1 million British thermal unit (MMBTU) of energy by different types of energy resources. On average coal requires 2-8 gallons of water without slurry transport and 13-32 gallons of water with slurry transport. On the other hand, only 0.82-3.7 gallons of water is needed by deep shale natural gas [31] to produce the same amount of energy, and groundwater is the major source of water used in shale gas exploration. It is clearly shown that water use for natural gas extraction can be less than the water used by other energy sources, therefore natural gas would be the best choice for saving water in energy production.

Table 2.1: Water use for energy production from various energy resources [32]

Energy Resource[1]	Range of Gallons of Water Used per MMBTU of Energy Produced
Deep Shale Natural Gas	0.84 – 3.70[2]
Coal (no slurry transport) Coal (with slurry transport)	2 – 8 13 – 32
Nuclear (uranium ready to use in a power plant)	8 – 14
Conventional Oil	8 – 20
Synfuel - Coal Gasification	11 – 26
Oil Shale	22 – 56
Tar Sands	27 – 68
Synfuel - Fisher Tropsch (from coal)	41 – 60
Enhanced Oil Recovery (EOR)	21 – 2,500
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

[1]Source: "Deep Shale Natural Gas: Abundant, Affordable, and Still Water Efficient", GWPC, 2010.
[2]The transport of natural gas can add between zero and two gallons per MMBTU.

On average 1 to 5 million gallons of water is used to drill and fracture a shale gas well, and sometimes a well can be fractured up to 18 times. According to "The Marcellus Effect," a typical gas well uses about 4 million gallons of fresh water over its lifetime [33]. A study of Noble oil and gas wells in Wattenberg field [6, 34] found that an average of 3 million gallons of fresh water is used for the hydraulic fracturing of one well. Besides the impact this might have on regional water availability, water transportation and storage must also be considered because the cost can be significant [35].

2.3. Water production from oil and gas wells

Water production, one of the major environmental, economic, and technical problems in the oil and gas industry, can limit the productive life of wells and cause severe operational problems such as corrosion, fines migration and hydrostatic loading. It is estimated that on average 8 barrels of water are generated while producing one barrel of oil, and the money spent in the United States to handle and dispose of the produced water is around 5 to 10 billion dollars every year [20].

2.3.1. Water production source and mechanism

The sources of produced water include injected water (frac water), formation water and aquifers. The injected hydraulic fracturing water could be the major source of water from oil and gas wells. After a large amount of water is injected into the formation where the well is drilled, only 15-40% of that water comes out as frac flowback [36]. The rest of the water stays in the formation and may come out at some point as produced water with oil and gas production through the life-cycle of the well. Formation water is another source of produced water. This is water which was originally trapped within the formation like oil and gas, but it can have limited contribution to water production. Aquifers could be another potential source of produced water.

Water can follow two types of paths to the wellbore. In the first one, water usually flows to the wellbore through a separate path from that of the hydrocarbons. Usually this type of water production will compete with oil and gas production, so in order to increase oil and gas production rates with higher recovery efficiency, this type of water production must be reduced. The second type of water production is water that is co-produced with oil, usually in the later life time of a well. In this case, the reduced water production may result in a corresponding reduction in oil production [20].

2.3.2. Causes of water production problems

The causes of water contamination and production problems can be divided into three main categories: mechanical problems, completion related problems and reservoir related problems.

Mechanical problems refer to poor mechanical integrity of the casing, such as holes, wear and splits, and other leaks. Casing leaks lead to unwanted water entry and a rise in water production. Completion related problems include channels behind the casing, completion into or close to a water zone and fracturing out of the zone. The reservoir related problems are mainly channeling, coning and depletion [20].

2.4. Characteristics of water production

Based on the quantity and quality of the water coming out of the well, the water can be classified as two types: frac flowback water and conventional produced water.

2.4.1. Frac flowback water

Frac flowback water is the water produced from the fracturing of oil and gas wells, and it usually consists of fracturing fluid which returns to the surface. This water always contains chemicals, metals, and other components that are used for hydraulic fracturing. The frac load recovery can be from 15-40% of the fracturing fluid [36], and it flows back over a period of 3 to 4 weeks after fracturing, most of it within 7-10 days. Flowback water usually has high salinity and total dissolved solids (TDS) as well as organics and metals [37]. Table 2.2 shows the comparison of water quality between feed water and frac flowback. From the table, water quality changes significantly from feed water to flowback. High salinity and TDS is seen in flowback water as well as organic materials like methanol and total organic carbon (TOC).

Table 2.2: Flowback water quality (mg/L) [35]

Parameter	Feed Water	Flowback
pH	8.5	4.5 to 6.5
Calcium	22	22,200
Magnesium	6	1,940
Sodium	57	32,300
Iron	4	539
Barium	0.22	228
Strontium	0.45	4,030
Manganese	1	4
Sulfate	5	32
Chloride	20	121,000
Methanol	Neglible	2,280
TOC	Neglible	5,690

2.4.2. Produced water

Produced water is the water that naturally occurs in the shale beds that are traversed by the wellbore. Usually, produced water flows throughout the whole lifecycle of the well along with oil and gas production, and there is currently no clear understanding of the volume and production rate of produced water over time. This water is also very saline with a high TDS. The water quality of produced water can vary a lot depending on the formation and the type of well [37]. The comparison of flowback water with conventional produced water is shown in Table 2.3. High TDS and TSS can be seen in produced water, and the oil and grease can vary a lot from a dry natural gas well to crude oil well.

Table 2.3: Comparison of flowback water quality with produced water quality [38]

Comparison of FB Water with Conventional Produced Water

Parameter	Location A 14-d FB	Location B 14-d FB	Conv. PW Ranges[₣]
pH	5.5	6.5	5 - 8
Alkalinity *	52	93	NA
TDS **	112,000	105,000	20,000 - 100,000
Tot Susp Solids **	17	197	0-250
Tot Org Carbon **	34	39	NA
Biochemical Oxygen Demand ¥	149	2.8	NA
Oil & Grease **	31	< 5 mg/l	3 – 100

* mg/l as $CaCO_3$ ¥ mg/l as O_2 † NA = Not Available
** mg/l ‡ ND = Nondetect ₣ IPEC, 2004; GRI, '94

2.5. Produced water management

Due to the potentially hazardous components in the flowback and produced water, U.S. Environmental Protection Agency (EPA) has regulated the disposal of produced water [39]. There are five ways currently in use for the management and disposal of flowback and produced water.

2.5.1. Evaporation in pits/ponds

Though natural evaporation would be the easiest and cheapest way to handle produced water, it is not practical due to a number of restrictions. Usually natural evaporation can only happen in dry areas where the precipitation rate is lower than the evaporation rate, and evaporation will be limited because of the extremely high salinity and TDS of the water. Also the grease and organics in the water may form a crust over the pond and lead to the failure of evaporation [35].

2.5.2. Disposal wells

As the most commonly used method for produced water disposal, the disposal well is a contentious topic. The injection of produced water into deep underground injection wells allows saltwater (frac flowback and produced water) to be managed [40]. According to the Energy Tomorrow Blog, the number of class II injection wells in each state is shown in Figure 2.2.

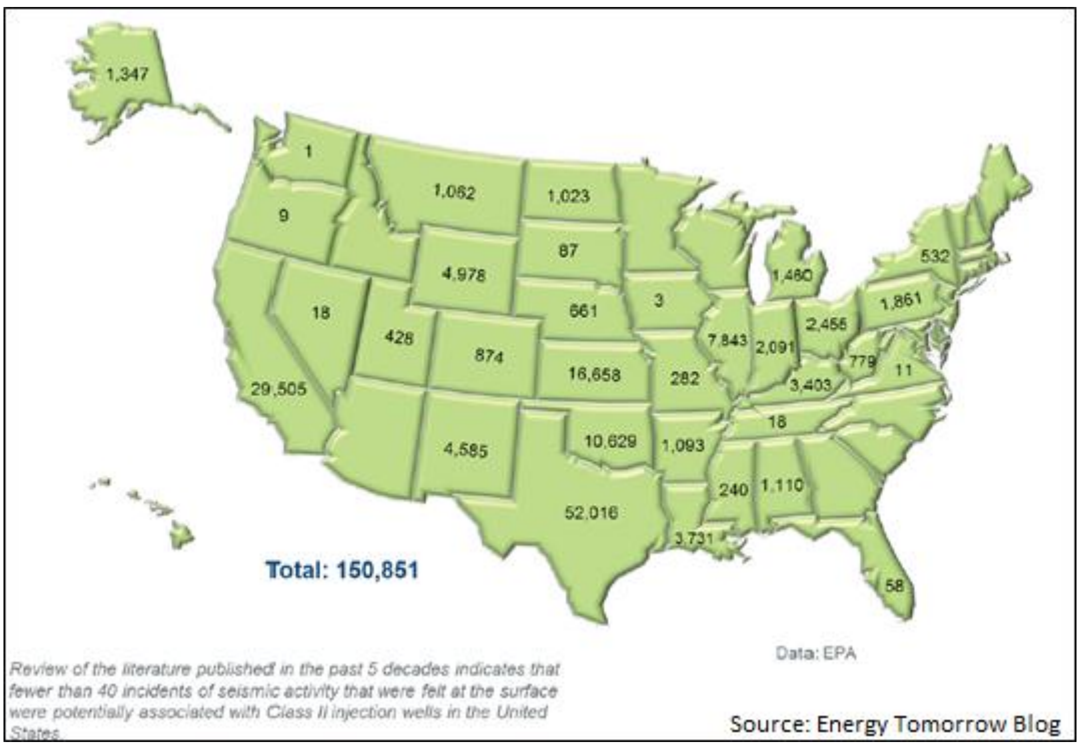

Figure 2.2. Class II injection wells across the country

EPA has delegated underground injection control to each state, following the federal Safe Drinking Water Act for surface ground water protection. Operators are therefore required to follow the disposal regulations of each state [40].

Figure 2.3 shows the typical construction of a class II injection well. The construction standards for a disposal well require three layers of casing to protect groundwater. The first layer is surface casing, with a steel pipe encased in cement from ground surface to the deepest groundwater level. This casing provides protection during the drilling of the well. The second layer is the production casing, with a pipe placed in the wellbore and cemented permanently in place. The third protection layer is the injection tubing string and packer through which the injected water can travel to the underground formation. Because of the three protection layers in a class II injection well, impact on groundwater can only be seen when all three layers fail at the same time [40].

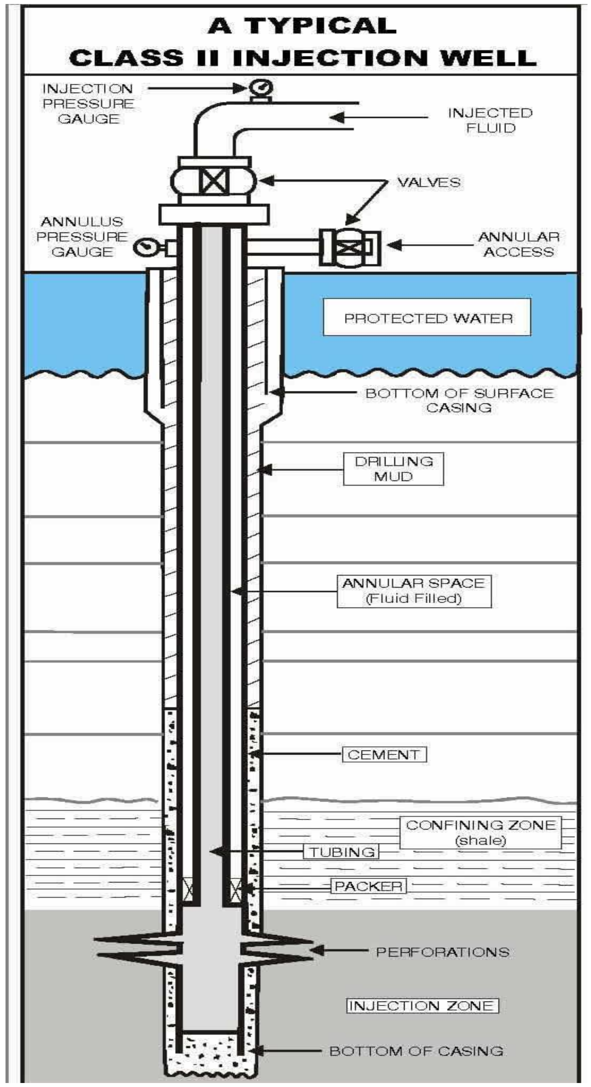

Figure 2.3. Wellbore of typical class II injection well [40]

Though disposal wells have been adopted widely for produced water management, it is considered unsafe to inject produced water directly into disposal wells because of the potential impacts to water supply aquifers and the possibility that the produced water may migrate to streams. So in many states, disposal wells are inspected at least once a year to make sure that no contamination has occurred. Another concern of injection wells was the potential of causing induced seismicity. Earthquakes related to injection wells have been reported in Texas and Ohio. In October 20, 2011 a 4.8 magnitude earthquake struck the area of South Texas where many oil and gas wells are located. Seismologists explained that it was not caused by hydraulic fracturing but the injection of disposed fracing wastewater [41]. Besides earthquakes, induced seismicity is more likely to happen as a result of the injection of fracing wastewater [42]. At the same time, due to the limited capacities of the disposal well (1200 to 3000 bpd) and the substantial capital investment with uncertain life span (1 to 2 million dollars), as well as other factors like transportation, few new injection wells have been permitted. As a result, disposal wells will probably play less of a future role in the management of produced water [35].

2.5.3. Disposal to publicly owned treatment works (POTWs)

Another alternative for handling produced water is to dispose of the water into publicly owned treatment works (POTWs). However, because of the high salinity of produced water and the biological processes commonly adapted in POTWs which do not remove TDS, it's currently impractical and perhaps not possible to treat the produced water in POTWs. In addition regulatory limitations prohibit this option [35].

2.5.4. Direct reuse for fracturing

Since the hydraulic fracturing fluid has high viscosity and various additives, many companies have considered reusing produced water directly for fracturing. Chemical additives can be recycled by recycling produced water for hydraulic fracturing, and because of the high salinity requirement of fracturing fluid, TDS does not need to be decreased, so that energy and cost for treatment can be kept at a lower level. However some other chemical components such as chlorides should be removed or reduced because they can cause corrosion and impact fracturing. Also safety problems such as chlorides and bacteria should be considered when reusing produced water for fracturing [35]. To treat produced water for fracturing use, typical treatment processes include: separation of oil and grease, organic material adsorption and removal, hardness removal and raw TSS removal. Figure 2.4 shows an example of the treatment process for treating produced water for reuse as fracturing fluid.

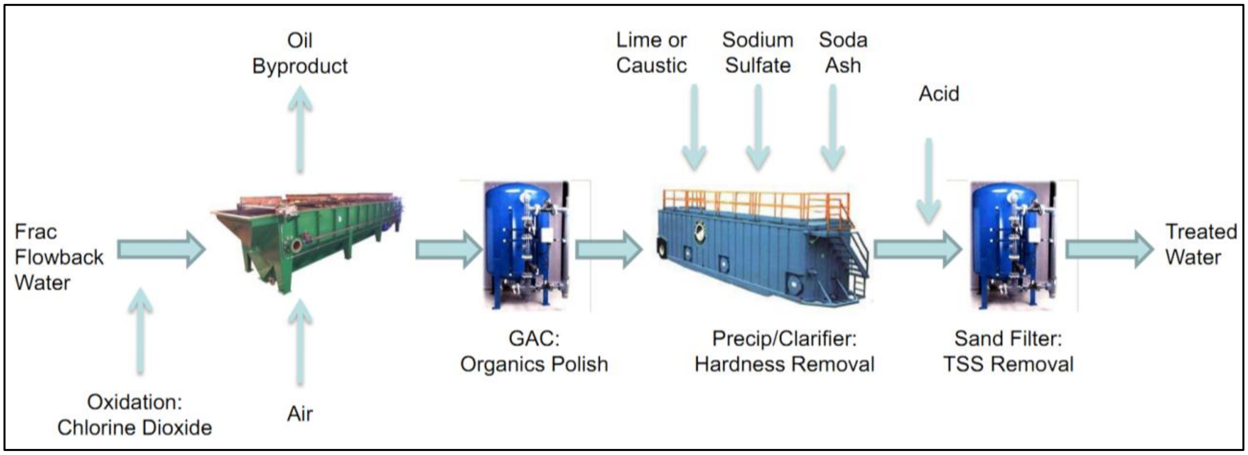

Figure 2.4. Example treatment process of produced water for reuse as fracturing fluid [43]

2.5.5. Treatment for reuse or surface discharge

In order to reuse produced water for purposes other than use in hydraulic fracturing, additional treatment processes are needed. TDS reduction is the most critical process in this type of treatment of produced water. For example, the TDS standard for agricultural irrigation is less than 2,000 mg/L and for surface discharge, the TDS should be less than 500 mg/L. Hence different treatment processes should be used for different TDS removal targets. For this type of reuse, membrane filtration is usually used after the treatment processes illustrated in Figure 2.4, and reverse osmosis (RO) membrane is the best choice. Figure 2.5 shows the treatment process for reusing produced water for agriculture or surface discharge.

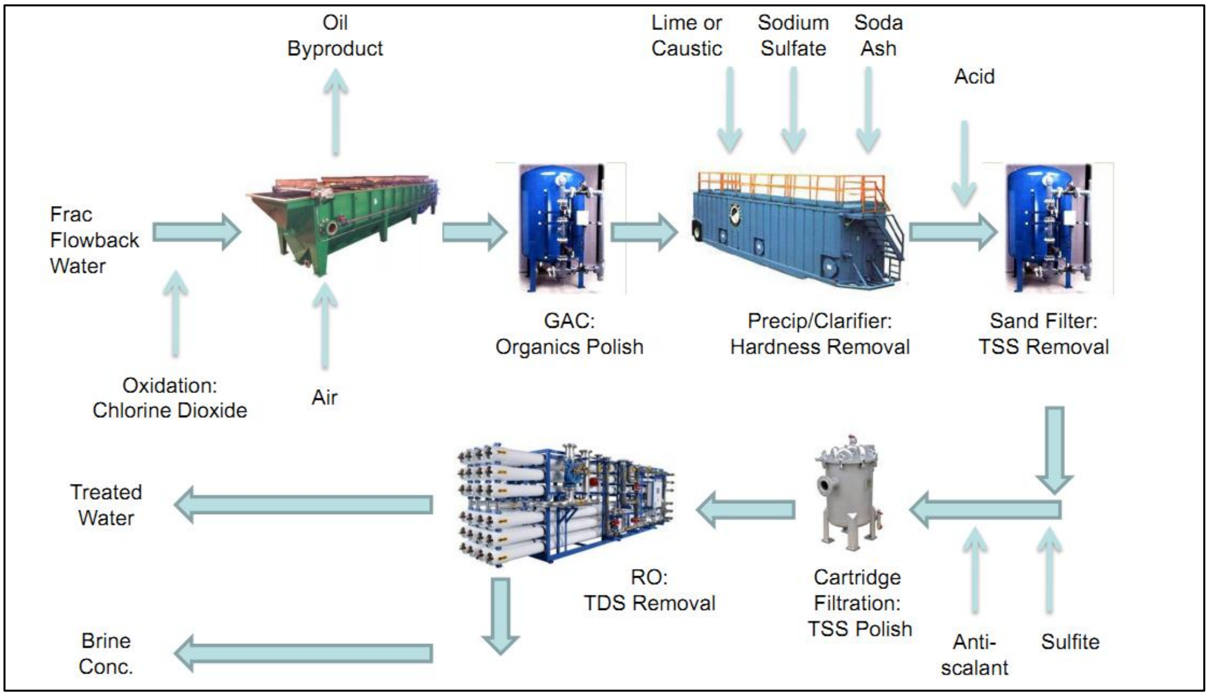

Figure 2.5. Example treatment process of produced water for agricultural use or surface discharge [43]

Though membrane filtration is the most efficient way for TDS removal, the cost is always high and varies depending on the influent water quality and outflow water quality target [35]. Figure 2.6 shows the relative cost vs. the range of applicability.

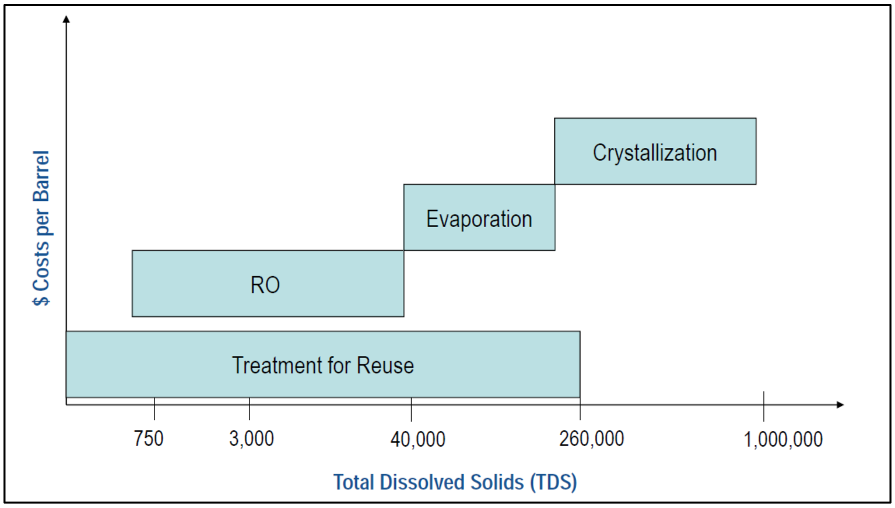

Figure 2.6. Range of applicability vs. cost for treating produced water [43]

2.6. Environmental impacts in the oil and gas industry

In addition to the amount of water use in hydraulic fracturing, there are other environmental and community concerns related to shale oil and gas development. The potential impacts are summarized in Figure 2.7: air issues, community impacts, water issues and land issues.

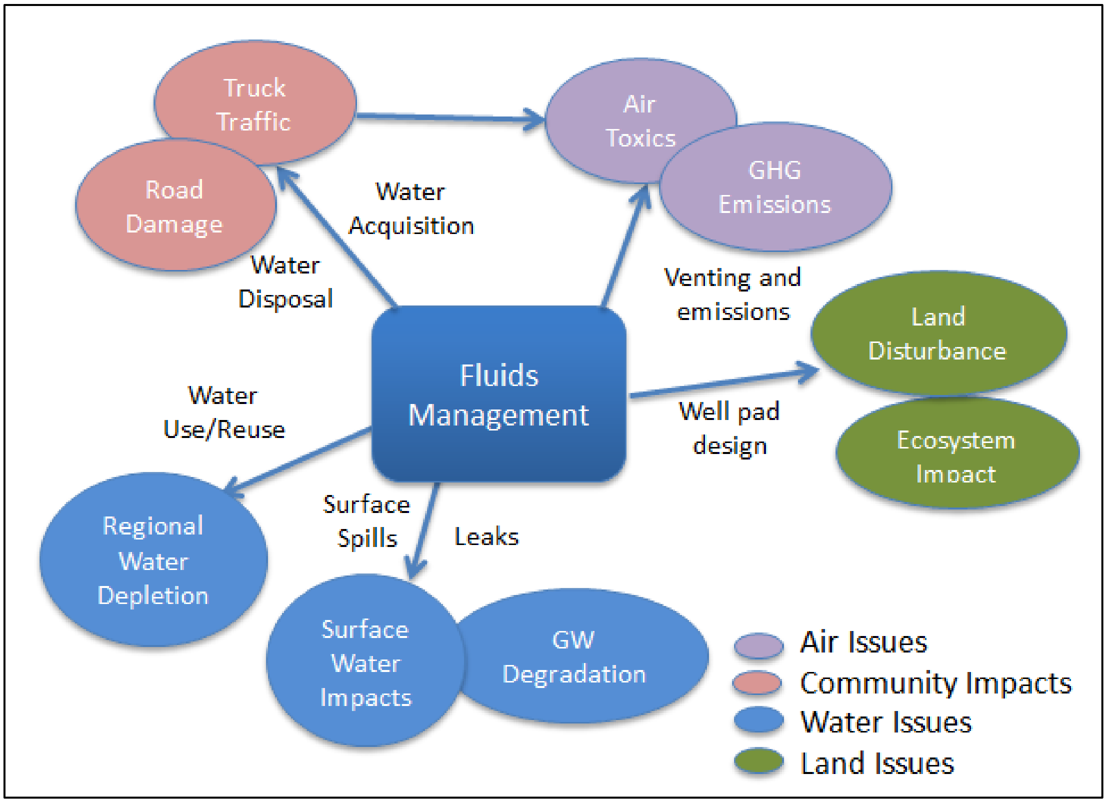

Figure 2.7. Major issues from shale oil and gas well development

2.6.1. Air issues

Leakage of gases from the well and engine emissions from trucks and pumps are two sources of air issues. The major type of leakage from a gas well is the gas itself, composed of methane, ethane, liquid condensate and VOCs. Some of these are potent greenhouse gases (GHGs) that can contribute to global warming and others (e.g. benzene) can cause public health problems. Studies conducted in Denver in 2011 and 2012 show that 4% (more than the 1-2% estimated previously) of the methane produced by gas wells was being released [28, 44, 45]. Research in 2012 shows that air pollution caused by fracturing may lead to acute and chronic health problems for people living near drilling sites [46]. Also, diesel trucks that transport water and other materials for fracturing and the engines for the high pressure pumping are important sources of emissions.

2.6.2. Community impacts

Because nearly all oil and gas wells are in rural areas, a dramatic increase in traffic is required. Gas Field Specialists, one of the well services companies in Shinglehouse, Pennsylvania, uses tanker trucks to carry fracturing fluids and wastewater from the well. According to their estimates, if 2 million gallons of water is used for one well, 366 tanker trucks are required for hauling fresh water and another 183 trucks for hauling waste water, so a total of 549 tanker truck trips are needed for the hydraulic fracturing of one well [47]. However in Pennsylvania, in order to drill one horizontal Marcellus well, total water use is 3.5 million gallons on average and it requires about 960 truck trips to carry all the fresh and waste water [47]. According to the study on Noble wells in Wattenberg field, Colorado, 3 million gallons of water is needed for hydraulic fracturing [6, 34] and 824 truck trips are needed.

2.6.3. Water issues

Water used for drilling and hydraulic fracturing usually comes from existing sources and therefore competes with other users. Due to the amount of water that is used for hydraulic fracturing, well drilling may lead to regional water depletion, especially in dry areas. Additionally, water contamination is another concern in oil and gas operations. Surface spills and leakages of fracturing fluid from the wellbore are two potential mechanisms for water contamination. Both fracturing liquids and produced water can spill out from the well and cause environmental contamination. Meanwhile, the wastewater disposed of either in disposal wells or evaporation ponds can pollute surface and ground water with both the chemicals used in the fracturing fluids, contaminants from the formation water and naturally occurring radioactive materials (NORM) from the deep shale formation. The typical gases that can escape during fracturing and drilling operations are methane, ethane, and other VOCs that may be hazardous (e.g. benzene).

2.6.4. Land issues

Another issue is the land and space used by the well. For a Marcellus well, only 16 wells can be spaced per square mile, and on average a town can contain up to 1500 wells [47]. Horizontal wells, on the other hand, require a large space, so more land is needed. Usually a pad can range from 5 to 15 acres. The development of natural gas could also potentially have an impact on the terrestrial ecosystem. Trees, shrubs and other understory plants respond to the fracturing fluid with leaves turning brown, wilting, and subsequent leaf and bud mortality [48]. Also it may have impact on wild animals by destroying their living habitats and ranges and exposing them with chemical additives. In Pennsylvania, September 2009, Dunkard Creek suffered from a massive fish kill and EPA scientists pointed out it may have been the result of the wastewater from hydraulic fracturing of shale gas [49]. At the same time, road damage as well as erosion and sediment can be seen as a result of drilling new natural gas well.

2.7. Ways to minimize environmental impacts from hydraulic fracturing

Since water is the most important part in hydraulic fracturing, the best way to minimize environmental impacts is better fluid management. This includes both water management and air emission control.

2.7.1. Water management

Oil and gas wells are usually widely dispersed and wastewater from the wells is generated in small volumes compared to domestic wastewater. In addition, there is a difference in water quality between frac flowback and produced water, and different purposes for the end use of the treated water exist. For these reasons, it is difficult to set up a centralized wastewater treatment facility in rural areas for these wells. Therefore, a Geographic Information System (GIS) based approach is required to optimize water management. Among all water management practices, water reuse and recycling is the most efficient and effective approach for minimizing impacts.

By recycling and reusing wastewater for hydraulic fracturing, fresh water demand will decrease and hence the required truck trips will also be decreased. Also, with less wastewater being injected into disposal wells or evaporation ponds, the possibility of surface and groundwater contamination will be lowered as well as the impact of the contamination on ecosystems.

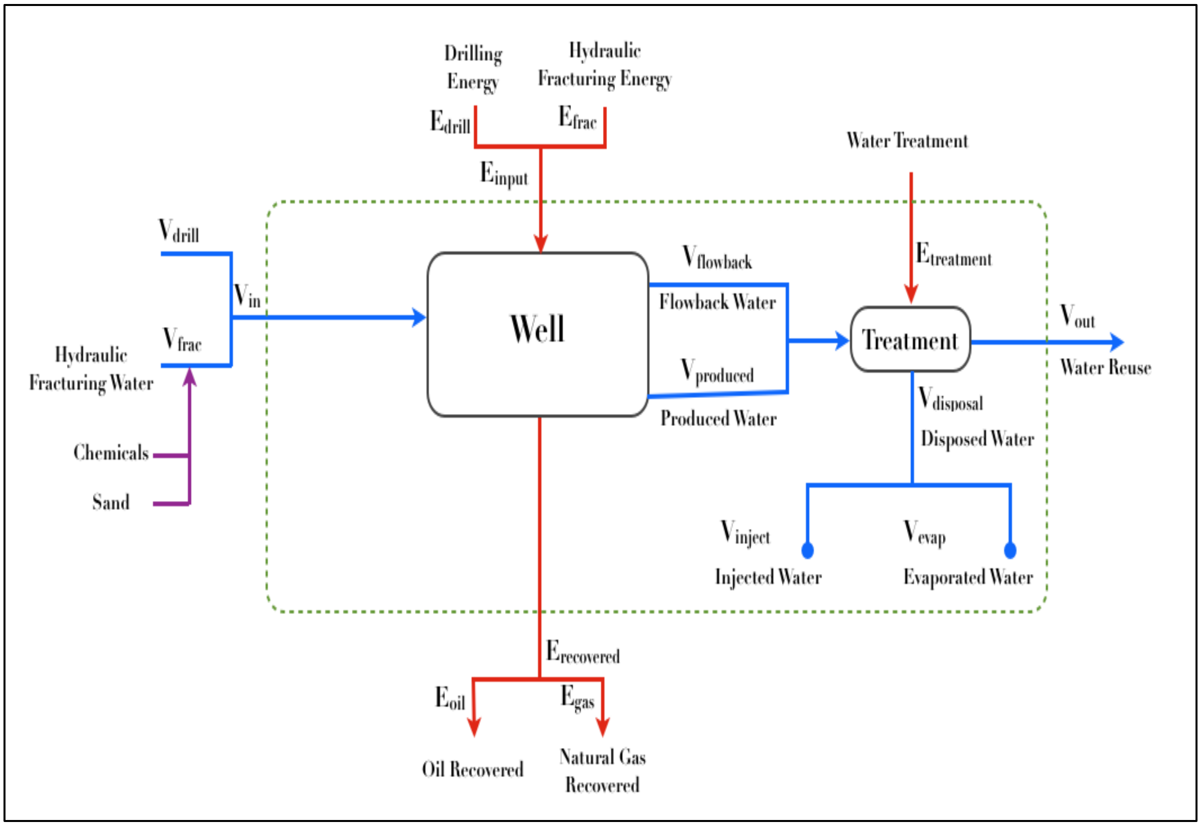

Figure 2.8. Oil and gas well energy and water balance

Figure 2.8 shows energy and water balance for a typical shale oil and gas well. Best water management can be achieved by treating wastewater from the well. According to Figure 2.8, by reusing treated water from the wastewater treatment facility, there will be less disposal water and the related issues will be reduced. Also the reused water will help decrease the amount of fresh water demand which provides higher efficiency of water use. In order to design the capacity of the treatment facility, both water quantity and quality of frac flowback and produced water is required. Water quality can be easily tested; however, there is no method for calculating and predicting water quantity from a dynamic well field that is being actively developed. Therefore, it is important to develop a protocol for water production calculation and prediction.

2.7.2. Green completions

Recycling wastewater can reduce air emissions from trucks since new water does not need to be transported to the site. In addition, other potential spills and leakages of gas can be lowered, such as the storage tank of wastewater from which gas (methane for example) can emit into the air. EPA issued new regulations on air pollution from hydraulically fractured gas wells on Apr. 17, 2012 [50]. The new regulation requires all operations to practice "reduced emissions" or "green completions" to capture gas and other volatile organic compounds (VOCs) that are released with hydraulic fracturing flowback water. Much of the gas released during fracturing is off-gassing from the flowback water and measures need to be taken to assure it is not vented to the atmosphere.

Green completion techniques are the methods designed to minimize the released natural gas and oil vapors into the environment during the completion period of a well. The benefits of green completions include minimizing the release of greenhouse gases (such as methane) and VOCs, and maximizing the recovery of natural resources by selling the gas instead of letting it go into the atmosphere [5].

Under the new rule, estimation was made that between 190,000 and 290,000 tons of VOCs emissions and from 12,000 to 20,000 tons of benzene emissions from hydraulic fracturing equipment would be eliminated per year. In addition, between 1 million and 1.7 million tons of unrecovered methane emissions would be eliminated by this rule. The EPA announced it would delay requiring the use of green completion technology until 2015 to provide time for producers to finish the transition. Before 2015 operators will have the option of using either green completion technology or flaring gas [51].

2.8. Current research on produced water quantity

In order to treat and reuse produced water, it is important to understand how much water is produced as well as its quality. Current research has focused on the quality of produced water, since the production pattern of produced water is complicated and changes from well to well. There are many factors impacting the volume of produced water: type of well drilled, location of well within the reservoir structure, type of completion, type of water separation and treatment facilities, water flooding for enhanced oil recovery, insufficient produced water volume for water flooding, loss of mechanical integrity and subsurface communication problems [20]. Typically horizontal wells have higher water production rates than vertical wells. On average, 7 bbls of water is produced with production of one bbl of crude oil in the U.S. [52], the same result American Petroleum Institute's (API) produced water surveys found in 1985 and 1995. API had calculated the water-to-oil ratio of about 7.5 bbls of water for each bbl of oil produced, and the number increased to approximately 9.5 according to the produced water survey in 2002 conducted by API [20].

There has been very limited research on produced water decline trends. In 2011, the USGS (United States Geological Survey) conducted a study on oil, gas and water production from Wattenberg Field in Colorado. Produced water volume of one sample well decreases from 1.2 to 0.65 bbl/day over 5 years from 1990 to 1995; however the pattern of water production is not analyzed [53].

The Arps equation (Equation 2.1) [54] is generally used for calculating the production rate of oil and gas and therefore can be used as a first approximation for modeling decline rates. In the Arps equation, $q_{(t)}$ is production rate at t, q_i is initial production rate, D_i is the decline rate constant, t is time and b is the degree of curvature.

$$q_{(t)} = \frac{q_i}{(1+D_i t)^{1/b}} \tag{2.1}$$

In the Arps equation (Equation 2.1), b value changes from 0 to 1. When b=0, the Arps equation changes to the form of $Q=Ae^{-kt}$ which is exponential decline, and when b=1, the equation changes to harmonic decline.

Figure 2.9 shows the different decline curves with different b values in Arps equation.

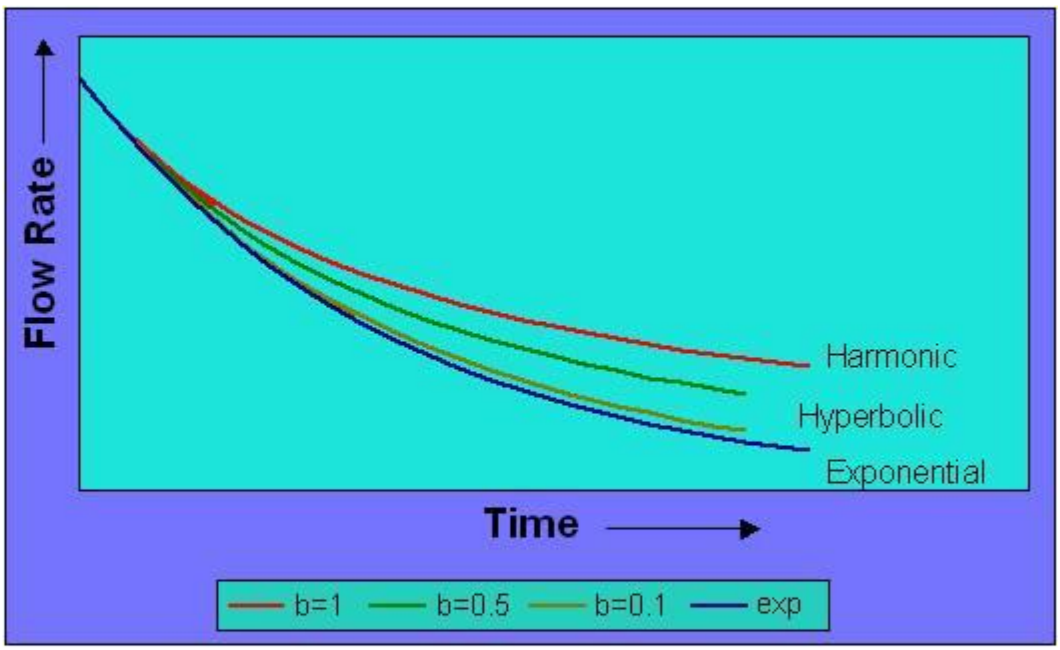

Figure 2.9. Decline curves from different b values in Arps equation [55]

2.9. Objectives and hypothesis

Previous research has focused on produced water quality and methods for treatment. When considering reusing frac flowback and produced water, the quantity of water is also important for designing the capacity of the treatment facility. Therefore, it is necessary to study the water production trends from these wells as well as the relationships between water production and spatial location. GIS will be the best tool for understanding how water quantity varies in different locations. At the same time, since disposal wells are still the most commonly used way to handle wastewater from oil and gas wells, it is important to be aware of how much water to expect so that truck trips to carry the water to disposal wells can be estimated.

This research focuses on fitting historical water production data from Noble Energy Inc. wells in Wattenberg field with the Arps equation, by studying the historical decline trends of water produced, and modeling prediction of water production. The research has four research objectives:

1. Develop protocol for predicting produced water production from vertical wells
2. Develop protocol for predicting frac flowback and produced water production from horizontal wells
3. Create Excel tool for predicting total water production for Wattenberg field
4. Complete case studies of tool application in three different well fields.

Chapter 3. Development of protocols and tools for predicting frac flowback and produced water volume from Wattenberg oil and gas field

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Abstract

The objective of this study was to develop protocols and interactive tools that could be used to predict frac flowback and produced water volumes considering the unique decline rates that exist for different types of oil and gas wells. Specifically, water production data from the Colorado Oil and Gas Conservation Commission (COGCC) and Noble Energy Inc. were used to develop protocols for modeling water production for vertical and horizontal wells, a distinction made largely due to the different amounts of water used for each. If centralized water treatment and handling facilities are going to be designed and constructed, it is important to have a reliable estimate of the water that will be produced in the future as wells are completed and brought on line. An Excel-based tool was developed utilizing the horizontal and vertical well protocols for predicting total volume of water production by current and future wells in Wattenberg Field. Two case studies have been conducted including one with all of the Noble wells in Wattenberg Field and one with a subset assuming a regional treatment center might be established. Uncertainty of the predictions was determined using standard error calculations on the two

modeling parameters for water flow decline rates. An interactive Excel-based spreadsheet has been developed to allow predictions of water production based on the number of horizontal and vertical wells drilled in the future.

Research highlights:

- Two protocols were developed for predicting water production from vertical and horizontal oil and gas wells.
- An Excel-based tool was created that utilizes the two protocols to predict total water production in Wattenberg field.
- Uncertainty of predictions was estimated by determining the 95% confidence limits of two parameters used for decline rate modeling.
- Two cases studies were conducted using the Excel-based tool to predict flowback and produced water.

***Keywords*: Oil and Gas Wells, Frac Flowback, Produced Water, Wattenberg Field**

3.1. Introduction

By the end of 2010, the proven reserves of crude oil in the U.S. were 19.1 billion barrels [56], and the natural gas reserves were estimated to be greater than 300 trillion cubic feet [57]. Since more than 60% of US energy is supplied by oil and gas, it is likely that the number of wells drilled over the next few decades will continue to increase as a result of increased energy demand [2]. In the oil and gas industry, water is a major concern, not only because of its demand in drilling and hydraulic fracturing, but also because of the water produced from oil and gas wells. Drilling and hydraulically fracturing a horizontal shale well requires an average of 3 to 6 million gallons of water [31] and in the Wattenberg field in northern Colorado, each vertical and horizontal well uses an average of 0.39 million and 2.8 million gallons of water respectively [6, 34]. Increased water demand for the oil and gas industry may stress already scarce water supplies in Colorado. However, after the completion of a well, a large amount of water, known as frac flowback and produced water returns with the extracted oil and gas. This water has higher total dissolved solids (TDS) and lower water quality than fresh water [35, 58] and can be difficult to handle and treat. Water pollution from frac flowback and produced water has drawn attention recently and will likely continue to be a controversial topic in the future. One of the best strategies to mitigate the water related risks in the oil and gas industry is to recycle and reuse water. Therefore it is important to understand how much water is being produced and what the quality of that water is so that the appropriate treatment processes can be chosen for reusing and recycling the water [59, 60].

Nomenclature

Q	Water flow rate (bbl/year)
t	Well age (year)
k	Vertical well water production decay rate (year^{-1})
k_1	Horizontal well frac flowback production decay rate (year^{-1})
a	Horizontal well produced water production decay rate (year^{-1})
A	Vertical well initial water flow rate (bbl/year)
A_1	Horizontal well initial frac flowback flow rate (bbl/year)
C	Horizontal well initial produced water flow rate (bbl/year)

3.2. Methods and materials

3.2.1. Site location and description

The Wattenberg field is an unconventional shale play located northeast of Denver, Colorado. With an estimated 195.3 billion cubic feet reserve of wet natural gas in 2009, the Wattenberg field is ranked as the 10th largest natural gas field in the United States [24]. Additionally, some estimates have predicted that Wattenberg field could yield as much as 1 to 2 billion barrels of oil equivalent, comprised of 70% oil and 30% natural gas [61]. Lying in the Denver-Julesburg Basin, the Wattenberg field has five formations: J Sandstone, Codell Sandstone, Niobrara Formation, Hygiene Sandstone and Terry Sandstone [62]. By August 2011, there were over 18,000 active wells in Wattenberg field with approximately 7,700 operated by Noble Energy [63]. Figure 3.1 shows the locations of Noble wells in Wattenberg field in Colorado.

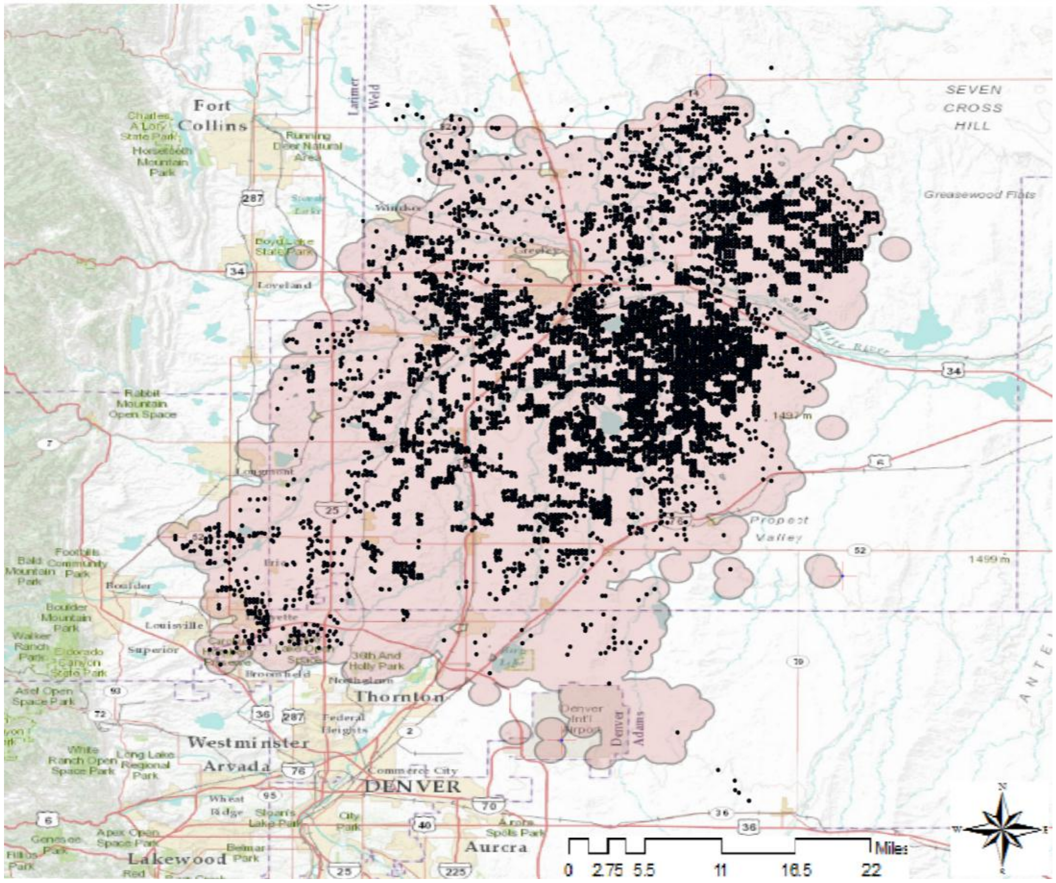


Figure 3.1. Location of Noble oil and gas wells in the Wattenberg field of Colorado

3.2.2. Methods and data collection

Based on the different types of oil and gas wells, separate methods of analysis were performed to study life-cycle water production trends of vertical and horizontal wells.

a. Methods and data collection for vertical oil and gas wells

For vertical wells, annual water production data for a sample of 1,677 Noble Energy wells from 1999 to 2011 was obtained from the Colorado Oil and Gas Conservation Commission (COGCC) database. According to the dates of completion and first production, new wells in each year were selected for this study as shown in Table 3.1.

The selected wells were then classified according to well age to study the water production trend for 13 years. This subset of Noble Energy wells was used to make water production predictions for the 30 year life-cycle of vertical wells in the Wattenberg field, a timeframe that was chosen to represent the maximum well life.

Table 3.1. New wells from 1999 to 2011 and number of wells in each operating year

Year	New wells	Years in Operation	Number of wells
1999	6	1	1677
2000	10	2	1494
2001	29	3	1324
2002	28	4	1140
2003	65	5	807
2004	105	6	535
2005	131	7	374
2006	161	8	243
2007	227	9	138
2008	333	10	73
2009	184	11	45
2010	170	12	16
2011	183	13	6

b. Methods and data collection for horizontal oil and gas wells

Since the drilling of horizontal wells is relatively new (first started in 2010 in Wattenberg) and since there are currently only approximately 200 horizontal wells for Noble Energy in the Wattenberg field, a sample of 32 Noble Energy horizontal wells were studied. Daily frac flowback and produced water data were acquired from Noble Energy. Based on the existing frac flowback and produced water data, predictions of water production for the 30 year life-cycle of horizontal wells in the Wattenberg field were made.

3.3. Data analysis and protocol

3.3.1. Protocol for vertical well predictions of produced water

The protocol for vertical wells is based on both frac flowback and produced water data. Total water production in each operating year was summed for the chosen subset of vertical wells and the average number of producing days in each operating year was calculated based on the distribution of existing Noble Energy data (Table 3.2). Average daily water production per well was computed from operating years 1 to 13 and annual water production was calculated by multiplying average daily water production with the average number of producing days. High water flow rates were observed in the first year of operation because of the intrinsic frac flowback period (typically 1 to 2 days of high volume water production) included in that year. Based on the results of these calculations, predictions of water production for future years were made to an assumed well life-cycle of 30 years.

Table 3.2. Distribution of producing days for each operating year

Operating Year	Average Producing Days
1	162
2	337
3	339
4	342
5	342
6	348
7	354
8	346
9	350
10	339
11	322
12	339
13	333

For the first operating year, all wells were not started at the beginning of the year; hence the average production period is 162 days (less than half of the production days in the following years). Based on the existing 13 years of water production data, an exponential decline curve was applied to the water production trend for predicting future water generation ($Q=Ae^{-kt}$). An exponential decline curve was chosen for this subset of wells because it best fits the behavior of vertical water production in the Wattenberg field. However, some fields with more connate water will have a different best-fit curve. The type of curve chosen as a foundation may change, but the protocol should yield a consistent outcome. Based on the average value of *A* and *k* (rate constant) from all 1,677 vertical wells (Appendix A, Table A.1), and the days of production from Table 3.2, the equation of water production rate is:

$$Q=1.981e^{-0.1614t} \qquad (R^2=0.5336) \tag{1}$$

Equation 1 shows the average water production rate from vertical wells in Wattenberg Field. However, from the water production data, it is known that the water production varies throughout the Wattenberg field. In order to understand the relationship between the spatial location of wells and the decay rate constant, an ArcGIS map was interpolated based on the decay rate constant (*k* value) of each vertical well as shown in Figure 3.2. Based on the interpolated GIS map of *k* values shown in Figure 3.2, the average *k* value for a selected subset of the Wattenberg field can be calculated in ArcGIS. An example of using ArcGIS to calculate average *k* value for a particular case study is described later in the paper.

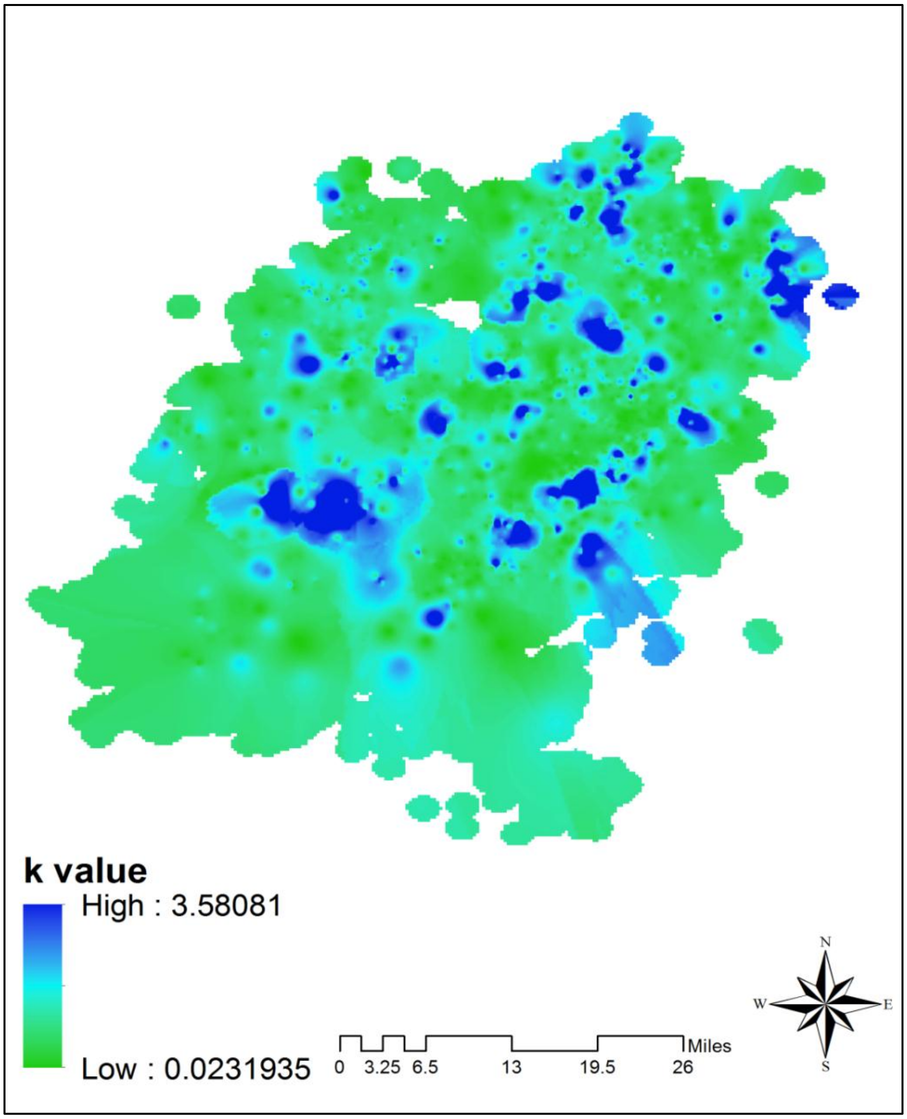


Figure 3.2. Interpolated *k* values of Noble Energy vertical oil and gas wells in Wattenberg field

In Figure 3.2, the *k* (decay rate) of water production from vertical wells varies from 0.023 (half-life of 30.14 years) in the southwest to 3.58 (half-life of 0.19 years) in the northeast of the Wattenberg field. The reason for the large variation in *k* or half-life may be due to geologic formation differences that can be studied in the future. Additionally, the newer a well is, the less water production data are available. This may lead to a higher *k* and shorter half-life prediction. It is also observed that the *k* value is not homogeneous, as shown by the dark blue pockets in light green areas. Therefore, to adequately determine the proper *k* value, a spatial area must be defined. In Equation 1, the k value was defined as the average k across the 1,677 vertical wells.

3.3.2. Protocol for horizontal well predictions of frac flowback and produced water

Unlike vertical wells, horizontal wells use more water for drilling and fracturing, while having longer frac flowback periods that last up to two months. The protocol for horizontal wells is based on both frac flowback and produced water data. However, since there are only about 200 horizontal wells in the Wattenberg field, all of which were completed after 2010, a sample of 32 horizontal wells from Noble Energy was chosen for the estimation of water production rates.

When production data are plotted by years in operation, it is seen that the water production decline rate is different for frac flowback and produced water. Therefore distinct rate models need to be developed. To distinguish flowback from produced water, two methods of analysis were performed on the data of the 32 horizontal wells. Raw data analysis uses the flowback report from Noble Energy as the flowback period and the day after the period as the first day of produced water generation. Another approach, the modified data analysis, uses the intersection point of first order decay trend lines of flowback and produced water curves as the first day of produced water generation. Both methods can be seen in Figure 3.3.

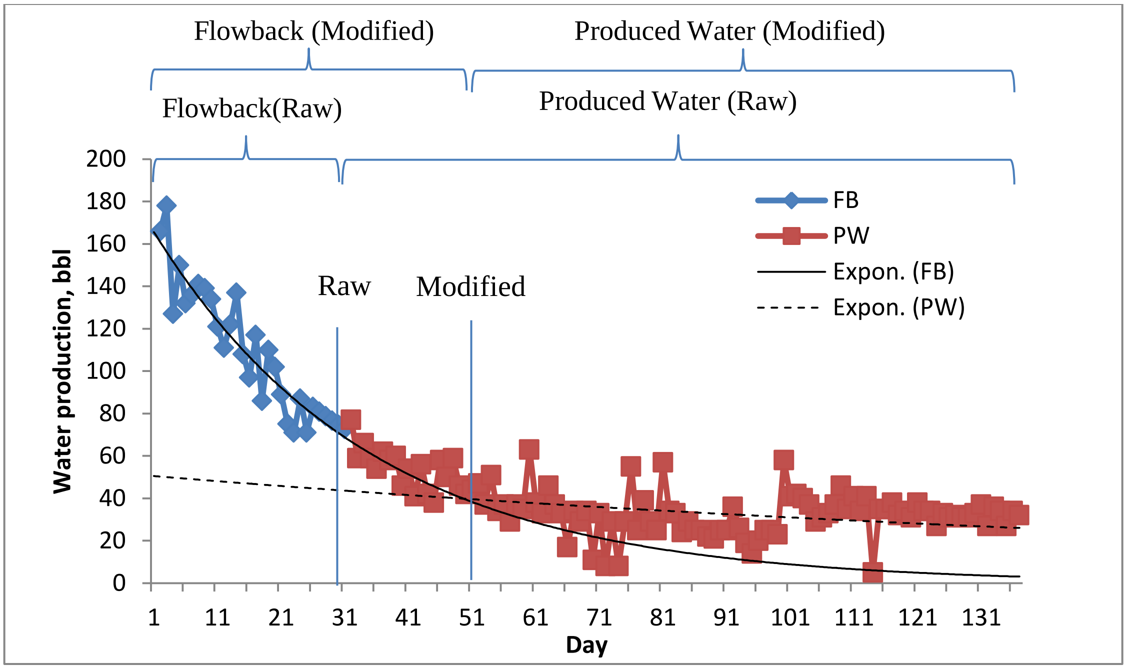


Figure 3.3. Comparison of two methods (raw and modified data analysis) of example horizontal well 70 Ranch BB21-65HN

Using the raw data analysis, it was found that the average flowback time for a horizontal well was 27 days. However, it was also found that the average horizontal well did not produce until the 74th day. This can be due to waiting for production equipment, waiting for midstream infrastructure, or waiting for other wells on the pad to be completed. Hence, a total flowback time is defined as the time after a well is completed till just before a well produces and the flowback period for the average horizontal well in Wattenberg is assumed to be 74 days from the raw data analysis. And from the modified analysis the average frac flowback period for horizontal wells in Wattenberg field is assumed to be 61 days. . After analyzing the frac flowback and produced water production curves for the 32 wells based on the modified analysis method, the average curve was plotted and a prediction of future water production was made. For frac flowback water, exponential decay function was used to calculate the water production rate. Based on the average $A_1$and k_1 for all 32 horizontal wells, the equation of frac flowback water production for horizontal wells in the first 61 days is:

$$Q = 264.4e^{-0.043t} \qquad (R^2 = 0.7869) \tag{2}$$

However for produced water, production rate was modeled with harmonic function for peak flow condition. The equation of harmonic decay is: $Q = \frac{C}{1+at}$, in which *C* is the initial water production rate and *a* is the initial decay rate. After applying harmonic function to each horizontal well, the average *C* and *a* value of 32 wells was calculated and the equation of produced water production for horizontal wells is:

$$Q = \frac{88.8638}{1+0.04469t} \qquad (R^2 = 0.7379) \tag{3}$$

The average number of production days in each operating year used in the analysis is the same as the vertical wells, and for the 162 days in the first operating year, there are assumed to be 61 days of frac flowback and 101 days of produced water production.

Again, ArcGIS interpolated maps are used to estimate the spatially-defined k_1 value (frac flowback decay rate constant) in Equation 2 and *a* value (produced water decay rate constant) in Equation 3. Figure 3.4 shows how k_1 and *a* for horizontal wells differ spatially throughout the Wattenberg field. Like the decay rate of vertical wells (*k*), the distribution of k_1 and *a* are not homogeneous. Therefore, in the analysis of all horizontal wells in the Wattenberg field, an average k_1 value of 0.043 (half-life of 16.12 days) and average *a* value of 0.04469 (half-life of 15.51 years) was used. The average is depicted in Equations 2 and 3.

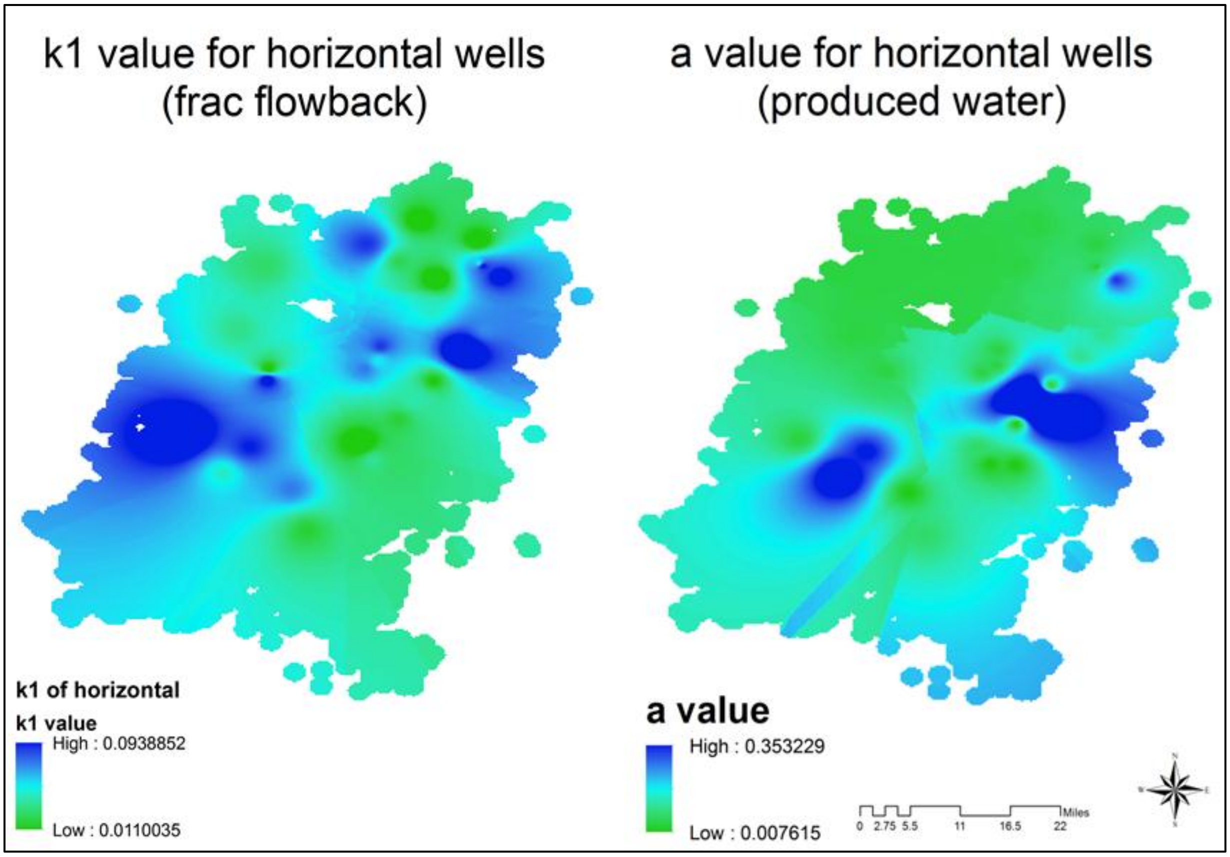


Figure 3.4. k_1 and *a* of horizontal oil and gas wells in the Wattenberg field

Based on Equation 1, 2 and 3, averaged water production curves of horizontal and vertical wells in the Wattenberg field are shown in Figure 3.5. With more fracturing water use and longer frac flowback time, horizontal wells have higher water production rate than vertical wells. Also shown in Figure 3.5, horizontal wells have faster decay in the first year of operation because of the large volume of frac flowback generated in the first year.

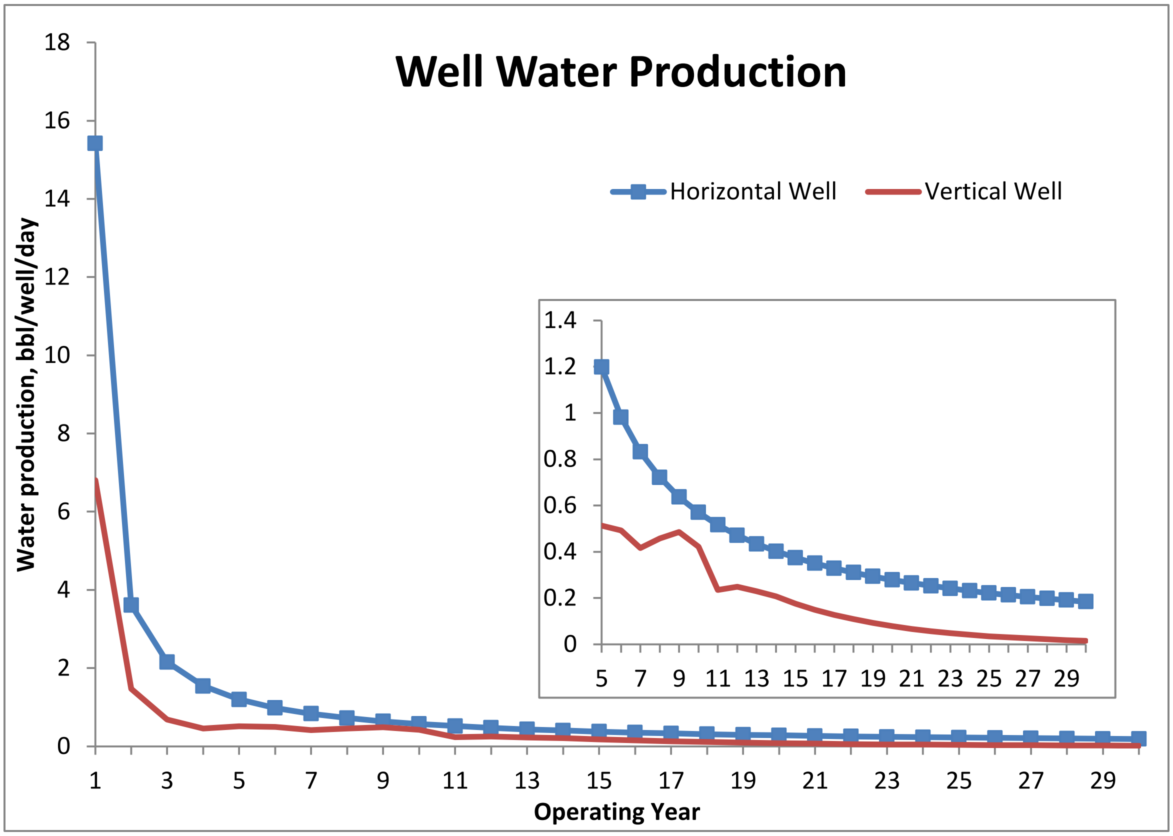


Figure 3.5. Horizontal and vertical well water production curves

3.4. Development of Excel-based tool for predicting frac flowback and produced water volumes from the Wattenberg oil and gas field

3.4.1. Introduction of the tool

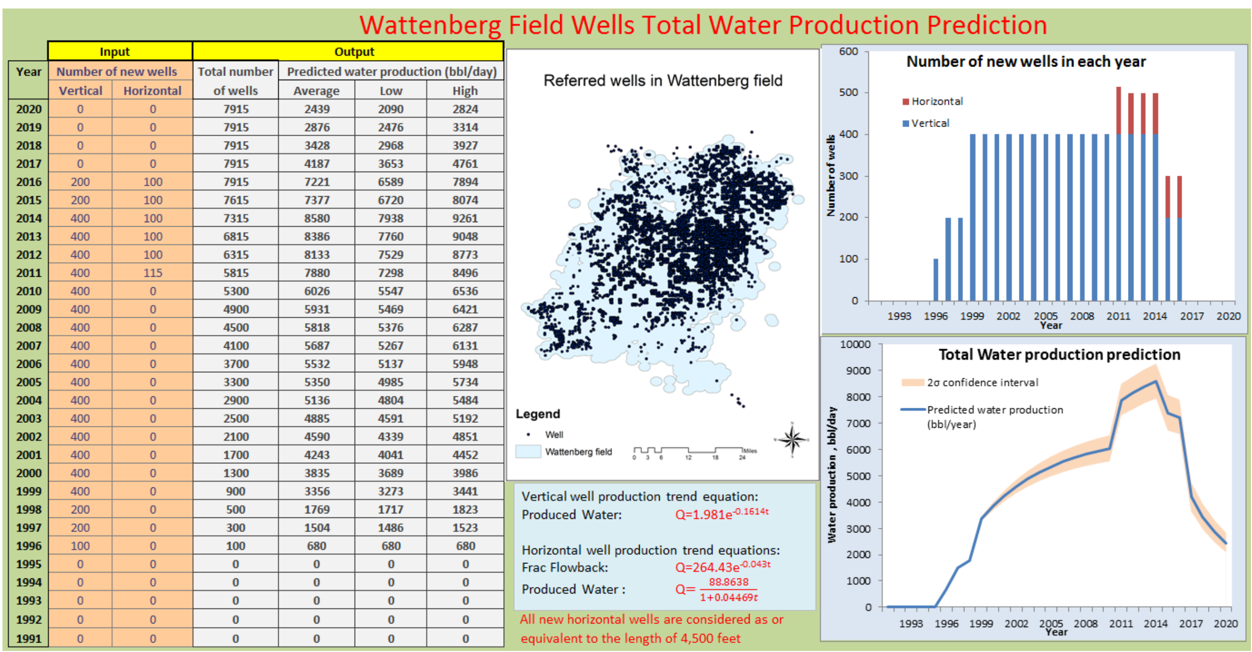
After combining the protocols of vertical and horizontal wells, an Excel-based tool was developed to predict frac flowback and produced water volumes for existing wells in the Wattenberg field. This was achieved through the development of the water production curves, based on current well counts and historical production data. As seen from the Wattenberg vertical and horizontal well models, water production prediction models can be fitted with a single curve or with multiple curves

The developed Excel-based tool can also be used to predict water production for future proposed development from given oil and gas field (or other spatially defined area) based on the historical data. In order to perform the calculation, the required historical data includes the number of existing wells, the type of these wells, and the associated production dates and volumes in the given area so that the years of operation of each well can be determined. Once curves are developed from existing wells in the area, the models can be applied to future annual drilling and fracturing in terms of yearly wells planned.

Prediction of total water production in future years is calculated after inputting the planned new wells and their types for each year, and by summing water produced from both existing wells and proposed wells.

Inputs and outputs of the tool

The tool, based on the model developed with spatially-relevant historical data, has two major inputs: the number of new vertical wells and the number of new horizontal wells for each future year. Because the water production rate changes with the length of wellbore, and all historical Noble wells were relatively homogeneous with the length of 4,500 feet, new wells are all considered as or equivalent to 4,500 feet long. The output of the tool is the predicted water production in each future year for the defined area. Figure 3.6 shows the screen shot of the Excel tool (Available on the CEWC (Colorado Energy Water Consortium) website).



Year	Input: Number of new wells		Output: Total number of wells	Output: Predicted water production (bbl/day)		
	Vertical	Horizontal		Average	Low	High
2020	0	0	7915	2439	2090	2824
2019	0	0	7915	2876	2476	3314
2018	0	0	7915	3428	2968	3927
2017	0	0	7915	4187	3653	4761
2016	200	100	7915	7221	6589	7894
2015	200	100	7615	7377	6720	8074
2014	400	100	7315	8580	7938	9261
2013	400	100	6815	8386	7760	9048
2012	400	100	6315	8133	7529	8773
2011	400	115	5815	7880	7298	8496
2010	400	0	5300	6026	5547	6536
2009	400	0	4900	5931	5469	6421
2008	400	0	4500	5818	5376	6287
2007	400	0	4100	5687	5267	6131
2006	400	0	3700	5532	5137	5948
2005	400	0	3300	5350	4985	5734
2004	400	0	2900	5136	4804	5484
2003	400	0	2500	4885	4591	5192
2002	400	0	2100	4590	4339	4851
2001	400	0	1700	4243	4041	4452
2000	400	0	1300	3835	3689	3986
1999	400	0	900	3356	3273	3441
1998	200	0	500	1769	1717	1823
1997	200	0	300	1504	1486	1523
1996	100	0	100	680	680	680
1995	0	0	0	0	0	0
1994	0	0	0	0	0	0
1993	0	0	0	0	0	0
1992	0	0	0	0	0	0
1991	0	0	0	0	0	0

Figure 3.6. Screen shot of the Excel tool with inputs and outputs

Method of prediction

From the described protocols, using historical water production data, area-specific water production equations can be determined. These equations can be used to model the future water production of existing wells. Additionally, the equations can be used to forecast water production for future, proposed wells within the defined boundaries. By default, a prediction of water produced from existing wells is made based on no new wells in future years. However, the effect of future wells on water production can be determined by inputting the planned number of each type of new wells into the developed tool.

In Figure 3.6, the tool depicts a Wattenberg-wide water prediction analysis where historical well counts for each year and associated water production were obtained from COGCC (pre 2009) and Noble Energy (after 2010). Example future well development was input for years of 2012 through 2014 to include 200 new vertical wells and 100 new horizontal wells annually in the defined area. These future development plans do not reflect Noble Energy's true well development forecasts for the Wattenberg field. Figure 3.7 shows how future water production is affected by existing wells and proposed wells. It is seen that water production will continue to increase along with well development but after drilling stops, water production starts to drop. Additionally, Figure 3.7 depicts the default prediction of the tool where no new wells are drilled and completed. In this example, water production drops off drastically in the first few years and then settles into a gentler decay.

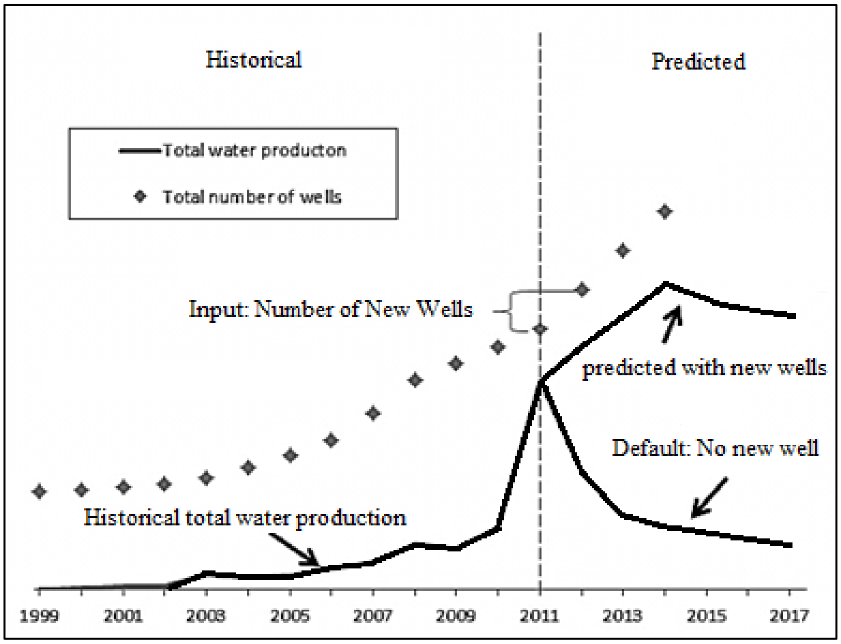


Figure 3.7. Description of method for predicting future total water production

Assumptions

Due to the complexity of the historical data, several assumptions were made during the development of the tool:

a. Though there are more than 7,000 Noble Energy vertical wells in Wattenberg field, only 1,677 vertical wells have available timeline information such as drilling dates and first production dates. Therefore, these 1,677 wells were chosen as a subset to develop the water production curves. This subset will affect assumptions drawn about field-wide production curves.

b. Water production changes with the length of wellbore, since all historical wells from Noble have been relatively homogeneous with the wellbore length of 4,500 feet, all new wells are considered equivalent to 4,500 feet long.

c. When a well is plugged and abandoned, it is assumed to have been operated for greater than 10 years so that it produced very little water. Additionally, only around 10 to 20 wells are plugged and abandoned in each year. Hence, the impact from plugged and abandoned wells on total water production in that year was assumed negligible.

d. Refractured wells are considered to behave similar to newly completed wells. This assumption will be verified in future work.

e. Future wells are assumed to behave the same as historical wells.

3.4.2. Uncertainty analysis

Water production trends of vertical wells, as well as frac flowback water production trends of horizontal wells in the Wattenberg field, were all fitted with an exponential decay function of the form $Q=A\cdot e^{-kt}$ and produced water production trends of horizontal wells were fitted with a harmonic decay function of the form $Q=\frac{C}{1+at}$. For the developed tool, average values of *A*, *k*, *C* and *a* for all Wattenberg field wells studied were used. However, Figures 3.2 and 3.5 both show significant variability in *k*, k_1, and *a*. Another variables, *A* and *C*, also will have variability from well to well. Therefore, uncertainty analyses were performed for all parameters.

For all 1,677 vertical wells, the water production decline trend for each well was analyzed and fitted to an exponential decay function. Since 438 of the vertical wells had limited water production data and another 113 wells did not fit the decay function, only 1,126 *k* values were used in the uncertainty analysis. A smaller subset of 153 wells was chosen randomly for evaluation of *A* variability. The normal distribution of *k* and *A* is shown in Figure 3.8.

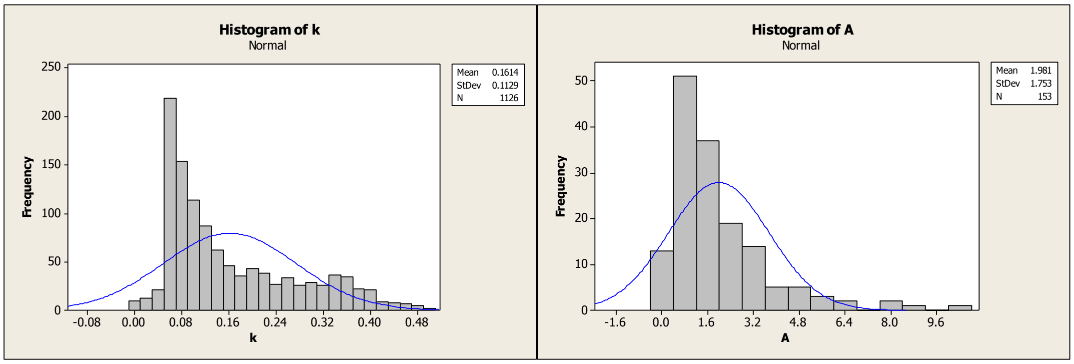


Figure 3.8. Distribution of k and A for vertical wells

Since horizontal wells in the Wattenberg field are modeled by two separate functions for flowback and produced water, four variables (A_1 and k_1 for flowback and C and a for produced water) were analyzed for uncertainty using the same statistical method. Figure 3.9 shows the distribution of k_1, A_1, C and a values of horizontal wells.

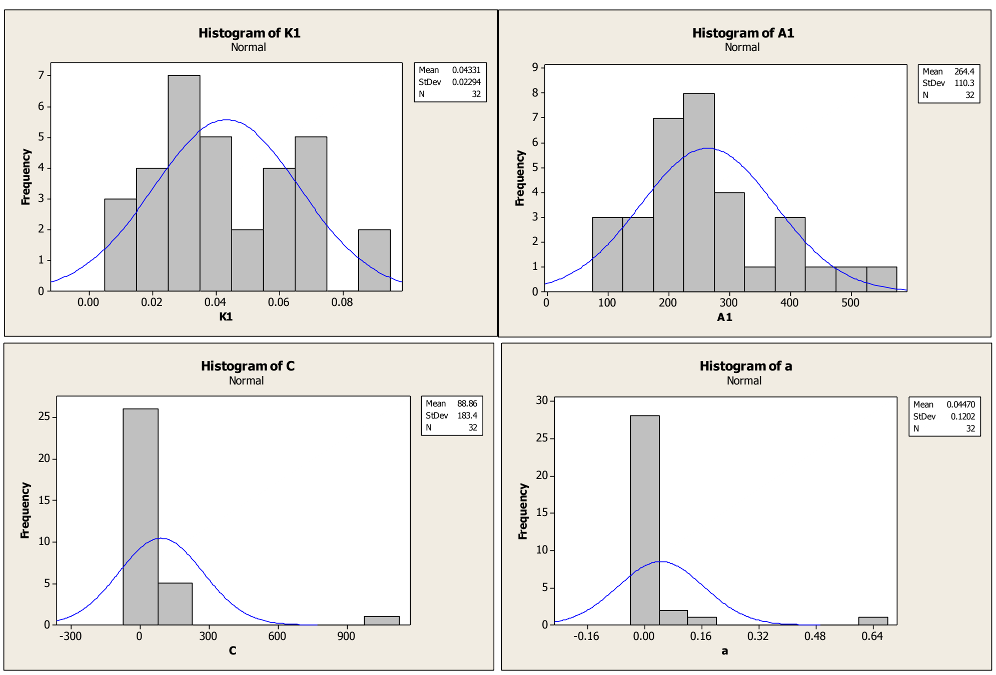


Figure 3.9. Distribution of k_1, A_1, C and a for horizontal wells

Assuming the parameter values for both vertical and horizontal wells are normally distributed, the z score for 95% confidence interval is 1.645 and the calculated statistical values are shown in Table 3.3.

Table 3.3. Uncertainty analysis and acceptable range of variables

	k	A	k_1	A_1	C	a
μ	0.1613	1.981	0.0434	264.4	88.8638	0.0447
σ	0.0033	0.141	0.0040	19.4	32.4282	0.0212
μ-1.645σ	0.1558	1.748	0.0366	232.3	35.5194	0.0098
μ+1.645σ	0.1669	2.214	0.0499	296.5	142.208	0.0796

3.5. Case study of Noble wells in Wattenberg field

A case study to estimate total water production for all Noble Energy wells from 2012 to 2017 in Wattenberg field was conducted using the developed Excel-based tool. Historical total water production and well count data was acquired for all Noble wells in Wattenberg Field each year from 1999 to 2011. Data from 1999 to 2009 were extracted from the COGCC website database, and the data for 2010 and 2011 was taken directly from the Noble Energy Carte® database.

By the end of 2011, a total of 7,486 wells from Noble Energy were producing in the Wattenberg field. Overall, there were 7,371 vertical wells and 115 horizontal wells. Each of these wells was modeled with the appropriate Wattenberg-average decay functions (Equations 1, 2, and 3) and their specific well age. All water production from existing wells in the Wattenberg field was projected out to 2017.

After applying the tool to all existing wells in the Wattenberg field, a development assumption was made where 100 new horizontal wells and 200 new vertical wells would be drilled and completed each year from 2012 to 2017. For each of these proposed wells, the appropriate water production model was also applied using the tool. This assumption of well development is used to demonstrate the planning capabilities of the tool if a company would like to know how their new well plans will affect future water production.

The additive predicted volume of water production from both existing and proposed wells from 2012 to 2017 is shown in Figure 3.10. Additionally, the case where no new wells are drilled is shown in Figure 3.10. Finally, the 95% confidence interval for both cases is also shown in Figure 3.10. The 95% or 2σ confidence interval is calculated using values from Table 3.3. For the high limit of the 95% confidence interval, the biggest A and smallest k value was used in the calculation. This means the water production curve has the biggest initial flow rate and slowest decay rate. For the lower limit of the 95% confidence interval, the smallest A and biggest k value was used in the model.

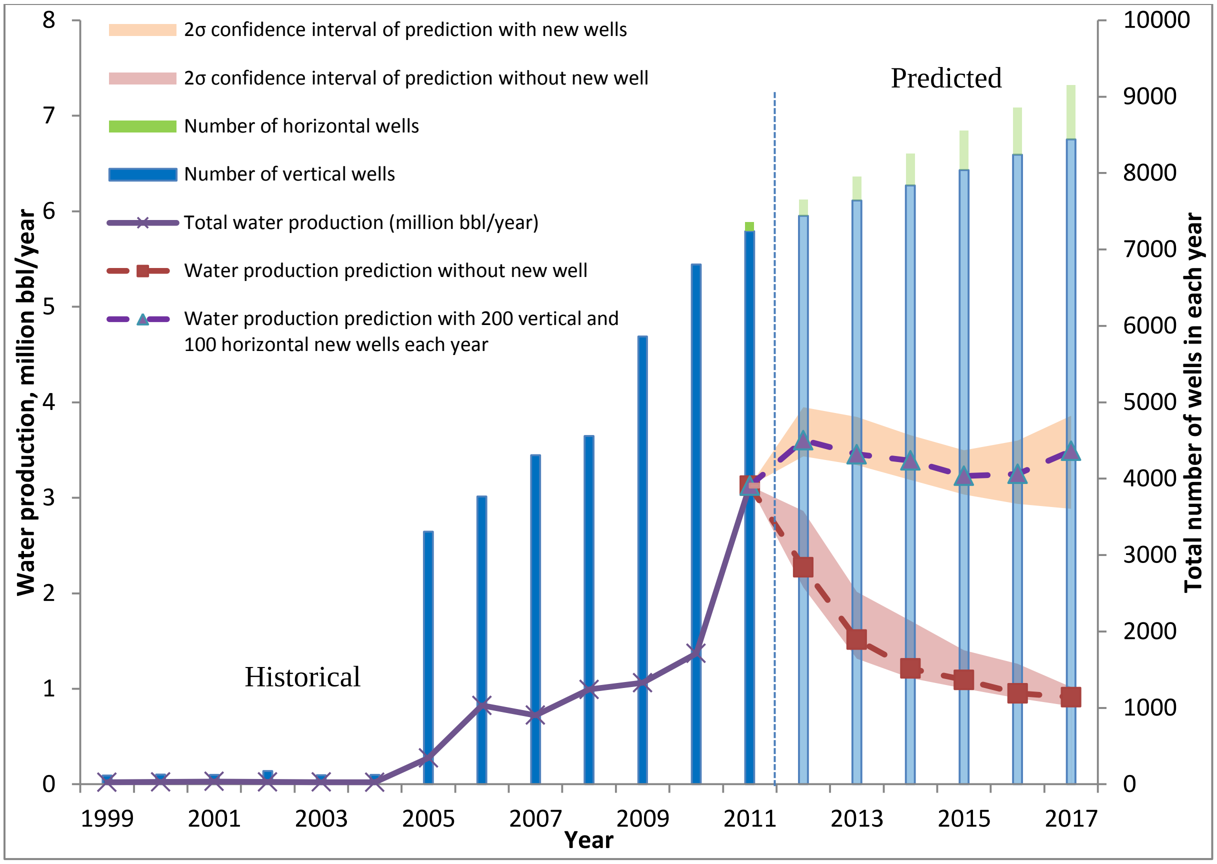


Figure 3.10. Total water production prediction of all Noble wells
in the Wattenberg field from 2012 to 2017

From Figure 3.10, a few observations can be drawn. A large jump in water production is seen in 2010. This is due to the introduction of horizontal wells. From the prediction made by the tool, it is also clear that water production will decrease from 2012 to 2015. From 2016 to 2017 the total water production increases again to around 3.5 million bbls. Though there are new wells being drilled each year from 2012 to 2015, total water production in Wattenberg field actually decreased due to the large number of new wells from 2009 to 2011. This shows that from 2012 to 2015, total water production in the Wattenberg field is strongly affected by the wells drilled in 2010 and 2011 (total of 1,415 vertical and 115 horizontal) rather than the new wells from 2012 to 2015 (200 vertical and 100 horizontal each year). Total water production increases again in 2016 and 2017 when new wells in each year provide greater influence than the existing wells. If no new wells are drilled, water production is seen to drop from approximately 3 million bbls in 2011 to about 1 million bbls in 2017. This is expected since without new wells, the water production trend would revert to the produced water rate after 2011, as seen in Figure 3.5.

3.6. Case study of selected Noble wells in northeast Wattenberg field

In the previous case study estimating water production for all 7,486 Noble wells in the Wattenberg field, the *k* values for both vertical and horizontal wells were average values for the whole field. However, according to Figures 3.2 and 3.5, *k* values vary spatially throughout the Wattenberg field. To make a more precise water production prediction, a smaller area can be chosen where the *k* value is more tailored. Therefore in order to understand the water produced in a smaller geographic area, a case study of selected wells in the northeast Wattenberg field was conducted using both the predictive *k* value tool in ArcGIS and the estimated water production tool in Excel. The selection of wells is shown in Figure 3.11.

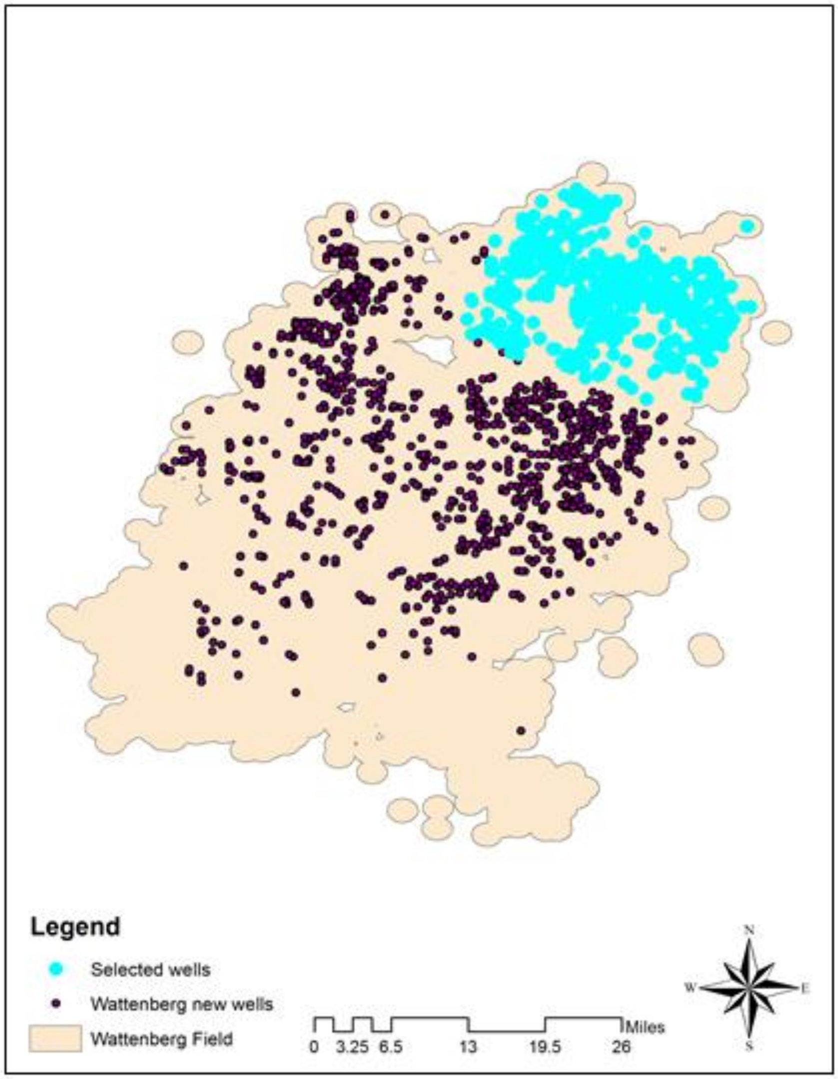


Figure 3.11. Selection of wells in northeast Wattenberg field

From the GIS attribute table of the selected region, 568 vertical and 12 horizontal wells were analyzed, and the average *k* values for both types of wells were computed in ArcGIS, as shown in Figure 3.12 and Figure 3.13.

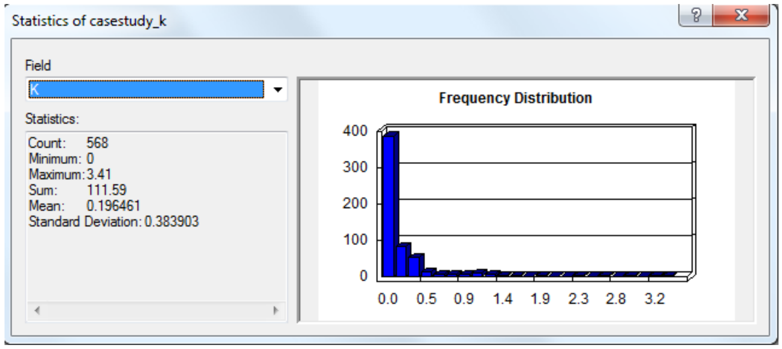


Figure 3.12. Distribution of *k* value of selected vertical wells in ArcGIS

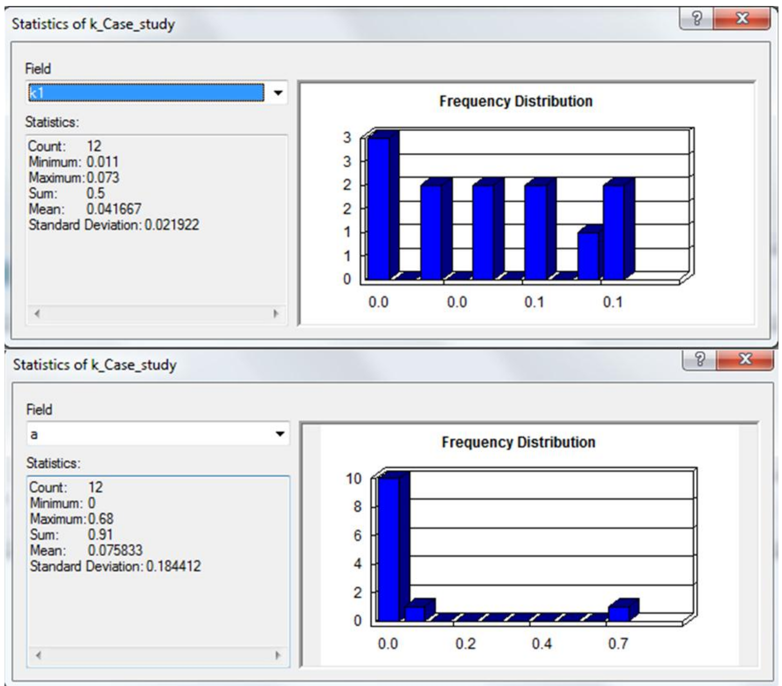


Figure 3.13. Distribution of k_1 and *a* values of selected horizontal wells in ArcGIS

After applying the computed, spatially relevant k, k_1 and a into Equations 1, 2, and 3, the water production functions for wells in the selected area of the Wattenberg field were modified from the averaged equations. And for the selected wells, the average value of A, A_1 and C was 2.003, 259.9 and 142.995 respectively. As a result, the equation for predicting vertical well water production for the selected area is:

$$Q=2.003e^{-0.197t} \qquad (R^2=0.8073) \tag{4}$$

The equation for predicting horizontal well frac flowback water production for the selected area is:

$$Q=259.9e^{-0.042t} \qquad (R^2=0.7849) \tag{5}$$

The equation for horizontal well produced water production for the selected area is:

$$Q = \frac{142.995}{1+0.07583t} \qquad (R^2=0.8022) \tag{6}$$

Water production for selected vertical and horizontal wells was calculated using the Excel-based tool. Figure 3.14 and Figure 3.15 show the comparison of water production trends for both vertical and horizontal wells between Wattenberg field-average *k* value and area-specific *k* values from selected wells in northeast Wattenberg Field.

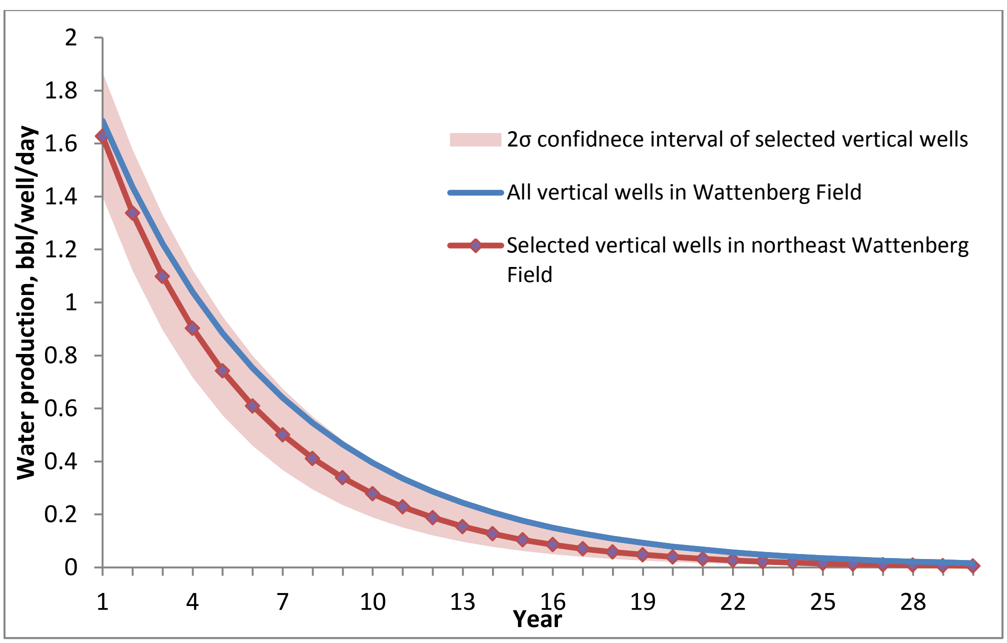


Figure 3.14. Comparison of water production trends between all vertical wells and selected vertical wells in northeast Wattenberg Field

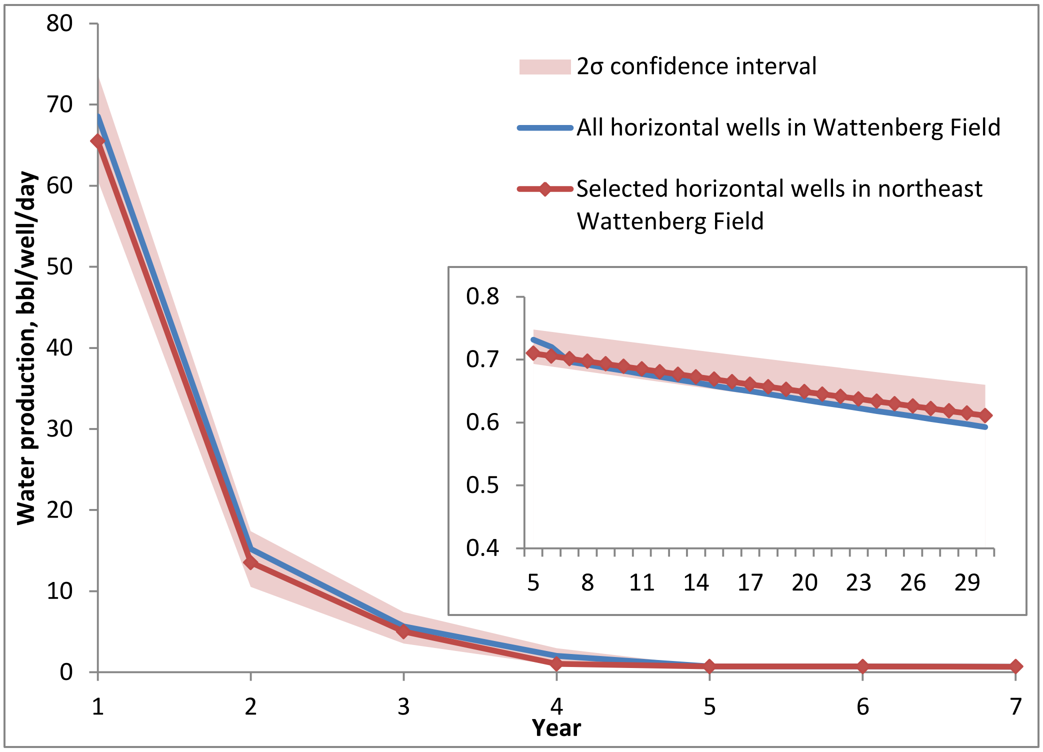


Fig. 3.15. Comparison of water production trends between all horizontal wells and selected horizontal wells in northeast Wattenberg field

In this case study, the difference in k, k_1, and a values for a chosen subset area (northeast part) of the Wattenberg field is compared to the entire field model. Different k, k_1, and a values result in different equations for both vertical and horizontal wells when predicting the water production. As shown in Figures 3.14 and 3.15, the model used for predictions of the well subset is different from the one of the whole Wattenberg field. It may be more accurate at predicting subset water production than applying the field-wide model. This case study shows the value of applying ArcGIS with the Excel tool to predict water production based on spatial locations.

3.7. Conclusion

Water usage in oil and gas development has been discussed at great length. However, it is known that oil and gas wells have the potential to produce and return water to the hydrologic cycle. Understanding these return flows is essential to understanding the complete water cycle associated with oil and gas development. Additionally, understanding these return flows can aid in treatment efforts that bring produced water back to beneficial uses.

This paper describes a simple tool for predicting total water production from existing and future oil and gas wells. While the tool is developed for the Wattenberg field in this paper, the case study of northeast Wattenberg demonstrates the tool's ability to be tailored to other areas by altering the functions. In the case of the Wattenberg field, the curves chosen are a first order decay function. It was determined that a single first order decay function was sufficient at modeling vertical well water production and two separate decay functions were required for predicting flowback and produced water from horizontal wells. Additionally, it was observed that decay rates vary drastically over a given area. Hence, to accurately forecast water production, a keen knowledge of historical decay rates and a defined project boundary are required.

From the first case study of all Noble wells in the Wattenberg field, it is clear that an increased total volume of produced water should be expected in the future with the expanded reliance on horizontal wells. Additionally, it is seen how proposed future development affects water production. As industry moves toward greater reliance on horizontal wells, water production will increase. From the second case study of the northeast Wattenberg field, it is seen that a tighter boundary can positively affect the accuracy of the decay rate. Therefore, choosing smaller project areas will increase the accuracy of the water production forecast.

While work can be done to minimize the effects of assumptions and historical data can be improved, ArcGIS and Excel tools can be built with models based on historical data to predict future water production for existing and proposed oil and gas wells. This knowledge of how current and future oil and gas development will affect water production in a field can be used to aid in decision making surrounding water treatment, disposal, transportation, and the efficacy of pursuing development in a given field.

Chapter 4. Case study on wells in Wells Ranch region, Wattenberg

4.1. Water production prediction of wells in Wells Ranch region

Another case study was performed in the Wells Ranch Region in northeast Wattenberg Field. Figure 4.1 shows the location and the studied wells in the Wells Ranch play in Wattenberg Field. A centralized water supply and wastewater treatment facility was considered to be built, and according to the database of Noble Energy, there are 283 vertical wells and 28 horizontal wells in this area. These wells were classified according to the year of the flowback report and Table 4.1 shows the number of new wells in each year.

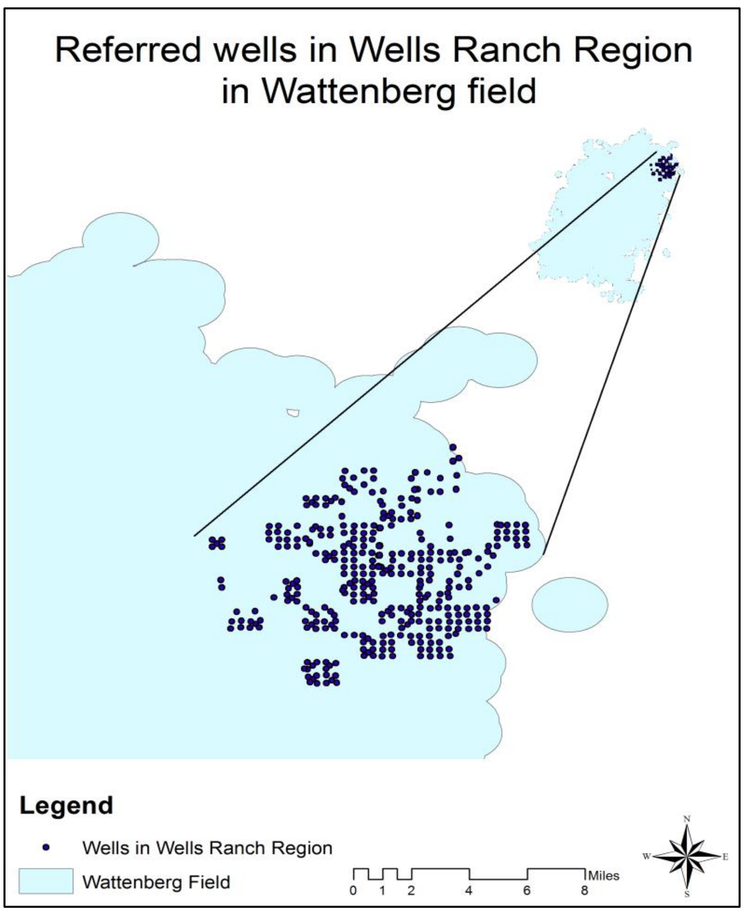


Figure 4.1: Location of wells ranch region and referred wells in Wattenberg Field

Table 4.1: Number of new wells in each year in Wells Ranch Region

Year	New vertical well	New horizontal well
2007	14	0
2008	83	0
2009	60	0
2010	37	5
2011	26	6
2012	63	17

Daily water production for each of these 311 wells was obtained from Noble Energy and due to the limited data for horizontal wells, only 15 flowback reports for horizontal wells were available from Noble Energy. Water production trends for vertical and horizontal wells were modeled all with exponential decay function.

In order to calculate the water production rate for these wells, production curves were made for each of these wells. Because among the 283 vertical wells, 61 wells have only one year of production data, data from 222 vertical wells were fitted to an exponential decline curve in water production and their *A* and *k* values were used to determine the vertical wells production rate. For the 15 horizontal wells with sufficient data sets, both frac flowback and produced water production curves were plotted.

Based on the average *A* and *k* values from 222 vertical wells, the water production rate for vertical wells in the Wells Ranch region is:

$$Q=5.189e^{-0.2747t} \qquad (R^2=0.8356) \tag{7}$$

And based on the average A_1, A_2, k_1 and k_2 values from 15 horizontal wells, frac flowback water production rate for horizontal wells in this region is:

$$Q=1773.45e^{-0.1946t} \qquad (R^2=0.7236) \tag{8}$$

And the produced water flow rate for horizontal wells in this region is:

$$Q=0.6731e^{-0.0082t} \qquad (R^2=0.8418) \qquad (9)$$

In Eq. (7), (8) and (9), the average value of A, k, A_1, k_1, A_2 and k_2 were used for the prediction of water production. In order to understand the reliability of these equations, an uncertainty analysis for these wells was performed. Figure 4.2 and 4.3 show the normal distribution of these variables.

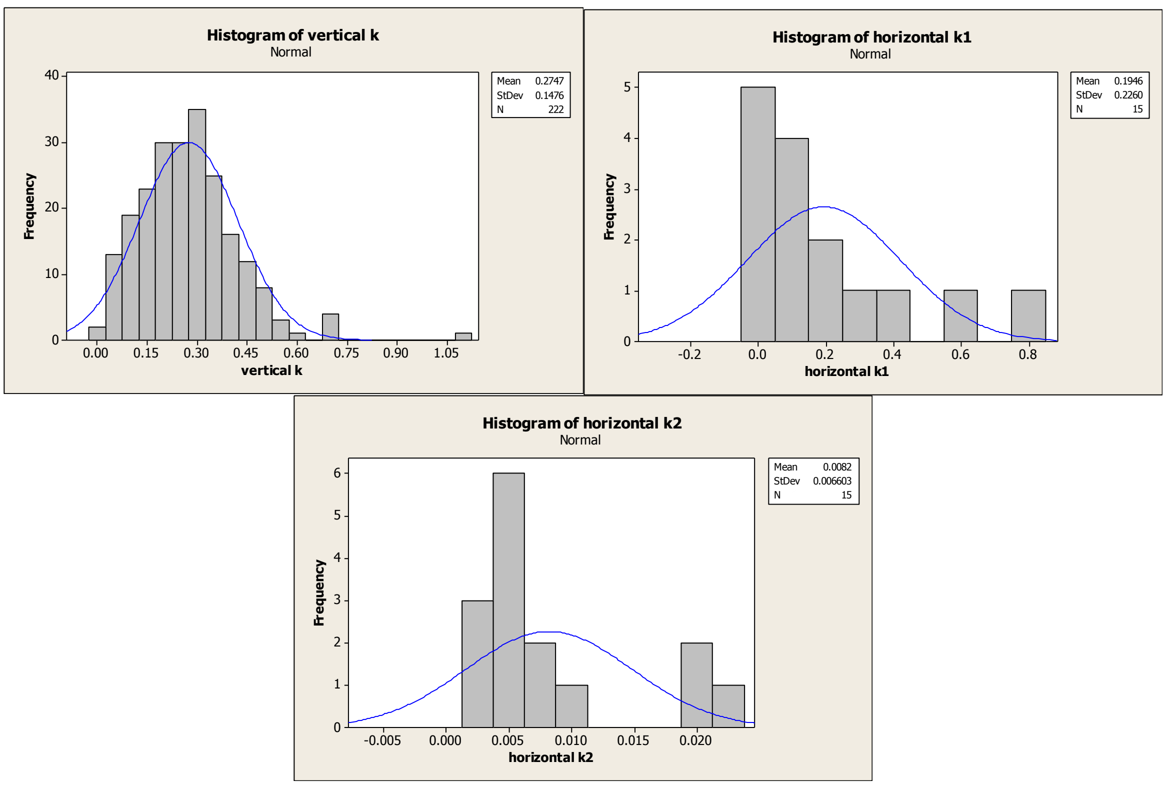


Figure 4.2: Distribution of k, k_1 and k_2 of wells in wells ranch region

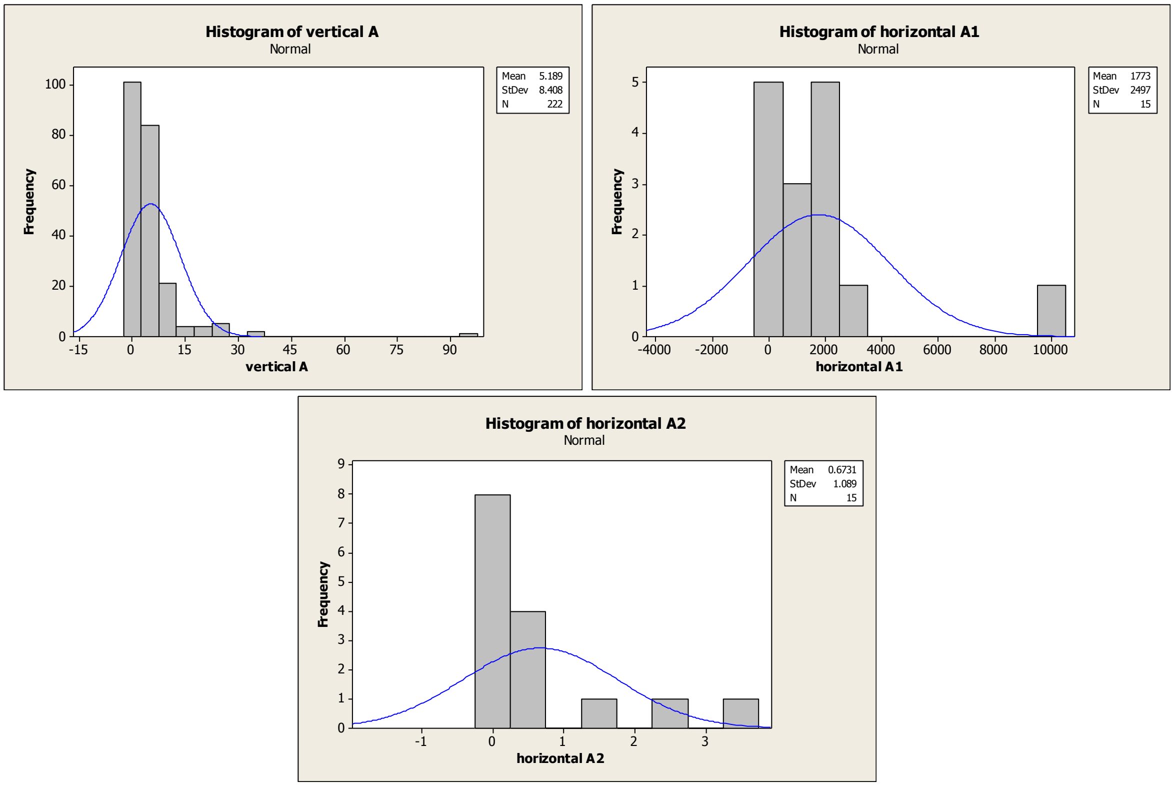


Figure 4.3: Distribution of A, A_1 and A_2 of wells in wells ranch region

Figure 4.4 shows a comparison of *k* values from all vertical wells (A) and 222 Wells Ranch vertical wells (B). Better resolution of *k* values is seen in the map B because more *k* values were used in map B compared to map A with only 66 *k* values.

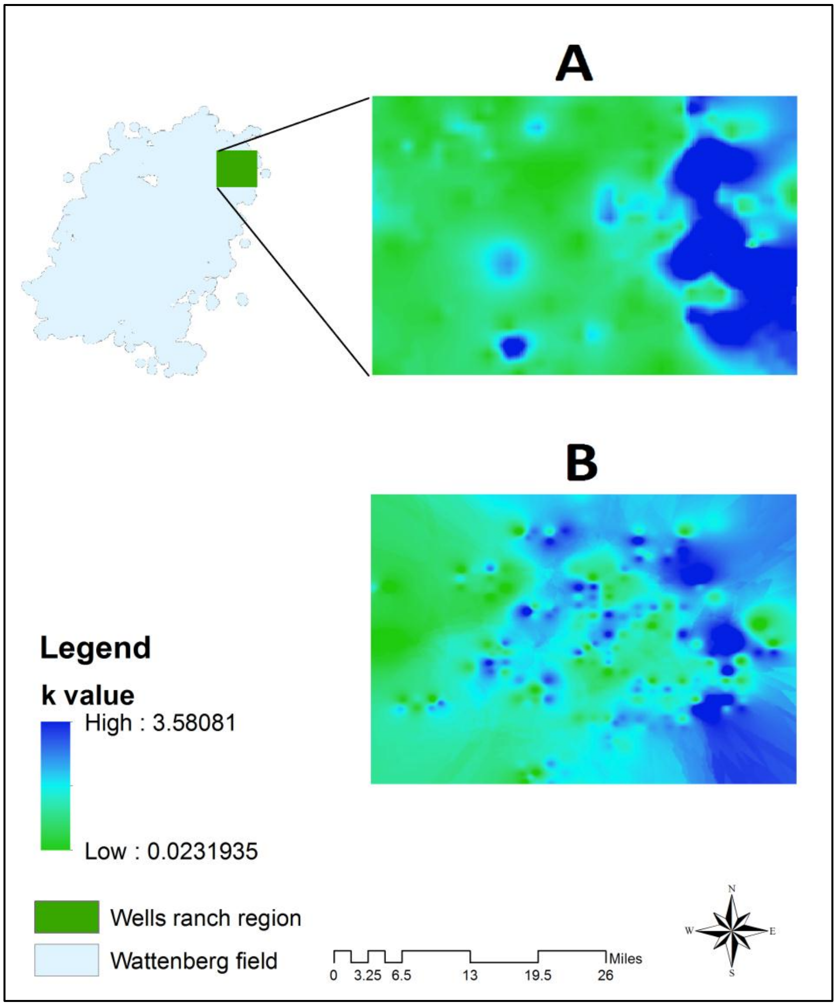


Figure 4.4: (A) Map of *k* values interpolated from 1,667 vertical wells in Wattenberg field (B) Map of *k* values interpolated from 222 wells ranch vertical wells

Table 4.2: Uncertainty analysis and acceptable range of variables

	k	A	k_1	A_1	k_2	A_2
μ	0.2747	5.189	0.1946	1773.45	0.0082	0.6731
σ	0.0099	0.564	0.0584	644.65	0.0017	0.2811
μ-1.645σ	0.258	4.261	0.099	713.001	0.005	0.211
μ+1.645σ	0.291	6.117	0.291	2833.9	0.011	1.136

Figure 4.5 and 4.6 show the production trends of vertical and horizontal well with 95% confidence intervals.

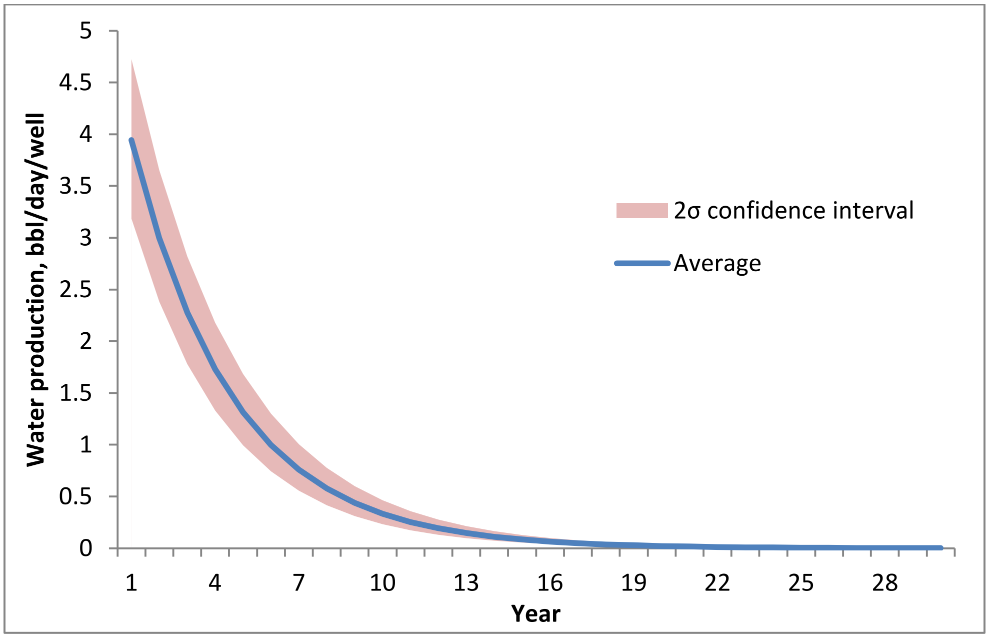


Figure 4.5. Water production trend of vertical well in wells ranch region

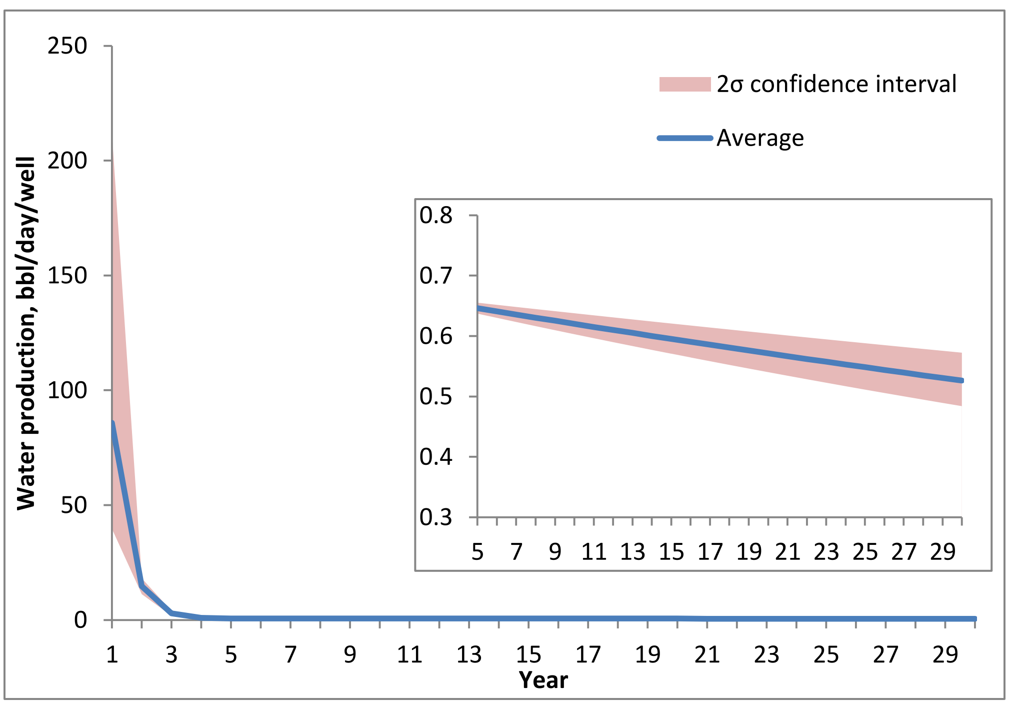


Figure 4.6. Water production trend of horizontal well in wells ranch region

Compared to the case study conducted in chapter 3 with selected wells in northeast Wattenberg field, this case study is more specific and focused on the Wells Ranch area, where Noble Energy is planning future development. This specific case study provides more precise water production trends of wells in Wells Ranch region compared to the results from average values of Wattenberg field. When predicting future water production in this region, more accurate computation will be available by using the Equations (7), (8) and (9).

Figure 4.7 shows the predicted water production from all wells in the Wells Ranch area with 50 vertical and 30 horizontal new wells drilled each year from 2012 to 2017. The assumption of well development is used to demonstrate the planning capabilities of the tool if a user would like to know how their new well plans will affect future water production. Because it is assumed that 30 new horizontal wells are drilled in 2012 compared to 6 in 2011, the water production increases rapidly. And since the number of new wells after 2012 stays constant, the predicted water production increases more consistently. On the other hand, if there are no new wells drilled after 2011, water production drops quickly from 400,000 to 70,000 bbl/year.

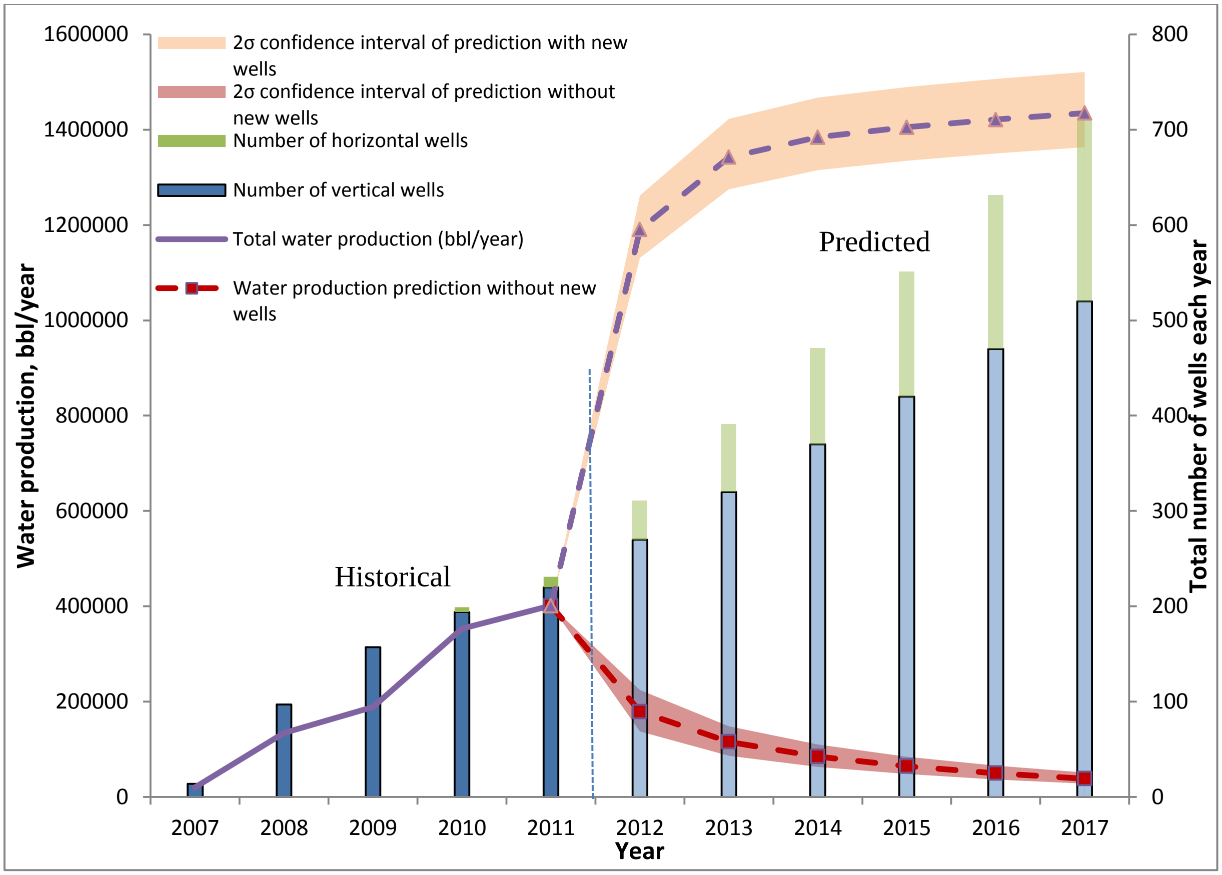


Figure 4.7. Total water production prediction of all wells in Wells Ranch Region from 2012 to 2017

4.2. Comparison of exponential and harmonic functions

In chapter 3 and 4, production of horizontal wells was fitted with exponential decline curves, however it may underestimate the volume of produced water since the exponential function is a form of Arps equation when b=0. When designing wastewater treatment facilities, it is essential to know the peak flow rate and in this case, exponential decline may not be the best function for predicting water production. Therefore, a comparison of exponential and harmonic functions was conducted on production predictions in the Wells Ranch area.

When b=1, the Arps equation is referred to as a harmonic decline with the equation of $= \frac{C}{1+at}$. After fitting the produced water data of 15 Wells Ranch wells with harmonic decline, the produced water production trend is:

$$Q = \frac{97.307}{1+0.022t} \qquad (R^2=0.7273) \qquad (10)$$

The comparison of exponential and harmonic functions is shown in Figure 4.8. When using an exponential function, the water production rate decays quickly from 85 bbl/day/well in the first year to 2.9 bbl/day/well in the third year. For the same decline rate constant (Di), the production rate decreases from 69 to 52 in the first three years assuming a harmonic function. Therefore the exponential function is considered as the aggressive decline and the harmonic function is considered as the conservative decline.

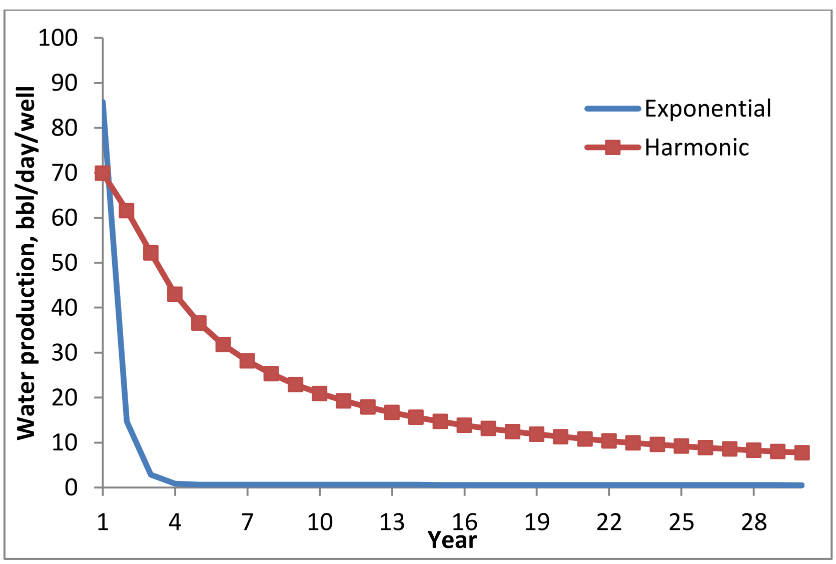


Figure 4.8. Comparison of exponential and harmonic decline of produced water production from 15 horizontal wells in Wells Ranch region in Wattenberg field, Colorado

Figure 4.8 shows a huge difference in water production between two different functions, and because the initial flow rates were different from two functions, the two water production curves in Figure 4.8 don’t start from the same point. As a result, produced water flow rate varies a lot with different fitting functions. Because there is only one year of data available for these 15 horizontal wells, it is not possible to determine the true long term decline trend and therefore an assumption needs to be made. In this case, it is recommended that wastewater treatment facilities be designed based on conservative decline assumptions and therefore it is recommended that a harmonic function be used.

Chapter 5. Conclusions

A study of water production from oil and gas wells in Wattenberg field was performed and Arps equation can be used for modeling produced water flow rate for both vertical and horizontal well. In this study, the water production rate was modeled with exponential decline which has the most aggressive decay when b=0 in the Arps equation. Limitations of the approach occurred because of the limited production data of horizontal wells and the use of average k values, even though there is considerable spatial variability as shown in Figure 3.2 and 3.4. The case study on Wells Ranch wells showed significant difference in the water production rate between exponential (b=0) and harmonic (b=1) functions, indicating that the exponential function may not be the best approach for predicting produced water production because it may underestimate the volume of produced water.

This study described a framework which can be used when trying to understand water production trends from oil and gas wells. In the future, more data will be collected and Arps equations with various b values will be studied to find out the best fitting function for water production. At the same time, in order to better understand the relationship between k values and spatial locations, a web based, user friendly GIS application will be developed using ArcGIS so that the prediction can be made based on the chosen area rather than the average value from the entire field. Finally water quality data will also be integrated into the application so it can provide a reference for users to design treatment facilities for water recycling.

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Appendix A. Method details

A.1. Vertical well water production data collection and analysis

There are two major sources for historical water production data of oil and gas wells in Wattenberg field. COGCC has yearly reports of all producing wells in each year in Colorado State, including oil, gas and water production data. Due to the limited access to all information of these wells, a sample of 1,677 vertical and 32 horizontal wells is chosen. Several filtration methods were applied to the COGCC reports to select the sample: All sample wells should be in Wattenberg field, and have all information including completion date, first production date, operation status and well type. The completion dates and first production dates are used in this study to determine well ages, and only wells that are producing were selected in this sample. There are totally 13 yearly reports of all wells in Colorado, after applying the filtration methods to all of these reports, 1,677 vertical wells with needed information were chosen for analysis.

Another source of data collection is the Carte® system of Noble Energy Incorporation. However there is not any information about completion and first production date in the system, only frac flowback data report of vertical wells were acquired from Noble Energy. After comparing flowback water with produced water of vertical wells in Wattenberg, it is necessary to neglect water produced during flowback period since it is so short (usually less than 1 to 2 days). Therefore, only produced water data from COGCC database was used for the analysis of water production trend of vertical wells in Wattenberg field.

The analysis is based on the average value of water production and producing days. From the COGCC data, average producing days were calculated (see Table 3.2) and depending on the well age, all these wells were classified from well age 1 to 13 (see Table 3.1). By summing up total water produced from all wells of the same well age and divided by total number of wells of the same well age, the average water production rate (bbl/well/year) was computed. And the daily water production rate is calculated from the yearly rate divided by average producing days in each year.

After plotting the daily water production in each operating year with time, the water production trend curve of vertical well is made. As shown in Eq. (1), the curve was fitted into exponential decay. The average decay rate for the entire Wattenberg field is 0.112 year^{-1} and in order to study the relationship between decay rate *k* and spatial location of wells, *k* value for each vertical well of 1,677 well samples was computed. And there are only 1,230 *k* values calculated from the sample, for the other 447 wells *k* value was not able to compute either because of the curve was not exponential decay or there was only one value (wells in 2011). All data and calculation results of vertical wells are shown in Table A.1 and A.2.

A.2. Horizontal well water production data collection and analysis

Unlike vertical wells, there was no horizontal well before 2010 so yearly water production data from COGCC cannot be used for analyzing water production trend for horizontal wells. Also because of long frac flowback period of horizontal wells, it is essential to study both frac flowback and produced water production trend.

All the analysis of horizontal wells in this research was based on water production data from Noble Energy Carte® system, including both hourly frac flowback report and daily produced water data. Only 32 wells' production data was acquired so only a sample of 32 horizontal wells was studied in this research. New report for each well was made by converting frac flowback data into daily data and combining them with produced water data. Frac flowback water curves were fitted into exponential decay and produced water curves were fitted into harmonic decay and k_1 and a values were calculated and these calculations were all made from the modified data analysis method for horizontal wells (Figure 3.3). All calculation results of horizontal wells are shown in Table A.3. After Calculating k_1 and a value for each well, curves were plotted for each k value of every well, and based on the 64 curves (32 for k_1 and 32 for a) the average curve (Eq.(2) and (3)) was made to represent the water production trend of all horizontal wells.

A.3. 30-year water production rate for vertical and horizontal wells

For both vertical and horizontal well, a life time (30 year) of water production rate was predicted for use by the developed Excel based tool. According to Eq. (1), (2) and (3), daily water production for both types of wells and predicted yearly volume of water production is shown in Table A.4 and A.5.

Table A.1. Water production data and *k* value calculation of 1677 sample vertical wells

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03	WP03	PD04	WP04	PD05	WP05	PD06	WP06	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 99	FR 00	FR 01	FR 02	FR 03	FR 04	FR 05	FR 06	FR 07	FR 08	FR 09	FR 10	FR 11	k

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03
1999	1	9395	39.94823N	104.61050W	36	745	353	2024	312	884	350	475	363
1999	123	19642	40.11084N	104.80308W	299	703	358	152	360	16	357	234	359
1999	123	19713	40.15832N	104.85016W	311	1232	365	508	286	482	349	470	362
1999	123	19770	40.13688N	104.90354W	166	1229	286	249	359	201	323	205	359
1999	123	19807	40.33582N	104.59502W	47	0	298	0	354	0	346	0	349
1999	123	19843	40.40297N	104.83553W	17	0	360	0	341	0	355	5	341
2000	1	9427	39.99516N	104.88610W			38	565	361	1302	363	835	360
2000	123	19767	40.09738N	104.99656W			117	1158	359	953	365	530	365
2000	123	19775	40.24025N	104.72752W			122	0	362	197	364	472	331
2000	123	19856	40.10769N	104.79406W			317	1566	333	838	363	691	361
2000	123	19891	40.17533N	104.80893W			307	1166	361	638	363	345	343
2000	123	19945	40.18620N	104.80329W			61	278	309	407	357	190	352
2000	123	20009	40.16155N	104.92598W			71	487	359	545	350	332	362
2000	123	20079	40.15455N	104.85154W			54	348	357	763	357	364	365
2000	123	20080	40.10387N	105.00590W			23	260	363	947	361	347	352
2000	123	20083	40.11515N	104.80771W			25	0	360	16	361	234	359
2001	123	7686	40.19281N	104.44734W					151	250	270	100	179
2001	123	10349	40.07847N	104.93546W					261	278	300	121	355

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03	WP03	PD04	WP04	PD05	WP05	PD06	WP06	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 99	FR 00	FR 01	FR 02	FR 03	FR 04	FR 05	FR 06	FR 07	FR 08	FR 09	FR 10	FR 11	k
2003	123	21558	40.11152N	104.61011W									71	1256	365	1259	365	770	365	463	377	451	541	403	730	594	730	522	486	298					17.690	3.449	2.110	1.268	1.196	0.745	0.814	0.715	0.613	0.316
2003	123	21569	40.48404N	104.51965W									45	0	334	0	294	0	314	0	316	189	355	248	361	228	334	565	231	329									0.598	0.699	0.632	1.692	1.424	0.325
2003	123	21572	40.47754N	104.83549W									122	0	313	0	317	41	164	0	236	380	264	278	361	116	334	38	230	0							0.129		1.610	1.053	0.321	0.114		0.237
2003	123	21573	40.48010N	104.52433W									114	0	335	0	354	0	315	0	256	57	299	172	363	118	328	88	225	63									0.223	0.575	0.325	0.268	0.280	0.437
2003	123	21575	40.48012N	104.51901W									122	0	337	0	353	0	427	0	320	175	361	209	363	137	279	70	231	97									0.547	0.579	0.377	0.251	0.420	1.017
2003	123	21595	40.20734N	104.89123W									68	356	364	496	364	289	365	479	314	15	348	83	120	57	344	63	243	65					5.235	1.363	0.794	1.312	0.048	0.239	0.475	0.183	0.267	0.585
2003	123	21612	40.50674N	104.52508W									114	0	351	0	360	0	376	0	326	72	332	59	364	72	328	20	243	12									0.221	0.178	0.198	0.061	0.049	0.473
2003	123	21621	40.48370N	104.57690W									104	0	316	0	295	0	314	0	309	360	364	131	350	80	330	68	243	51									1.165	0.360	0.229	0.206	0.210	0.339
2003	123	21622	40.51079N	104.64694W									8	0	340	0	321	0	334	0	293	355	300	184	353	192	330	21	243	0									1.212	0.613	0.544	0.064		0.293
2003	123	21624	40.51327N	104.54369W									107	0	331	0	241	0	385	11	295	162	345	109	353	116	314	37	243	44								0.029	0.549	0.316	0.329	0.118	0.181	0.328
2003	123	21642	40.48066N	104.57732W									95	0	349	0	312	0	312	0	299	437	363	211	347	91	333	69	225	45									1.462	0.581	0.262	0.207	0.200	
2003	123	21645	40.49883N	104.62733W									84	0	355	0	291	0	427	0	316	206	362	177	356	160	292	79	243	0									0.652	0.489	0.449	0.271		
2003	123	21658	40.49148N	104.57652W									24	0	344	0	342	0	354	9	319	592	290	228	337	161	307	27	165	17								0.025	1.856	0.786	0.478	0.088	0.103	
2003	123	21659	40.44470N	104.51967W									43	0	321	0	343	0	361	15	253	109	291	45	324	41	325	120	224	78								0.042	0.431	0.155	0.127	0.369	0.348	0.232
2003	123	21660	40.51825N	104.64692W									13	0	270	0	247	0	343	4	299	87	283	52	341	37	334	0	166	0								0.012	0.291	0.184	0.109			0.079
2003	123	21661	40.47703N	104.51487W									40	0	347	0	355	0	364	29	270	369	239	767	364	682	285	128	241	0								0.080	1.367	3.209	1.874	0.449		0.051
2003	123	21708	40.35278N	104.79003W									29	102	366	315	319	382	365	194	365	356	348	81	365	107	342	127	226	44					3.517	0.861	1.197	0.532	0.975	0.233	0.293	0.371	0.195	0.385
2003	123	21728	40.30915N	104.56990W									25	137	332	320	365	173	365	64	365	50	365	29	360	53	335	73	242	164					5.480	0.964	0.474	0.175	0.137	0.079	0.147	0.218	0.678	0.491
2004	123	16079	40.42674N	104.61888W											238	424	347	481	362	111	287	0	361	12	364	152	365	226	236	150						1.782	1.386	0.307		0.033	0.418	0.619	0.636	0.362
2004	123	19240	40.33186N	104.52543W											276	1299	339	432	361	151	362	35	366	116	358	117	365	67	243	95						4.707	1.274	0.418	0.097	0.317	0.327	0.184	0.391	0.421
2004	123	19245	40.32152N	104.52513W											49	133	362	194	361	136	365	82	358	50	346	274	335	90	243	88						2.714	0.536	0.377	0.225	0.140	0.792	0.269	0.362	0.515
2004	123	20377	40.01660N	104.95649W											244	781	365	293	361	113	365	61	351	34	322	21	362	24	243	49						3.201	0.803	0.313	0.167	0.097	0.065	0.066	0.202	0.739
2004	123	20407	40.27826N	104.88452W											289	0	350	0	276	0	305	144	289	530	363	309	303	74	243	151									0.472	1.834	0.851	0.244	0.621	0.343
2004	123	20444	40.28523N	104.57237W											273	0	360	0	319	0	330	132	262	1079	365	510	328	173	243	112									0.400	4.118	1.397	0.527	0.461	0.119
2004	123	20846	40.12109N	104.92779W											253	481	365	233	361	134	365	49	362	18	549	276	730	205	486	169						1.901	0.638	0.371	0.134	0.050	0.503	0.281	0.348	
2004	123	21170	40.14035N	104.56356W											36	0	321	1026	383	180	364	107	364	60	372	50	365	30	335	37							3.196	0.470	0.294	0.165	0.134	0.082	0.110	
2004	123	21180	40.35028N	104.51978W											300	225	353	809	358	177	330	16	365	77	361	107	354	159	239	100						0.750	2.292	0.494	0.048	0.211	0.296	0.449	0.418	0.914
2004	123	21332	40.32278N	104.58881W											236	380	322	862	361	482	363	698	366	275	365	138	365	145	243	89						1.610	2.677	1.335	1.923	0.751	0.378	0.397	0.366	0.03
2004	123	21339	40.40517N	104.87291W											332	0	362	0	361	0	298	501	329	609	365	312	332	188	243	143									1.681	1.851	0.855	0.566	0.588	0.347
2004	123	21340	40.38698N	104.89036W											324	0	355	0	328	0	315	76	272	600	350	401	334	114	243	162									0.241	2.206	1.146	0.341	0.667	0.136
2004	123	21539	40.11139N	104.65234W											210	1387	365	276	341	270	333	169	667	437	730	164	730	157	482	83						6.605	0.756	0.792	0.508	0.655	0.225	0.215	0.172	0.303
2004	123	21548	40.15824N	104.60068W											389	1640	730	725	702	329	730	78	732	234	730	0	728	0	486	0						4.216	0.993	0.469	0.107	0.320				0.509
2004	123	21560	40.16890N	104.61992W											92	521	365	287	503	129	589	159	365	49	364	67	333	116	217	675						5.663	0.786	0.256	0.270	0.134	0.184	0.348	3.111	0.344
2004	123	21570	40.43798N	104.88554W											122	4	349	0	330	0	304	36	318	393	356	120	334	28	235	172						0.033			0.118	1.236	0.337	0.084	0.732	0.407
2004	123	21574	40.17297N	104.66154W											277	0	347	0	394	0	314	85	300	122	363	70	315	53	243	18									0.271	0.407	0.193	0.168	0.074	0.399
2004	123	21577	40.47894N	104.70957W											337	0	351	0	362	14	308	193	357	210	363	160	334	84	243	0								0.039	0.627	0.588	0.441	0.251		0.896
2004	123	21578	40.16585N	104.66632W											292	0	358	0	322	0	313	72	290	693	363	282	327	202	243	115									0.230	2.390	0.777	0.618	0.473	0.321
2004	123	21649	40.44170N	104.88589W											89	0	346	0	358	0	311	362	350	517	345	165	334	46	243	18									1.164	1.477	0.478	0.138	0.074	0.501
2004	123	21681	40.14367N	104.60576W											408	1690	730	0	586	264	716	338	704	336	730	194	1077	209	729	139						4.142		0.451	0.472	0.477	0.266	0.194	0.191	0.272
2004	123	21706	40.35205N	104.51168W											306	10	355	3	327	2	314	1	277	1	357	1	311	208	237	86						0.033	0.008	0.006	0.003	0.004	0.003	0.669	0.363	0.788
2004	123	21818	40.22427N	104.87511W											243	991	348	291	328	176	318	115	338	176	310	95	365	35	242	46						4.078	0.836	0.537	0.362	0.521	0.306	0.096	0.190	0.076
2004	123	21829	40.38191N	104.77062W											323	416	325	247	365	466	357	336	354	322	365	336	365	177	243	101						1.288	0.760	1.277	0.941	0.910	0.921	0.485	0.416	
2004	123	21833	40.21189N	104.71374W											245	1209	323	791	361	672	365	120	353	284	317	128	362	141	239	92						4.935	2.449	1.861	0.329	0.805	0.404	0.390	0.385	
2004	123	21863	40.28002N	104.84423W											17	155	365	488	365	147	365	95	366	20	365	86	308	85	243	43						9.118	1.337	0.403	0.260	0.055	0.236	0.276	0.177	
2004	123	21869	40.42655N	104.52459W											233	525	371	503	355	121	310	26	317	194	361	173	253	65	243	51						2.253	1.356	0.341	0.084	0.612	0.479	0.257	0.210	0.393
2004	123	21878	40.25680N	104.49239W											236	2790	365	1482	353	1210	316	518	359	337	446	817	694	663	388	452						11.822	4.060	3.428	1.639	0.939	1.832	0.955	1.165	0.443
2004	123	21884	40.33288N	104.50583W											288	421	335	294	357	675	365	116	363	91	335	129	365	98	228	67						1.462	0.878	1.891	0.318	0.251	0.385	0.268	0.294	0.296
2004	123	21907	40.20235N	104.65149W											261	423	363	201	359	90	362	103	350	528	365	139	365	41	243	63						1.621	0.554	0.251	0.285	1.509	0.381	0.112	0.259	0.09
2004	123	21923	40.30747N	104.87540W											227	392	363	146	335	274	365	53	365	149	341	41	364	47	223	60						1.727	0.402	0.818	0.145	0.408	0.120	0.129	0.269	0.266
2004	123	21926	40.36559N	104.83913W											61	338	325	468	344	371	365	39	357	128	342	136	307	92	231	73						5.541	1.440	1.078	0.107	0.359	0.398	0.300	0.316	0.4
2004	123	21929	40.33149N	104.55988W											18	136	402	1764	355	146	361	72	311	38	365	50	364	68	241	39						7.556	4.388	0.411	0.199	0.122	0.137	0.187	0.162	0.133
2004	123	21942	40.48434N	104.61865W											155	0	294	0	331	0	250	752	360	249	350	175	300	56	204	16									3.008	0.692	0.500	0.187	0.078	0.366
2004	123	21943	40.48488N	104.63705W											244	0	344	0	324	0	331	147	344	952	345	446	327	112	238	9									0.444	2.767	1.293	0.343	0.038	0.41
2004	123	21944	40.48424N	104.63356W											255	0	313	0	330	0	331	160	350	962	328	271	321	70	234	2									0.483	2.749	0.826	0.218	0.009	0.46
2004	123	21945	40.48064N	104.63358W											254	0	324	0	329	0	331	156	348	161	337	92	327	42	231	4									0.471	0.463	0.273	0.128	0.017	0.261
2004	123	21946	40.48738N	104.62263W											236	0	332	0	329	0	254	228	300	1046	351	483	316	126	242	63									0.898	3.487	1.376	0.399	0.260	
2004	123	21947	40.48749N	104.62807W											228	0	325	0	323	0	278	434	327	1057	355	458	315	130	213	29									1.561	3.232	1.290	0.413	0.136	0.308
2004	123	21980	40.26515N	104.62552W											15	47	365	503	325	326	342	211	336	113	364	211	341	696	243	535						3.133	1.378	1.003	0.617	0.336	0.580	2.041	2.202	0.287
2004	123	21981	40.34208N	104.70359W											254	310	365	445	364	55	326	70	338	0	338	168	365	605	243	325						1.220	1.219	0.151	0.215		0.497	1.658	1.337	0.264
2004	123	21982	40.35460N	104.45695W											227	2618	264	682	308	224	46	488	380	408	359	146	365	155	240	88						11.533	2.583	0.727	10.609	1.074	0.407	0.425	0.367	0.257
2004	123	21997	40.48488N	104.64779W											225	0	341	0	313	0	320	106	332	119	355	610	328	144	243	0									0.331	0.358	1.718	0.439		0.213
2004	123	22022	40.46984N	104.53864W											142	0	333	0	355	0	317	67	246	330	350	53	283	251	201	89									0.211	1.341	0.151	0.887	0.443	0.279
2004	123	22023	40.46621N	104.54335W											147	0	333	0	342	0	315	74	259	493	346	118	262	195	224	63									0.235	1.903	0.341	0.744	0.281	0.353
2004	123	22024	40.46632N	104.53390W											154	0	338	0	351	0	307	55	281	373	349	49	300	155	206	26									0.179	1.327	0.140	0.517	0.126	0.158
2004	123	22025	40.47644N	104.53791W											9	0	322	0	313	0	319	153	280	62	362	37	328	64	215	186									0.480	0.221	0.102	0.195	0.865	0.553
2004	123	22067	40.11481N	104.69567W											248	1760	365	988	365	429	365	671	351	401	338	233	353	44	212	0						7.097	2.707	1.175	1.838	1.142	0.689	0.125		0.86
2004	123	22068	40.47487N	104.79890W											217	0	344	11	331	0	334	91	263	90	364	127	334	51	243	21							0.032		0.272	0.342	0.349	0.153	0.086	0.702
2004	123	22077	40.41185N	104.82037W											243	508	355	197	362	145	338	92	351	127	315	112	339	934	243	304						2.091	0.555	0.401	0.272	0.362	0.356	2.755	1.251	0.106
2004	123	22080	40.44529N	104.88116W											54	0	342	0	361	0	301	299	324	1433	363	308	334	144	234	215									0.993	4.423	0.848	0.431	0.919	0.789
2004	123	22081	40.44534N	104.88682W											92	0	344	0	357	0	307	243	344	640	345	269	334	88	243	21									0.792	1.860	0.780	0.263	0.086	0.464
2004	123	22082	40.44845N	104.88254W											73	0	342	0	309	0	287	243	253	443	363	234	334	89	234	106									0.847	1.751	0.645	0.266	0.453	0.694
2004	123	22083	40.44465N	104.87639W											18	0	326	0	326	0	323	99	310	86	355	347	334	120	243	248									0.307	0.277	0.977	0.359	1.021	
2004	123	22084	40.44836N	104.87633W											39	22	332	0	364	0	250	170	264	396	362	327	334	88	243	19						0.564			0.680	1.500	0.903	0.263	0.078	0.033
2004	123	22085	40.43891N	104.87900W											111	19	337	0	332	0	311	47	328	198	359	79	334	29	235	190						0.171			0.151	0.604	0.220	0.087	0.809	
2004	123	22086	40.15477N	104.71364W											258	2016	730	616	718	1373	690	1650	724	339	424	145	730	102	486	59						7.814	0.844	1.912	2.391	0.468	0.342	0.140	0.121	0.443
2004	123	22096	40.44127N	104.88095W											98	0	349	0	356	0	305	301	354	648	349	291	325	80	243	20									0.987	1.831	0.834	0.246	0.082	
2004	123	22097	40.44831N	104.87254W											47	22	337	0	350	0	152	133	270	510	362	242	334	101	243	22						0.468			0.875	1.889	0.669	0.302	0.091	
2004	123	22098	40.44212N	104.87554W											53	0	328	0	328	0	262	126	344	102	363	92	334	43	170	48									0.481	0.297	0.253	0.129	0.282	0.058
2004	123	22099	40.35255N	104.59806W											234	769	305	422	363	296	712	88	704	215	726	318	696	488	476	259						3.286	1.384	0.815	0.124	0.305	0.438	0.701	0.544	0.164
2004	123	22117	40.16960N	104.68530W											239	934	730	845	708	663	723	835	722	386	730	367	730	269	486	45						3.908	1.158	0.936	1.155	0.535	0.503	0.368	0.093	
2004	123	22119	40.08249N	105.00111W											148	501	365	117	311	635	320	0	331	102	699	462	730	357	486	169						3.385	0.321	2.042		0.308	0.661	0.489	0.348	
2004	123	22121	40.37669N	104.93289W											149	0	358	0	304	0	321	14	186	474	365	304	332	148	243	57									0.044	2.548	0.833	0.446	0.235	0.532
2004	123	22133	40.51531N	104.78048W											165	0	215	0	288	73	295	165	251	124	350	92	334	115	236	68								0.253	0.559	0.494	0.263	0.344	0.288	0.31
2004	123	22143	40.24808N	104.73653W											212	232	364	129	363	57	306	19	335	77	349	727	358	838	237	322						1.094	0.354	0.157	0.062	0.230	2.083	2.341	1.359	0.301
2004	123	22152	40.12574N	104.69907W											120	885	365	229	364	701	360	676	365	641	365	184	365	61	243	11						7.375	0.627	1.926	1.878	1.756	0.504	0.167	0.045	
2004	123	22153	40.20732N	104.70079W											224	372	363	237	293	195	351	231	358	263	358	230	354	201	238	106						1.661	0.653	0.666	0.658	0.735	0.642	0.568	0.445	0.248
2004	123	22155	40.24807N	104.84734W											197	248	365	315	364	230	363	113	340	0	365	401	365	226	243	102						1.259	0.863	0.632	0.311		1.099	0.619	0.420	0.638
2004	123	22173	40.26357N	104.46430W											58	76	279	1640	363	1250	365	482	366	456	365	113	363	86	243	0						1.310	5.878	3.444	1.321	1.246	0.310	0.237		0.313
2004	123	22177	40.25634N	104.52537W											148	2769	339	1627	356	223	365	132	358	63	356	94	390	174	182	90						18.709	4.799	0.626	0.362	0.176	0.264	0.446	0.495	
2004	123	22188	40.24533N	104.49717W											158	2651	135	302	260	2215	318	569	359	392	261	78	356	107	238	82						16.778	2.237	8.519	1.789	1.092	0.299	0.301	0.345	0.226
2004	123	22194	40.33299N	104.63821W											165	232	360	497	537	1165	718	806	687	741	724	675	502	583	486	730						1.406	1.381	2.169	1.123	1.079	0.932	1.161	1.502	
2004	123	22197	40.24530N	104.49246W											92	655	397	1336	266	1909	316	562	310	334	269	82	276	118	235	146						7.120	3.365	7.177	1.778	1.077	0.305	0.428	0.621	0.535
2004	123	22199	40.13285N	104.74606W											115	561	365	800	326	212	363	0	366	10	151	26	365	185	243	95						4.878	2.192	0.650		0.027	0.172	0.507	0.391	0.697
2004	123	22202	40.44950N	104.88667W											56	0	325	0	362	0	269	153	263	622	362	390	334	154	235	208									0.569	2.365	1.077	0.461	0.885	0.199
2004	123	22209	40.21609N	104.47816W											148	0	365	0	444	303	649	56	700	114	455	104	704	250	462	307								0.682	0.086	0.163	0.229	0.355	0.665	0.19
2004	123	22215	40.36703N	104.57815W											146	476	320	289	324	409	322	23	375	5	338	292	365	206	198	96						3.260	0.903	1.262	0.071	0.013	0.864	0.564	0.485	0.202
2004	123	22222	40.11543N	104.61463W											125	1020	365	508	309	618	592	702	661	1226	668	688	694	292	468	166						8.160	1.392	2.000	1.186	1.855	1.030	0.421	0.355	0.101
2004	123	22226	40.19859N	104.45439W											166	0	730	90	682	548	720	0	712	0	704	33	688	70	347	0							0.123	0.804			0.047	0.102		0.411
2004	123	22227	40.09679N	104.75143W											183	1120	730	1187	542	659	835	1079	1095	918	1095	793	1095	717	729	326						6.120	1.626	1.216	1.292	0.838	0.724	0.655	0.447	0.216
2004	123	22234	40.45003N	104.81382W											92	0	337	32	322	0	312	67	264	169	351	231	326	34	176	131							0.095		0.215	0.640	0.658	0.104	0.744	0.249
2004	123	22235	40.44907N	104.81931W											40	0	329	0	320	0	312	65	224	437	356	1075	317	166	215	118									0.208	1.951	3.020	0.524	0.549	
2004	123	22262	40.14436N	104.61391W											28	613	365	352	364	750	689	1012	583	696	612	1083	692	627	486	113						21.893	0.964	2.060	1.469	1.194	1.770	0.906	0.233	0.041
2004	123	22276	40.09668N	104.71363W											140	770	361	647	346	349	343	148	355	270	365	167	326	97	137	46						5.500	1.792	1.009	0.431	0.761	0.458	0.298	0.336	
2004	123	22280	40.30247N	104.46346W											76	1521	334	4362	288	1632	326	659	314	533	356	615	335	853	239	7						20.013	13.060	5.667	2.021	1.697	1.728	2.546	0.029	0.552
2004	123	22299	40.19430N	104.81876W											102	528	362	654	362	290	350	84	366	51	426	844	365	155	243	57						5.176	1.807	0.801	0.240	0.139	1.981	0.425	0.235	0.118
2004	123	22300	40.01324N	104.78040W											29	230	544	822	730	340	726	274	672	324	678	206	730	172	464	94						7.931	1.511	0.466	0.377	0.482	0.304	0.236	0.203	0.083
2004	123	22303	40.45880N	104.53341W											113	1096	171	512	338	230	354	15	345	19	365	139	365	24	163	57						9.699	2.994	0.680	0.042	0.055	0.381	0.066	0.350	0.43
2004	123	22304	40.37571N	104.48492W											102	173	268	183	332	124	365	740	335	31	356	55	430	1117	239	554						1.696	0.683	0.373	2.027	0.093	0.154	2.598	2.318	1.413
2004	123	22312	40.27430N	104.47811W											28	181	365	656	349	95	310	43	332	65	146	0	70	0	235	0						6.464	1.797	0.272	0.139	0.196				0.484
2004	123	22328	40.51823N	104.81504W											1	0	247	0	332	25	297	544	253	109	356	128	333	70	238	25								0.075	1.832	0.431	0.360	0.210	0.105	0.156
2004	123	22329	40.29796N	104.96705W											38	0	288	0	211	0	142	91	200	102	363	72	334	17	243	16									0.641	0.510	0.198	0.051	0.066	0.569
2004	123	22331	40.18237N	104.68214W											86	401	357	72	358	0	346	341	304	83	361	115	365	97	243	40						4.663	0.202		0.986	0.273	0.319	0.266	0.165	0.035
2004	123	22355	40.38340N	104.93379W											46	0	354	0	318	0	326	170	293	361	344	206	334	39	240	90									0.521	1.232	0.599	0.117	0.375	
2004	123	22384	40.46813N	104.82333W											22	0	307	0	324	1	324	73	321	917	364	316	332	204	243	24								0.003	0.225	2.857	0.868	0.614	0.099	0.445
2004	123	22385	40.47110N	104.82350W											17	0	277	14	318	0	325	92	310	96	357	78	333	97	243	26							0.051		0.283	0.310	0.218	0.291	0.107	0.382
2004	123	22399	40.11493N	104.56796W											23	743	365	0	365	278	342	521	365	395	365	120	364	356	243	142						32.304		0.762	1.523	1.082	0.329	0.978	0.584	0.075
2004	123	22404	40.47373N	104.54296W											17	0	334	0	315	0	319	110	280	627	362	286	331	251	228	144									0.345	2.239	0.790	0.758	0.632	
2004	123	22406	40.36694N	104.82828W											57	224	357	312	361	162	365	69	342	327	365	504	362	151	243	58						3.930	0.874	0.449	0.189	0.956	1.381	0.417	0.239	0.22
2004	123	22419	40.19449N	104.63788W											18	197	135	127	205	126	287	142	366	154	360	120	362	89	242	39						10.944	0.941	0.615	0.495	0.421	0.333	0.246	0.161	0.351
2004	123	22425	40.35076N	104.82534W											38	140	333	364	365	160	365	60	335	101	48	130	359	85	243	66						3.684	1.093	0.438	0.164	0.301	2.708	0.237	0.272	0.279

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03	WP03	PD04	WP04	PD05	WP05	PD06	WP06	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 99	FR 00	FR 01	FR 02	FR 03	FR 04	FR 05	FR 06	FR 07	FR 08	FR 09	FR 10	FR 11	k
2004	123	22440	40.35132N	104.58752W											57	235	318	524	309	252	347	52	363	69	201	38	331	12	207	41						4.123	1.648	0.816	0.150	0.190	0.189	0.036	0.198	0.296
2004	123	22516	40.21507N	104.87140W											42	191	343	617	365	374	339	251	319	135	365	109	358	94	233	69						4.548	1.799	1.025	0.740	0.423	0.299	0.263	0.296	
2004	123	22582	40.47573N	104.53150W											6	0	337	0	310	31	312	103	352	1385	337	440	319	256	207	134								0.100	0.330	3.935	1.306	0.803	0.647	
2005	123	19251	40.46424N	104.79051W													201	49	327	3	318	122	277	36	362	109	302	45	238	16							0.244	0.009	0.384	0.130	0.301	0.149	0.067	0.125
2005	123	20202	40.16243N	104.95370W													311	1781	348	942	332	633	356	55	465	391	698	555	452	339							5.727	2.707	1.907	0.154	0.841	0.795	0.750	0.39
2005	123	21073	40.30303N	104.47809W													87	76	365	185	365	35	366	99	365	43	341	1430	240	258							0.874	0.507	0.096	0.270	0.118	4.194	1.075	0.361
2005	123	21721	40.30986N	104.53215W													321	186	333	288	351	67	366	40	365	153	365	222	243	59							0.579	0.865	0.191	0.109	0.419	0.608	0.243	0.686
2005	123	21881	40.44783N	104.59551W													293	277	353	97	340	0	358	0	353	44	361	0	233	33							0.945	0.275			0.125		0.142	0.707
2005	123	21927	40.36507N	104.83484W													279	564	323	339	365	29	359	141	364	226	365	188	243	91							2.022	1.050	0.079	0.393	0.621	0.515	0.374	0.318
2005	123	22026	40.47221N	104.53438W													340	0	313	0	322	148	273	66	360	29	331	50	224	415									0.460	0.242	0.081	0.151	1.853	0.429
2005	123	22079	40.44462N	104.87302W													319	0	328	0	324	102	304	99	359	348	334	132	243	253									0.315	0.326	0.969	0.395	1.041	0.522
2005	123	22113	40.37466N	104.85589W													120	514	365	209	361	152	366	138	296	1241	364	660	238	86							4.283	0.573	0.421	0.377	4.193	1.813	0.361	
2005	123	22174	40.26754N	104.46917W													79	798	327	1156	157	232	276	422	314	21	364	2	243	0							10.101	3.535	1.478	1.529	0.067	0.005		0.079
2005	123	22180	40.26035N	104.52524W													188	336	348	216	346	125	355	59	333	91	352	171	217	117							1.787	0.621	0.361	0.166	0.273	0.486	0.539	0.956
2005	123	22195	40.24124N	104.49192W													201	632	331	14	360	0	362	0	304	390	706	459	476	335							3.144	0.042			1.283	0.650	0.704	0.143
2005	123	22281	40.29217N	104.46364W													122	1389	315	2334	332	635	333	504	145	52	365	190	239	0							11.385	7.410	1.913	1.514	0.359	0.521		0.686
2005	123	22308	40.29312N	104.86286W													197	112	303	45	321	90	366	138	363	91	365	75	224	51							0.569	0.149	0.280	0.377	0.251	0.205	0.228	0.308
2005	123	22350	40.20495N	104.65212W													268	0	287	79	331	67	306	65	360	72	322	34	210	31								0.275	0.202	0.212	0.200	0.106	0.148	0.147
2005	123	22370	40.48115N	104.61840W													263	0	331	5	301	175	352	106	315	80	294	25	197	13								0.015	0.581	0.301	0.254	0.085	0.066	0.302
2005	123	22379	40.47828N	104.82456W													274	7	329	0	316	103	314	68	365	90	334	32	242	5							0.026		0.326	0.217	0.247	0.096	0.021	0.562
2005	123	22380	40.47811N	104.82979W													266	0	329	0	329	99	201	47	0	0	0	0	112	22									0.301	0.234			0.196	0.633
2005	123	22381	40.47524N	104.82436W													265	0	291	0	322	87	311	146	358	77	333	107	243	59									0.270	0.469	0.215	0.321	0.243	0.095
2005	123	22402	40.18960N	104.93799W													357	1170	365	603	311	89	362	40	145	107	357	399	179	124							3.277	1.652	0.286	0.110	0.738	1.118	0.693	0.059
2005	123	22413	40.41924N	104.93313W													271	163	362	19	356	37	364	0	365	0	365	69	240	65							0.601	0.052	0.104			0.189	0.271	
2005	123	22418	40.19086N	104.63782W													222	662	351	144	335	113	366	134	362	80	365	60	243	29							2.982	0.410	0.337	0.366	0.221	0.164	0.119	
2005	123	22427	40.07143N	104.70368W													684	1576	716	492	710	408	724	892	730	460	730	406	486	260							2.304	0.687	0.575	1.232	0.630	0.556	0.535	0.466
2005	123	22428	40.44468N	104.50966W													273	647	333	0	239	0	212	0	365	0	345	107	189	44							2.370					0.310	0.233	0.161
2005	123	22536	40.37451N	104.67198W													293	2869	267	989	319	822	689	402	365	73	348	148	214	0							9.792	3.704	2.577	0.583	0.200	0.425		
2005	123	22543	40.23776N	104.92821W													321	207	362	57	365	15	335	42	361	30	365	40	243	23							0.645	0.157	0.041	0.125	0.083	0.110	0.095	0.218
2005	123	22566	40.04175N	104.75224W													444	1102	730	548	724	290	726	432	726	196	730	124	486	72							2.482	0.751	0.401	0.595	0.270	0.170	0.148	0.074
2005	123	22589	40.21185N	104.89097W													352	203	365	0	365	0	331	190	124	88	343	199	243	207							0.577			0.574	0.710	0.580	0.852	0.425
2005	123	22604	40.26899N	104.84344W													311	332	325	236	350	0	353	0	335	0	365	0	242	211							1.068	0.726					0.872	0.455
2005	123	22612	40.22448N	104.80691W													333	1162	358	56	347	68	364	555	365	0	362	0	239	0							3.489	0.156	0.196	1.525				
2005	123	22616	40.48217N	104.62575W													289	273	342	0	360	0	324	7	361	1	365	0	224	0							0.945			0.022	0.003			0.236
2005	123	22619	40.43904N	104.61555W													313	155	360	0	325	0	366	0	350	25	217	75	42	550							0.495				0.071	0.346	13.095	0.168
2005	123	22623	40.50995N	104.60015W													57	0	256	112	315	89	306	9	343	28	239	0	240	0								0.438	0.283	0.029	0.082			0.393
2005	123	22641	40.32820N	104.51570W													278	447	357	188	359	202	361	369	363	190	338	101	216	96							1.608	0.527	0.563	1.022	0.523	0.299	0.444	0.53
2005	123	22653	40.10413N	104.58195W													561	0	582	170	676	468	714	554	730	281	730	208	486	152								0.292	0.692	0.776	0.385	0.285	0.313	0.393
2005	123	22665	40.40075N	104.48205W													291	0	360	13	332	44	306	35	364	61	334	42	240	25								0.036	0.133	0.114	0.168	0.126	0.104	0.741
2005	123	22667	40.05969N	104.92560W													411	887	724	313	704	202	657	58	714	59	714	125	486	0							2.158	0.432	0.287	0.088	0.083	0.175		0.206
2005	123	22669	40.03888N	104.88930W													551	565	730	178	718	720	610	276	710	243	716	181	486	0							1.025	0.244	1.003	0.452	0.342	0.253		0.422
2005	123	22671	40.05344N	104.97699W													94	0	718	258	728	224	712	294	730	234	714	278	486	134								0.359	0.308	0.413	0.321	0.389	0.276	0.024
2005	123	22679	40.16918N	104.57286W													265	0	303	105	151	28	121	31	210	43	364	87	243	89								0.347	0.185	0.256	0.205	0.239	0.366	
2005	123	22680	40.36921N	104.84402W													257	446	358	256	365	21	366	133	359	155	363	191	237	55							1.735	0.715	0.058	0.363	0.432	0.526	0.232	0.011
2005	123	22686	40.52140N	104.81587W													225	0	356	0	314	146	248	56	353	73	334	51	237	15									0.465	0.226	0.207	0.153	0.063	0.226
2005	123	22687	40.06785N	105.00089W													218	415	685	230	706	23774	730	982	728	363	712	386	476	291							1.904	0.336	33.674	1.345	0.499	0.542	0.611	1.412
2005	123	22690	40.49325N	104.80370W													198	0	307	7	293	229	253	52	339	75	334	27	238	19								0.023	0.782	0.206	0.221	0.081	0.080	
2005	123	22691	40.49640N	104.80436W													205	0	323	30	328	75	232	82	343	122	334	77	242	27								0.093	0.229	0.353	0.356	0.231	0.112	0.756
2005	123	22692	40.49639N	104.80852W													209	0	324	39	320	73	287	98	362	101	334	43	240	31								0.120	0.228	0.341	0.279	0.129	0.129	0.73
2005	123	22693	40.49655N	104.79892W													205	0	316	0	308	56	113	30	295	93	330	45	242	22									0.182	0.265	0.315	0.136	0.091	0.432
2005	123	22694	40.50042N	104.79943W													193	0	295	0	330	61	231	75	360	97	333	41	242	22									0.185	0.325	0.269	0.123	0.091	0.181
2005	123	22695	40.51520N	104.81411W													230	0	311	0	310	219	236	68	340	89	333	48	234	17									0.706	0.288	0.262	0.144	0.073	0.086
2005	123	22708	40.36709N	104.84642W													262	451	365	234	365	30	355	119	362	126	362	453	241	600							1.721	0.641	0.082	0.335	0.348	1.251	2.490	
2005	123	22711	40.04552N	104.98793W													271	1298	358	423	360	218	356	285	359	118	357	62	243	38							4.790	1.182	0.606	0.801	0.329	0.174	0.156	0.534
2005	123	22712	40.44579N	104.52199W													252	0	328	0	264	6	293	20	344	0	277	0	214	0									0.023	0.068				0.194
2005	123	22715	40.49231N	104.80803W													247	0	322	0	301	239	289	126	361	94	332	52	200	24									0.794	0.436	0.260	0.157	0.120	0.025
2005	123	22727	40.50954N	104.61324W													196	0	362	17	309	220	311	102	346	46	332	10	243	0								0.047	0.712	0.328	0.133	0.030		0.064
2005	123	22728	40.48865N	104.49526W													210	0	334	0	309	88	249	74	354	65	313	47	241	58									0.285	0.297	0.184	0.150	0.241	0.165
2005	123	22731	40.47651N	104.67098W													232	0	348	0	314	146	272	117	293	74	312	12	218	0									0.465	0.430	0.253	0.038		0.438
2005	123	22737	40.46771N	104.54118W													176	0	351	0	319	74	269	275	337	59	309	117	217	31									0.232	1.022	0.175	0.379	0.143	0.238
2005	123	22738	40.47357N	104.67029W													236	0	341	0	328	164	315	172	326	91	323	14	218	0									0.500	0.546	0.279	0.043		0.013
2005	123	22742	40.46155N	104.79069W													205	45	325	0	309	140	283	39	353	97	301	43	238	17							0.220		0.453	0.138	0.275	0.143	0.071	
2005	123	22743	40.48229N	104.82980W													150	0	295	0	321	54	229	49	77	28	188	19	163	0									0.168	0.214	0.364	0.101		0.045
2005	123	22744	40.48499N	104.82456W													185	8	294	11	324	110	343	66	344	78	288	39	215	11							0.043	0.037	0.340	0.192	0.227	0.135	0.051	0.205
2005	123	22745	40.48243N	104.82460W													178	0	299	0	323	47	344	45	346	89	293	44	217	5									0.146	0.131	0.257	0.150	0.023	0.239
2005	123	22778	40.49124N	104.49190W													228	0	331	0	286	50	254	57	348	53	333	38	221	104									0.175	0.224	0.152	0.114	0.471	0.524
2005	123	22779	40.48830N	104.49080W													206	0	313	0	310	54	256	88	356	56	323	77	192	42									0.174	0.344	0.157	0.238	0.210	0.385
2005	123	22780	40.49175N	104.49525W													225	0	340	0	293	49	263	63	346	63	316	55	185	50									0.167	0.240	0.182	0.174	0.270	0.525
2005	123	22790	40.25735N	104.50399W													209	225	351	148	353	207	362	146	361	289	351	66	239	8							1.077	0.422	0.586	0.403	0.801	0.188	0.033	
2005	123	22792	40.48538N	104.81353W													165	25	337	14	324	144	360	95	360	94	311	77	240	16							0.152	0.042	0.444	0.264	0.261	0.248	0.067	0.48
2005	123	22793	40.48155N	104.82001W													170	0	276	45	215	158	360	139	360	107	312	69	242	20								0.163	0.735	0.386	0.297	0.221	0.083	0.037
2005	123	22796	40.47525N	104.80847W													115	0	332	0	321	92	308	68	357	55	329	39	182	61									0.287	0.221	0.154	0.119	0.335	
2005	123	22799	40.37923N	104.92956W													66	0	318	0	77	13	50	16	99	1	325	23	223	46									0.169	0.320	0.010	0.071	0.206	0.239
2005	123	22800	40.37978N	104.93285W													78	0	316	0	304	72	271	36	364	69	334	13	243	17									0.237	0.133	0.190	0.039	0.070	0.257
2005	123	22806	40.44135N	104.51042W													207	461	365	0	345	0	347	0	365	21	365	75	198	37							2.227				0.058	0.205	0.187	0.302
2005	123	22810	40.48197N	104.81481W													187	0	348	0	319	151	348	112	361	117	317	94	242	41									0.473	0.322	0.324	0.297	0.169	0.801
2005	123	22814	40.48981N	104.81866W													27	0	66	0	37	56	61	16	51	41	50	3	14	1									1.514	0.262	0.804	0.060	0.071	0.196
2005	123	22815	40.48895N	104.81422W													164	0	331	0	325	128	280	65	360	53	332	35	235	29									0.394	0.232	0.147	0.105	0.123	0.801
2005	123	22819	40.41985N	104.82595W													219	303	347	282	356	146	358	121	329	559	353	498	243	269							1.384	0.813	0.410	0.338	1.699	1.411	1.107	0.187
2005	123	22820	40.27244N	104.60735W													153	86	345	507	358	277	356	449	360	170	365	73	221	20							0.562	1.470	0.774	1.261	0.472	0.200	0.090	0.1
2005	123	22847	40.48218N	104.57902W													157	0	317	0	299	175	364	62	363	61	323	39	243	18									0.585	0.170	0.168	0.121	0.074	0.414
2005	123	22848	40.46271N	104.52914W													145	1008	341	236	331	15	345	19	365	139	365	24	157	25							6.952	0.692	0.045	0.055	0.381	0.066	0.159	0.355
2005	123	22853	40.15819N	104.59174W													406	0	730	318	718	340	732	288	730	121	728	202	486	146								0.436	0.474	0.393	0.166	0.277	0.300	
2005	123	22855	40.19239N	104.63424W													151	156	325	177	328	152	362	153	362	122	361	89	242	39							1.033	0.545	0.463	0.423	0.337	0.247	0.161	0.009
2005	123	22858	40.12480N	104.64248W													166	1949	358	457	348	91	224	0	362	351	365	252	243	174							11.741	1.277	0.261		0.970	0.690	0.716	
2005	123	22860	40.15478N	104.52583W													144	996	720	927	708	730	702	288	494	58	686	0	380	186							6.917	1.288	1.031	0.410	0.117		0.489	0.418
2005	123	22877	40.51828N	104.78080W													61	0	305	0	281	127	137	107	328	54	333	47	222	27									0.452	0.781	0.165	0.141	0.122	0.386
2005	123	22880	40.47489N	104.81908W													180	0	285	8	333	89	198	39	204	27	127	16	0	0								0.028	0.267	0.197	0.132	0.126		0.207
2005	123	22881	40.46944N	104.51902W													173	0	309	0	177	26	292	36	353	48	316	29	199	28									0.147	0.123	0.136	0.092	0.141	0.301
2005	123	22900	40.17951N	104.54894W													114	744	365	695	362	105	366	44	365	59	365	66	243	46							6.526	1.904	0.290	0.120	0.163	0.181	0.189	0.024
2005	123	22901	40.17624N	104.54933W													109	689	365	695	362	105	366	44	308	17	365	66	243	46							6.321	1.904	0.290	0.120	0.055	0.181	0.189	0.111
2005	123	22903	40.23358N	104.61380W													175	472	361	292	365	197	366	162	360	69	362	82	193	48							2.697	0.809	0.540	0.443	0.303	0.227	0.249	0.367
2005	123	22910	40.23835N	104.46375W													211	494	672	230	604	20	444	159	281	0	355	17	243	84							2.341	0.342	0.033	0.358		0.048	0.346	0.456
2005	123	22916	40.08156N	104.72852W													81	823	359	1616	365	439	358	290	333	106	352	81	243	18							10.160	4.501	1.203	0.810	0.318	0.230	0.074	0.214
2005	123	22917	40.40199N	104.87616W													172	0	363	29	360	93	352	20	365	28	365	108	240	57								0.080	0.258	0.057	0.077	0.296	0.238	0.758
2005	123	22920	40.08283N	104.98350W													57	600	365	229	243	143	243	264	365	72	357	12	243	9							10.526	0.627	0.588	1.086	0.197	0.034	0.037	0.311
2005	123	22925	40.22844N	104.61727W													178	26	360	13	357	9	366	11	365	9	365	8	242	4							0.146	0.036	0.025	0.030	0.025	0.022	0.017	0.047
2005	123	22926	40.25836N	104.52333W													136	180	360	226	365	132	346	54	331	91	331	154	225	165							1.324	0.628	0.362	0.156	0.275	0.465	0.733	0.356
2005	123	22933	40.25074N	104.55130W													177	139	326	171	319	129	337	482	151	122	323	189	181	62							0.785	0.525	0.404	1.521	0.808	0.585	0.343	0.602
2005	123	22934	40.25120N	104.56043W													164	294	354	213	345	123	346	131	343	137	291	300	234	209							1.793	0.602	0.357	0.379	0.399	1.031	0.893	
2005	123	22949	40.23556N	104.58907W													148	195	357	189	362	252	364	105	351	40	365	7	241	5							1.318	0.529	0.696	0.288	0.114	0.019	0.021	0.448
2005	123	22955	40.11671N	104.68515W													55	22	722	428	722	474	696	298	501	275	730	545	486	100							0.400	0.593	0.657	0.428	0.549	0.747	0.206	0.497
2005	123	22957	40.04614N	104.72380W													25	408	365	456	365	261	356	222	333	116	365	113	238	0							16.320	1.249	0.715	0.624	0.348	0.310		0.124
2005	123	23014	40.30417N	104.92537W													97	122	365	30	365	310	364	1075	346	0	345	117	228	249							1.258	0.082	0.849	2.953		0.339	1.092	0.267
2005	123	23020	40.27120N	104.47891W													143	0	498	15	352	43	336	65	349	70	351	40	243	0								0.030	0.122	0.193	0.201	0.114		0.297
2005	123	23023	40.13615N	104.73283W													99	492	350	189	364	291	362	266	150	51	365	83	243	44							4.970	0.540	0.799	0.735	0.340	0.227	0.181	0.477
2005	123	23028	40.17987N	104.50184W													141	483	333	191	446	80	359	76	306	30	220	112	57	0							3.426	0.574	0.179	0.212	0.098	0.509		
2005	123	23039	40.30154N	104.96722W													108	5	299	30	314	119	301	107	362	70	334	19	243	17							0.046	0.100	0.379	0.355	0.193	0.057	0.070	0.061
2005	123	23041	40.49150N	104.58203W													95	130	341	14	360	0	364	0	365	0	359	50	243	0							1.368	0.041				0.139		0.434
2005	123	23044	40.24208N	104.68503W													154	1024	364	576	310	188	366	213	365	91	359	140	242	82							6.649	1.582	0.606	0.582	0.249	0.390	0.339	0.265
2005	123	23046	40.30843N	104.79242W													142	546	351	665	362	456	349	310	360	390	365	464	241	712							3.845	1.895	1.260	0.888	1.083	1.271	2.954	0.038
2005	123	23061	40.39957N	104.54395W													29	343	176	727	306	1247	357	409	365	268	336	519	240	557							11.828	4.131	4.075	1.146	0.734	1.545	2.321	0.358
2005	123	23070	40.29338N	104.96707W													111	16	319	0	313	124	293	120	364	99	334	20	243	20							0.144		0.396	0.410	0.272	0.060	0.082	0.568
2005	123	23085	40.19098N	104.62831W													110	1607	313	770	331	283	365	222	206	182	358	21	241	42							14.609	2.460	0.855	0.608	0.883	0.059	0.174	0.603
2005	123	23114	40.20554N	104.47352W													65	325	704	402	730	374	732	428	730	48	730	553	484	249							5.000	0.571	0.512	0.585	0.066	0.758	0.514	0.367
2005	123	23125	40.54917N	104.59920W													42	0	254	0	304	58	196	129	283	132	151	99	1	0									0.191	0.658	0.466	0.656		0.288
2005	123	23126	40.53542N	104.60427W													7	0	340	12	295	124	284	80	336	100	333	65	243	30								0.035	0.420	0.282	0.298	0.195	0.123	0.688
2005	123	23128	40.49565N	104.58152W													83	5	289	42	287	24	303	17	363	57	332	24	223	12							0.060	0.145	0.084	0.056	0.157	0.072	0.054	0.787
2005	123	23129	40.48199N	104.63587W													110	0	328	0	327	149	348	149	347	110	292	71	193	11									0.456	0.428	0.317	0.243	0.057	0.364
2005	123	23166	40.34549N	104.50360W													119	641	352	545	337	302	365	267	365	145	352	109	228	100							5.387	1.548	0.896	0.732	0.397	0.310	0.439	0.853

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03	WP03	PD04	WP04	PD05	WP05	PD06	WP06	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 99	FR 00	FR 01	FR 02	FR 03	FR 04	FR 05	FR 06	FR 07	FR 08	FR 09	FR 10	FR 11	k
2005	123	23168	40.40322N	104.55013W													91	403	346	1186	336	910	364	842	362	442	365	463	202	344							4.429	3.428	2.708	2.313	1.221	1.268	1.703	0.27
2005	123	23174	40.05795N	104.72463W													9	268	287	1179	365	628	358	373	331	223	365	196	243	2							29.778	4.108	1.721	1.042	0.674	0.537	0.008	0.094
2005	123	23197	40.18019N	104.64726W													56	618	361	294	354	387	363	211	365	173	365	161	243	67							11.036	0.814	1.093	0.581	0.474	0.441	0.276	0.056
2005	123	23204	40.17829N	104.64486W													46	259	325	321	348	203	353	168	354	138	364	118	240	48							5.630	0.988	0.583	0.476	0.390	0.324	0.200	0.032
2005	123	23207	40.44271N	104.83330W													6	0	356	264	362	16	366	0	365	37	365	118	232	251								0.742	0.044		0.101	0.323	1.082	0.746
2005	123	23208	40.44190N	104.84370W													5	0	267	28	303	132	243	0	549	87	604	135	231	77								0.105	0.436		0.158	0.224	0.333	0.751
2005	123	23231	40.44678N	104.75191W													27	31	358	300	360	84	366	0	365	105	351	56	224	77							1.148	0.838	0.233		0.288	0.160	0.344	0.061
2005	123	23251	40.17992N	104.65208W													42	231	348	416	348	150	363	167	142	41	364	78	153	41							5.500	1.195	0.431	0.460	0.289	0.214	0.268	0.68
2005	123	23328	40.47925N	104.78019W													13	219	291	667	361	178	366	0	365	101	354	61	243	77							16.846	2.292	0.493		0.277	0.172	0.317	
2005	123	23329	40.47597N	104.78571W													9	152	339	624	361	145	366	0	303	70	365	51	243	64							16.889	1.841	0.402		0.231	0.140	0.263	0.218
2005	123	25593	40.21177N	104.92760W													345	1143	365	967	354	0	363	399	365	352	363	171	212	135							3.313	2.649		1.099	0.964	0.471	0.637	0.166
2005	123	25607	40.41194N	104.81842W													149	536	363	202	365	162	361	154	365	173	365	193	243	33							3.597	0.556	0.444	0.427	0.474	0.529	0.136	
2005	123	25613	40.11549N	104.62010W													270	2143	365	426	365	297	366	0	365	388	365	168	233	0							7.937	1.167	0.814		1.063	0.460		0.447
2005	123	25620	40.37468N	104.84690W													275	228	360	141	359	90	366	55	365	125	365	179	188	48							0.829	0.392	0.251	0.150	0.342	0.490	0.255	0.419
2006	123	17804	40.26301N	104.49772W															138	286	362	239	366	143	365	237	365	135	233	55								2.072	0.660	0.391	0.649	0.370	0.236	0.02
2006	123	21175	40.16919N	104.58251W															122	191	317	308	353	259	364	122	364	5	243	4								1.566	0.972	0.734	0.335	0.014	0.016	0.239
2006	123	21858	40.41224N	104.82471W															207	185	362	197	362	200	151	62	359	58	243	27								0.894	0.544	0.552	0.411	0.162	0.111	0.451
2006	123	21905	40.34683N	104.53406W															270	1168	310	123	322	70	365	196	365	182	243	127								4.326	0.397	0.217	0.537	0.499	0.523	0.062
2006	123	22120	40.37311N	104.93427W															248	0	327	26	251	211	365	61	334	34	243	16									0.080	0.841	0.167	0.102	0.066	0.306
2006	123	22259	40.43815N	104.87377W															344	55	292	68	345	398	357	81	334	29	235	184								0.160	0.233	1.154	0.227	0.087	0.783	0.181
2006	123	22420	40.33965N	104.83632W															291	382	365	33	342	201	325	305	365	182	243	134								1.313	0.090	0.588	0.938	0.499	0.551	0.74
2006	123	22622	40.51259N	104.59914W															274	0	317	99	305	6	363	25	330	0	241	0									0.312	0.020	0.069			0.297
2006	123	22625	40.51307N	104.59465W															309	32	317	99	303	5	352	23	329	0	240	0								0.104	0.312	0.017	0.065			
2006	123	22718	40.38372N	104.82542W															328	373	332	484	351	170	365	404	348	327	236	228								1.137	1.458	0.484	1.107	0.940	0.966	0.282
2006	123	22721	40.38309N	104.83046W															334	432	364	204	353	176	361	401	342	315	230	221								1.293	0.560	0.499	1.111	0.921	0.961	
2006	123	22722	40.38096N	104.81732W															319	600	365	431	366	157	365	162	357	150	234	153								1.881	1.181	0.429	0.444	0.420	0.654	0.125
2006	123	22824	40.43689N	104.52516W															330	0	349	22	364	0	358	18	365	56	234	48									0.063		0.050	0.153	0.205	0.472
2006	123	22827	40.46303N	104.52461W															273	1579	339	0	356	0	365	66	365	130	194	67								5.784			0.181	0.356	0.345	0.413
2006	123	22861	40.37583N	104.92866W															101	0	317	218	293	59	361	56	333	344	233	661									0.688	0.201	0.155	1.033	2.837	0.202
2006	123	22862	40.37300N	104.92960W															184	0	328	174	266	66	364	39	334	30	222	144									0.530	0.248	0.107	0.090	0.649	1.057
2006	123	22899	40.18032N	104.55405W															232	431	352	99	335	44	363	59	365	66	243	46								1.858	0.281	0.131	0.163	0.181	0.189	0.469
2006	123	22915	40.07145N	104.99669W															244	551	360	5864	347	246	365	185	355	89	243	58								2.258	16.289	0.709	0.507	0.251	0.239	0.452
2006	123	22962	40.39760N	104.82563W															309	397	360	140	351	200	307	631	363	370	243	231								1.285	0.389	0.570	2.055	1.019	0.951	
2006	123	23008	40.31542N	104.57944W															269	467	351	255	366	136	363	93	348	273	240	93								1.736	0.726	0.372	0.256	0.784	0.388	
2006	123	23127	40.53599N	104.61744W															138	0	304	20	211	35	309	25	315	64	238	0									0.066	0.166	0.081	0.203		0.359
2006	123	23229	40.44481N	104.73686W															82	105	353	102	366	0	365	83	352	85	227	29								1.280	0.289		0.227	0.241	0.128	0.24
2006	123	23233	40.44477N	104.73706W															91	72	365	99	366	0	365	64	354	60	195	79								0.791	0.271		0.175	0.169	0.405	0.154
2006	123	23255	40.44491N	104.84920W															270	187	365	46	366	0	365	16	354	34	237	0								0.693	0.126		0.044	0.096		0.461
2006	123	23259	40.41856N	104.79062W															271	727	360	53	366	0	362	89	361	105	206	477								2.683	0.147		0.246	0.291	2.316	0.501
2006	123	23267	40.33544N	104.47355W															323	87	346	0	366	0	334	48	363	189	243	2								0.269			0.144	0.521	0.008	0.0131
2006	123	23268	40.33897N	104.47289W															317	4713	345	257	366	174	364	48	363	236	243	109								14.868	0.745	0.475	0.132	0.650	0.449	0.451
2006	123	23275	40.50622N	104.49553W															306	467	294	0	302	29	352	0	324	15	229	35								1.526		0.096		0.046	0.153	0.548
2006	123	23276	40.49539N	104.49220W															255	61	320	0	363	101	359	22	362	234	216	236								0.239		0.278	0.061	0.646	1.093	0.507
2006	123	23301	40.35228N	104.81785W															154	203	334	189	366	53	364	103	364	151	243	61								1.318	0.566	0.145	0.283	0.415	0.251	
2006	123	23306	40.27868N	104.94336W															318	46	330	129	287	310	361	0	365	58	243	22								0.145	0.391	1.080		0.159	0.091	0.244
2006	123	23316	40.40307N	104.85568W															340	321	339	67	339	20	355	11	322	106	203	1050								0.944	0.198	0.059	0.031	0.329	5.172	0.19
2006	123	23340	40.11908N	104.54985W															338	254	365	478	365	537	365	370	365	222	243	0								0.751	1.310	1.471	1.014	0.608		0.396
2006	123	23385	40.52172N	104.64682W															272	0	265	0	339	67	364	0	362	32	243	0										0.198		0.088		0.631
2006	123	23393	40.50922N	104.60336W															306	110	303	0	192	0	344	0	361	20	243	0								0.359				0.055		0.65
2006	123	23394	40.51252N	104.60328W															241	110	288	0	280	0	362	0	365	22	243	0								0.456				0.060		0.068
2006	123	23402	40.29376N	104.56017W															327	42	358	307	361	198	361	263	365	164	225	82								0.128	0.858	0.548	0.729	0.449	0.364	0.402
2006	123	23405	40.35907N	104.57815W															327	776	350	49	339	0	341	163	364	184	129	91								2.373	0.140		0.478	0.505	0.705	0.468
2006	123	23417	40.34262N	104.85644W															283	536	341	69	358	165	331	130	347	314	241	174								1.894	0.202	0.461	0.393	0.905	0.722	0.506
2006	123	23421	40.27241N	104.96719W															152	0	365	62	362	137	90	49	0	0	0	0									0.170	0.378	0.544			0.105
2006	123	23437	40.48482N	104.45854W															208	7	202	95	303	49	355	45	333	31	243	38								0.034	0.470	0.162	0.127	0.093	0.156	0.191
2006	123	23440	40.50300N	104.54329W															282	0	260	184	342	170	364	47	331	19	243	39									0.708	0.497	0.129	0.057	0.160	0.069
2006	123	23441	40.50302N	104.53923W															271	0	280	302	335	253	363	63	334	24	243	40									1.079	0.755	0.174	0.072	0.165	0.014
2006	123	23444	40.38312N	104.94342W															86	0	321	72	263	15	364	1	331	16	243	71									0.224	0.057	0.003	0.048	0.292	
2006	123	23446	40.27099N	104.79017W															329	961	365	130	362	7	365	195	314	195	243	96								2.921	0.356	0.019	0.534	0.621	0.395	0.665
2006	123	23447	40.49402N	104.79539W															169	6	323	220	250	333	364	271	334	85	232	0								0.036	0.681	1.332	0.745	0.254		0.275
2006	123	23451	40.49822N	104.58196W															274	2	293	86	305	18	363	101	332	19	234	13								0.007	0.294	0.059	0.278	0.057	0.056	0.513
2006	123	23454	40.32335N	104.50354W															307	639	365	257	363	152	358	145	365	112	186	44								2.081	0.704	0.419	0.405	0.307	0.237	0.611
2006	123	23471	40.54951N	104.59513W															220	0	290	60	88	115	92	48	36	0	1	0									0.207	1.307	0.522			0.838
2006	123	23474	40.45896N	104.54299W															245	0	347	36	353	21	365	142	365	42	239	52									0.104	0.059	0.389	0.115	0.218	0.764
2006	123	23512	40.51007N	104.48711W															184	0	100	77	300	52	316	25	261	4	110	32									0.770	0.173	0.079	0.015	0.291	0.143
2006	123	23514	40.52428N	104.45364W															190	8	203	325	96	48	195	120	326	77	209	0								0.042	1.601	0.500	0.615	0.236		
2006	123	23520	40.34423N	104.93555W															68	0	361	36	364	73	360	40	365	38	240	30									0.100	0.201	0.111	0.104	0.125	0.336
2006	123	23522	40.17353N	104.68578W															229	386	365	756	366	641	365	558	341	391	226	198								1.686	2.071	1.751	1.529	1.147	0.876	0.383
2006	123	23523	40.48444N	104.49556W															225	0	325	0	345	0	365	0	361	422	231	284												1.169	1.229	
2006	123	23525	40.53352N	104.74732W															86	0	288	66	232	32	29	1	0	0	223	3									0.229	0.138	0.034		0.013	
2006	123	23531	40.45182N	104.67593W															281	249	338	0	354	17	365	51	365	12	243	29								0.886		0.048	0.140	0.033	0.119	0.909
2006	123	23542	40.45737N	104.69934W															243	521	359	267	366	87	365	51	362	49	238	52								2.144	0.744	0.238	0.140	0.135	0.218	0.437
2006	123	23548	40.48739N	104.53801W															239	0	335	0	336	0	333	0	356	74	238	29												0.208	0.122	0.553
2006	123	23549	40.47307N	104.51084W															383	533956	598	362	363	0	363	139	362	248	221	132								1394.141	0.605		0.383	0.685	0.597	0.02
2006	123	23551	40.47373N	104.85852W															75	0	329	304	269	218	362	163	334	24	243	0									0.924	0.810	0.450	0.072		0.148
2006	123	23552	40.47734N	104.85853W															159	0	314	281	266	178	362	102	334	13	243	0									0.895	0.669	0.282	0.039		
2006	123	23553	40.45730N	104.69933W															291	602	365	273	366	87	365	57	365	54	238	52								2.069	0.748	0.238	0.156	0.148	0.218	0.74
2006	123	23560	40.48961N	104.73672W															230	224	360	145	366	79	365	440	365	213	243	0								0.974	0.403	0.216	1.205	0.584		0.432
2006	123	23563	40.49135N	104.73966W															291	691	357	299	366	129	365	48	365	19	224	0								2.375	0.838	0.352	0.132	0.052		0.487
2006	123	23593	40.52187N	104.76322W															264	159	243	331	73	63	207	0	361	80	243	45								0.602	1.362	0.863		0.222	0.185	0.534
2006	123	23594	40.48946N	104.84001W															18	0	250	176	357	104	362	75	332	27	225	0									0.704	0.291	0.207	0.081		
2006	123	23595	40.48104N	104.47340W															84	19	317	232	213	34	332	105	332	84	243	34								0.226	0.732	0.160	0.316	0.253	0.140	0.825
2006	123	23600	40.48353N	104.82717W															172	0	294	62	350	97	358	104	302	44	176	9									0.211	0.277	0.291	0.146	0.051	1.027
2006	123	23608	40.37463N	104.93040W															179	6	329	35	287	30	364	0	300	325	237	804								0.034	0.106	0.105		1.083	3.392	0.472
2006	123	23613	40.27997N	104.62557W															251	551	337	447	357	330	274	372	362	373	243	222								2.195	1.326	0.924	1.358	1.030	0.914	
2006	123	23619	40.45879N	104.65126W															216	375	313	0	362	34	365	89	365	58	243	24								1.736		0.094	0.244	0.159	0.099	0.949
2006	123	23626	40.13719N	104.71770W															31	443	361	141	364	0	365	156	365	154	225	593								14.290	0.391		0.427	0.422	2.636	0.826
2006	123	23641	40.39280N	104.82218W															150	216	356	152	354	99	365	68	365	72	243	36								1.440	0.427	0.280	0.186	0.197	0.148	0.346
2006	123	23651	40.39908N	104.82197W															125	90	350	65	366	145	365	74	365	94	243	40								0.720	0.186	0.396	0.203	0.258	0.165	0.682
2006	123	23654	40.15908N	104.70358W															197	127	357	108	356	46	393	38	358	42	203	21								0.645	0.303	0.129	0.097	0.117	0.103	0.14
2006	123	23675	40.14364N	104.60927W															375	236	728	786	732	750	730	58	728	0	486	0								0.629	1.080	1.025	0.079			0.394
2006	123	23683	40.49258N	104.83498W															111	0	221	113	335	83	342	55	332	27	232	0									0.511	0.248	0.161	0.081		0.348
2006	123	23684	40.49067N	104.83704W															159	10	252	165	358	93	352	72	332	32	243	0								0.063	0.655	0.260	0.205	0.096		
2006	123	23685	40.51272N	104.61411W															192	15	334	107	296	52	351	137	334	9	243	0								0.078	0.320	0.176	0.390	0.027		0.136
2006	123	23692	40.18708N	104.49256W															132	72	307	75	359	156	326	5	285	7	36	0								0.545	0.244	0.435	0.015	0.025		0.489
2006	123	23708	40.28913N	104.47277W															150	1014	329	673	361	480	334	193	346	184	173	70								6.760	2.046	1.330	0.578	0.532	0.405	0.269
2006	123	23712	40.47313N	104.51083W															171	257943	360	184	366	0	364	121	358	201	242	125								1508.439	0.511		0.332	0.561	0.517	0.254
2006	123	23714	40.22188N	104.55152W															153	295	363	219	366	83	363	76	343	441	219	131								1.928	0.603	0.227	0.209	1.286	0.598	0.403
2006	123	23715	40.22700N	104.55416W															153	295	361	221	362	82	363	143	342	632	219	190								1.928	0.612	0.227	0.394	1.848	0.868	0.202
2006	123	23718	40.07174N	104.69492W															39	497	331	1107	328	654	365	381	364	391	233	293								12.744	3.344	1.994	1.044	1.074	1.258	0.407
2006	123	23720	40.17834N	104.55174W															239	490	350	105	274	44	332	59	365	66	243	46								2.050	0.300	0.161	0.178	0.181	0.189	0.351
2006	123	23722	40.07069N	105.00197W															184	559	365	373	366	265	334	185	356	178	243	94								3.038	1.022	0.724	0.554	0.500	0.387	0.626
2006	123	23723	40.17669N	104.54465W															203	447	358	91	366	37	353	50	365	58	243	34								2.202	0.254	0.101	0.142	0.159	0.140	0.595
2006	123	23724	40.17616N	104.53994W															182	303	358	91	366	37	365	52	365	58	243	34								1.665	0.254	0.101	0.142	0.159	0.140	0.031
2006	123	23725	40.17980N	104.53992W															204	325	357	79	336	42	365	49	365	55	243	18								1.593	0.221	0.125	0.134	0.151	0.074	0.193
2006	123	23731	40.20496N	104.61393W															211	460	346	315	365	157	365	143	365	94	243	75								2.180	0.910	0.430	0.392	0.258	0.309	0.897
2006	123	23736	40.27970N	104.47580W															158	895	359	412	324	260	394	1298	365	925	243	627								5.665	1.148	0.802	3.294	2.534	2.580	0.495
2006	123	23740	40.22193N	104.60784W															226	221	357	10	345	103	360	250	365	141	236	89								0.978	0.028	0.299	0.694	0.386	0.377	0.542
2006	123	23741	40.04239N	104.95884W															75	1039	310	674	347	174	274	737	358	346	243	130								13.853	2.174	0.501	2.690	0.966	0.535	
2006	123	23742	40.51390N	104.61897W															84	15	332	134	298	53	344	138	334	11	156	0								0.179	0.404	0.178	0.401	0.033		0.105
2006	123	23745	40.28478N	104.55321W															84	447	322	227	361	137	359	147	363	108	222	49								5.321	0.705	0.380	0.409	0.298	0.221	0.004
2006	123	23746	40.48646N	104.77976W															128	0	326	78	321	45	358	55	334	23	238	6									0.239	0.140	0.154	0.069	0.025	0.293
2006	123	23747	40.52450N	104.60319W															16	0	307	174	251	92	324	103	316	78	243	186									0.567	0.367	0.318	0.247	0.765	0.307
2006	123	23750	40.50248N	104.57115W															192	0	348	0	344	0	365	0	365	151	237	101												0.414	0.426	0.447
2006	123	23751	40.50422N	104.56858W															186	0	330	0	336	0	363	0	361	24	219	30												0.066	0.137	0.381
2006	123	23752	40.50251N	104.56637W															171	0	305	0	328	0	357	0	361	24	219	30												0.066	0.137	0.363
2006	123	23753	40.26515N	104.96250W															153	0	243	0	152	215	365	114	365	151	243	209										1.414	0.312	0.414	0.860	0.424
2006	123	23754	40.26776N	104.96730W															184	0	365	161	365	423	365	63	365	15	243	21									0.441	1.159	0.173	0.041	0.086	0.384
2006	123	23755	40.53681N	104.74794W															80	0	328	59	306	38	346	134	326	160	223	2									0.180	0.124	0.387	0.491	0.009	0.469
2006	123	23756	40.22914N	104.59219W															117	515	362	444	365	219	359	483	685	567	486	588								4.402	1.227	0.600	1.345	0.828	1.210	0.39

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD99	WP99	PD00	WP00	PD01	WP01	PD02	WP02	PD03	WP03	PD04	WP04	PD05	WP05	PD06	WP06	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 99	FR 00	FR 01	FR 02	FR 03	FR 04	FR 05	FR 06	FR 07	FR 08	FR 09	FR 10	FR 11	k
2006	123	23763	40.49220N	104.51564W															76	41	247	101	274	149	341	32	331	68	235	46								0.539	0.409	0.544	0.094	0.205	0.196	0.004
2006	123	23764	40.14210N	104.95577W															122	234	363	360	360	173	365	118	365	124	243	77								1.918	0.992	0.481	0.323	0.340	0.317	0.486
2006	123	23766	40.33094N	104.59767W															194	748	365	536	359	124	365	314	365	350	243	192								3.856	1468	0.345	0.860	0.959	0.790	
2006	123	23795	40.39611N	104.86502W															208	133	348	75	366	25	365	14	264	41	193	67								0.639	0.216	0.068	0.038	0.155	0.347	0.339
2006	123	23823	40.10342N	104.89750W															110	496	352	811	360	554	362	70	362	45	243	41								4.509	2.304	1.539	0.193	0.124	0.169	0.526
2006	123	23826	40.50612N	104.56706W															61	0	350	0	327	0	365	0	365	132	224	67												0.362	0.299	0.521
2006	123	23844	40.43426N	104.81883W															162	470	360	106	366	14	348	256	348	721	236	277								2.901	0.294	0.038	0.736	2.072	1.174	0.264
2006	123	23850	40.48234N	104.77978W															121	0	326	116	318	95	359	86	330	24	235	6									0.356	0.299	0.240	0.073	0.026	
2006	123	23853	40.50609N	104.57186W															54	0	340	0	341	0	365	0	365	132	233	65												0.362	0.279	
2006	123	23863	40.15406N	104.59589W															142	162	360	253	365	227	365	477	212	140	200	236								1.141	0.703	0.622	1.307	0.660	1.180	
2006	123	23866	40.11118N	104.87432W															146	94	363	303	361	187	365	139	364	88	243	81								0.644	0.835	0.518	0.381	0.242	0.333	0.121
2006	123	23867	40.11503N	104.87452W															106	79	362	302	360	187	365	139	365	88	243	81								0.745	0.834	0.519	0.381	0.241	0.333	0.66
2006	123	23873	40.47429N	104.83949W															145	73	180	217	221	167	363	122	334	38	230	0								0.503	1.206	0.756	0.336	0.114		0.462
2006	123	23888	40.27097N	104.55358W															103	171	339	321	361	262	300	642	358	529	243	182								1.660	0.947	0.726	2.140	1.478	0.749	0.195
2006	123	23920	40.47432N	104.83510W															147	0	329	226	268	204	363	108	334	46	230	0									0.687	0.761	0.298	0.138		0.254
2006	123	23927	40.10718N	104.86999W															30	0	122	35	366	114	365	92	365	63	243	38									0.287	0.311	0.252	0.173	0.156	0.36
2006	123	23928	40.10597N	104.90101W															130	253	351	425	358	231	355	50	335	79	241	53								1.946	1.211	0.645	0.141	0.236	0.220	0.237
2006	123	23934	40.27254N	104.57958W															59	0	318	397	289	260	337	116	316	105	218	224									1.248	0.900	0.344	0.332	1.028	
2006	123	23935	40.28689N	104.59796W															22	0	330	275	306	136	365	96	334	134	242	343									0.833	0.444	0.263	0.401	1.417	0.776
2006	123	23936	40.28697N	104.58896W															39	0	345	263	297	132	337	114	334	226	230	95									0.762	0.444	0.338	0.677	0.413	0.132
2006	123	23938	40.10785N	104.89815W															120	253	351	425	361	231	360	50	355	89	235	50								2.108	1.211	0.640	0.139	0.251	0.213	0.95
2006	123	23948	40.08257N	104.72249W															181	74	333	100	366	109	278	93	331	60	242	2								0.409	0.300	0.298	0.335	0.181	0.008	0.365
2006	123	23972	40.27092N	104.63777W															101	597	358	817	212	245	364	415	365	329	243	178								5.911	2.282	1.156	1.140	0.901	0.733	0.594
2006	123	23981	40.26307N	104.50716W															136	637	363	557	366	184	365	147	352	402	243	175								4.684	1.534	0.503	0.403	1.142	0.720	0.712
2006	123	23982	40.27485N	104.49152W															145	13	345	7	335	2	365	2	361	0	243	0								0.090	0.020	0.006	0.005			1.353
2006	123	23988	40.20735N	104.68238W															73	0	322	192	268	164	353	158	332	109	216	75									0.596	0.612	0.448	0.328	0.347	0.288
2006	123	23990	40.27256N	104.70068W															67	0	320	355	305	212	361	309	334	226	243	91									1.109	0.695	0.856	0.677	0.374	
2006	123	23998	40.41937N	104.43488W															28	0	358	13	365	52	243	118	362	189	229	84									0.036	0.142	0.486	0.522	0.367	0.161
2006	123	24005	40.18705N	104.51123W															65	359	346	401	365	243	365	170	365	116	239	58								5.523	1.159	0.666	0.466	0.318	0.243	0.321
2006	123	24006	40.10358N	104.87006W															30	0	122	35	366	114	365	92	365	63	243	38									0.287	0.311	0.252	0.173	0.156	0.779
2006	123	24024	40.47926N	104.82072W															45	0	322	173	272	169	358	194	303	44	243	94									0.537	0.621	0.542	0.145	0.387	0.19
2006	123	24041	40.11532N	104.72330W															31	169	364	471	345	266	351	102	363	36	126	12								5.452	1294	0.771	0.291	0.099	0.095	0.492
2006	123	24050	40.33815N	104.60603W															23	0	322	471	302	848	339	288	248	122	196	87									1463	2.808	0.850	0.492	0.444	
2006	123	24078	40.21468N	104.65463W															73	0	307	262	365	155	363	165	312	109	243	120									0.853	0.425	0.455	0.349	0.494	0.668
2006	123	24107	40.42879N	104.58750W															47	0	356	98	366	0	365	93	365	52	243	47									0.275		0.255	0.142	0.193	0.26
2006	123	24125	40.30273N	104.47340W															60	407	362	533	349	109	365	119	365	199	224	54								6.783	1472	0.312	0.326	0.545	0.241	0.501
2006	123	24128	40.29618N	104.47816W															44	0	365	1037	362	166	365	143	365	691	150	305									2.841	0.459	0.392	1893	2.033	0.902
2006	123	24132	40.30119N	104.47580W															31	0	243	44	209	33	365	135	360	361	227	125									0.181	0.158	0.370	1.003	0.551	0.047
2006	123	24155	40.32583N	104.89408W															122	262	243	56	90	35	296	41	321	856	235	246								2.148	0.230	0.389	0.139	2.667	1.047	0.209
2006	123	24181	40.17980N	104.52110W															92	481	365	589	366	222	365	195	365	166	241	68								5.228	1.614	0.607	0.534	0.455	0.282	0.23
2006	123	24189	40.17695N	104.52081W															61	481	365	589	366	222	365	195	365	166	238	66								7.885	1.614	0.607	0.534	0.455	0.277	0.425
2006	123	24191	40.29463N	104.56984W															92	164	321	191	366	174	357	61	331	364	243	240								1.783	0.595	0.475	0.171	1.100	0.988	0.045
2006	123	24218	40.10917N	104.87295W															75	140	364	249	362	115	365	83	363	55	237	53								1.867	0.684	0.318	0.227	0.152	0.224	0.775
2006	123	24247	40.43467N	104.85658W															36	133	335	113	359	10	365	17	362	59	243	37								3.694	0.337	0.028	0.047	0.163	0.152	0.576
2006	123	24277	40.19835N	104.62364W															16	4	323	478	354	390	334	182	357	64	243	80								0.250	1480	1.102	0.545	0.179	0.329	0.546
2006	123	24298	40.50652N	104.48677W															28	0	282	0	45	36	328	25	365	26	227	23										0.800	0.076	0.071	0.101	0.544
2006	123	27281	40.28706N	104.55170W															67	330	330	211	360	136	360	147	361	107	225	50								4.925	0.639	0.378	0.408	0.296	0.222	0.18
2006	123	27299	40.45558N	104.70198W															29	237	365	436	363	201	365	67	364	115	243	60								8.172	1.195	0.554	0.184	0.316	0.247	0.495
2006	123	27308	40.34494N	104.55053W															46	39	333	251	359	0	337	249	365	168	237	111								0.848	0.754		0.739	0.460	0.468	0.262
2006	123	27338	40.39342N	104.53296W															29	39	344	540	365	231	352	135	365	148	209	77								1.345	1.570	0.633	0.384	0.405	0.368	0.859
2006	123	27356	40.34517N	104.55995W															51	81	325	452	365	0	365	119	362	165	241	142								1.588	1.391		0.326	0.456	0.589	0.488
2006	123	27403	40.19835N	104.62359W															20	5	323	478	354	390	334	182	357	64	243	80								0.250	1480	1.102	0.545	0.179	0.329	0.139
2006	123	29979	40.43212N	104.49350W															99	0	297	36	364	154	364	31	365	62	214	41								0.000	0.121	0.423	0.085	0.170	0.192	
2006	123	29986	40.34446N	104.60678W															8	0	318	741	299	358	353	455	246	225	207	197								0.000	2.330	1.197	1289	0.915	0.952	0.081
2006	123	29998	40.34261N	104.85632W															108	177	341	69	359	165	349	176	340	339	223	174								1.639	0.202	0.460	0.504	0.997	0.780	0.506
2007	123	18510	40.15038N	105.02334W																	31	0	0	0	244	71	365	10	243	23											0.291	0.027	0.095	0.597
2007	123	20288	40.08432N	104.95585W																	122	123	198	215	362	212	358	77	243	0									1008	1086	0.586	0.215		0.494
2007	123	20299	40.08433N	104.95589W																	155	145	290	249	364	212	358	77	243	0									0.935	0.859	0.582	0.215		1081
2007	123	21870	40.43380N	104.67061W																	80	0	362	0	365	0	365	32	225	457												0.088	2.031	0.622
2007	123	21966	40.23594N	104.77765W																	245	113	366	157	313	173	340	709	239	342									0.461	0.429	0.553	2.085	1431	0.362
2007	123	22797	40.51818N	104.82005W																	206	60	252	97	359	140	334	0	241	68									0.291	0.385	0.390		0.282	0.378
2007	123	23401	40.46084N	104.74705W																	282	77	366	0	243	46	363	74	161	28									0.273		0.189	0.204	0.174	0.299
2007	123	23443	40.48783N	104.45893W																	214	408	274	85	350	61	290	41	237	708									1907	0.310	0.174	0.141	2.987	0.961
2007	123	23581	40.50411N	104.80926W																	296	851	131	686	277	122	331	72	242	55									2.875	5.237	0.440	0.218	0.227	0.17
2007	123	23596	40.53252N	104.81522W																	178	235	286	255	344	135	292	67	232	84									1320	0.892	0.392	0.229	0.362	0.618
2007	123	23629	40.34784N	104.94573W																	339	68	366	203	362	128	365	35	243	33									0.201	0.555	0.354	0.096	0.136	0.22
2007	123	23652	40.49098N	104.80695W																	274	383	290	151	362	146	334	70	243	70									1398	0.521	0.403	0.210	0.288	0.568
2007	123	23701	40.46288N	104.71129W																	154	286	213	139	365	95	363	129	236	50									1857	0.653	0.260	0.355	0.212	
2007	123	23716	40.06762N	104.69014W																	157	622	332	664	365	381	352	374	233	293									3.962	2.000	1044	1063	1258	0.18
2007	123	23717	40.07123N	104.69020W																	214	940	542	1030	730	762	728	782	466	586									4.393	1900	1044	1074	1258	0.211
2007	123	23781	40.29613N	104.96549W																	161	227	302	144	364	73	334	20	243	20									1410	0.477	0.201	0.060	0.082	0.839
2007	123	23806	40.48767N	104.48152W																	160	130	281	151	335	62	324	41	138	2									0.813	0.537	0.185	0.127	0.014	
2007	123	23807	40.49131N	104.48290W																	169	115	161	66	321	78	328	50	239	43									0.680	0.410	0.243	0.152	0.180	0.602
2007	123	23808	40.53629N	104.82401W																	235	314	313	253	351	73	328	45	234	39									1336	0.808	0.208	0.137	0.167	0.826
2007	123	23809	40.52411N	104.57718W																	104	355	305	445	336	180	331	89	243	55									3.413	1459	0.536	0.269	0.226	1399
2007	123	23810	40.52722N	104.58051W																	19	300	275	636	309	170	328	92	115	0									15.789	2.313	0.550	0.280		0.413
2007	123	23814	40.53630N	104.83447W																	228	296	292	323	355	115	327	245	237	0									1298	1106	0.324	0.749		0.426
2007	123	23818	40.50208N	104.50478W																	138	184	196	348	318	109	301	481	232	146									1333	1776	0.343	1598	0.629	1007
2007	123	23820	40.06807N	104.78049W																	90	26	81	24	0	0	365	54	243	20									0.289	0.296		0.148	0.082	0.129
2007	123	23858	40.41654N	104.81635W																	184	339	293	282	361	241	333	214	234	43									1842	0.962	0.668	0.643	0.184	0.125
2007	123	23862	40.28654N	105.01130W																	29	110	277	1280	353	70	330	72	240	46									3.793	4.621	0.198	0.218	0.192	0.559
2007	123	23893	40.53305N	104.83449W																	162	350	90	166	21	21	60	12	5	0									2.160	1844	1000	0.200		
2007	123	23921	40.46734N	104.83454W																	229	147	286	48	361	46	335	12	243	22									0.642	0.168	0.127	0.036	0.091	0.36
2007	123	23922	40.47076N	104.83455W																	202	146	268	38	358	34	334	12	243	23									0.723	0.142	0.095	0.036	0.095	0.561
2007	123	23931	40.43977N	104.88212W																	208	239	352	575	360	138	334	39	235	272									1.149	1634	0.383	0.117	1157	
2007	123	23932	40.44655N	104.87547W																	226	595	330	457	304	251	334	88	243	20									2.633	1385	0.826	0.263	0.082	
2007	123	23933	40.43369N	104.83609W																	144	315	348	140	360	100	334	80	239	59									2.188	0.402	0.278	0.240	0.247	1299
2007	123	23960	40.43214N	104.89220W																	25	90	330	266	364	72	334	21	242	14									3.600	0.806	0.198	0.063	0.058	1248
2007	123	23961	40.33823N	104.62568W																	82	636	357	540	362	296	334	232	243	124									7.756	1.513	0.818	0.695	0.510	0.367
2007	123	23962	40.35259N	104.60701W																	208	466	345	47	337	8	331	46	226	82									2.240	0.136	0.024	0.139	0.363	1594
2007	123	24025	40.12890N	104.74198W																	361	0	344	0	364	82	359	111	243	61											0.225	0.309	0.251	1538
2007	123	24036	40.44474N	104.85816W																	260	431	342	376	360	259	303	30	240	20									1658	1099	0.719	0.099	0.083	
2007	123	24037	40.04194N	104.89397W																	365	571	305	301	354	166	298	0	243	0									1564	0.987	0.469			0.529
2007	123	24075	40.53636N	104.82861W																	244	329	135	113	125	11	59	9	48	18									1348	0.837	0.088	0.153	0.375	0.856
2007	123	24076	40.52086N	104.62302W																	279	336	286	159	311	50	332	0	243	0									1204	0.556	0.161			0.59
2007	123	24111	40.38166N	104.64517W																	195	416	303	345	341	228	334	126	243	55									2.133	1.139	0.669	0.377	0.226	1.157
2007	123	24133	40.51670N	104.62304W																	241	706	277	172	362	79	331	0	243	0									2.929	0.621	0.218			0.061
2007	123	24134	40.50964N	104.61760W																	265	768	332	184	360	100	334	19	243	0									2.898	0.554	0.278	0.057		0.865
2007	123	24135	40.49119N	104.50547W																	212	603	272	420	338	264	329	111	225	218									2.844	1.544	0.781	0.337	0.969	0.442
2007	123	24137	40.55228N	104.73234W																	189	252	309	259	362	213	333	32	243	2									6.095	0.838	0.588	0.096	0.008	0.563
2007	123	24187	40.27857N	105.02487W																	121	688	307	657	362	311	334	57	230	64									5.686	2.140	0.859	0.171	0.278	0.893
2007	123	24190	40.51127N	104.61555W																	241	292	360	120	361	75	334	10	243	0									1.212	0.333	0.208	0.030		0.444
2007	123	24214	40.45569N	104.70198W																	261	943	366	299	365	95	361	63	232	24									3.613	0.817	0.260	0.175	0.103	0.9
2007	123	24221	40.31002N	104.46409W																	87	216	152	87	269	67	315	88	240	51									2.483	0.572	0.249	0.279	0.213	0.148
2007	123	24222	40.31365N	104.46410W																	217	2060	351	1902	364	176	330	329	239	61									9.493	5.419	0.484	0.997	0.255	0.965
2007	123	24225	40.31053N	104.46874W																	163	222	356	209	354	96	330	95	241	51									1362	0.587	0.271	0.288	0.212	0.276
2007	123	24227	40.31726N	104.46408W																	224	2184	358	1997	360	174	332	332	238	61									9.750	5.578	0.483	1.000	0.256	0.503
2007	123	24228	40.22210N	104.68232W																	242	15	354	16	361	10	360	9	241	8									0.062	0.045	0.028	0.025	0.033	
2007	123	24230	40.44479N	104.85815W																	164	856	335	531	333	279	301	109	240	21									5.220	1585	0.838	0.362	0.088	0.795
2007	123	24244	40.48815N	104.51548W																	185	437	280	452	365	78	320	81	208	312									2.362	1.614	0.214	0.253	1.500	0.24
2007	123	24252	40.49693N	104.57983W																	40	180	348	295	337	40	332	50	235	47									4.500	0.848	0.119	0.151	0.200	0.162
2007	123	24259	40.23382N	104.60427W																	81	81	329	813	363	638	365	253	213	121									1.000	2.471	1.758	0.693	0.568	0.668
2007	123	24278	40.32142N	104.48258W																	140	3435	121	109	272	47	365	425	234	179									24.536	0.901	0.173	1.164	0.765	
2007	123	24280	40.54595N	104.57122W																	326	14	231	0	304	0	298	29	145	12									0.043			0.097	0.083	1.615
2007	123	24291	40.51389N	104.48721W																	148	171	295	124	361	90	282	16	193	69									1.155	0.420	0.249	0.057	0.358	1.621
2007	123	24300	40.48484N	104.51563W																	188	345	208	509	309	219	328	157	189	79									1.835	2.447	0.709	0.479	0.418	0.435
2007	123	24307	40.48058N	104.46259W																	134	135	159	171	154	93	322	50	230	690									1.007	1.075	0.604	0.155	3.000	1.805
2007	123	24321	40.49264N	104.45259W																	89	55	259	225	119	94	97	150	16	22									0.618	0.869	0.790	1.546	1.375	0.627
2007	123	24324	40.48449N	104.45326W																	209	436	292	104	344	68	289	45	243	63									2.086	0.356	0.198	0.156	0.259	0.459
2007	123	24331	40.47338N	104.48677W																	267	18	363	0	361	0	365	121	243	97									0.067			0.332	0.399	0.374

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2007	123	24341	40.51374N	104.49589W	302	0	362	81	125	5	365	37	243	8		0.224	0.040	0.101	0.033	0.812
2007	123	24343	40.37885N	104.65719W	398	451	393	314	334	150	365	169	232	98	1.133	0.799	0.449	0.463	0.422	
2007	123	24359	40.32835N	104.47345W	147	795	337	406	151	94	365	121	242	94	5.408	1.205	0.623	0.332	0.388	0.202
2007	123	24372	40.55733N	104.55655W	334	0	299	0	365	0	273	22	118	3				0.081	0.025	0.128
2007	123	24387	40.17128N	104.54266W	123	250	361	157	365	24	365	214	243	178	2.033	0.435	0.066	0.586	0.733	4.072
2007	123	24421	40.33958N	104.81958W	281	338	316	5	351	122	364	110	243	70	1.203	0.016	0.348	0.302	0.288	
2007	123	24458	40.50262N	104.50104W	138	174	216	418	333	127	292	331	232	145	1.261	1.935	0.381	1.134	0.625	3.349
2007	123	24480	40.47716N	104.48161W	149	0	138	0	365	0	365	93	243	53				0.255	0.218	3.057
2007	123	24483	40.49880N	104.63315W	238	0	360	62	360	0	365	0	233	0		0.172				0.5
2007	123	24496	40.49934N	104.55710W	298	0	363	0	356	0	365	65	142	28				0.178	0.197	
2007	123	24522	40.34487N	104.57876W	246	381	360	8	365	114	365	177	236	108	1.549	0.022	0.312	0.485	0.458	0.482
2007	123	24525	40.33774N	104.55035W	253	236	360	121	365	293	349	298	241	157	0.933	0.336	0.803	0.854	0.651	0.252
2007	123	24526	40.31607N	104.52252W	10	3	364	561	363	130	365	168	241	87	0.300	1.541	0.358	0.460	0.361	0.656
2007	123	24529	40.54208N	104.57155W	280	0	303	0	336	0	365	71	119	30				0.195	0.252	1.154
2007	123	24534	40.54807N	104.53068W	419	0	307	0	321	5	298	27	51	113			0.016	0.091	2.216	0.174
2007	123	24536	40.54578N	104.57610W	249	0	345	0	365	9	361	91	243	40			0.025	0.252	0.165	0.421
2007	123	24537	40.54785N	104.54061W	215	0	337	0	365	0	326	15	11	1				0.046	0.091	
2007	123	24546	40.53124N	104.51926W	246	0	288	0	343	0	323	44	237	44				0.136	0.186	0.556
2007	123	24566	40.54746N	104.56854W	138	15	190	0	353	0	365	29	160	15	0.109			0.079	0.094	0.194
2007	123	24567	40.51892N	104.50365W	244	0	362	70	123	4	156	26	243	8		0.193	0.033	0.167	0.033	1.373
2007	123	24578	40.47700N	104.50086W	185	320	211	240	319	133	326	7	223	177	1.730	1.137	0.417	0.021	0.794	0.155
2007	123	24587	40.51931N	104.45540W	174	0	112	29	338	251	328	125	43	0		0.259	0.743	0.381		
2007	123	24588	40.51257N	104.45564W	95	0	244	119	358	241	319	121	18	0		0.488	0.673	0.379		
2007	123	24597	40.44132N	104.48194W	176	84	331	40	354	30	364	61	243	22	0.477	0.121	0.085	0.168	0.091	
2007	123	24598	40.54959N	104.69214W	136	0	58	7	289	14	361	15	212	0		0.121	0.048	0.042		
2007	123	24625	40.28678N	104.54217W	266	401	366	289	365	147	352	152	235	93	1.508	0.790	0.403	0.432	0.396	0.084
2007	123	24626	40.27264N	104.53206W	19	1	363	156	356	172	354	82	186	568	0.053	0.430	0.483	0.232	3.054	
2007	123	24635	40.35184N	104.52544W	140	0	364	205	151	127	365	481	243	276		0.563	0.841	1.318	1.136	
2007	123	24639	40.28707N	104.55613W	196	198	321	125	362	65	365	395	225	197	1.010	0.389	0.180	1.082	0.876	
2007	123	24665	40.34499N	104.66388W	223	482	355	179	342	148	333	100	238	91	2.161	0.504	0.433	0.300	0.382	
2007	123	24666	40.34501N	104.67250W	199	504	305	321	334	236	331	245	240	253	2.533	1.052	0.707	0.740	1.054	
2007	123	24674	40.13683N	104.72339W	245	471	366	243	365	87	365	75	242	326	1.922	0.664	0.238	0.205	1.347	0.053
2007	123	24690	40.41184N	104.91354W	34	36	302	155	357	105	334	5	243	12	1.059	0.513	0.294	0.015	0.049	0.368
2007	123	24697	40.51870N	104.57913W	75	0	326	0	317	0	341	150	235	56				0.440	0.238	0.103
2007	123	24711	40.50217N	104.50999W	149	0	178	36	362	23	365	91	243	50		0.202	0.064	0.249	0.206	0.553
2007	123	24712	40.49480N	104.51901W	141	0	175	0	356	0	365	44	243	23				0.121	0.095	
2007	123	24713	40.39566N	104.55019W	30	57	176	323	364	710	365	865	223	476	1.900	1.835	1.951	2.370	2.135	0.126
2007	123	24717	40.54089N	104.61558W	119	0	164	0	318	45	211	0	136	0			0.142			0.3
2007	123	24718	40.54028N	104.60582W	114	0	140	20	237	27	8	0	0	0		0.143	0.114			0.533
2007	123	24719	40.54694N	104.60733W	99	0	157	34	332	14	365	0	243	12		0.217	0.042		0.049	0.328
2007	123	24725	40.46815N	104.47508W	128	28	121	81	365	2	362	50	243	25	0.219	0.669	0.005	0.138	0.103	
2007	123	24732	40.32878N	104.47806W	107	0	177	149	363	363	365	387	242	332		0.842	1.000	1.060	1.372	
2007	123	24754	40.38123N	104.53118W	31	45	91	72	364	196	359	169	238	80	1.452	0.791	0.538	0.471	0.336	
2007	123	24764	40.48940N	104.83408W	186	290	327	107	362	70	332	29	243	0	1.559	0.327	0.193	0.087		0.398
2007	123	24766	40.52789N	104.45815W	33	95	247	150	104	65	254	33	68	0	2.879	0.607	0.625	0.130		0.211
2007	123	24767	40.44888N	104.48194W	140	212	358	202	365	174	357	141	243	83	1.514	0.564	0.477	0.395	0.342	0.188
2007	123	24792	40.17283N	104.53991W	122	836	365	185	90	0	365	179	243	147	6.852	0.507		0.490	0.605	0.967
2007	123	24795	40.16594N	104.53568W	94	572	362	143	89	0	365	34	243	63	6.085	0.395		0.093	0.259	0.613
2007	123	24796	40.16541N	104.54039W	115	782	361	127	300	0	365	232	243	293	6.800	0.352		0.636	1.206	
2007	123	24799	40.16176N	104.54041W	103	1022	361	450	304	0	365	524	243	116	9.922	1.247		1.436	0.477	0.242
2007	123	24806	40.54264N	104.59489W	18	86	311	0	286	20	314	0	243	0	4.778		0.070			
2007	123	24807	40.53898N	104.59448W	22	109	311	0	270	20	321	0	199	0	4.955		0.074			
2007	123	24808	40.53791N	104.59968W	66	128	337	354	347	72	325	18	243	13	1.939	1.050	0.207	0.055	0.053	0.226
2007	123	24833	40.33787N	104.65451W	207	367	304	256	355	142	294	116	234	100	1.773	0.842	0.400	0.395	0.427	0.411
2007	123	24844	40.51900N	104.77672W	115	120	329	200	356	187	331	29	238	45	1.043	0.608	0.525	0.088	0.189	0.309
2007	123	24849	40.47936N	104.80910W	31	217	297	425	356	395	334	137	208	21	7.000	1.431	1.110	0.410	0.101	
2007	123	24851	40.51681N	104.62713W	198	349	279	125	362	56	329	0	243	0	1.763	0.448	0.155			0.345
2007	123	24869	40.19289N	104.63133W	205	640	121	170	364	194	363	95	243	57	3.122	1.405	0.533	0.262	0.235	0.917
2007	123	24873	40.34478N	104.55573W	179	292	360	0	365	259	365	287	241	165	1.631		0.710	0.786	0.685	0.927
2007	123	24894	40.14406N	104.75618W	82	16	121	0	365	152	359	252	243	135	0.195		0.416	0.702	0.556	0.334
2007	123	24896	40.12499N	104.74751W	187	0	354	0	365	332	359	398	243	249			0.910	1.109	1.025	0.286
2007	123	24902	40.27310N	104.62573W	106	485	336	335	358	173	334	186	219	83	4.575	0.997	0.483	0.557	0.379	0.489
2007	123	24904	40.49280N	104.83876W	167	316	355	100	362	70	332	38	243	0	1.892	0.282	0.193	0.114		0.776
2007	123	24906	40.44185N	104.86951W	31	0	262	132	361	76	322	93	240	127		0.504	0.211	0.289	0.529	0.287
2007	123	24907	40.36287N	104.52223W	197	258	349	103	87	0	365	226	243	115	1.310	0.295		0.619	0.473	0.593
2007	123	24917	40.54026N	104.59708W	58	73	334	286	332	88	325	18	243	9	1.259	0.856	0.265	0.055	0.037	0.737
2007	123	24924	40.15536N	104.70966W	161	49	333	91	90	9	303	26	123	8	0.304	0.273	0.100	0.086	0.065	2.112
2007	123	24932	40.46299N	104.71128W	158	718	366	430	365	102	365	165	240	79	4.544	1.175	0.279	0.452	0.329	2.101
2007	123	24936	40.49333N	104.77030W	125	50	272	182	362	68	333	39	243	0	0.400	0.669	0.188	0.117		1.012
2007	123	24953	40.50260N	104.49594W	85	0	366	122	295	1	364	37	236	45		0.333	0.003	0.102	0.191	0.36
2007	123	24968	40.10047N	104.75142W	101	117	0	0	31	14	212	83	235	67	1.158		0.452	0.392	0.285	0.535
2007	123	24969	40.27225N	104.58845W	183	342	365	293	352	191	358	207	239	0	1.869	0.803	0.543	0.578		0.973
2007	123	24971	40.34570N	104.61731W	155	662	306	477	362	329	334	320	239	153	4.271	1.559	0.909	0.958	0.640	1.217
2007	123	24975	40.32337N	104.63450W	92	0	295	175	360	20	334	62	238	226		0.593	0.056	0.186	0.950	0.842
2007	123	24982	40.41083N	104.89372W	31	175	342	138	360	409	397	891	424	381	5.645	0.404	1.136	2.244	0.899	0.686
2007	123	24991	40.34806N	104.55476W	207	149	364	0	365	207	331	186	242	196	0.720		0.567	0.562	0.810	0.212
2007	123	24993	40.11113N	104.72713W	38	52	169	144	330	272	365	384	240	239	1.368	0.852	0.824	1.052	0.996	
2007	123	24997	40.42525N	104.45551W	175	1682	366	1317	330	333	363	269	212	14	9.611	3.598	1.009	0.741	0.066	
2007	123	24998	40.42507N	104.46582W	167	4037	366	656	365	212	365	173	212	5	24.174	1.792	0.581	0.474	0.024	0.556
2007	123	25003	40.34093N	104.57955W	218	213	363	16	365	563	342	986	239	488	0.977	0.044	1.542	2.883	2.042	0.879
2007	123	25029	40.12607N	104.73665W	99	0	344	0	362	208	359	298	243	165			0.575	0.830	0.679	
2007	123	25033	40.39161N	104.50869W	78	0	363	0	365	78	365	140	226	88			0.214	0.384	0.389	0.129
2007	123	25036	40.38397N	104.51608W	165	2053	210	317	365	369	365	350	240	154	12.442	1.510	1.011	0.959	0.642	0.979
2007	123	25049	40.46111N	104.42751W	157	1742	366	707	365	3464	730	330	460	34	11.096	1.932	9.490	0.452	0.074	0.424
2007	123	25051	40.43953N	104.39901W	143	1156	336	598	89	128	362	198	243	10	8.084	1.780	1.438	0.547	0.041	0.771
2007	123	25057	40.22945N	104.46635W	37	1545	0	0	241	794	363	722	144	320	41.757		3.295	1.989	2.222	0.621
2007	123	25064	40.25809N	104.58872W	100	55	260	410	333	64	333	113	195	634	0.550	1.577	0.192	0.339	3.251	0.496
2007	123	25065	40.32724N	104.70143W	83	48	354	133	365	149	358	149	243	73	0.578	0.376	0.408	0.416	0.300	0.507
2007	123	25077	40.28708N	104.58054W	124	280	366	80	365	47	361	165	239	82	2.258	0.219	0.129	0.457	0.343	
2007	123	25079	40.44663N	104.39931W	57	848	355	270	355	374	365	317	243	14	14.877	0.761	1.054	0.868	0.058	
2007	123	25080	40.48967N	104.77163W	127	60	272	183	363	77	334	72	243	0	0.472	0.673	0.212	0.216		0.462
2007	123	25087	40.09971N	104.73723W	71	36	60	55	305	85	365	75	243	37	0.507	0.917	0.279	0.205	0.152	0.831
2007	123	25093	40.27274N	104.67272W	132	34	306	95	364	52	303	15	196	0	0.258	0.310	0.143	0.050		0.346
2007	123	25097	40.21969N	104.52588W	90	67	366	139	358	371	365	171	243	129	0.744	0.380	1.036	0.468	0.531	0.391
2007	123	25098	40.22724N	104.54419W	81	120	363	176	354	130	334	394	219	81	1.481	0.485	0.367	1.180	0.370	0.428
2007	123	25105	40.26081N	104.93962W	94	0	285	440	363	122	315	229	240	221		1.544	0.336	0.727	0.921	
2007	123	25113	40.33075N	104.70572W	76	100	352	114	331	274	353	261	243	207	1.316	0.324	0.828	0.739	0.852	0.196
2007	123	25115	40.41752N	104.39934W	76	847	353	1096	273	41	364	44	240	13	11.145	3.105	0.150	0.121	0.054	
2007	123	25128	40.25856N	104.93836W	98	0	273	346	359	102	334	218	240	227		1.267	0.284	0.653	0.946	0.042
2007	123	25129	40.53614N	104.83920W	33	225	292	251	359	81	332	37	236	71	6.818	0.860	0.226	0.111	0.301	1.154
2007	123	25130	40.34428N	104.75999W	109	63	349	22	353	22	365	0	240	0	0.578	0.063	0.062			1.519
2007	123	25148	40.26693N	105.04329W	88	484	270	263	361	30	265	2	241	4	5.500	0.974	0.083	0.008	0.017	
2007	123	25149	40.25781N	104.94401W	175	663	326	363	331	96	365	66	241	37	3.789	1.113	0.290	0.181	0.154	
2007	123	25150	40.32725N	104.70152W	93	79	347	172	361	203	358	171	243	122	0.849	0.496	0.562	0.478	0.502	
2007	123	25164	40.57845N	104.55698W	8	0	194	415	247	60	164	160	133	217		2.139	0.243	0.976	1.632	0.638
2007	123	25176	40.22908N	104.69213W	130	168	345	296	365	252	365	222	241	196	1.292	0.858	0.690	0.608	0.813	1.148
2007	123	25177	40.35893N	104.61679W	44	50	330	310	360	215	277	0	190	23	1.136	0.939	0.597		0.121	1.174
2007	123	25178	40.38483N	104.51265W	141	3087	364	557	365	191	363	267	219	344	21.894	1.530	0.523	0.736	1.571	0.775
2007	123	25183	40.53256N	104.82942W	26	161	266	426	333	81	318	61	94	14	6.192	1.602	0.243	0.192	0.149	
2007	123	25187	40.20238N	104.66105W	95	288	358	412	365	278	365	193	243	92	3.032	1.151	0.762	0.529	0.379	0.121
2007	123	25192	40.05283N	104.79390W	160	473	320	347	358	147	120	42	152	41	2.956	1.084	0.411	0.350	0.270	0.303
2007	123	25194	40.37562N	104.87645W	165	0	356	583	365	681	462	585	472	706		1.638	1.866	1.266	1.496	1.097
2007	123	25212	40.33416N	104.70155W	76	120	340	220	353	141	363	238	243	128	1.579	0.647	0.399	0.656	0.527	0.351
2007	123	25218	40.42488N	104.42755W	90	2422	353	518	59	62	358	264	241	12	26.911	1.467	1.051	0.737	0.050	0.065
2007	123	25219	40.49755N	104.40862W	155	966	343	827	333	18	365	0	216	33	6.232	2.411	0.054		0.153	0.39
2007	123	25222	40.53250N	104.83923W	32	250	216	190	48	16	7	7	5	6	7.813	0.880	0.333	1.000	1.200	0.572
2007	123	25236	40.35237N	104.64400W	56	64	338	551	361	304	365	261	243	91	1.143	1.630	0.842	0.715	0.374	0.047
2007	123	25264	40.32302N	104.64342W	135	274	294	328	358	324	333	266	175	129	2.030	1.116	0.905	0.799	0.737	0.189
2007	123	25267	40.46294N	104.42074W	146	2892	306	515	365	349	365	205	243	40	19.808	1.683	0.956	0.562	0.165	1.612
2007	123	25268	40.45932N	104.42548W	31	164	61	12	365	4037	365	328	243	37	5.290	0.197	11.060	0.899	0.152	1.714

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2007	123	25269	40.53263N	104.82518W	24	117	237	311	354	82	327	47	226	53	4.875	1.312	0.232	0.144	0.235	141
2007	123	25275	40.46092N	104.81867W	41	334	315	375	363	239	334	20	243	101	8.146	1.190	0.658	0.060	0.416	1363
2007	123	25281	40.42328N	104.45841W	155	1112	366	1317	330	195	363	269	212	14	7.174	3.598	0.591	0.741	0.066	1.116
2007	123	25286	40.36891N	104.67127W	67	689	350	590	357	248	292	20	220	11	10.284	1.686	0.695	0.068	0.050	0.078
2007	123	25291	40.49072N	104.50198W	133	719	327	429	348	291	323	116	235	110	5.406	1.312	0.836	0.359	0.468	0.542
2007	123	25292	40.49174N	104.50071W	112	190	297	382	348	300	323	114	235	90	1.696	1.286	0.862	0.353	0.383	0.004
2007	123	25926	40.39043N	104.78155W	83	87	359	712	151	230	332	474	237	290	1.048	1.983	1.523	1.428	1.224	139
2007	123	25933	40.43208N	104.49823W	139	369	327	215	360	151	358	325	214	164	2.655	0.657	0.419	0.908	0.766	0.005
2007	123	25936	40.35237N	104.64384W	31	82	87	103	333	309	365	234	243	77	2.645	1.184	0.928	0.641	0.317	0.828
2007	123	25937	40.35237N	104.64411W	30	70	82	99	333	318	365	194	243	69	2.333	1.207	0.955	0.532	0.284	1.114
2007	123	25939	40.42486N	104.49821W	125	253	335	180	362	169	288	234	238	147	2.024	0.537	0.467	0.813	0.618	1.11
2007	123	25940	40.42849N	104.49348W	128	278	333	240	365	151	365	331	214	164	2.172	0.721	0.414	0.907	0.766	
2007	123	25952	40.26848N	104.56065W	1	0	347	847	364	390	363	195	241	102		2.441	1.071	0.537	0.423	1647
2007	123	25953	40.26532N	104.55604W	2	0	348	1005	362	395	365	232	243	119		2.888	1.091	0.636	0.490	0.823
2007	123	25965	40.25064N	104.59950W	94	0	306	20	348	0	330	173	218	324		0.065		0.524	1.486	0.109
2007	123	25978	40.33266N	104.69900W	20	10	350	91	348	424	364	525	243	307	0.500	0.260	1.218	1.442	1.263	
2007	123	25979	40.46358N	104.81866W	41	388	341	415	363	223	334	20	243	92	9.463	1.217	0.614	0.060	0.379	0.421
2007	123	26024	40.30160N	104.94340W	45	125	287	677	357	426	297	61	243	21	2.778	2.359	1.193	0.205	0.086	1.698
2007	123	26026	40.50276N	104.47743W	107	0	366	94	300	133	359	87	236	32		0.257	0.443	0.242	0.136	0.127
2007	123	26064	40.51892N	104.62544W	99	304	250	115	363	73	333	0	243	0	3.071	0.460	0.201			0.578
2007	123	26075	40.20763N	104.65445W	112	509	306	337	353	255	334	138	243	126	4.545	1.101	0.722	0.413	0.519	0.6
2007	123	26079	40.46761N	104.53040W	39	122	301	562	361	1545	324	397	212	449	3.128	1.867	4.280	1.225	2.118	0.958
2007	123	26080	40.53245N	104.65596W	32	85	306	319	334	87	263	0	243	0	2.656	1.042	0.260			0.494
2007	123	26084	40.56730N	104.54332W	56	0	249	0	362	0	341	11	243	345				0.032	1.420	0.592
2007	123	26090	40.56746N	104.56633W	75	0	243	0	358	0	60	0	140	366					2.614	0.066
2007	123	26092	40.50639N	104.47739W	41	0	235	79	364	131	364	96	233	41		0.336	0.360	0.264	0.176	0.218
2007	123	26117	40.48319N	104.44662W	66	0	152	0	119	37	365	88	243	87			0.311	0.241	0.358	1.327
2007	123	26126	40.48485N	104.44438W	66	0	345	371	333	147	365	88	243	87		1.075	0.441	0.241	0.358	1.008
2007	123	26127	40.48075N	104.44854W	64	0	318	1	148	0	365	97	243	91		0.003		0.266	0.374	0.362
2007	123	26132	40.42675N	104.39230W	87	1273	366	433	365	136	365	138	243	53	14.632	1.183	0.373	0.378	0.218	0.306
2007	123	26151	40.55463N	104.67931W	1	0	292	399	299	140	288	50	185	0		1.366	0.468	0.174		0.236
2007	123	26192	40.47055N	104.50609W	28	150	324	310	354	105	323	137	220	141	5.357	0.957	0.297	0.424	0.641	1.068
2007	123	26206	40.34495N	104.57470W	41	0	356	28	365	377	365	327	243	173		0.079	1.033	0.896	0.712	0.558
2007	123	26207	40.53841N	104.57706W	44	0	306	0	363	0	361	87	243	50				0.241	0.206	0.828
2007	123	26210	40.42718N	104.45320W	12	300	324	695	330	441	362	2690	243	48	25.000	2.145	1.336	7.431	0.198	0.894
2007	123	26218	40.33773N	104.54667W	30	0	354	165	365	96	325	240	242	394		0.466	0.263	0.738	1.628	0.537
2007	123	26219	40.54717N	104.47272W	5	0	229	265	332	100	261	0	77	0		1.157	0.301			2.37
2007	123	26227	40.54152N	104.59956W	25	24	292	188	143	15	306	18	45	8	0.960	0.644	0.105	0.059	0.178	1.096
2007	123	26230	40.23195N	104.61689W	76	276	364	867	365	628	365	316	242	160	3.632	2.382	1.721	0.866	0.661	1.386
2007	123	26232	40.33462N	104.55096W	35	0	356	152	337	123	365	681	243	207		0.427	0.365	1.866	0.852	0.055
2007	123	26240	40.20737N	104.63134W	72	314	357	586	365	130	365	59	242	94	4.361	1.641	0.356	0.162	0.388	0.619
2007	123	26244	40.26146N	104.94949W	3	28	357	1062	364	63	365	39	218	0	9.333	2.975	0.173	0.107		0.427
2007	123	26266	40.19565N	104.65986W	17	66	364	817	365	300	365	211	243	147	3.882	2.245	0.822	0.578	0.605	0.336
2007	123	26285	40.31749N	104.46869W	10	165	183	1543	90	79	365	392	240	61	16.500	8.432	0.878	1.074	0.254	1.784
2007	123	26287	40.31753N	104.45485W	25	0	335	441	175	30	150	0	0	0		1.316	0.171			0.227
2007	123	26368	40.55130N	104.72861W	14	0	312	401	361	173	364	19	243	3		1.285	0.479	0.052	0.012	
2007	123	26370	40.47750N	104.74918W	19	0	237	58	304	267	365	166	232	125		0.245	0.878	0.455	0.539	0.008
2007	123	26409	40.44118N	104.43483W	29	522	349	687	365	543	365	180	238	18	18.000	1.968	1.488	0.493	0.076	1.769
2007	123	26415	40.25278N	104.49782W	6	19	138	249	347	154	356	108	224	99	3.167	1.804	0.444	0.303	0.442	2.769
2007	123	26416	40.44498N	104.43465W	20	10	349	546	365	371	363	371	243	15	0.500	1.564	1.016	1.022	0.062	0.609
2007	123	26418	40.54583N	104.59915W	26	53	191	300	254	190	113	78	1	0	2.038	1.571	0.748	0.690		0.676
2007	123	26426	40.27190N	104.74866W	31	151	361	231	365	355	365	411	240	574	4.871	0.640	0.973	1.126	2.392	0.587
2007	123	26435	40.46645N	104.47259W	27	262	362	266	365	13	365	290	243	146	9.704	0.735	0.036	0.795	0.601	1.173
2007	123	26467	40.51722N	104.50062W	2	0	318	106	85	0	365	86	243	42		0.333		0.236	0.173	0.519
2007	123	26500	40.48022N	104.51558W	8	0	247	964	317	221	333	57	185	242		3.903	0.697	0.171	1.308	0.675
2007	123	26511	40.50406N	104.54156W	10	0	344	0	365	0	331	21	241	0				0.063		0.748
2007	123	26528	40.25050N	104.60708W	2	0	351	279	364	356	363	274	238	376		0.795	0.978	0.755	1.580	0.63
2007	123	26533	40.37608N	104.82496W	12	11	362	450	147	218	365	439	240	160	0.917	1.243	1.483	1.203	0.667	0.96
2007	123	27047	40.45535N	104.38783W	179	477	364	745	365	90	365	54	238	30	2.665	2.047	0.247	0.148	0.126	0.621
2007	123	27050	40.46606N	104.48253W	304	0	358	34	365	15	365	96	243	54		0.095	0.041	0.263	0.222	1.026
2007	123	27053	40.48449N	104.46729W	268	853	209	61	316	91	332	96	243	43	3.183	0.292	0.288	0.289	0.177	
2007	123	27056	40.31607N	104.53132W	324	308	356	267	343	161	365	19	243	9	0.951	0.750	0.469	0.052	0.037	
2007	123	27059	40.31620N	104.54191W	265	1025	366	227	365	143	365	123	243	110	3.868	0.620	0.392	0.337	0.453	0.577
2007	123	27282	40.46584N	104.52508W	178	538	290	228	351	207	309	88	197	48	3.022	0.786	0.590	0.285	0.244	0.481
2007	123	27294	40.27865N	105.02079W	142	991	276	1229	355	451	331	68	226	55	6.979	4.453	1.270	0.205	0.243	
2007	123	27296	40.44204N	104.86968W	31	0	261	94	361	50	272	131	238	158		0.360	0.139	0.482	0.664	0.453
2007	123	27322	40.55478N	104.58763W	195	0	121	91	324	213	99	79	121	31		0.752	0.657	0.798	0.256	1.763
2007	123	27323	40.32348N	104.55083W	278	244	359	135	365	158	365	312	238	189	0.878	0.376	0.433	0.855	0.794	0.565
2007	123	27326	40.42571N	104.79260W	277	0	365	0	364	99	327	125	242	51			0.272	0.382	0.211	1.695
2007	123	27327	40.42571N	104.79255W	259	0	365	0	364	99	365	157	242	51			0.272	0.430	0.211	1.041
2007	123	27343	40.44841N	104.86899W	32	54	294	245	307	100	334	17	228	43	1.688	0.833	0.326	0.051	0.189	0.135
2007	123	27351	40.32263N	104.47580W	263	390	366	539	364	503	365	1240	234	494	1.483	1.473	1.382	3.397	2.111	1.22
2007	123	27391	40.44855N	104.86331W	34	41	296	370	358	187	334	29	176	260	1.206	1.250	0.522	0.087	1.477	0.539
2007	123	27392	40.44193N	104.86961W	31	0	262	94	352	55	322	173	240	258		0.359	0.156	0.537	1.075	0.647
2007	123	27393	40.53116N	104.51548W	249	0	366	0	364	0	346	54	243	31				0.156	0.128	1.157
2007	123	27394	40.30876N	104.66373W	339	288	329	485	365	333	365	329	236	447	0.850	1.474	0.912	0.901	1.894	1.212
2007	123	27397	40.38756N	104.94229W	157	219	352	339	365	124	334	87	214	103	1.395	0.963	0.340	0.260	0.481	0.234
2007	123	27398	40.39118N	104.94227W	163	177	303	297	140	40	310	60	214	179	1.086	0.980	0.286	0.194	0.836	1.123
2007	123	27401	40.44189N	104.85587W	145	0	335	16	359	9	322	0	203	27		0.048	0.025		0.133	0.814
2007	123	27402	40.44196N	104.85586W	152	0	339	16	359	18	334	0	232	7		0.047	0.050		0.030	0.496
2007	123	29976	40.52935N	104.84802W	67	177	309	239	361	159	318	0	240	0	2.642	0.773	0.440			
2007	123	29977	40.42984N	104.89041W	23	105	328	398	364	111	334	98	241	54	4.565	1.213	0.305	0.293	0.224	
2007	123	29978	40.43033N	104.89430W	27	115	346	323	364	98	334	66	241	38	4.259	0.934	0.269	0.198	0.158	0
2007	123	29988	40.41194N	104.91357W	32	59	302	188	363	123	334	5	243	51	1.844	0.623	0.339	0.015	0.210	
2007	123	29993	40.52477N	104.84808W	81	153	211	186	329	146	318	0	241	0	1.889	0.882	0.444			1.823
2007	123	29996	40.43458N	104.90376W	60	234	349	245	365	86	334	0	241	32	3.900	0.702	0.236		0.133	
2007	123	29999	40.43007N	104.90434W	52	146	295	121	361	64	334	0	241	38	2.808	0.410	0.177		0.158	
2008	123	22954	40.00887N	105.00146W			197	877	326	480	358	247	243	114		4.452	1.472	0.690	0.469	1.931
2008	123	23436	40.52165N	104.79074W			142	200	357	760	332	262	206	44		1.408	2.129	0.789	0.214	0.995
2008	123	23499	40.39058N	104.92881W			302	644	364	47	332	25	243	30		2.132	0.129	0.075	0.123	1.023
2008	123	23768	40.41284N	104.79719W			212	22	356	146	353	76	233	42		0.104	0.410	0.215	0.180	0.67
2008	123	23837	40.00886N	105.00136W			195	367	327	481	358	247	243	114		1.882	1.471	0.690	0.469	
2008	123	23959	40.44663N	104.88552W			309	1297	332	227	331	80	179	205		4.197	0.684	0.242	1.145	0.548
2008	123	23989	40.28197N	105.01479W			187	246	350	103	332	69	239	45		1.316	0.294	0.208	0.188	0.982
2008	123	24045	40.48079N	104.50072W			116	462	345	165	303	0	193	10		3.983	0.478		0.052	0.162
2008	123	24116	40.58013N	104.77661W			22	110	0	0	97	0	0	0		5.000				0.169
2008	123	24117	40.48567N	104.80374W			230	287	362	200	334	62	209	113		1.248	0.552	0.186	0.541	0.638
2008	123	24136	40.48426N	104.50615W			136	1032	346	138	296	0	227	11		7.588	0.399		0.048	0.849
2008	123	24249	40.48935N	104.62547W			312	50	337	0	317	0	80	0		0.160				0.451
2008	123	24288	40.51418N	104.47668W			25	305	334	1119	319	75	206	28		12.200	3.350	0.235	0.136	0.855
2008	123	24289	40.51131N	104.47644W			14	140	334	188	322	34	216	17		10.000	0.563	0.106	0.079	2.657
2008	123	24293	40.51055N	104.47807W			12	185	326	161	307	36	214	13		15.417	0.494	0.117	0.061	
2008	123	24303	40.38754N	104.93981W			209	551	360	137	332	43	214	54		2.636	0.381	0.130	0.252	0.344
2008	123	24420	40.28761N	104.91004W			213	485	365	96	324	257	243	94		2.277	0.263	0.793	0.387	0.668
2008	123	24576	40.53808N	104.58500W			235	125	214	40	201	186	158	35		0.532	0.187	0.925	0.222	1.229
2008	123	24791	40.16892N	104.53961W			153	0	365	0	365	2	243	1				0.005	0.004	0.164
2008	123	24805	40.52442N	104.49044W			212	320	275	150	188	65	1	0		1.509	0.545	0.346		1.323
2008	123	24864	40.48810N	104.50546W			102	720	311	179	334	91	219	120		7.059	0.576	0.272	0.548	0.542
2008	123	24931	40.50041N	104.80920W			266	514	338	297	333	71	232	55		1.932	0.879	0.213	0.237	1.421
2008	123	24937	40.51119N	104.59805W			346	555	346	225	331	197	243	74		1.604	0.650	0.595	0.305	1.211
2008	123	24950	40.50271N	104.49131W			182	77	358	1	363	37	236	45		0.423	0.003	0.102	0.191	2.874
2008	123	24963	40.47116N	104.80369W			314	484	363	388	334	159	243	105		1.541	1.069	0.476	0.432	0.321
2008	123	24964	40.46859N	104.80363W			310	518	363	365	333	153	243	33		1.671	1.006	0.459	0.136	0.352
2008	123	25082	40.42616N	104.60901W			335	0	365	291	365	313	243	170			0.797	0.858	0.700	0.408
2008	123	25099	40.25716N	104.93478W			29	1213	352	226	333	163	240	51		41.828	0.642	0.489	0.213	0.099
2008	123	25100	40.26091N	104.93467W			30	1462	347	228	334	148	240	44		48.733	0.657	0.443	0.183	0.712
2008	123	25101	40.25716N	104.93015W			27	2016	353	107	334	162	215	125		74.667	0.303	0.485	0.581	1.168
2008	123	25102	40.25971N	104.92899W			21	1728	354	95	334	165	242	173		82.286	0.268	0.494	0.715	2.534
2008	123	25103	40.26079N	104.93004W			27	1056	360	79	331	170	242	173		39.111	0.219	0.514	0.715	1.372
2008	123	25106	40.50056N	104.80371W			253	236	349	322	334	94	242	55		0.933	0.923	0.281	0.227	0.102

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2008	123	25131	40.39606N	104.42680W			366	552	90	108	363	236	197	9		1.508	1.200	0.650	0.046	1.459
2008	123	25171	40.60388N	104.55669W			93	665	232	955	128	314	181	378		7.151	4.116	2.453	2.088	1
2008	123	25174	40.57875N	104.50942W			9	860	156	1928	237	759	170	0		95.556	12.359	3.203		2.884
2008	123	25287	40.42288N	104.62389W			60	0	334	320	365	364	204	175			0.958	0.997	0.858	1.548
2008	123	25293	40.27381N	104.69357W			308	434	304	102	334	176	243	96		1.409	0.336	0.527	0.395	0.194
2008	123	25294	40.49388N	104.79930W			225	2474	361	438	332	103	241	0		10.996	1.213	0.310		0.135
2008	123	25299	40.35385N	104.66122W			294	574	362	414	361	396	243	191		1.952	1.144	1.097	0.786	1.14
2008	123	25300	40.32392N	104.71140W			300	99	365	475	365	412	236	291		0.330	1.301	1.129	1.233	0.097
2008	123	25304	40.27652N	104.60673W			253	252	358	287	365	271	170	169		0.996	0.802	0.742	0.994	0.115
2008	123	25306	40.49151N	104.51019W			194	2152	364	432	329	106	231	0		11.093	1.187	0.322		1.641
2008	123	25308	40.53662N	104.65575W			214	991	303	88	216	0	243	0		4.631	0.290			0.944
2008	123	25310	40.47530N	104.51264W			161	2083	355	41	276	148	233	237		12.938	0.115	0.536	1.017	0.768
2008	123	25323	40.33702N	104.71093W			266	2118	333	394	298	102	231	292		7.962	1.183	0.342	1.264	
2008	123	25346	40.09648N	104.69519W			259	292	365	71	365	0	241	37		1.127	0.195		0.154	
2008	123	25347	40.32335N	104.57924W			45	1330	343	665	322	137	238	234		29.556	1.939	0.425	0.983	0.359
2008	123	25348	40.11496N	104.67132W			259	532	363	628	365	311	243	112		2.054	1.730	0.852	0.461	0.063
2008	123	25367	40.40312N	104.55505W			256	3417	365	609	365	539	216	317		13.348	1.668	1.477	1.468	1.387
2008	123	25380	40.45936N	104.41129W			225	142	327	231	365	197	243	14		0.631	0.706	0.540	0.058	
2008	123	25385	40.12602N	104.71355W			283	1021	151	271	359	329	237	131		3.608	1.795	0.916	0.553	
2008	123	25386	40.12948N	104.70880W			293	463	335	217	365	85	243	22		1.580	0.648	0.233	0.091	0.52
2008	123	25388	40.48550N	104.80911W			230	474	363	281	334	93	241	88		2.061	0.774	0.278	0.365	0.644
2008	123	25394	40.19535N	104.59293W			272	826	345	159	362	75	231	30		3.037	0.461	0.207	0.130	0.496
2008	123	25396	40.19640N	104.58994W			270	20	345	121	364	46	243	0		0.074	0.351	0.126		0.276
2008	123	25398	40.30866N	104.54963W			295	4	359	5	365	4	243	7		0.014	0.014	0.011	0.029	0.586
2008	123	25400	40.12554N	104.68026W			61	45	364	159	365	96	243	31		0.738	0.437	0.263	0.128	0.627
2008	123	25418	40.19976N	104.59417W			274	451	365	124	365	167	243	73		1.646	0.340	0.458	0.300	0.34
2008	123	25419	40.33794N	104.54045W			279	0	360	8	358	6	227	7			0.022	0.017	0.031	1.267
2008	123	25420	40.19992N	104.59816W			308	463	365	124	365	167	243	73		1.503	0.340	0.458	0.300	0.717
2008	123	25425	40.49627N	104.43998W			169	1890	236	161	320	53	179	9		11.183	0.682	0.166	0.050	0.313
2008	123	25426	40.19644N	104.58511W			270	246	284	148	364	141	229	35		0.911	0.521	0.387	0.153	0.818
2008	123	25429	40.48078N	104.50543W			114	1289	345	177	306	0	208	11		11.307	0.513		0.053	0.347
2008	123	25430	40.48808N	104.50063W			139	2490	339	1175	287	349	210	166		17.914	3.466	1.216	0.790	0.108
2008	123	25432	40.28240N	104.48154W			237	408	144	59	364	163	243	259		1.722	0.410	0.448	1.066	1.37
2008	123	25433	40.28690N	104.48044W			263	309	147	9	365	11	235	6		1.175	0.061	0.030	0.026	0.493
2008	123	25439	40.48430N	104.50073W			96	91	336	129	294	0	201	26		0.948	0.384		0.129	0.926
2008	123	25441	40.29813N	104.51356W			287	70	334	0	332	8	229	0		0.244		0.024		0.949
2008	123	25450	40.48622N	104.79920W			214	2110	362	0	334	29	238	110		9.860		0.087	0.462	0.409
2008	123	25453	40.33041N	104.66283W			259	302	365	372	315	211	216	133		1.166	1.019	0.670	0.616	1.589
2008	123	25457	40.33707N	104.59868W			171	1787	356	311	334	163	243	73		10.450	0.874	0.488	0.300	1.726
2008	123	25463	40.31581N	104.48028W			239	623	365	534	357	344	242	139		2.607	1.463	0.964	0.574	
2008	123	25465	40.25772N	104.71135W			237	91	365	72	354	17	241	13		0.384	0.197	0.048	0.054	
2008	123	25472	40.27993N	104.48085W			223	185	88	30	332	428	191	220		0.830	0.341	1.289	1.152	
2008	123	25475	40.53084N	104.57241W			157	1572	310	104	329	86	101	0		10.013	0.335	0.261		0.185
2008	123	25489	40.29384N	104.51741W			34	0	334	185	332	379	243	238			0.554	1.142	0.979	
2008	123	25491	40.49887N	104.44001W			227	3030	298	120	321	32	176	6		13.348	0.403	0.100	0.034	
2008	123	25492	40.28000N	105.02292W			169	1650	364	0	334	0	241	119		9.763			0.494	
2008	123	25498	40.29837N	104.54098W			235	510	365	291	365	126	243	23		2.170	0.797	0.345	0.095	0.478
2008	123	25505	40.13475N	104.72582W			232	693	151	194	339	176	201	87		2.987	1.285	0.519	0.433	0.94
2008	123	25508	40.33363N	104.56036W			162	0	365	288	365	348	242	199			0.789	0.953	0.822	1.261
2008	123	25517	40.32741N	104.51299W			272	640	364	481	365	193	241	124		2.353	1.321	0.529	0.515	1.009
2008	123	25518	40.34038N	104.62775W			72	978	365	703	365	370	242	154		13.583	1.926	1.014	0.636	0.465
2008	123	25520	40.34911N	104.62620W			127	183	352	412	350	391	243	207		1.441	1.170	1.117	0.852	0.997
2008	123	25521	40.34911N	104.62620W			123	183	350	407	350	391	240	206		1.488	1.163	1.117	0.858	0.002
2008	123	25522	40.34877N	104.62622W			123	511	365	685	364	494	243	134		4.154	1.877	1.357	0.551	0.216
2008	123	25523	40.34870N	104.62622W			140	624	365	127	364	89	243	72		4.457	0.348	0.245	0.296	0.486
2008	123	25526	40.34884N	104.62622W			136	348	365	264	350	206	243	148		2.559	0.723	0.589	0.609	0.503
2008	123	25527	40.34863N	104.62621W			140	638	365	127	364	89	243	72		4.557	0.348	0.245	0.296	0.196
2008	123	25539	40.47584N	104.85707W			237	2017	362	153	334	14	243	0		8.511	0.423	0.042		0.185
2008	123	25544	40.27230N	104.72976W			251	0	364	0	365	0	239	0						0.595
2008	123	25547	40.30472N	104.63011W			262	495	363	455	365	313	236	161		1.889	1.253	0.858	0.682	0.586
2008	123	25554	40.36677N	104.68267W			236	411	360	332	365	250	236	49		1.742	0.922	0.685	0.208	
2008	123	25555	40.38645N	104.92850W			242	1676	363	53	334	25	243	35		6.926	0.146	0.075	0.144	
2008	123	25556	40.31782N	104.54853W			234	335	345	101	365	270	240	146		1.432	0.293	0.740	0.608	0.491
2008	123	25557	40.46803N	104.53481W			229	1910	351	73	314	190	239	17		8.341	0.208	0.605	0.071	0.111
2008	123	25581	40.32243N	104.53091W			33	140	363	795	365	296	243	236		4.242	2.190	0.811	0.971	0.858
2008	123	25582	40.49120N	104.81682W			216	1093	357	146	332	71	236	13		5.060	0.409	0.214	0.055	
2008	123	25583	40.49253N	104.81475W			224	1534	361	245	332	65	235	43		6.848	0.679	0.196	0.183	0.945
2008	123	25639	40.22469N	104.60712W			424	1953	670	1069	726	481	478	275		4.606	1.596	0.663	0.575	0.938
2008	123	25640	40.49406N	104.76669W			139	136	229	103	334	50	243	7		0.978	0.450	0.150	0.029	0.252
2008	123	25647	40.30848N	104.86227W			13	2160	358	187	332	347	241	0		166.154	0.522	1.045		0.207
2008	123	25648	40.30836N	104.85343W			3	0	341	936	332	231	242	0			2.745	0.696		
2008	123	25650	40.25819N	104.59756W			203	472	359	238	296	439	243	307		2.325	0.663	1.483	1.263	0.276
2008	123	25651	40.49237N	104.47677W			119	1390	361	1052	332	410	208	25		11.681	2.914	1.235	0.120	1.179
2008	123	25652	40.29413N	104.60696W			53	785	332	570	330	286	226	150		14.811	1.717	0.867	0.664	0.689
2008	123	25655	40.48465N	104.48716W			232	1991	246	118	334	0	169	0		8.582	0.480			1.363
2008	123	25669	40.45449N	104.81696W			67	1682	365	480	329	68	243	65		25.104	1.315	0.207	0.267	0.185
2008	123	25675	40.26522N	104.49919W			217	20	357	17	356	15	219	11		0.092	0.048	0.042	0.050	0.135
2008	123	25681	40.26843N	104.50409W			179	12	365	18	360	15	243	11		0.067	0.049	0.042	0.045	0.532
2008	123	25693	40.33771N	104.61499W			143	2401	336	743	333	208	243	139		16.790	2.211	0.625	0.572	0.12
2008	123	25702	40.29801N	104.49868W			210	149	149	91	362	204	243	128		0.710	0.611	0.564	0.527	1.161
2008	123	25714	40.37687N	104.57857W			225	0	365	374	365	264	243	198			1.025	0.723	0.815	
2008	123	25715	40.51583N	104.62512W			216	885	340	270	312	0	243	0		4.097	0.794			0.47
2008	123	25723	40.29412N	104.61569W			57	700	363	1045	333	319	240	183		12.281	2.879	0.958	0.763	2.336
2008	123	25724	40.47019N	104.41122W			207	66	365	154	365	33	243	10		0.319	0.422	0.090	0.041	
2008	123	25732	40.39932N	104.55016W			200	782	365	609	365	539	192	236		3.910	1.668	1.477	1.229	0.225
2008	123	25750	40.46272N	104.39225W			185	309	362	360	365	264	238	78		1.670	0.994	0.723	0.328	0.487
2008	123	25757	40.25950N	104.60993W			227	925	365	326	361	298	243	119		4.075	0.893	0.825	0.490	1.916
2008	123	25759	40.36984N	104.57434W			104	0	357	761	365	548	239	189			2.132	1.501	0.791	0.887
2008	123	25763	40.33602N	104.65134W			62	0	364	674	359	370	241	257			1.852	1.031	1.066	
2008	123	25764	40.43759N	104.36858W			165	256	363	126	362	143	237	50		1.552	0.347	0.395	0.211	0.39
2008	123	25767	40.44463N	104.36843W			51	112	303	87	311	105	82	55		2.196	0.287	0.338	0.671	0.955
2008	123	25770	40.50233N	104.46721W			117	735	348	394	322	46	218	40		6.282	1.132	0.143	0.183	
2008	123	25773	40.49572N	104.36785W			195	314	365	52	365	14	241	55		1.610	0.142	0.038	0.228	0.915
2008	123	25785	40.45242N	104.34955W			32	0	108	75	365	95	124	46			0.694	0.260	0.371	
2008	123	25786	40.30862N	104.76903W			191	474	364	191	310	163	234	38		2.482	0.525	0.526	0.162	1.032
2008	123	25800	40.25749N	104.60697W			192	438	363	396	365	400	243	174		2.281	1.091	1.096	0.716	
2008	123	25802	40.46619N	104.39729W			186	76	365	185	333	173	212	60		0.409	0.507	0.520	0.283	
2008	123	25807	40.38278N	104.92964W			18	136	364	257	331	38	243	35		7.556	0.706	0.115	0.144	1.102
2008	123	25809	40.47765N	104.41176W			178	190	365	242	365	184	212	48		1.067	0.663	0.504	0.226	0.506
2008	123	25811	40.53435N	104.83757W			143	579	350	216	330	44	240	74		4.049	0.617	0.133	0.308	
2008	123	25820	40.29855N	104.71093W			19	246	147	271	365	218	243	194		12.947	1.844	0.597	0.798	0.158
2008	123	25822	40.11151N	104.65712W			150	408	337	310	365	321	241	170		2.720	0.920	0.879	0.705	0.844
2008	123	25837	40.45185N	104.81551W			68	2282	365	543	329	106	243	68		33.559	1.488	0.322	0.280	
2008	123	25862	40.12583N	104.67135W			23	1670	359	808	297	150	243	92		72.609	2.251	0.505	0.379	1.346
2008	123	25875	40.42451N	104.60704W			110	101	362	387	357	253	213	121		0.918	1.069	0.709	0.568	0.577
2008	123	25880	40.44827N	104.41151W			174	610	365	530	365	508	212	153		3.506	1.452	1.392	0.722	0.016
2008	123	25883	40.44462N	104.39688W			163	234	360	351	363	300	212	14		1.436	0.975	0.826	0.066	0.442
2008	123	25884	40.43741N	104.39664W			191	331	89	194	361	197	243	10		1.733	2.180	0.546	0.041	
2008	123	25894	40.38027N	104.64873W			151	1035	341	244	334	159	243	66		6.854	0.716	0.476	0.272	1.161
2008	123	25904	40.19618N	104.65027W			294	995	295	1342	546	791	404	425		3.384	4.549	1.449	1.052	0.715
2008	123	25916	40.12977N	104.66632W			108	311	355	361	365	179	242	32		2.880	1.017	0.490	0.132	1.625
2008	123	25973	40.50075N	104.74757W			152	10	365	144	365	52	243	0		0.066	0.395	0.142		
2008	123	25975	40.26853N	104.55593W			145	250	364	390	364	194	241	102		1.724	1.071	0.533	0.423	0.507
2008	123	25976	40.01653N	105.00157W			215	204	243	219	714	768	398	246		0.949	0.901	1.076	0.618	0.455
2008	123	25977	40.49864N	104.80630W			269	663	360	257	334	90	241	47		2.465	0.714	0.269	0.195	0.951
2008	123	26047	40.51039N	104.42971W			11	0	233	243	365	56	238	164			1.043	0.153	0.689	1.041
2008	123	26060	40.54038N	104.82547W			271	329	351	143	328	124	143	71		1.214	0.407	0.378	0.497	2.039
2008	123	26061	40.52441N	104.82786W			227	1438	360	70	323	42	225	32		6.335	0.194	0.130	0.142	
2008	123	26062	40.53955N	104.81982W			168	441	364	173	334	138	235	65		2.625	0.475	0.413	0.277	0.555
2008	123	26065	40.40123N	104.38245W			165	278	360	412	303	427	239	203		1.685	1.144	1.409	0.849	3.414

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2008	123	26066	40.39020N	104.40142W			319	598	320	161	333	237	212	83		1.875	0.503	0.712	0.392	0.645
2008	123	26085	40.56553N	104.33376W			70	293	134	256	364	63	159	309		4.186	1.910	0.173	1.943	0.818
2008	123	26087	40.59623N	104.54240W			33	0	297	336	293	245	189	2			1.131	0.836	0.011	3.747
2008	123	26101	40.43056N	104.38280W			329	171	365	63	365	61	241	25		0.520	0.173	0.167	0.104	1.242
2008	123	26129	40.34377N	104.75581W			270	55	347	16	355	0	238	75		0.204	0.046		0.315	
2008	123	26130	40.42315N	104.38241W			347	459	334	102	362	61	157	12		1.323	0.305	0.169	0.076	
2008	123	26157	40.52062N	104.53382W			119	0	365	8	360	138	239	75			0.022	0.383	0.314	0.467
2008	123	26176	40.39446N	104.42839W			366	552	365	340	361	237	209	9		1.508	0.932	0.657	0.043	1.975
2008	123	26228	40.50651N	104.46788W			196	246	340	197	320	55	239	427		1.255	0.579	0.172	1.787	1.615
2008	123	26235	40.48245N	104.84755W			302	316	354	116	334	0	242	0		1.046	0.328			
2008	123	26264	40.54809N	104.64215W			119	0	353	36	350	0	173	0			0.102			0.684
2008	123	26267	40.36090N	104.73581W			255	864	365	413	361	350	243	190		3.388	1.132	0.970	0.782	1.363
2008	123	26282	40.30857N	104.45726W			271	552	310	96	273	83	243	0		2.037	0.310	0.304		0.464
2008	123	26311	40.53568N	104.45838W			212	332	104	230	106	0	26	0		1.566	2.212			0.318
2008	123	26326	40.51740N	104.46790W			295	98	358	63	292	32	69	0		0.332	0.176	0.110		0.445
2008	123	26329	40.35124N	104.61640W			302	665	349	271	333	118	243	81		2.202	0.777	0.354	0.333	0.358
2008	123	26332	40.55794N	104.83428W			194	690	121	190	126	0	171	0		3.557	1.570			1.233
2008	123	26333	40.55762N	104.83946W			54	965	178	75	147	0	226	0		17.870	0.421			0.572
2008	123	26334	40.48522N	104.84915W			308	390	350	128	334	0	204	0		1.266	0.366			0.461
2008	123	26337	40.27845N	105.03366W			31	0	272	21	365	0	217	289			0.077		1.332	
2008	123	26342	40.59671N	104.54710W			106	60	311	0	139	0	199	0		0.566				0.399
2008	123	26348	40.36690N	104.78034W			60	120	360	274	354	195	243	114		2.000	0.761	0.551	0.469	0.069
2008	123	26361	40.51205N	104.64411W			312	538	360	190	331	11	243	0		1.724	0.528	0.033		0.086
2008	123	26371	40.53923N	104.84336W			263	368	365	115	330	0	235	36		1.399	0.315		0.153	
2008	123	26379	40.53176N	104.56646W			173	2087	357	134	331	92	240	34		12.064	0.375	0.278	0.142	
2008	123	26380	40.53534N	104.56789W			142	167	315	115	324	69	60	18		1.176	0.365	0.213	0.300	1.514
2008	123	26386	40.45955N	104.51490W			61	0	364	8	352	11	172	2			0.022	0.031	0.012	0.577
2008	123	26394	40.52581N	104.60607W			280	645	343	141	331	118	243	133		2.304	0.411	0.356	0.547	0.605
2008	123	26395	40.52817N	104.60432W			279	632	309	100	327	92	243	175		2.265	0.324	0.281	0.720	0.549
2008	123	26417	40.54986N	104.58959W			250	0	248	0	130	105	1	26				0.808	26.000	0.645
2008	123	26420	40.46081N	104.80436W			152	0	365	107	318	42	243	62			0.293	0.132	0.255	1.032
2008	123	26428	40.43325N	104.63750W			306	32	360	12	365	13	243	57		0.105	0.033	0.036	0.235	
2008	123	26429	40.43331N	104.63750W			306	32	358	12	365	13	243	57		0.105	0.034	0.036	0.235	0.454
2008	123	26431	40.25373N	104.96794W			20	501	357	575	334	150	243	60		25.050	1.611	0.449	0.247	
2008	123	26432	40.47010N	104.47738W			348	1887	361	34	365	237	243	101		5.422	0.094	0.649	0.416	1.992
2008	123	26433	40.47011N	104.47257W			349	2075	362	34	365	237	243	101		5.946	0.094	0.649	0.416	
2008	123	26436	40.46104N	104.50304W			294	261	88	27	361	89	243	27		0.888	0.307	0.247	0.111	
2008	123	26437	40.44405N	104.65163W			326	0	365	73	365	26	243	0			0.200	0.071		0.212
2008	123	26439	40.55282N	104.52448W			290	0	344	0	21	0	27	0						0.243
2008	123	26442	40.35642N	104.73980W			301	1208	329	672	304	311	243	270		4.013	2.043	1.023	1.111	0.248
2008	123	26444	40.32234N	105.02017W			49	20	0	0	293	1144	207	94		0.408		3.904	0.454	1.062
2008	123	26448	40.42668N	104.42118W			332	3282	90	140	364	67	243	0		9.886	1.556	0.184		0.989
2008	123	26465	40.45385N	104.49351W			289	21	361	210	364	271	241	288		0.073	0.582	0.745	1.195	0.507
2008	123	26468	40.51723N	104.49588W			102	37	73	0	365	86	243	42		0.363		0.236	0.173	1.629
2008	123	26478	40.43953N	104.50299W			307	144	365	140	363	60	239	65		0.469	0.384	0.165	0.272	0.652
2008	123	26480	40.18195N	104.64071W			232	1162	365	294	361	185	243	41		5.009	0.805	0.512	0.169	0.468
2008	123	26481	40.17818N	104.64053W			229	914	361	228	365	131	241	43		3.991	0.632	0.359	0.178	0.733
2008	123	26482	40.35628N	104.73979W			302	1473	360	893	362	414	243	283		4.877	2.481	1.144	1.165	
2008	123	26498	40.48492N	104.51048W			22	2483	339	562	331	218	189	127		112.864	1.658	0.659	0.672	
2008	123	26499	40.48036N	104.51038W			245	894	298	276	328	215	189	88		3.649	0.926	0.655	0.466	
2008	123	26502	40.40495N	104.42494W			240	481	335	293	362	190	155	32		2.004	0.875	0.525	0.206	1.636
2008	123	26503	40.42292N	104.85315W			241	10	365	40	365	111	243	47		0.041	0.110	0.304	0.193	0.556
2008	123	26505	40.42734N	104.85698W			241	10	365	40	343	99	241	48		0.041	0.110	0.289	0.199	0.975
2008	123	26512	40.48808N	104.51007W			192	2009	357	647	330	131	231	0		10.464	1.812	0.397		
2008	123	26524	40.39387N	104.42024W			195	607	365	395	357	205	208	31		3.113	1.082	0.574	0.149	
2008	123	26525	40.33240N	104.84143W			62	35	362	329	330	450	243	296		0.565	0.909	1.364	1.218	0.09
2008	123	26529	40.43202N	104.51331W			331	132	353	258	365	239	235	72		0.399	0.731	0.655	0.306	0.098
2008	123	26531	40.51339N	104.56212W			85	0	334	0	361	92	238	55				0.255	0.231	0.767
2008	123	26532	40.53080N	104.59465W			315	206	137	356	354	53	137	18		0.654	2.599	0.150	0.131	0.067
2008	123	26534	40.39729N	104.42929W			30	50	306	314	360	199	174	19		1.667	1.026	0.553	0.109	0.879
2008	123	26537	40.37413N	104.80790W			139	187	359	275	360	152	240	92		1.345	0.766	0.422	0.383	0.436
2008	123	26545	40.18232N	104.65428W			319	830	361	256	365	150	243	178		2.602	0.709	0.411	0.733	0.435
2008	123	26551	40.39372N	104.42484W			281	231	365	340	365	237	169	9		0.822	0.932	0.649	0.053	0.857
2008	123	26553	40.35634N	104.73981W			296	1202	329	672	365	353	243	270		4.061	2.043	0.967	1.111	0.464
2008	123	26557	40.35168N	104.66359W			320	170	362	470	335	565	243	232		0.531	1.298	1.687	0.955	
2008	123	26560	40.39783N	104.42509W			31	53	306	314	358	198	156	19		1.710	1.026	0.553	0.122	0.854
2008	123	26569	40.27105N	105.04784W			52	17	297	36	365	59	165	33		0.327	0.121	0.162	0.200	0.119
2008	123	26572	40.44861N	104.53893W			294	0	365	391	365	105	243	120			1.071	0.288	0.494	0.387
2008	123	26586	40.46104N	104.50295W			298	261	89	27	365	67	243	27		0.876	0.303	0.184	0.111	0.67
2008	123	26591	40.54581N	104.60375W			287	146	181	16	149	0	242	11		0.509	0.088		0.045	0.738
2008	123	26592	40.53851N	104.60381W			284	71	356	32	362	0	243	0		0.250	0.090			1.023
2008	123	26602	40.41186N	104.62290W			306	73	359	384	360	184	243	114		0.239	1.070	0.511	0.469	
2008	123	26619	40.43078N	104.83905W			239	10	149	0	365	58	243	52		0.042		0.159	0.214	0.226
2008	123	26621	40.36597N	104.61589W			115	154	299	296	365	252	243	150		1.339	0.990	0.690	0.617	
2008	123	26636	40.35987N	104.51208W			311	98	365	247	365	442	243	325		0.315	0.677	1.211	1.337	0.268
2008	123	26637	40.34311N	104.76750W			157	69	348	15	338	118	205	90		0.439	0.043	0.349	0.439	
2008	123	26642	40.48780N	104.59038W			112	0	353	0	353	37	174	28				0.105	0.161	
2008	123	26645	40.48124N	104.49658W			301	0	365	0	364	134	226	88				0.368	0.389	
2008	123	26652	40.19783N	104.70814W			234	1353	151	68	273	121	208	80		5.782	0.450	0.443	0.385	
2008	123	26654	40.28370N	104.56061W			322	1316	363	400	361	265	217	88		4.087	1.102	0.734	0.406	0.619
2008	123	26656	40.36985N	104.61121W			275	363	360	630	363	336	243	202		1.320	1.750	0.926	0.831	0.815
2008	123	26657	40.41024N	104.52232W			320	197	355	128	360	258	216	157		0.616	0.361	0.717	0.727	0.734
2008	123	26660	40.31677N	104.61616W			231	3733	341	729	334	333	243	156		16.160	2.138	0.997	0.642	0.202
2008	123	26662	40.48964N	104.49315W			289	1095	345	174	332	103	241	51		3.789	0.504	0.310	0.212	
2008	123	26663	40.19454N	104.65227W			244	1170	356	254	350	186	243	114		4.795	0.713	0.531	0.469	1.044
2008	123	26664	40.19251N	104.65484W			261	1149	360	321	365	224	243	116		4.402	0.892	0.614	0.477	0.914
2008	123	26666	40.19482N	104.65645W			246	1178	355	254	363	185	243	115		4.789	0.715	0.510	0.473	0.727
2008	123	26669	40.52168N	104.78147W			240	974	365	197	333	141	236	53		4.058	0.540	0.423	0.225	0.704
2008	123	26672	40.36092N	104.73571W			257	576	365	451	358	357	240	192		2.241	1.236	0.997	0.800	0.728
2008	123	26674	40.28694N	104.57021W			261	1610	355	0	334	37	243	0		6.169		0.111		0.893
2008	123	26675	40.45326N	104.81396W			182	827	365	307	328	82	243	68		4.544	0.841	0.250	0.280	0.33
2008	123	26678	40.32294N	104.65317W			280	1119	363	416	333	249	237	140		3.996	1.146	0.748	0.591	2.01
2008	123	26705	40.46725N	104.32964W			159	80	365	228	365	186	243	71		0.503	0.625	0.510	0.292	0.958
2008	123	26758	40.41603N	104.40671W			128	256	87	0	365	184	242	91		2.000		0.504	0.376	0.616
2008	123	26770	40.42289N	104.37834W			156	160	334	149	365	159	241	66		1.026	0.446	0.436	0.274	0.183
2008	123	26773	40.43358N	104.39185W			168	166	334	162	365	76	238	25		0.988	0.485	0.208	0.105	0.623
2008	123	26775	40.22175N	104.66814W			137	315	365	504	363	140	238	174		2.299	1.381	0.386	0.731	
2008	123	26782	40.23217N	104.66829W			22	145	365	641	365	270	243	531		6.591	1.756	0.740	2.185	0.576
2008	123	26787	40.42454N	104.61652W			91	0	325	202	349	365	203	118			0.622	1.046	0.581	0.432
2008	123	26791	40.33055N	104.58848W			143	209	365	668	360	260	206	31		1.462	1.830	0.722	0.150	0.399
2008	123	26804	40.46666N	104.44904W			111	305	365	83	365	206	243	146		2.748	0.227	0.564	0.601	0.757
2008	123	26809	40.47019N	104.43488W			131	1349	292	146	365	216	243	141		10.298	0.500	0.592	0.580	0.471
2008	123	26811	40.47010N	104.43988W			105	455	319	146	365	216	243	141		4.333	0.458	0.592	0.580	0.418
2008	123	26813	40.47389N	104.44907W			117	428	365	64	365	94	243	62		3.658	0.175	0.258	0.255	0.033
2008	123	26814	40.47723N	104.44880W			115	345	365	43	365	102	243	32		3.000	0.118	0.279	0.132	0.775
2008	123	26815	40.47746N	104.43474W			61	413	306	56	365	259	243	140		6.770	0.183	0.710	0.576	0.365
2008	123	26816	40.47363N	104.43513W			105	166	361	23	365	60	243	61		1.581	0.064	0.164	0.251	
2008	123	26818	40.47767N	104.43962W			136	491	357	56	365	259	243	140		3.610	0.157	0.710	0.576	0.846
2008	123	26825	40.19638N	104.65448W			153	700	344	799	361	352	243	144		4.575	2.323	0.975	0.593	0.577
2008	123	26845	40.30242N	104.94581W			94	150	357	137	328	196	243	130		1.596	0.384	0.598	0.535	0.76
2008	123	26846	40.49048N	104.76648W			96	885	364	329	334	94	243	30		9.219	0.904	0.281	0.123	0.851
2008	123	26847	40.49235N	104.76784W			114	889	364	346	334	109	243	19		7.798	0.951	0.326	0.078	0.604
2008	123	26867	40.30437N	104.94344W			132	2104	347	610	296	223	243	109		15.939	1.758	0.753	0.449	0.457
2008	123	26868	40.50240N	104.46242W			93	606	350	399	318	38	242	36		6.516	1.140	0.119	0.149	0.4
2008	123	26872	40.11311N	104.65881W			114	438	359	941	365	1087	243	756		3.842	2.621	2.978	3.111	0.7
2008	123	26874	40.37178N	104.59047W			18	88	284	227	358	125	235	88		4.889	0.799	0.349	0.374	0.284
2008	123	26877	40.29755N	104.55060W			132	937	365	240	365	214	240	85		7.098	0.658	0.586	0.354	1.411
2008	123	26892	40.45558N	104.35337W			31	0	151	93	365	95	150	0			0.616	0.260		1.488
2008	123	26896	40.11710N	104.64997W			94	115	359	275	365	249	243	151		1.223	0.766	0.682	0.621	
2008	123	26930	40.13803N	104.76800W			109	0	360	189	359	202	174	58			0.525	0.563	0.333	1.156

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k	Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2008	123	26932	40.23967N	104.58900W			94	264	359	522	365	421	216	137		2.809	1.454	1.153	0.634	1.359	2009	123	29060	40.48829N	104.37795W					187	67	365	42	223	66			0.358	0.115	0.296	0.94
2008	123	26935	40.51929N	104.82773W			76	1235	301	40	305	30	243	32		16.250	0.133	0.098	0.132	0.051	2009	123	29063	40.47368N	104.36336W					161	365	334	245	243	81			2.267	0.734	0.333	0.982
2008	123	26966	40.48811N	104.38660W			113	287	159	33	0	0	0	0		2.540	0.208			0.854	2009	123	29070	40.46706N	104.36309W					172	598	304	902	243	311			3.477	2.967	1.280	0.453
2008	123	26967	40.49220N	104.39194W			113	287	360	33	365	26	231	105		2.540	0.092	0.071	0.455	0.911	2009	123	29082	40.23638N	104.53736W					258	711	726	3214	486	1172			2.756	4.427	2.412	0.342
2008	123	26974	40.51779N	104.82922W			77	732	359	340	279	0	210	7		9.506	0.947		0.033	0.861	2009	123	29087	40.52085N	104.49590W					257	19	365	269	241	126			0.074	0.737	0.523	0.761
2008	123	26983	40.49090N	104.47465W			73	1745	353	38	331	44	197	30		23.904	0.108	0.133	0.152	0.215	2009	123	29088	40.50995N	104.50541W					283	76	286	210	108	139			0.269	0.734	1.287	0.89
2008	123	26988	40.47519N	104.83769W			15	1613	363	379	333	93	230	0		107.533	1.044	0.279		0.227	2009	123	29089	40.50969N	104.49592W					270	43	359	30	242	134			0.159	0.084	0.554	1.161
2008	123	27003	40.48843N	104.41585W			72	83	350	224	365	234	209	17		1.153	0.640	0.641	0.081	0.47	2009	123	29091	40.51348N	104.49119W					67	18	365	489	243	118			0.269	1.340	0.486	1.275
2008	123	27004	40.50674N	104.41092W			33	0	332	64	365	27	241	199			0.193	0.074	0.826	1.475	2009	123	29092	40.52100N	104.50544W					266	742	365	159	243	42			2.789	0.436	0.173	0.555
2008	123	27008	40.50320N	104.40166W			70	0	365	0	365	66	229	108				0.181	0.472	0.661	2009	123	29100	40.13087N	104.64547W					53	80	353	950	227	75			1.509	2.691	0.330	
2008	123	27009	40.14004N	104.89303W			31	0	362	397	365	156	243	123			1.097	0.427	0.506		2009	123	29106	40.44244N	104.49848W					265	5486	321	3391	220	4259			20.702	10.564	19.359	
2008	123	27021	40.22187N	104.69760W			200	442	730	1688	726	1590	484	1068		2.210	2.312	2.190	2.207	0.606	2009	123	29120	40.24744N	104.54145W					166	612	362	253	236	133			3.687	0.699	0.564	0.974
2008	123	27024	40.23651N	104.55557W			76	115	365	163	321	7	243	9		1.513	0.447	0.022	0.037		2009	123	29127	40.17706N	104.68046W					321	496	365	204	243	66			1.545	0.559	0.272	
2008	123	27025	40.11720N	104.65852W			97	70	365	135	365	134	243	60		0.722	0.370	0.367	0.247	0.657	2009	123	29138	40.37547N	104.80047W					49	441	364	921	243	350			9.000	2.530	1.440	0.866
2008	123	27031	40.12580N	104.64762W			6	38	486	134	718	379	466	451		6.333	0.276	0.528	0.968	2.504	2009	123	29146	40.25813N	104.52705W					119	1839	364	384	237	145			15.454	1.055	0.612	
2008	123	27103	40.25787N	104.55693W			36	0	358	577	345	364	243	187			1.612	1.055	0.770	0.541	2009	123	29150	40.29785N	104.55570W					179	166	360	40	242	16			0.927	0.111	0.066	
2008	123	27117	40.24669N	104.56609W			64	91	361	437	354	196	226	85		1.422	1.211	0.554	0.376		2009	123	29151	40.29430N	104.55550W					358	65	365	92	225	31			0.182	0.252	0.138	0.74
2008	123	27144	40.35405N	104.78269W			80	0	357	1048	365	653	243	257			2.936	1.789	1.058	0.005	2009	123	29200	40.36977N	104.57098W					298	620	365	336	243	190			2.081	0.921	0.782	0.55
2008	123	27151	40.49200N	104.35395W			31	0	365	33	303	33	195	16			0.090	0.109	0.082	1.854	2009	123	29204	40.29253N	104.56731W					231	150	358	234	243	170			0.649	0.654	0.700	
2008	123	27154	40.31635N	104.60708W			51	139	355	529	365	395	239	228		2.725	1.490	1.082	0.954	1.496	2009	123	29225	40.30549N	104.50326W					312	800	365	188	243	105			2.564	0.515	0.432	
2008	123	27159	40.33350N	104.58865W			92	150	365	815	365	454	211	139		1.630	2.233	1.244	0.659	2.977	2009	123	29226	40.30543N	104.49442W					316	869	362	396	235	195			2.750	1.094	0.830	0.697
2008	123	27164	40.52107N	104.38198W			45	21	332	230	365	89	209	38		0.467	0.693	0.244	0.182		2009	123	29233	40.49945N	104.73024W					251	417	365	42	242	0			1.661	0.115		0.598
2008	123	27165	40.29739N	104.61683W			92	533	363	749	361	519	236	259		5.793	2.063	1.438	1.097		2009	123	29234	40.50101N	104.73258W					92	0	365	11	227	0				0.030		
2008	123	27168	40.29619N	104.61799W			91	1622	349	699	361	392	236	200		17.824	2.003	1.086	0.847		2009	123	29239	40.49215N	104.38273W					189	17	365	43	223	104			0.090	0.118	0.466	
2008	123	27169	40.42401N	104.61030W			72	0	365	273	352	463	202	184			0.748	1.315	0.911	0.34	2009	123	29240	40.49204N	104.38761W					175	31	365	32	243	14			0.177	0.088	0.058	0.427
2008	123	27178	40.45936N	104.41603W			1	0	312	371	365	190	243	50			1.189	0.521	0.206	3.33	2009	123	29243	40.22189N	104.55643W					320	2878	702	2837	478	820			8.994	4.041	1.715	0.101
2008	123	27183	40.31552N	104.56989W			45	305	357	440	329	72	241	123		6.778	1.232	0.219	0.510	0.384	2009	123	29246	40.49216N	104.42551W					143	677	365	482	243	32			4.734	1.321	0.132	0.716
2008	123	27189	40.33770N	104.61208W			70	3020	336	75	333	94	243	297		43.143	0.223	0.282	1.222	1.297	2009	123	29252	40.35513N	104.82401W					40	0	365	380	243	280				1.041	1.152	0.816
2008	123	27194	40.51397N	104.39215W			33	0	327	139	365	0	97	33			0.425		0.340	0.795	2009	123	29260	40.48320N	104.43770W					96	0	365	228	243	128				0.625	0.527	1.272
2008	123	27195	40.52103N	104.39193W			66	0	317	312	365	83	182	49			0.984	0.227	0.269		2009	123	29261	40.49046N	104.44598W					284	18	365	248	9	18			0.063	0.679	2.000	0.892
2008	123	27197	40.51384N	104.38149W			21	0	292	84	345	3	143	5			0.288	0.009	0.035		2009	123	29263	40.48479N	104.43961W					85	0	365	169	243	120				0.463	0.494	0.877
2008	123	27199	40.51746N	104.37724W			42	19	348	235	365	89	204	38		0.452	0.675	0.244	0.186	0.387	2009	123	29271	40.48297N	104.44173W					298	47	365	88	243	87			0.158	0.241	0.358	0.656
2008	123	27304	40.42572N	104.79277W			152	0	365	97	364	112	226	57			0.266	0.308	0.252	0.674	2009	123	29273	40.48744N	104.44657W					310	44	365	114	5	0			0.142	0.312		0.77
2008	123	27305	40.42572N	104.79281W			152	0	365	97	364	112	231	59			0.266	0.308	0.255		2009	123	29278	40.32019N	104.51319W					280	1182	365	171	238	107			4.221	0.468	0.450	0.597
2008	123	27333	40.42376N	104.66299W			301	670	349	230	329	45	184	36		2.226	0.659	0.137	0.196	1.487	2009	123	29301	40.17787N	104.66851W					300	673	364	202	243	49			2.243	0.555	0.202	
2008	123	28001	40.33230N	104.59997W			56	299	365	482	365	284	243	176		5.339	1.321	0.778	0.724	0.371	2009	123	29302	40.48641N	104.43744W					25	0	365	114	224	47				0.312	0.210	0.252
2008	123	28007	40.23951N	104.59831W			53	385	363	543	365	621	216	121		7.264	1.496	1.701	0.560	0.006	2009	123	29303	40.22171N	104.53739W					121	1030	365	626	223	158			8.512	1.715	0.709	0.746
2008	123	28010	40.51765N	104.51893W			41	419	356	407	293	20	130	17		10.220	1.143	0.068	0.131	1.415	2009	123	29304	40.48158N	104.39186W					200	18	365	34	241	84			0.090	0.093	0.349	0.825
2008	123	28011	40.29814N	104.70639W			3	0	357	676	356	551	243	346			1.894	1.548	1.424	0.322	2009	123	29307	40.36162N	104.79587W					341	760	362	346	238	191			2.229	0.956	0.803	2.699
2008	123	28012	40.52127N	104.51893W			44	386	351	391	295	25	108	15		8.773	1.114	0.085	0.139	0.499	2009	123	29308	40.36164N	104.79595W					345	795	361	358	231	197			2.304	0.992	0.853	0.096
2008	123	28020	40.36396N	104.78023W			82	348	362	621	364	302	239	140		4.244	1.715	0.830	0.586	0.563	2009	123	29309	40.48475N	104.38759W					198	18	365	33	243	83			0.091	0.090	0.342	0.959
2008	123	28027	40.36380N	104.78366W			86	1022	365	779	364	460	238	130		11.884	2.134	1.264	0.546	0.873	2009	123	29316	40.27596N	104.51349W					550	2727	718	823	486	1108			4.958	1.146	2.280	0.5
2008	123	28035	40.57508N	104.51896W			20	1085	185	48	264	0	226	3		54.250	0.259		0.013		2009	123	29348	40.22520N	104.78219W					321	245	365	340	243	154			0.763	0.932	0.634	0.574
2008	123	28039	40.30139N	104.51287W			47	511	362	809	332	244	228	136		10.872	2.235	0.735	0.596	0.579	2009	123	29349	40.22828N	104.78230W					267	418	305	229	243	166			1.566	0.751	0.683	
2008	123	28040	40.12270N	104.64803W			59	281	226	118	359	253	243	231		4.763	0.522	0.705	0.951	0.916	2009	123	29391	40.28328N	104.53236W					287	449	357	617	243	226			1.564	1.728	0.930	0.067
2008	123	28084	40.40793N	104.44027W			25	0	81	41	313	310	219	143			0.506	0.990	0.653	0.49	2009	123	29405	40.51644N	104.57591W					280	0	339	116	236	59				0.342	0.250	
2008	123	28099	40.32652N	104.51767W			18	173	361	960	365	235	235	141		9.611	2.659	0.644	0.600	0.938	2009	123	29409	40.29324N	104.78240W					277	1044	358	802	243	297			3.769	2.240	1.222	
2008	123	28106	40.37419N	104.83733W			1	0	345	40	334	316	230	63			0.116	0.946	0.274	1.954	2009	123	29412	40.48482N	104.38262W					184	145	365	31	243	155			0.788	0.085	0.638	
2008	123	28107	40.50377N	104.50415W			33	225	351	320	317	0	243	98		6.818	0.912		0.403	1.769	2009	123	29415	40.46276N	104.37755W					220	799	365	256	173	32			3.632	0.701	0.185	
2008	123	28154	40.47580N	104.51644W			39	1001	359	39	284	130	230	358		25.667	0.109	0.458	1.557	1.003	2009	123	29417	40.45926N	104.39215W					130	196	365	303	238	89			1.508	0.830	0.374	1.391
2008	123	28168	40.27286N	104.64063W			44	142	363	826	301	398	176	164		3.227	2.275	1.322	0.932	0.726	2009	123	29418	40.45934N	104.38277W					47	43	306	164	232	70			0.915	0.536	0.302	
2008	123	28171	40.31628N	104.60286W			61	217	365	621	365	233	238	108		3.557	1.701	0.638	0.454	0.37	2009	123	29419	40.45568N	104.37794W					225	1294	365	336	236	101			5.751	0.921	0.428	0.76
2008	123	29010	40.52090N	104.41504W			29	0	329	134	365	36	243	30			0.407	0.099	0.123	0.477	2009	123	29421	40.45200N	104.38276W					223	1351	365	354	236	105			6.058	0.970	0.445	0.034
2008	123	29011	40.47812N	104.51269W			39	0	360	40	287	136	226	0			0.111	0.474			2009	123	29422	40.51642N	104.57167W					310	0	364	354	186	162				0.973	0.871	
2008	123	29054	40.49615N	104.83404W			16	1380	363	265	328	128	233	0		86.250	0.730	0.390			2009	123	29445	40.22539N	104.56081W					342	3051	702	1613	486	676			8.921	2.298	1.391	1.844
2008	123	29075	40.18370N	104.59616W			53	133	365	634	363	278	236	115		2.509	1.737	0.766	0.487	1.61	2009	123	29489	40.46683N	104.40143W					110	239	365	366	243	113			2.173	1.003	0.465	0.939
2008	123	29109	40.50039N	104.50386W			45	2773	358	259	246	179	243	32		61.622	0.723	0.728	0.132	0.51	2009	123	29490	40.46662N	104.41155W					126	982	365	746	243	240			7.794	2.044	0.988	0.869
2008	123	29134	40.38024N	104.93762W			25	0	356	9	331	18	243	84			0.025	0.054	0.346	0.049	2009	123	29499	40.45928N	104.41115W					216	1685	365	1931	243	3725			7.801	5.290	15.329	
2008	123	29404	40.52002N	104.58138W			12	0	338	0	348	110	233	55				0.316	0.236	0.347	2009	123	29547	40.25878N	104.77518W					548	570	724	1034	478	574			1.040	1.428	1.201	0.735
2008	123	29989	40.40924N	104.91355W			284	198	362	116	334	5	243	8		0.697	0.320	0.015	0.033	0.33	2009	123	29554	40.28695N	104.51870W					236	768	365	465	243	192			3.254	1.274	0.790	0.916
2009	123	24301	40.48519N	104.47331W					350	265	330	174	243	87			0.757	0.527	0.358		2009	123	29590	40.43713N	104.66160W					245	74	365	57	242	23			0.302	0.156	0.095	0.653
2009	123	24309	40.48058N	104.46863W					335	354	332	38	207	146			1.057	0.114	0.705	0.042	2009	123	29603	40.33110N	104.48369W					303	1453	365	620	243	346			4.795	1.699	1.424	
2009	123	24330	40.48423N	104.46267W					334	852	333	79	186	367			2.551	0.237	1.973	0.387	2009	123	29611	40.12978N	104.69573W					256	1011	365	220	243	112			3.949	0.603	0.461	1.615
2009	123	24459	40.48865N	104.45284W					307	531	299	246	243	27			1.730	0.823	0.111	0.535	2009	123	29612	40.12587N	104.68999W					221	424	333	67	242	45			1.919	0.201	0.186	1.32
2009	123	25276	40.02032N	105.01649W					148	724	359	744	241	403			4.892	2.072	1.672	0.975	2009	123	29622	40.26041N	104.76819W					518	692	726	1020	486	340			1.336	1.405	0.700	0.138
2009	123	25277	40.02436N	105.01644W					350	2536	716	485	484	0			7.246	0.677			2009	123	29627	40.31127N	104.78323W					248	1107	365	274	239	225			4.464	0.751	0.941	0.489
2009	123	25438	40.24758N	104.61626W					138	258	304	212	242	154			1.870	0.697	0.636	0.877	2009	123	29636	40.52011N	104.57138W					310	0	364	354	237	247				0.973	1.042	
2009	123	25462	40.33190N	104.75228W					260	1991	361	737	241	362			7.658	2.042	1.502	1.354	2009	123	29650	40.30784N	104.78201W					271	915	365	672	242	260			3.376	1.841	1.074	0.89
2009	123	25471	40.48792N	104.63777W					344	0	365	0	161	20					0.124	0.268	2009	123	29653	40.31473N	104.52888W					255	1052	304	550	243	157			4.125	1.809	0.646	0.599
2009	123	25490	40.34258N	104.74208W					278	18	356	58	236	54			0.065	0.163	0.229	0.949	2009	123	29669	40.39784N	104.85794W					244	310	363	357	243	158			1.270	0.983	0.650	0.944
2009	123	25587	40.26432N	105.00105W					28	353	11	0	199	8			12.607		0.040	0.697	2009	123	29671	40.38619N	104.40071W					259	115	364	511	243	210			0.444	1.404	0.864	2.67
2009	123	25734	40.53636N	104.81446W					31	0	317	239	236	167				0.754	0.708	0.535	2009	123	29672	40.38653N	104.39649W					238	17	365	201	232	81			0.071	0.551	0.349	
2009	123	26107	40.36096N	104.40618W					2	0	88	254	243	289				2.886	1.189	1.046	2009	123	29675	40.40489N	104.38251W					11	0	327	8532	239	11254				26.092	47.088	
2009	123	26155	40.59685N	104.50430W					16	0	211	252	231	0				1.194		0.111	2009	123	29676	40.40130N	104.37730W					92	0	362	268	239	38				0.740	0.159	0.562
2009	123	26612	40.33934N	104.83257W					330	286	365	182	243	134			0.867	0.499	0.551	0.648	2009	123	29681	40.33072N	104.53705W					290	98	358	473	243	149			0.338	1.321	0.613	0.828
2009	123	26651	40.03874N	104.67076W					622	1926	728	710	486	436			3.096	0.975	0.897	1.054	2009	123	29691	40.11486N	104.70871W					219	1430	350	339	243	186			6.530	0.969	0.765	1.791
2009	123	26708	40.30181N	104.57928W					338	1108	330	1176	243	229			3.278	3.564	0.942	0.368	2009	123	29695	40.10750N	104.71330W					265	745	358	315	130	63			2.811	0.880	0.485	
2009	123	26807	40.46652N	104.44427W					303	78	365	206	243	146			0.257	0.564	0.601	0.506	2009	123	29696	40.11118N	104.71352W					270	3420	358	1122	243	608			12.667	3.134	2.502	0.17
2009	123	26944	40.30079N	104.79260W					327	1461	365	693	242	288			4.468	1.899	1.190	0.605	2009	123	29698	40.52438N	104.44857W					196	980	354	135	238	29			5.000	0.381	0.122	
2009	123	26957	40.29335N	104.78678W					339	2065	365	712	238	390			6.091	1.951	1.639	0.979	2009	123	29715	40.24498N	104.84275W					138	624	365	1327	216	672			4.522	3.636	3.111	
2009	123	26992	40.43338N	104.64274W					305	255	268	511	243	103			0.836	1.907	0.424		2009	123	29720	40.19542N	104.79651W					38	0	362	592	243	563				1.635	2.317	
2009	123	26995	40.42374N	104.62651W					335	190	332	12	243	64			0.567	0.036	0.263	0.645	2009	123	29730	40.30928N	104.52239W					20	990	360	1369	243	312			49.500	3.803	1.284	
2009	123	27010	40.29544N	104.78948W					338	1216	365	481	241	225			3.598	1.318	0.934	0.026	2009	123	29735	40.28881N	105.00300W					8	197	262	465	238	0			24.625	1.775		
2009	123	27018	40.42381N	104.62651W					346	20	332	0	243	125			0.058		0.514	0.02	2009	123	29740	40.28298N	105.00039W					3	85	203	166	234	119			28.333	0.818	0.509	1.12
2009	123	27019	40.42394N	104.62651W					341	3520	332	444	237	125			10.323	1.337	0.527	0.125	2009	123	29782	40.24143N	104.83600W					140	78	365	642	243	211			0.557	1.759	0.868	
2009	123	27020	40.42387N	104.62652W					334	176	332	11	243	61			0.527	0.033	0.251	0.304	2009	123	29825	40.28348N	104.72943W					258	1063	362	1067	243	563			4.120	2.948	2.317	1.205
2009	123	27065	40.42395N	104.63661W					324	177	332	0	227	19			0.546		0.084		2009	123	29832	40.40086N	104.81981W					135	15	363	0	236	0			0.111			0.398
2009	123	27066	40.42408N	104.63661W					329	2279	332	191	223	31			6.927	0.575	0.139	0.128	2009	123	29833	40.40121N	104.82015W					137	147	365	0	240	0			1.073			1.243
2009	123	27067	40.42401N	104.63661W					339	1672	333	191	223	32			4.932	0.574	0.143	0.128	2009	123	29836	40.40116N	104.82009W					82	0	363	580	236	381				1.598	1.614	
2009	123	27068	40.42386N	104.63664W					324	191	332	0	227	18			0.590		0.079	0.887	2009	123	29839	40.40090N	104.81954W					76	0	338	527	243	300				1.559	1.235	0.511
2009	123	27069	40.42379N	104.63663W					319	114	331	0	227	19			0.357		0.084	0.315	2009	123	29840	40.40081N	104.81977W					136	424	365	1478	243	526			3.118	4.049	2.165	0.497
2009	123	27125	40.43139N	104.63416W					341	4075	365	0	243	116			11.950		0.477	0.718	2009	123	29854	40.30495N	104.79654W					245	783	365	415	243	223			3.196	1.137	0.918	
2009	123	27163	40.16277N	104.93026W					55	16	316	142	486	130			0.291	0.449	0.267		2009	123	29857	40.30500N	104.80075W					243	1084	365	523	243	212			4.461	1.433	0.872	0.388
2009	123	27181	40.27107N	104.51088W					66	609	354	256	234	144			9.227	0.723	0.615	0.264	2009	123	29859	40.28694N	104.72489W					267	350	365	698	243	422			1.311	1.912	1.737	
2009	123	27182	40.33791N	104.53186W					104	41	332	92	243	56			0.394	0.277	0.230	0.226	2009	123	29892	40.27951N	104.71489W					126	0	365	1307	243	534				3.581	2.198	0.093
2009	123	27184	40.34389N	104.78139W					259	80	362	23	209	16			0.309	0.064	0.077		2009	123	29938	40.22188N	104.52717W					168	1058	365	348	243	150			6.298	0.953	0.617	0.415
2009	123	27187	40.44868N	104.47305W					302	790	345	530	243	218			2.616	1.536	0.897	0.202	2009	123	30077	40.35394N	104.59987W					50	537	352	638	241	198			10.740	1.813	0.822	0.605
2009	123	28013	40.57686N	104.52134W					157	48	220	0	223	2			0.306		0.009		2009	123	30078	40.27968N	104.72547W					27	0	357	955	243	360				2.675	1.481	
2009	123	28016	40.10891N	104.70482W					306	333	365	258	242	132			1.088	0.707	0.545	0.344	2009	123	30106	40.55989N	104.59491W					14	0	349	141	52	411				0.404	7.904	0.26
2009	123	28023	40.23069N	104.69506W					544	872	717	326	478	130			1.603	0.455	0.272	0.214	2009	123	30113	40.40099N	104.81994W					87	0	345	437	243	230				1.267	0.947	
2009	123	28030	40.36664N	104.59260W					210	1003	365	341	235	187			4.776	0.934	0.796		2009	123	30128	40.41893N	104.37799W					159	37	364	414	240	100			0.233	1.137	0.417	
2009	123	28032	40.36997N	104.58796W					221	432	365	179	243	113			1.955	0.490	0.465	0.164	2009	123	30129	40.41603N	104.38221W					112	0	365	288	240	104				0.789	0.433	
2009	123	28034	40.57505N	104.52369W					243	64	273	0	240	2			0.263		0.008	0.162	2009	123	30149	40.41561N	104.38748W					124	0	365	237	239	56				0.649	0.234	0.292
2009	123	28036	40.29266N	105.02451W					1	0	123	31	106	80				0.252	0.755	0.652	2009	123	30153	40.41886N	104.39183W					153	4634	365	13826	232	65			30.288	37.879	0.280	0.314
2009	123	28037	40.29274N	105.01952W					1	0	123	35	182	145				0.285	0.797	0.756	2009	123	30158	40.41524N	104.39179W					149	0	364	277	239	65				0.761	0.272	0.563
2009	123	28038	40.21445N	104.51388W					163	1306	365	845	234	286			8.012	2.315	1.222	1.589	2009	123	30168	40.43063N	104.37386W					185	0	365	344	243	110				0.942	0.453	1.914
2009	123	28045	40.23541N	104.67655W					92	0	359	416	243	200				1.159	0.823	0.143	2009	123	30170	40.43076N	104.36412W					123	0	317	149	243	76				0.470	0.313	0.106
2009	123	28057	40.35170N	104.59276W					257	793	350	331	242	163			3.086	0.946	0.674	1.501	2009	123	30172	40.43021N	104.36855W					169	0	362	390	243	128				1.077	0.527	1.489
2009	123	28058	40.36352N	104.81736W					321	2382	364	597	243	304			7.421	1.640	1.251	1.764	2009	123	30173	40.43363N	104.36825W					171	0	364	438	243	114				1.203	0.469	0.697
2009	123	28065	40.10861N	104.80157W					322	1035	365	130	243	61			3.214	0.356	0.251		2009	123	30280	40.29018N	104.54576W					209	1066	363	294	239	110			5.100	0.810	0.460	0.555
2009	123	28122	40.30493N	104.78327W					230	1245	359	635	238	293			5.413	1.769	1.231	0.345	2009	123	30281	40.36256N	104.67068W					30	274	361	470	243	103			9.133	1.302	0.424	1.299
2009	123	28141	40.51073N	104.41563W					313	205	365	64	243	53			0.655	0.175	0.218	0.667	2009	123	30284	40.36121N	104.66616W					15	0	362	360	213	129				0.994	0.606	1.306
2009	123	28161	40.32652N	104.52261W					275	502	365	233	241	133			1.825	0.638	0.552	0.887	2009	123	30473	40.43384N	104.38776W					121	0	365	652	241	228				1.786	0.946	0.11
2009	123	28170	40.23858N	104.67018W					92	0	358	645	242	394				1.802	1.628	0.976	2009	123	30474	40.43377N	104.37819W					118	0	365	559	241	234				1.532	0.971	
2009	123	28197	40.25797N	104.53256W					176	943	353	119	233	98			5.358	0.337	0.421	0.896	2009	123	30476	40.41938N	104.39722W					92	0	364	487	241	151				1.338	0.627	0.929
2009	123	28198	40.25119N	104.54189W					194	1788	336	968	230	356			9.216	2.881	1.548	0.718	2009	123	30488	40.24373N	104.61200W					107	1356	317	744	237	981			12.673	2.347	4.139	
2009	123	29003	40.36093N	104.58084W					238	800	364	410	203	188			3.361	1.126	0.581	1.727	2009	123	30493	40.44646N	104.63560W					43	562	361	374	239	157			13.070	1.036	0.657	
2009	123	29004	40.23937N	104.59352W					252	779	363	608	215	179			3.091	1.675	0.833	2.588	2009	123	30520	40.23771N	104.78467W					75	846	355	788	237	399			11.280	2.220	1.684	0.738
2009	123	29007	40.28196N	104.52552W					310	1145	362	402	241	191			3.694	1.110	0.793		2009	123	30521	40.12830N	104.90895W					18	0	714	2740	486	1183				3.838	2.434	1.253
2009	123	29037	40.28298N	104.55102W					358	566	341	274	176	168			1.581	0.804	0.955		2009	123	30543	40.32916N	104.78791W					107	279	357	868	243	291			2.607	2.431	1.198	1.531

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2009	123	30544	40.32925N	104.78768W					56	1020	348	855	241	357			18.214	2.457	1.481	
2009	123	30545	40.32928N	104.78759W					113	385	357	1000	233	322			3.407	2.801	1.382	
2009	123	30546	40.32930N	104.78750W					57	747	354	765	241	323			13.105	2.161	1.340	
2009	123	30547	40.32922N	104.78775W					131	1172	335	984	235	382			8.947	2.937	1.626	
2010	123	24320	40.48318N	104.45632W							8	421	243	218				52.625	0.897	
2010	123	24322	40.48123N	104.45389W							12	599	239	419				49.917	1.753	0.771
2010	123	24323	40.48091N	104.45849W							12	645	241	609				53.750	2.527	1.033
2010	123	24445	40.46658N	104.48608W							365	186	243	71				0.510	0.292	
2010	123	25474	40.54751N	104.59699W							157	30	1	35				0.191	35.000	
2010	123	25729	40.39925N	104.55979W							365	0	225	0						
2010	123	25730	40.39544N	104.55520W							365	1025	225	668				2.808	2.969	
2010	123	25736	40.46483N	104.78037W							323	837	238	154				2.591	0.647	
2010	123	25739	40.46670N	104.36808W							365	258	132	187				0.707	1.417	
2010	123	25749	40.49947N	104.37296W							365	14	237	55				0.038	0.232	0.708
2010	123	25765	40.44098N	104.37371W							362	143	237	50				0.395	0.211	
2010	123	25863	40.12954N	104.67617W							730	245	486	448				0.336	0.922	
2010	123	25864	40.48274N	104.64454W							275	890	183	0				3.236		0.578
2010	123	25876	40.38873N	104.85660W							25	0	210	716					3.410	0.607
2010	123	25877	40.38247N	104.84488W							12	0	159	592					3.723	
2010	123	25878	40.38952N	104.84699W							31	0	151	357					2.364	1.074
2010	123	26106	40.55022N	104.85307W							213	521	100	36				2.446	0.360	1.167
2010	123	26328	40.52731N	104.60937W							8	202	207	172				25.250	0.831	0.626
2010	123	26460	40.34628N	104.76642W							120	0	212	51					0.241	0.323
2010	123	26516	40.46910N	104.48511W							365	186	243	71				0.510	0.292	0.778
2010	123	26766	40.46300N	104.77868W							313	415	230	198				1.326	0.861	
2010	123	26947	40.59314N	104.51867W							365	60195	238	21413				164.918	89.971	
2010	123	26968	40.59670N	104.52811W							365	21188	198	27626				58.049	139.525	0.573
2010	123	26969	40.60026N	104.52838W							34	9335	211	57668				274.559	273.308	0.927
2010	123	26989	40.43181N	104.64449W							254	14	243	54				0.055	0.222	
2010	123	26990	40.43183N	104.64455W							260	26	243	51				0.100	0.210	0.437
2010	123	26991	40.43179N	104.64438W							266	19	243	51				0.071	0.210	0.335
2010	123	26993	40.43298N	104.64691W							313	5000	243	139				15.974	0.572	
2010	123	26999	40.48261N	104.50307W							89	851	223	583				9.562	2.614	
2010	123	27046	40.44095N	104.36929W							122	234	237	259				1.918	1.093	
2010	123	27124	40.51930N	104.82792W							76	0	224	26					0.116	1.538
2010	123	27160	40.32643N	104.58040W							312	66	238	0				0.212		
2010	123	28014	40.57865N	104.52375W							52	0	190	0						1.072
2010	123	28060	40.11075N	104.80282W							490	708	486	220				1.445	0.453	0.879
2010	123	28076	40.41201N	104.43487W							360	1170	223	416				3.250	1.865	0.811
2010	123	28146	40.51754N	104.41550W							364	42	243	34				0.115	0.140	1.857
2010	123	28165	40.12041N	104.65891W							28	0	182	873					4.797	1.095
2010	123	28194	40.52072N	104.41957W							364	166	243	49				0.456	0.202	
2010	123	29039	40.35581N	104.58249W							365	585	242	184				1.603	0.760	0.187
2010	123	29040	40.51354N	104.42928W							363	167	243	49				0.460	0.202	
2010	123	29136	40.37546N	104.80065W							311	774	243	290				2.489	1.193	0.322
2010	123	29139	40.37546N	104.80073W							361	1019	243	357				2.823	1.469	1.117
2010	123	29143	40.21009N	104.61200W							334	132	234	100				0.395	0.427	1.826
2010	123	29230	40.51111N	104.54142W							275	831	222	261				3.022	1.176	2.63
2010	123	29277	40.51114N	104.54487W							306	756	216	0				2.471		2.01
2010	123	29364	40.36004N	104.78960W							122	241	243	262				1.975	1.078	1.186
2010	123	29400	40.53078N	104.59122W							238	53	93	34				0.223	0.366	0.903
2010	123	29401	40.53542N	104.58531W							300	37	191	141				0.123	0.738	
2010	123	29402	40.53531N	104.59115W							351	1764	190	2590				5.026	13.632	0.71
2010	123	29411	40.27563N	104.65830W							362	449	235	43				1.240	0.183	
2010	123	29469	40.36008N	104.78965W							117	512	241	504				4.376	2.091	0.539
2010	123	29474	40.37376N	104.77967W							363	731	240	138				2.014	0.575	2.001
2010	123	29477	40.36000N	104.78955W							122	782	243	337				6.410	1.387	1.174
2010	123	29560	40.33796N	104.66309W							307	166	236	403				0.541	1.708	0.288
2010	123	29615	40.39045N	104.78205W							212	470	243	288				2.217	1.185	
2010	123	29635	40.52449N	104.55699W							350	36	242	0				0.103		
2010	123	29660	40.23576N	104.78183W							644	1360	478	1017				2.112	2.128	
2010	123	29666	40.17505N	104.64932W							176	129	243	115				0.733	0.473	0.233
2010	123	29700	40.17628N	104.67554W							329	591	243	146				1.796	0.601	0.182
2010	123	29721	40.19202N	104.80058W							181	254	175	178				1.403	1.017	0.867
2010	123	29729	40.17641N	104.65664W							660	1909	486	460				2.892	0.947	
2010	123	29762	40.06785N	104.74228W							313	1050	243	249				3.355	1.025	0.624
2010	123	29781	40.19234N	104.85879W							335	656	242	192				1.958	0.793	0.816
2010	123	29783	40.20274N	104.85411W							333	354	243	127				1.063	0.523	0.141
2010	123	29807	40.23083N	104.78031W							683	953	486	1030				1.395	2.119	1.373
2010	123	29808	40.28648N	104.73430W							330	619	243	266				1.876	1.095	0.488
2010	123	29816	40.17636N	104.66628W							322	745	243	76				2.314	0.313	0.218
2010	123	29823	40.36694N	104.66330W							322	472	234	106				1.466	0.453	1.161
2010	123	29846	40.35554N	104.50273W							350	951	240	274				2.717	1.142	0.896
2010	123	29848	40.32223N	104.60735W							170	0	236	552				0.000	2.339	0.745
2010	123	29891	40.35183N	104.67331W							275	2462	243	551				8.953	2.267	0.815
2010	123	29907	40.33227N	104.52937W							275	259	243	184				0.942	0.757	
2010	123	30002	40.22196N	104.58374W							317	1206	184	179				3.804	0.973	0.206
2010	123	30015	40.28668N	104.72997W							344	2191	243	911				6.369	3.749	0.807
2010	123	30042	40.33526N	104.52620W							265	527	242	371				1.989	1.533	1.222
2010	123	30046	40.31337N	104.83705W							304	862	243	365				2.836	1.502	0.724
2010	123	30047	40.43870N	104.62005W							317	2031	233	358				6.407	1.536	0.802
2010	123	30083	40.12906N	104.91723W							728	1551	482	433				2.130	0.898	
2010	123	30087	40.32675N	104.52654W							275	263	241	170				0.956	0.705	0.655
2010	123	30110	40.56753N	104.58057W							67	53	156	354				0.791	2.269	1.364
2010	123	30111	40.57114N	104.57581W							327	233	28	31				0.713	1.107	
2010	123	30148	40.55312N	104.54753W							185	261	99	34				1.411	0.343	0.53
2010	123	30166	40.57121N	104.60833W							326	1102	231	4				3.380	0.017	0.26
2010	123	30176	40.56759N	104.60835W							259	938	243	31				3.622	0.128	0.635
2010	123	30228	40.17782N	104.81036W							724	933	462	663				1.289	1.435	1.428
2010	123	30265	40.56025N	104.58558W							358	242	25	19				0.676	0.760	1.285
2010	123	30267	40.59670N	104.52334W							184	21689	239	44441				117.875	185.946	0.591
2010	123	30269	40.32246N	104.60752W							362	2652	472	1634				7.326	3.462	0.864
2010	123	30273	40.30322N	104.64630W							250	503	222	443				2.012	1.995	0.304
2010	123	30293	40.59307N	104.52818W							118	12906	234	35798				109.373	152.983	
2010	123	30297	40.31792N	104.77557W							257	983	214	451				3.825	2.107	
2010	123	30333	40.42289N	104.37287W							197	363	243	219				1.843	0.901	
2010	123	30357	40.23770N	104.78476W							638	504	466	484				0.790	1.039	0.291
2010	123	30426	40.47214N	104.51671W							180	549	237	947				3.050	3.996	
2010	123	30480	40.44863N	104.35425W							169	513	243	264				3.036	1.086	0.599
2010	123	30482	40.44844N	104.36373W							135	377	243	206				2.793	0.848	1.415
2010	123	30485	40.47750N	104.36787W							153	681	243	156				4.451	0.642	1.019
2010	123	30489	40.44492N	104.35372W							176	1930	243	106				10.966	0.436	2.342
2010	123	30497	40.23232N	104.54194W							246	886	241	195				3.602	0.809	1.029
2010	123	30499	40.46955N	104.62790W							137	133	217	15				0.971	0.069	5.274
2010	123	30550	40.56020N	104.56186W							122	358	141	364				2.934	2.582	0.733
2010	123	30551	40.56043N	104.55688W							109	155	226	102				1.422	0.451	0.407
2010	123	30552	40.56046N	104.55215W							70	167	190	104				2.386	0.547	0.716
2010	123	30553	40.43110N	104.87463W							120	284	223	325				2.367	1.457	0.942
2010	123	30554	40.43122N	104.87455W							120	258	226	300				2.150	1.327	3.346
2010	123	30555	40.43116N	104.87459W							113	364	223	418				3.221	1.874	
2010	123	30595	40.23664N	104.83175W							692	2293	480	305				3.314	0.635	
2010	123	30614	40.32047N	104.54150W							309	847	240	395				2.741	1.646	
2010	123	30637	40.30759N	104.80625W							353	916	240	500				2.595	2.083	
2010	123	30665	40.31129N	104.77804W							275	1040	230	646				3.782	2.809	0.75
2010	123	30672	40.34726N	104.79509W							300	620	233	309				2.067	1.326	0.008
2010	123	30683	40.45979N	104.40163W							111	695	243	506				6.261	2.082	1.203
2010	123	30688	40.33737N	104.71630W							309	1875	243	544				6.068	2.239	1.535
2010	123	30690	40.22513N	104.54710W							147	317	219	272				2.156	1.242	0.496
2010	123	30704	40.23175N	104.54560W							117	331	241	322				2.829	1.336	
2010	123	30713	40.18991N	104.82230W							474	1368	486	592				2.886	1.218	0.596

Year	api_county	api_seq	lat	long	PD07	WP07	PD08	WP08	PD09	WP09	PD10	WP10	PD11	WP11	FR 07	FR 08	FR 09	FR 10	FR 11	k
2010	123	30732	40.22963N	104.53656W							112	253	243	204				2.259	0.840	0.715
2010	123	30735	40.22513N	104.53701W							214	1351	223	205				6.313	0.919	
2010	123	30747	40.19502N	104.81474W							306	298	474	704				0.974	1.485	
2010	123	30750	40.22170N	104.54708W							172	396	188	190				2.302	1.011	0.636
2010	123	30768	40.22974N	104.54739W							108	219	241	233				2.028	0.967	0.456
2010	123	30788	40.34638N	104.66106W							236	956	242	219				4.051	0.905	0.759
2010	123	30789	40.35626N	104.59242W							243	1298	241	516				5.342	2.141	1.027
2010	123	30792	40.35626N	104.59261W							260	647	242	350				2.488	1.446	1.192
2010	123	30793	40.35069N	104.67061W							245	705	243	405				2.878	1.667	1.936
2010	123	30796	40.24939N	104.73854W							244	690	486	991				2.828	2.039	0.559
2010	123	30810	40.22465N	104.78663W							275	1041	239	646				3.785	2.703	3.224
2010	123	30841	40.29965N	104.64228W							539	2342	450	1314				4.345	2.920	1.495
2010	123	30848	40.22527N	104.55602W							114	251	241	275				2.202	1.141	1.493
2010	123	30855	40.34692N	104.65671W							143	736	242	442				5.147	1.826	2.642
2010	123	30869	40.34685N	104.65671W							143	498	243	370				3.483	1.523	0.951
2010	123	30872	40.14426N	104.58191W							190	1328	178	580				6.989	3.258	0.455
2010	123	30882	40.14003N	104.57747W							198	1559	178	571				7.874	3.208	0.389
2010	123	30892	40.32065N	104.52809W							272	776	242	271				2.853	1.120	1.255
2010	123	30899	40.44500N	104.36361W							77	332	243	325				4.312	1.337	0.451
2010	123	30914	40.35784N	104.87884W							229	72	241	30				0.314	0.124	1.14
2010	123	30921	40.14419N	104.57753W							478	4083	484	1091				8.542	2.254	0.853
2010	123	30939	40.31584N	104.50892W							275	440	242	314				1.600	1.298	0.128
2010	123	30976	40.18588N	104.57942W							1	95	215	292				95.000	1.358	1.148
2010	123	30985	40.18666N	104.57691W							29	0	218	415					1.904	1.472
2010	123	31014	40.15806N	104.57347W							54	219	482	536				4.056	1.112	0.485
2010	123	31043	40.23209N	104.55156W							108	234	243	300				2.167	1.235	0.482
2010	123	31055	40.60398N	104.53274W							122	1927	242	1138				15.795	4.702	0.541
2010	123	31075	40.43802N	104.35901W							95	2272	243	370				23.916	1.523	1.652
2010	123	31157	40.27257N	104.53762W							17	0	236	867					3.674	0.51
2010	123	31158	40.27266N	104.54583W							22	0	227	851					3.749	0.22
2010	123	31161	40.57503N	104.60893W							7	0	129	214					1.659	0.297
2010	123	31168	40.26645N	104.54306W							31	0	237	632					2.667	0.444
2010	123	31170	40.26747N	104.53492W							23	0	229	849					3.707	
2010	123	31172	40.26364N	104.54429W							31	0	232	432					1.862	1.101
2010	123	31179	40.34064N	104.99210W							244	388	422	975				1.590	2.310	0.997
2010	123	31240	40.26704N	105.03902W							122	154	241	244				1.262	1.012	0.552
2010	123	31262	40.20578N	104.92183W							134	733	229	151				5.470	0.659	0.75
2010	123	31279	40.20584N	104.92183W							276	719	474	945				2.605	1.994	0.863
2010	123	31283	40.36102N	104.39628W							31	43	238	433				1.387	1.819	0.99
2010	123	31307	40.21875N	104.58347W							116	619	352	850				5.336	2.415	1.927
2010	123	31313	40.57144N	104.53317W							120	238	181	0				1.983		
2010	123	31317	40.58956N	104.50920W							9	164	209	0				18.222		
2010	123	31318	40.58589N	104.52362W							26	72	241	0				2.769		0.823
2010	123	31453	40.35774N	104.39639W							31	40	243	412				1.290	1.695	0.741
2010	123	31470	40.59657N	104.53286W							35	3750	203	5526				107.143	27.222	1.499
2010	123	31618	40.41903N	104.36340W							43	461	243	280				10.721	1.152	0.914
2010	123	31932	40.28279N	105.00040W							66	40	241	161				0.606	0.668	
2010	123	31955	40.28285N	105.00039W							47	47	206	335				1.000	1.626	0.543
2010	123	31972	40.55749N	104.50893W							18	0	137	0						0.546
2010	123	32110	40.59657N	104.58530W							15	0	242	604					2.496	0.327
2010	123	32115	40.57849N	104.59464W							3	0	241	523					2.170	0.337
2010	123	32149	40.26093N	104.59828W							21	0	225	406					1.804	0.397
2010	123	32161	40.26099N	104.59828W							21	20	229	411				0.952	1.795	0.657
2010	123	32256	40.48298N	104.46021W							12	0	210	914					4.352	1.036
2011	123	23815	40.48277N	104.80433W									141	164					1.163	0.827
2011	123	25138	40.51134N	104.48418W									200	151					0.755	
2011	123	25866	40.27145N	104.66352W									222	908					4.090	0.763
2011	123	26052	40.30356N	104.40234W									219	194					0.886	0.898
2011	123	26734	40.47714N	104.80645W									165	376					2.279	
2011	123	26849	40.53518N	104.74899W									237	32					0.135	
2011	123	26945	40.51823N	104.78596W									152	677					4.454	0.935
2011	123	26948	40.52202N	104.78698W									148	771					5.209	1.171
2011	123	27122	40.48275N	104.61674W									202	155					0.767	0.927
2011	123	28077	40.24655N	104.58941W									98	365					3.724	1.332
2011	123	28117	40.58066N	104.81954W									101	167					1.653	0.21
2011	123	28118	40.57592N	104.81955W									95	142					1.495	4.248
2011	123	28147	40.51970N	104.52187W									212	266					1.255	
2011	123	28166	40.34450N	104.61091W									202	1055					5.223	1.294
2011	123	29077	40.39085N	104.84852W									52	37					0.712	0.562
2011	123	29098	40.46712N	104.43033W									189	696					3.683	
2011	123	29107	40.24348N	104.58949W									87	328					3.770	1.212
2011	123	29299	40.48978N	104.57830W									161	530					3.292	2.754
2011	123	29345	40.39085N	104.84874W									52	251					4.827	
2011	123	29389	40.31120N	104.76840W									190	1181					6.216	
2011	123	29438	40.49073N	104.57073W									202	550					2.723	
2011	123	29446	40.38367N	104.84322W									24	50					2.083	
2011	123	29448	40.37918N	104.84318W									13	0					0.000	
2011	123	29481	40.51947N	104.44649W									149	0					0.000	
2011	123	29482	40.51761N	104.44884W									159	170					1.069	
2011	123	29483	40.51715N	104.44346W									158	0					0.000	
2011	123	29484	40.51398N	104.44884W									124	16					0.129	
2011	123	29485	40.51399N	104.44407W									130	14					0.108	
2011	123	29495	40.51039N	104.44080W									104	21					0.202	
2011	123	29496	40.51218N	104.44646W									162	67					0.414	
2011	123	29497	40.51035N	104.44884W									116	18					0.155	0.221
2011	123	29510	40.58225N	104.52849W									124	794					6.403	
2011	123	29579	40.58961N	104.50445W									126	666					5.286	2.116
2011	123	29604	40.20730N	104.68702W									108	591					5.472	0.267
2011	123	29702	40.39048N	104.85670W									44	40					0.909	
2011	123	30003	40.25099N	104.49461W									31	354					11.419	
2011	123	30260	40.39786N	104.53365W									92	95					1.033	
2011	123	30673	40.45206N	104.41128W									92	231					2.511	0.793
2011	123	30741	40.30342N	104.52503W									156	341					2.186	
2011	123	30791	40.30631N	104.79871W									148	1338					9.041	
2011	123	30870	40.35984N	104.55944W									174	434					2.494	
2011	123	30887	40.37385N	104.79025W									198	661					3.338	
2011	123	30889	40.37385N	104.79035W									201	1058					5.264	
2011	123	31054	40.22492N	104.57969W									32	139					4.344	1.37
2011	123	31147	40.30336N	104.46929W									17	260					15.294	
2011	123	31152	40.30329N	104.46929W									17	410					24.118	
2011	123	31173	40.29622N	104.46922W									15	2193					146.200	
2011	123	31178	40.29615N	104.46922W									15	1426					95.067	
2011	123	31224	40.34720N	104.50582W									42	0					0.000	
2011	123	31251	40.60461N	104.49878W									232	0					0.000	
2011	123	31303	40.59691N	104.49480W									230	0					0.000	
2011	123	31305	40.21870N	104.58340W									420	1908					4.543	2.23
2011	123	31411	40.20833N	104.71242W									212	3067					14.467	
2011	123	31473	40.59260N	104.53293W									77	4599					59.727	
2011	123	31474	40.56242N	104.60035W									209	5479					26.215	
2011	123	31485	40.58934N	104.52809W									175	92329					527.594	
2011	123	31488	40.58589N	104.53794W									243	966					3.975	
2011	123	31508	40.34698N	104.50090W									47	0					0.000	
2011	123	31511	40.37638N	104.84424W									163	334					2.049	
2011	123	31533	40.27566N	105.00169W									92	139					1.511	
2011	123	31645	40.36517N	104.84082W									8	0					0.000	
2011	123	31646	40.36518N	104.84054W									8	0					0.000	
2011	123	31647	40.36517N	104.84072W									6	0					0.000	
2011	123	31648	40.36518N	104.84063W									7	0					0.000	
2011	123	31660	40.36917N	104.85171W									141	909					6.447	
2011	123	31663	40.29678N	104.74510W									10	0					0.000	

Table A.1 (Cont.)

Year	api_county	api_seq	lat	long	PD11	WP11	FR 11	k	Year	api_county	api_seq	lat	long	PD11	WP11	FR 11	k	Year	api_county	api_seq	lat	long	PD11	WP11	FR 11	k
2011	123	31665	40.29664N	104.74494W	45	116	2.578		2011	123	32300	40.24839N	104.62272W	167	728	4.359		2011	123	32575	40.50457N	104.46553W	109	0	0.000	
2011	123	31667	40.29669N	104.74499W	31	43	1387		2011	123	32301	40.25397N	104.59404W	122	922	7.557		2011	123	32579	40.20668N	104.65065W	107	416	3.888	
2011	123	31671	40.29660N	104.74489W	45	71	1578		2011	123	32302	40.25397N	104.59395W	143	1658	11594		2011	123	32580	40.20664N	104.65048W	194	517	2.665	
2011	123	31697	40.23194N	104.94880W	31	60	1935		2011	123	32304	40.25397N	104.59422W	154	3757	24.396		2011	123	32584	40.20666N	104.65056W	210	630	3.000	
2011	123	31715	40.55252N	104.56235W	184	381	2.071		2011	123	32322	40.25397N	104.59413W	149	2127	14.275		2011	123	32630	40.42504N	104.53223W	100	524	5.240	
2011	123	31737	40.21151N	104.93104W	128	216	1688		2011	123	32357	40.49009N	104.45633W	212	127	0.599		2011	123	32642	40.50293N	104.43455W	161	1202	7.466	
2011	123	31778	40.21149N	104.93096W	100	81	0.810		2011	123	32358	40.49024N	104.46035W	154	205	1331		2011	123	32643	40.50099N	104.43722W	154	124	0.805	
2011	123	31843	40.52581N	104.82533W	184	586	3.185		2011	123	32359	40.49029N	104.46031W	168	894	5.321		2011	123	32644	40.49811N	104.43718W	161	60	0.373	
2011	123	31850	40.25426N	104.54188W	38	728	19.158		2011	123	32375	40.35212N	104.62674W	196	721	3.679		2011	123	32648	40.47515N	104.63728W	137	5930	43.285	
2011	123	31880	40.26155N	104.53657W	87	658	7.563		2011	123	32394	40.24117N	104.62864W	292	18	0.062		2011	123	32652	40.39297N	104.54831W	20	612	30.600	
2011	123	31894	40.47710N	104.42565W	55	29	0.527		2011	123	32410	40.24207N	104.63317W	67	0	0.000		2011	123	32655	40.48209N	104.59673W	66	419	6.348	
2011	123	31895	40.47710N	104.42565W	53	58	1094		2011	123	32412	40.24207N	104.63326W	65	300	4.615		2011	123	32656	40.54602N	104.54322W	24	468	19.500	
2011	123	31896	40.47385N	104.43008W	54	1270	23.519		2011	123	32418	40.24207N	104.63307W	2	0	0.000		2011	123	32666	40.48277N	104.58823W	138	644	4.667	
2011	123	31910	40.24923N	104.54906W	35	260	7.429		2011	123	32431	40.22101N	104.93427W	255	1121	4.396		2011	123	32700	40.33014N	104.67288W	177	1238	6.994	
2011	123	31914	40.17275N	104.61043W	411	1721	4.187		2011	123	32464	40.31834N	104.77414W	172	1507	8.762		2011	123	32701	40.33007N	104.67288W	176	1880	10.682	
2011	123	31918	40.51409N	104.45339W	89	0	0.000		2011	123	32466	40.31827N	104.77414W	146	1418	9.712		2011	123	32722	40.54114N	104.54148W	46	105	2.283	
2011	123	31920	40.16926N	104.60952W	3	1723	574.333		2011	123	32478	40.34102N	104.60678W	186	309	1661		2011	123	32724	40.53899N	104.54301W	54	52	0.963	
2011	123	31947	40.16868N	104.61393W	153	380	2.484		2011	123	32506	40.34597N	104.61363W	83	322	3.880		2011	123	32788	40.21842N	104.53261W	61	398	6.525	
2011	123	31950	40.47390N	104.42487W	55	1171	21.291		2011	123	32507	40.34597N	104.61381W	82	423	5.159		2011	123	32822	40.35972N	104.83548W	63	1578	25.048	
2011	123	31965	40.25477N	104.60696W	182	779	4.280		2011	123	32508	40.49576N	104.44431W	161	627	3.894		2011	123	32823	40.35965N	104.83547W	76	944	12.421	
2011	123	32011	40.26099N	104.58769W	32	436	13.625		2011	123	32509	40.49772N	104.44248W	154	129	0.838		2011	123	32827	40.33018N	104.61701W	63	260	4.127	
2011	123	32072	40.30468N	104.53196W	161	154	0.957		2011	123	32510	40.34597N	104.61336W	69	445	6.449		2011	123	32830	40.47760N	104.38767W	193	1141	5.912	
2011	123	32075	40.61128N	104.54220W	142	1401	9.866		2011	123	32512	40.34597N	104.61354W	85	405	4.765		2011	123	32865	40.52607N	104.55053W	2	0	0.000	
2011	123	32077	40.30341N	104.53462W	160	80	0.500		2011	123	32513	40.34597N	104.61371W	80	403	5.038		2011	123	32907	40.17691N	104.59179W	6	0	0.000	
2011	123	32108	40.48287N	104.46537W	175	608	3.474		2011	123	32516	40.34596N	104.61344W	81	295	3.642		2011	123	32964	40.41215N	104.53702W	79	508	6.430	
2011	123	32113	40.45627N	104.61995W	206	197	0.956		2011	123	32517	40.20732N	104.65870W	248	2409	9.714		2011	123	33116	40.26605N	104.50658W	77	1630	21.169	
2011	123	32134	40.29466N	104.53723W	135	209	1548		2011	123	32531	40.32098N	104.66115W	178	2030	11.404		2011	123	33117	40.26617N	104.50664W	76	1872	24.632	
2011	123	32140	40.29460N	104.53722W	143	187	1308		2011	123	32534	40.24488N	104.63350W	161	130	0.807		2011	123	33187	40.46683N	104.33895W	72	447	6.208	
2011	123	32152	40.36766N	104.47491W	84	431	5.131		2011	123	32535	40.24487N	104.63340W	158	0	0.000		2011	123	33206	40.49958N	104.37715W	52	139	2.673	
2011	123	32239	40.47398N	104.41548W	56	1237	22.089		2011	123	32536	40.24487N	104.63332W	156	0	0.000		2011	123	33224	40.49063N	104.36086W	94	162	1723	
2011	123	32250	40.47750N	104.42058W	54	25	0.463		2011	123	32538	40.34597N	104.61327W	85	540	6.353		2011	123	33242	40.19598N	104.58368W	37	241	6.514	
2011	123	32252	40.47413N	104.42111W	49	618	12.612		2011	123	32545	40.35413N	104.61787W	166	488	2.940		2011	123	33282	40.52416N	104.66534W	29	484	16.690	
2011	123	32253	40.47750N	104.41585W	55	18	0.327		2011	123	32546	40.50252N	104.46251W	106	0	0.000		2011	123	33283	40.52416N	104.66541W	27	248	9.185	
2011	123	32260	40.48645N	104.45643W	211	666	3.156		2011	123	32547	40.35756N	104.61852W	170	680	4.000		2011	123	33284	40.52416N	104.66520W	27	205	7.593	
2011	123	32263	40.51617N	104.44648W	168	258	1536		2011	123	32555	40.25425N	104.54196W	53	667	12.585		2011	123	33286	40.52416N	104.66549W	38	355	9.342	
2011	123	32266	40.48607N	104.46527W	177	450	2.542		2011	123	32563	40.32306N	104.66272W	177	1653	9.339		2011	123	33289	40.52416N	104.66527W	24	153	6.375	
2011	123	32269	40.32446N	104.77177W	135	630	4.667		2011	123	32568	40.50451N	104.46553W	51	9	0.176		2011	123	33327	40.24763N	104.51798W	20	142	7.100	
2011	123	32282	40.48621N	104.46070W	170	665	3.912		2011	123	32571	40.50464N	104.46553W	52	16	0.308		2011	123	33329	40.24763N	104.51806W	17	150	8.824	
2011	123	32299	40.32453N	104.77178W	129	457	3.543		2011	123	32573	40.50444N	104.46553W	113	22	0.195		2011	123	33351	40.55764N	104.45839W	54	0	0.000	

Table A.2: Results of produced water analysis of 1,677 vertical wells in Wattenberg field

Operating year	Number of wells	Total WP	WP/well	Production days	WP/well/day
		(bbl)	(bbl)		(bbl)
1	1,677	1,847,953	1,101.940	162	6.802
2	1,494	736,296	492.835	336	1.467
3	1,324	306,487	231.486	339	0.683
4	1,140	175,038	153.542	341	0.450
5	807	141,775	175.682	342	0.514
6	535	91,548	171.118	348	0.492
7	374	55,024	147.123	354	0.416
8	243	38,351	157.823	345	0.457
9	138	23,375	169.384	349	0.485
10	73	10,410	142.603	338	0.422
11	45	3,395	75.444	322	0.234
12	16	1,351	84.438	339	0.249
13	6	957	159.5	333	0.479

Table A.3. Results of frac flowback and produced water analysis for 32 horizontal wells in Wattenberg field

							Raw Data			Protocol Data		
API	Well Name	Well Number	Well Type	Total Water (gal)	Flowback Trend	Produced Water Trend	Flowback Days	Total Flowback (gal)	FB/Total Water	Flowback Days	Total Flowback (gal)	FB/Total Water
05-123-33576	70 RANCH BB	21-65HN	HORIZONTAL	3258822	$y = 165.57e^{-0.029x}$	y=72.05784/(1+0.013901x)	30	132477.1814	0.041	52	181734.80	0.056
05-123-33577	70 RANCH BB	21-63HN	HORIZONTAL	2666958	$y = 251.47e^{-0.056x}$	y=39.52193/(1+0.004337x)	25	151704	0.057	26	153363.00	0.058
05-123-33579	70 RANCH BB	21-67HN	HORIZONTAL	2581530	$y = 201.09e^{-0.053x}$	y=93.3955/(1+0.036711x)	20	96264	0.037	25	119679.00	0.046
05-123-33556	70 RANCH USX	BB09-63HN	HORIZONTAL	2741928	$y = 243.54e^{-0.034x}$	y=176.9398/(1+0.102339x)	39	236594.4738	0.086	43	246282.03	0.090
05-123-33546	Degenhart State	AE16-63HN	HORIZONTAL	2777418	$y = 227.18e^{-0.044x}$	y=56.20368/(1+0.015408x)	51	187383	0.067	38	165816.00	0.060
05-123-33545	Degenhart USX	AE17-63HN	HORIZONTAL	2826432	$y = 260.5e^{-0.052x}$	y=156.3435/(1+0.11475x)	51	193389	0.068	35	169176.00	0.060
05-123-32595	Feit	E23-97HZ	HORIZONTAL	2894136	$y = 244.16e^{-0.065x}$	y=8.53998/(1+0.006637x)	175	242526.1298	0.084	48	148998.93	0.051
05-123-32648	FEIT E	23-99HZ	HORIZONTAL	2968938	$y = 223.52e^{-0.072x}$	y=16.00014/(1+0.007997x)	168	275972.5047	0.093	32	110844.10	0.037
05-123-32649	FEIT E	23-98HZ	HORIZONTAL	3315984	$y = 364.7e^{-0.062x}$	y=17.19166/(1+0.009755x)	179	402624.0295	0.121	49	237325.13	0.072
05-123-33277	Guttersen	D29-65HN	HORIZONTAL	2987838	$y = 258.59e^{-0.018x}$	y=43.53527/(1+0.023925x)	69	423217.428	0.142	92	486373.06	0.163
05-123-33326	GUTTERSEN	D02-75HN	HORIZONTAL	2774436	$y = 313.58e^{-0.094x}$	y=68.45044/(1+0.015931x)	14	90220.73921	0.033	24	119758.81	0.043
05-123-32709	GUTTERSEN D	29-99HZ	HORIZONTAL	3207708	$y = 389.68e^{-0.055x}$	y=14.64023/(1+0.019218x)	147	400945.8772	0.125	49	279001.46	0.087
05-123-33223	Guttersen State	D28-79HN	HORIZONTAL	3096072	$y = 310.36e^{-0.026x}$	y=19.62883/(1+0.010333x)	91	441607.2448	0.143	114	462904.27	0.150
05-123-32650	KLEIN	B16-99HZ	HORIZONTAL	3924900	$y = 235.22e^{-0.011x}$	y=46.31031/(1+0.004432x)	110	625734.6464	0.159	144	697897.28	0.178
05-123-32651	KLEIN	B16-98HZ	HORIZONTAL	4593414	$y = 251.78e^{-0.011x}$	y=50.62407/(1+0.005129x)	131	728625.6548	0.159	178	806661.65	0.176
05-123-33320	SCHOLFIELD STATE A	36-69HN	HORIZONTAL	3238830	$y = 384.88e^{-0.04x}$	y=70.23207/(1+0.014761x)	54	342594	0.106	47	329175.00	0.102
05-123-33325	SCHOLFIELD STATE A	36-79HN	HORIZONTAL	3200022	$y = 389.29e^{-0.04x}$	y=67.42931/(1+0.010178x)	54	344799	0.108	39	308385.00	0.096
05-123-34231	SOONER STATE B	36-63HN	HORIZONTAL	2789934	$y = 194.58e^{-0.036x}$	y=22.12595/(1+002263x)	56	195195	0.070	54	193053.00	0.069
05-123-32821	SPIKE STATE D	16-99HZ	HORIZONTAL	3377556	$y = 583.52e^{-0.055x}$	y=9.206827/(1+0.004122x)	140	655660.1738	0.194	57	479955.59	0.142
05-123-33114	STATE C	36-99HZ	HORIZONTAL	3182676	$y = 221.52e^{-0.019x}$	y=43.56955/(1+0.015602x)	75	362313.5943	0.114	108	419439.05	0.132
05-123-33415	STOCKLEY	C22-79HN	HORIZONTAL	2391984	$y = 173.02e^{-0.072x}$	y=69.26069/(1+0.021961x)	21	72093	0.030	30	84084.00	0.035
05-123-33416	STOCKLEY	C15-79HN	HORIZONTAL	3460170	$y = 455.64e^{-0.073x}$	y=24.36715/(1+0.003722x)	27	211113	0.061	28	215964.00	0.062
05-123-33698	STREAR V	06-63HN	HORIZONTAL	2504292	$y = 69.649e^{-0.04x}$	y=28.62867/(1+0.031515x)	29	49527.7692	0.020	34	53572.88	0.021
05-123-33702	TANNER K	33-65HN	HORIZONTAL	3144960	$y = 286.78e^{-0.071x}$	y=1057.131/(1+0.676856x)	19	116088	0.037	25	133507.61	0.042
05-123-32747	UPRC	H17-99HZ	HORIZONTAL	3444546	$y = 210.88e^{-0.017x}$	y=26.88737/(1+0.009147x)	128	457164.1289	0.133	133	462864.47	0.134
05-123-33869	Wacker	B01-79HN	HORIZONTAL	3001236	$y = 178.09e^{-0.031x}$	y=31.962/(1+0.011489x)	53	206703	0.069	51	202293.00	0.067
05-123-33870	Wacker	B11-69HN	HORIZONTAL	2488458	$y = 178.21e^{-0.031x}$	y=31.48131/(1+0.011091x)	53	206661	0.083	52	204960.00	0.082
05-123-33874	Wacker	B12-69HN	HORIZONTAL	712614	$y = 109.36e^{-0.026x}$	y=60.28455/(1+0.028376x)	38	119553	0.168	34	113253.00	0.159
05-123-33100	Wells Ranch USX	BB15-65HN	HORIZONTAL	3363654	$y = 110.94e^{-0.011x}$	y=195.5892/(1+0.150384x)	95	269140.1773	0.080	137	323608.77	0.096
05-123-33101	Wells Ranch USX	BB15-67HN	HORIZONTAL	3019296	$y = 163.31e^{-0.022x}$	y=162.7571/(1+0.023175x)	84	264085.8987	0.087	96	278429.17	0.092
05-123-33708	WELLS RANCH USX	AA11-65HN	HORIZONTAL	4350822	$y = 1701.4e^{-0.089x}$	y=40.7521/(1+0.012849x)	67	746692.2559	0.172	37	764269.26	0.176
05-123-33324	Wells Ranch USX AE	29-68HN	HORIZONTAL	924840	$y = 569.79e^{-0.031x}$	y=22.59393/(1+0.012061x)	66	673887.3773	0.729	35	512677.76	0.554

Table A.4. Vertical well 30-year water production trend prediction

Operating Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Water Type	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW
Production rate (bbl/well/day)	6.802097	1.466772	0.682849	0.45027	0.513689	0.491718	0.415602	0.457458	0.485341	0.421902	0.2343	0.249078	0.478979	0.2335	0.212551
Producdion days	162	336	339	341	342	348	354	345	349	338	322	339	333	341	341
Predicted WP (bbl/well/year)	1101.94	492.9428	231.2637	153.6113	175.6135	171.0472	146.9945	157.8433	169.5051	142.7997	75.36069	84.42089	159.2605	79.62354	72.47994
Operating Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Water Type	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW
Production rate (bbl/well/day)	0.193482	0.176123	0.160322	0.145938	0.132845	0.120926	0.110077	0.100201	0.091212	0.083028	0.075579	0.068799	0.062626	0.057007	0.051893
Producdion days	341	341	341	341	341	341	341	341	341	341	341	341	341	341	341
Predicted WP (bbl/well/year)	65.97724	60.05794	54.66971	49.7649	45.30013	41.23592	37.53635	34.16869	31.10317	28.31268	25.77255	23.4603	21.35551	19.43955	17.69549

Table A.5. Horizontal well 30-year water production trend prediction

Operating Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Water Type	FF+PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW
Production rate (bbl/well/day)	68.56049	15.20399	5.64254	2.016466	0.731484	0.719873	0.714137	0.708447	0.702802	0.697202	0.691647	0.686136	0.680668	0.675245	0.669864
Producdion days	162	336	339	341	342	348	354	345	349	338	322	339	333	341	341
Predicted WP (bbl/well/year)	11106.8	5109.655	1910.987	687.9247	250.0705	250.4127	252.5839	244.4456	245.4532	235.9798	222.463	232.5542	226.3223	230.2585	228.4238
Operating Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Water Type	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW	PW
Production rate (bbl/well/day)	0.664527	0.659232	0.653979	0.648768	0.643599	0.63847	0.633383	0.628336	0.62333	0.618363	0.613436	0.608548	0.603699	0.598888	0.594116
Producdion days	341	341	341	341	341	341	341	341	341	341	341	341	341	341	341
Predicted WP (bbl/well/year)	226.6037	224.7981	223.0069	221.2299	219.4671	217.7184	215.9836	214.2626	212.5554	210.8617	209.1816	207.5148	205.8613	204.221	202.5937

FF−Frac Flowback   PW−Produced Water

Appendix B. Uncertainty analysis

B.1. Uncertainty analysis of 1,677 vertical and 32 horizontal wells in Wattenberg field

In order to model the decline functions of both vertical and horizontal wells in the whole Wattenberg field, average *A* and *k* values of 1,677 vertical wells and average k_1, *a*, A_1 and *C* values of 32 horizontal wells were used. However from Figure 3.2 and 3.4, all decay rate value (*k* for vertical well and k_1, *a* for horizontal well) varies spatially in the Wattenberg field, it is necessary to study the reliability of the water production trends from Equation (1), (2) and (3).

For all 1,677 vertical wells, water production trend for each well was analyzed and fitted to an exponential decay function. Because there are 438 wells having only one year water production data (one data point) due to limited data got from COGCC database and another 113 wells have increased water production trends (which did not fit exponential decay function used in this study), only 1,126 *k* values of vertical wells were used in this uncertainty analysis. Unlike the *k* value, only 153 wells' *A* values were selected by random from these vertical wells. Assuming the distributions of *k* and *A* were normal, and for 2σ (95%) confidence interval, the *z* score was 1.645.

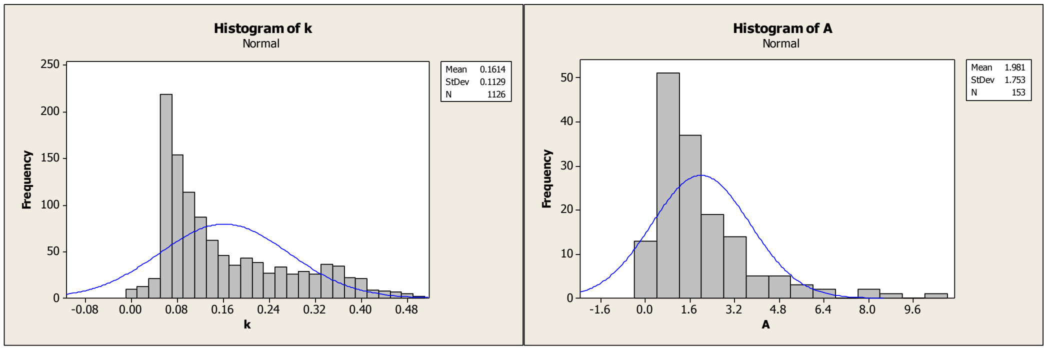

Figure B.1. Distribution of *k* and *A* of vertical wells

For 32 horizontal wells, flowback and produced water curves were all fitted and the distributions of A_1, k_1, C and a were analyzed.

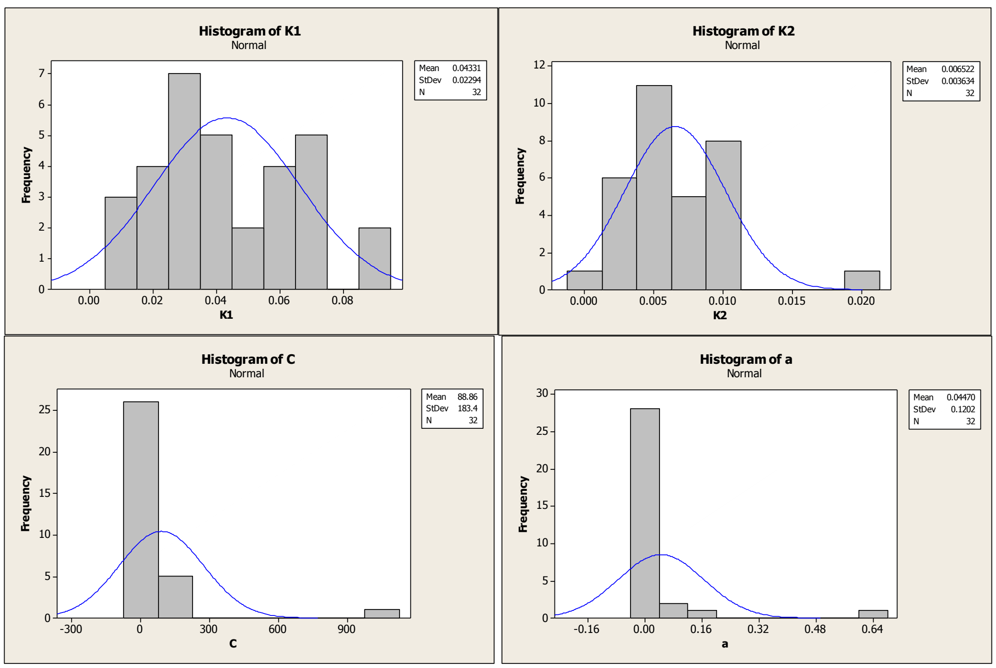

Figure B.2. Distribution of k_1, A_1, C and a for horizontal wells

Assuming all distributions were normal, and the z score for 2σ (95%) confidence interval was 1.645. Table B.1 shows the 2σ (95%) confidence interval for all variables of vertical and horizontal wells.

Table B.1. Uncertainty analysis and acceptable range of variables of all wells

	k	***A***	***k_1***	***A_1***	***C***	***a***
μ	0.1613	1.981	0.0434	264.4	88.8638	0.0447
σ	0.0033	0.141	0.0040	19.4	32.4282	0.0212
μ-1.645σ	0.1558	1.748	0.0366	232.3	35.5194	0.0098
μ+1.645σ	0.1669	2.214	0.0499	296.5	142.208	0.0796

For horizontal wells, because frac flowback only lasts for 61 days, the water production rate for the first year is the average of 61 days of frac flowback and 101 days of produced water. Figure B.3 and B.4 show the water production trends with 2σ confidence interval of vertical and horizontal wells in the Wattenberg field.

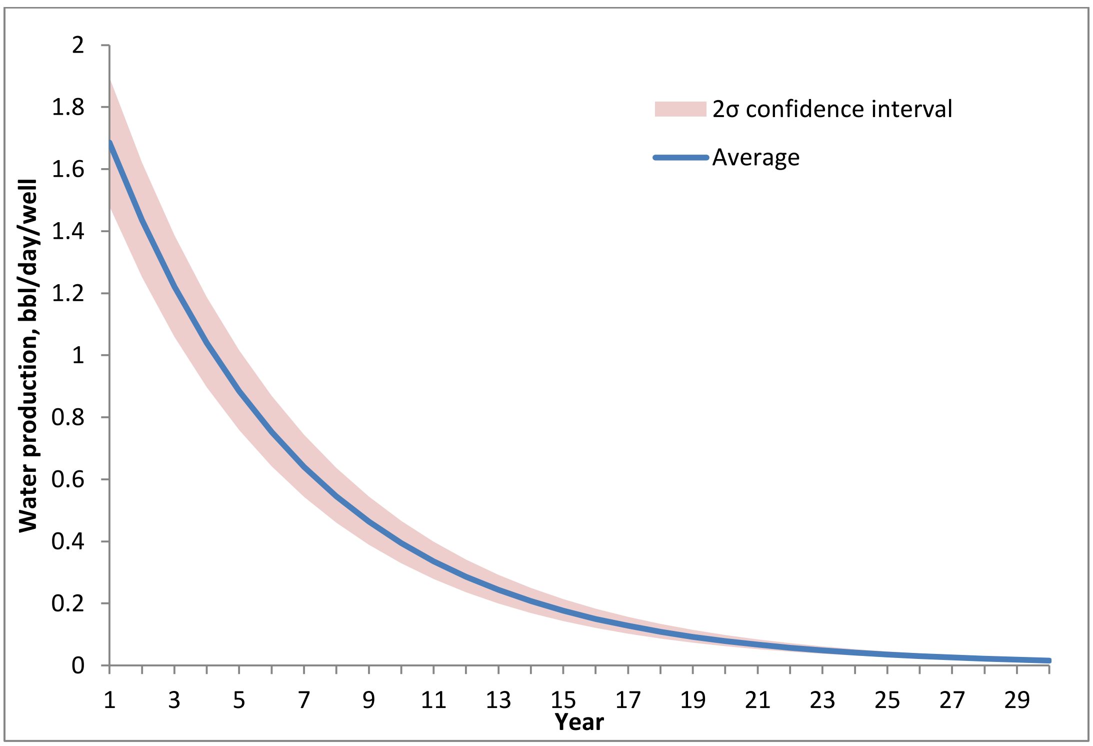

Figure B.3. Vertical well water production trend with 2σ (95%) confidence interval

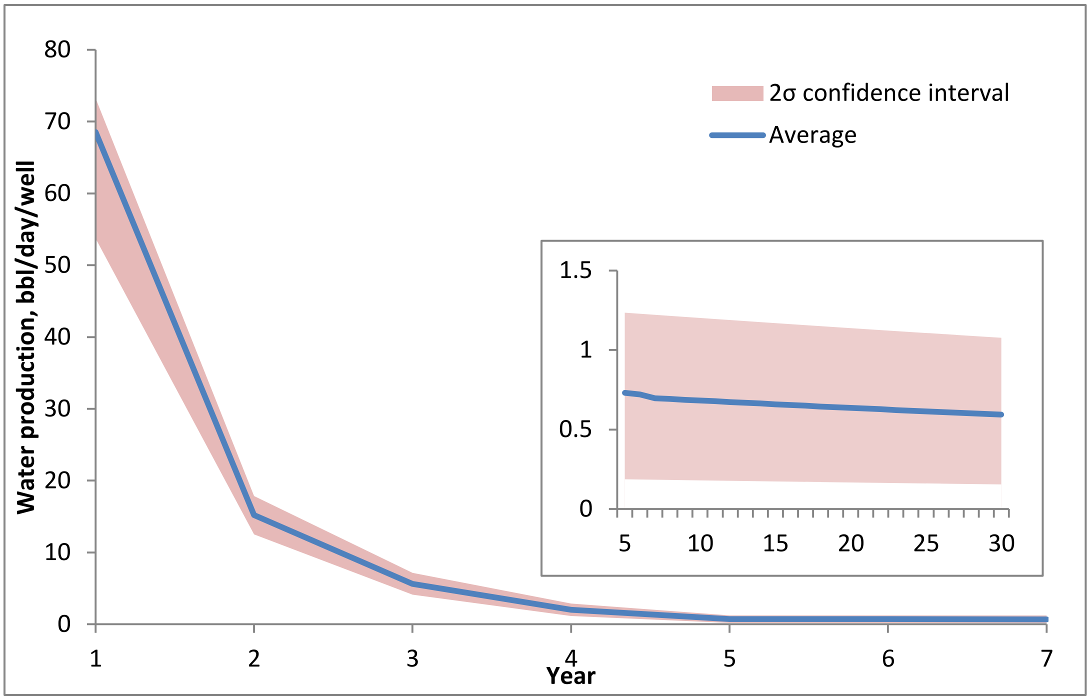

Figure B.4. Horizontal well water production trend with 2σ (95%) confidence interval

B.2. Uncertainty analysis of case study of selected wells in northeast Wattenberg field

In the case study of selected wells in northeast Wattenberg Field, 568 vertical and 12 horizontal wells were included and the same methods of uncertainty analysis were conducted to these wells. Figure B.5 shows the distribution of k, k_1, A, A_1, C and a values of all selected wells.

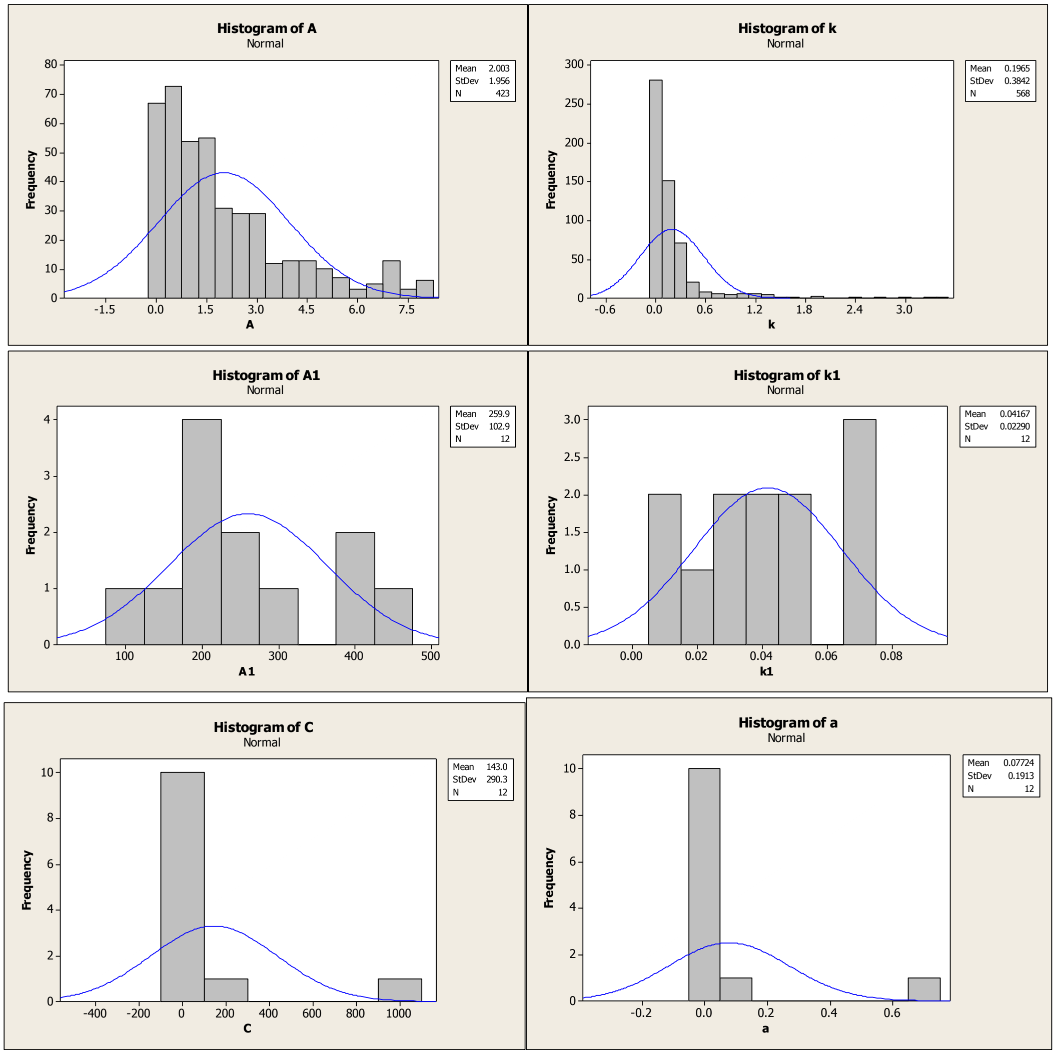

Figure B.5. Distribution of all parameters of selected wells in northeast Wattenberg field

Also the results of uncertainty analysis and acceptable ranges of variables of selected wells were shown in Table B.2.

Table B.2. Uncertainty analysis and acceptable range of variables of selected wells

	k	A	k_1	A_1	C	a
μ	0.197	2.003	0.042	259.9	142.994	0.0772
σ	0.016	0.095	0.006	29.70	83.8	0.0452
μ-1.645σ	0.171	1.847	0.032	343.6	5.143	0.0029
μ+1.645σ	0.223	2.159	0.052	441.4	280.847	0.1516

Water production trends of these selected wells were shown in Figure B.6 (vertical) and Figure B.7 (horizontal), with 2σ (95%) confidence interval.

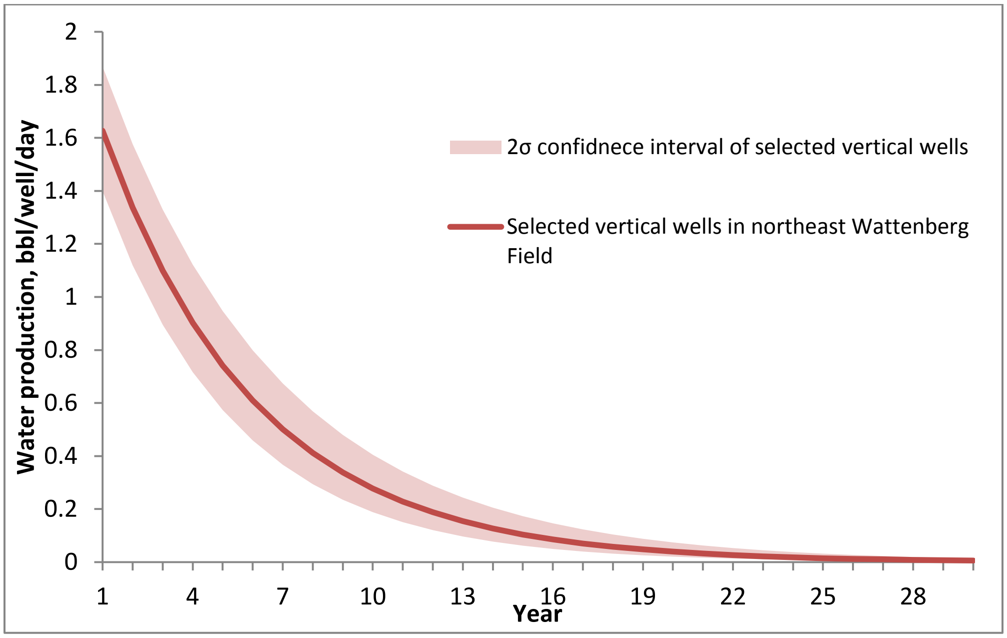

Figure B.6. Water production trend of selected vertical wells in northeast Wattenberg field with 2σ (95%) confidence interval

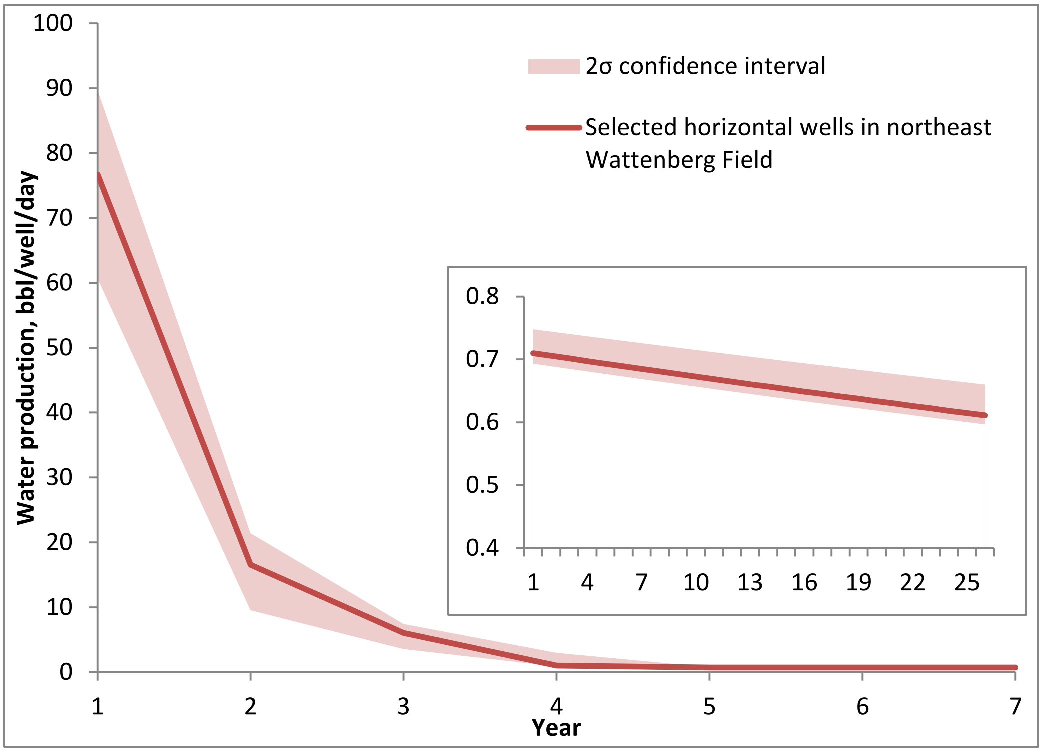

Figure B.7. Water production trend of selected horizontal wells in northeast Wattenberg field with 2σ (95%) confidence interval

Appendix C. 7,486 Noble wells case study data and results

From COGCC database, number of all Noble wells in Wattenberg field and total water production from 1999 to 2009 was collected. Data for 2010 and 2011 was collected from Noble Energy Carte® system. The case study was based on the existing data and the prediction was based on 200 new vertical and 100 new horizontal wells increase each following year. The summary of data is shown in Table C.1.

Table C.1: Historical and Prediction Data of 7,486 Noble Wells Case Study

Year	Number of vertical wells	Number of horizontal wells	Total WP	Predicted WP without new well	Predicted total WP with new wells
			(million bbl)	(million bbl)	(million bbl)
1999	113	0	0.020		
2000	127	0	0.024		
2001	122	0	0.029		
2002	174	0	0.024		
2003	118	0	0.022		
2004	123	0	0.021		
2005	3,306	0	0.275		
2006	3,768	0	0.824		
2007	4,309	0	0.722		
2008	4,558	0	0.992		
2009	5,862	0	1.063		
2010	6,803	0	1.369		
2011	7,371	115	3.125	3.125	3.125
2012	7,571*	215*		2.273*	4.238*
2013	7,771*	315*		1.516*	5.352*
2014	7,971*	415*		1.214*	6.466*
2015	8,171*	515*		0.954*	7.580*
2016	8,371*	615*		0.914*	8.694*
2017	8,571*	715*		1.097*	9.808*

* Predicted Value from 2012 to 2017, with 200 new vertical and 100 new horizontal wells each year