RICHMOND CITY CORPORATION
ORDINANCE 2011-6

WHEREAS, Utah Code Annotated Title 19, Chapter 4 establishes the Utah Safe Drinking Water Act; and

WHEREAS, Rule 309-600 of said Act establishes the requirement for each culinary water supplier to establish a Drinking Water Source Protection Plan; and

WHEREAS, said Drinking Water Source Protection Plan must be up-dated and resubmitted to the Division of Drinking Water every six (6) years; and

WHEREAS, Richmond City has previously submitted a separate plan for spring ground water sources and a plan for well ground water sources; and

WHEREAS, Richmond City contracted with the Utah Geological Service to conduct a complete analysis of the hydrological aspects of all culinary water sources; and

WHEREAS, Richmond City deems it only logical to submit a single Drinking Water Source Protection Plan for all sources,

NOW THEREFORE the City Council of Richmond City, County of Cache, State of Utah, hereby adopts, passes and publishes the following ordinance entitled:

> AN ORDINANCE ESTABLISHING THE DRINKING WATER SOURCE PROTECTION PLAN TO ENSURE THE PROVISION OF SAFE AND SANITARY CULINARY WATER SUPPLY FOR RICHMOND CITY BY ESTABLISHMENT OF WATER SOURCE PROTECTION ZONES SURROUNDING THE NATURAL SPRINGS, DEVELOPED SPRINGS, AND WELLHEADS FOR ALL CULINARY WATER SOURCES WITHIN THE RICHMOND CITY CULINARY WATER SYSTEM.

A. Introduction.

1. System Information:

    a. Richmond City Corporation

    b. System Number 03018.

    c. Community water system with a population of less than 3,000 and approximately 570 hook-ups at the time that this ordinance is prepared.

2. Source Information:

a. Cherry Creek Spring complex.

1) This system is designated WS-001 and is comprised of water source numbers 25-7241 and 25-3060.

b. City Creek Spring complex.

1) This system is designated WS-002 and is comprised of water source number 25-4764.

c. 600 South Well.
1) This well is designated WS-003 and is currently in an Inactive status.
a) Water source number 25-4884.

d. WCDI aka Dairy Well.
1) This well is designated WS-004 and is currently the only Active well.
a) This well is used only in emergency or during the summer when culinary water demand exceeds what is available through WS-001 and WS-002 sources.
b) Water source number 25-2330.

e. "Cherry Creek Well."
1) This well was purchased by Richmond City in 2006 and at this time is not permitted as a Municipal Water Source.
2) At the time of the preparation of this ordinance, an active Culinary Water Project is underway which will include bringing this source on-line with a yet-to-be designated WS number.
a) Water source number 25-6053.

3. Designated Responsible Person in Charge:
W. "Scott" Ball
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Richmond, UT 84333-0009
435-258-2092 or 435-994-1572
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B. Delineation Report.

1. Geologic Data is provided by the Utah Geological Survey report compiled in 2010 by Paul Inkenbrandt, UGS. The complete report is available upon request from the Richmond City Office.

a. Cherry Creek Springs - WS-001 - Richmond City and its springs are near the eastern margin of Cache Valley. Cache Valley is an elongate, complex graben bounded by the east and west Cache fault zones (Evans and Oaks, 1996). Tertiary and Quaternary sediments fill the basin to depths as great as 1000 feet (Robinson, 1999). The Bear River Range, which borders the basin on the east, is made up of Proterozoic and Paleozoic rocks, mostly carbonates and quartzite.

b. City Creek Springs - WS-002 - Richmond City and its springs are near the eastern margin of Cache Valley. Cache Valley is an elongate, complex graben bounded by the east and west Cache fault zones (Evans and Oaks, 1996). Tertiary and Quaternary sediments fill the basin to depths as great as 1000 feet (Robinson, 1999). The Bear River Range, which borders the basin on the east, is made up of Proterozoic and Paleozoic rocks, mostly carbonates and quartzite.

c. 600 South Well - WS-003 - The 600 South well was drilled along the eastern Cache Valley margin, where basin fill material overlies Tertiary Salt Lake Formation and is dissected by normal faults. The well's water source is Tertiary Salt Lake Formation and Paleozoic bedrock, the latter of which is likely from a block slide along a detachment fault in the mountains to the east (Brummer and McCalpin, 1995). The 600 South well is located in east-central Cache Valley. Cache Valley is an enlongate, complex graben bounded by the East and West Cache fault zones (Evans and Oaks, 1996). Tertiary and Quaternary sediments fill the basin to depths as great as 1000 feet (Robinson, 1999). The mountains surrounding the basin are made up of Proterozoic and Paloezoic age rocks, mostly carbonates and quartzite. Along the margins of the valley, and beneath most of the Quaternary basin fill material is the Tertiary Salt Lake Formation. Common lithologies of the Salt Lake Formation in Cache Valley are calcite-cemented tuffaceous sandstones and conglomerates (Smith, 1997).

d. WCDI aka Dairy Well - WS-004 - This well is located in east-central Cache Valley. Cache Valley is an enlongate, complex graben bounded by the East and West Cache fault zones (Evans and Oaks, 1996). Tertiary and Quaternary sediments fill the basin to depths as great as 1000 feet (Robinson, 1999). The mountains surrounding the basin are made up of Proterozoic and Paloezoic-age rocks, mostly carbonates and quartzite. Along the margins of the valley, and beneath most of the Quaternary basin fill material is the Tertiary Salt Lake Formation (Tsl). Common lithologies of the Salt Lake Formation in Cache Valley are calcite-cemented tuffaceous sandstones and conglomerates (Smith, 1997). Overlying the Tertiary deposits in the center of the basin are up to 800 feet of Quaternary alluvial deposits, which predate the Little Valley lacustrine sediments deposited 140,000 to 90,000 years ago (ya) (Robinson, 1999). The pre-Little Valley deposits consist of angular sand and cobbles mottled with poorly sorted beds of silt and clay near the valley margins (Williams, 1962). These deposits become clay-rich towards the center of the valley (Robinson, 1999).

e. Cherry Creek Well - non-permitted - The Cherry Creek well site is along the eastern Cache Valley margin, where Tertiary Salt Lake Formation is dissected by normal faults.

The Cherry Creek well water is sourced in the Salt Lake Formation (Brummer and McCalpin, 1995). Cache Valley is an elongate, complex graben bounded by the east and west Cache fault zones (Evans and Oaks, 1996). Tertiary and Quaternary sediments fill the basin to depths as great as 1000 feet (Robinson, 1999). The mountains surrounding the basin are Proterozoic and Paleozoic rocks, mostly carbonates and quartzite. Along the margins of the valley, and beneath most of the Quaternary basin-fill material, is the Tertiary Salt Lake Formation. Common lithologies of the Salt Lake Formation in Cache Valley are calcite-cemented, tuffaceous sandstones and conglomerates (Smith, 1997). Overlying the Tertiary deposits in the center of the basin are up to 800 feet of Quaternary alluvial deposits, which predate the Little Valley lacustrine sediments that were deposited 140,000 to 90,000 years ago (140 to 90 ka) (Robinson, 1999). The pre-Little Valley deposits consist of angular sand and cobbles, mottled with poorly sorted beds of silt and clay near the valley margins (Williams, 1962). These deposits become clay-rich towards the center of the valley (Robinson, 1999).

2. Construction Data.

a. Cherry Creek Springs - WS-001 - These springs date back into the 19th century with no original construction data available. In 1985 a spring improvement project was undertaken which brought the collection system into compliance with all EPA and DDW regulations. The collection system for the springs consists of shallow perforated pipe in gravel that leads to concrete collection structures.

1) The Cherry Creek Springs have locked, concrete collection boxes. Barbed wire fencing surrounds each spring.

b. City Creek Springs - WS-002 - These springs flowed naturally from the hillside prior to the Spring of 1965 when Richmond City arranged to take control of the springs. At that time the City constructed a collection system for the springs consisting of shallow perforated pipe in gravel that leads to concrete collection structures. On December 17, 1965, the Utah State Department of Health approved the integrity of the collection system.

1) Each spring collection box is locked and surrounded by a chain-link, barbed wire topped fence.

c. 600 South Well - WS-003 - Table below summarizes the construction information of the 600 South well. The wellhead elevation is 4567 feet (NAVD 88 datum). The National Elevation Dataset (root mean squared error of 8 ft) verifies the wellhead elevation value, which is likely accurate within 3 feet (Gesch, 2007).

Summary of well construction and pump information.

WELL	Elevation (NAVD 1988 datum) Completed Completed Depth (below surface) Drilling Method	4567 ft November 30, 1977 504 feet Cable tool
CASING	Internal Diameter Type Steel Thickness	16 inches Steel 0.375 inches

Summary of well construction and pump information, continued

PERFORATIONS	Depths (below ground surface) Number respective to depth (total) Size	150-185; 192-256; 397-504 feet 270; 512; 856 (1638) 0.5 inches x 3 inches
PUMP	Maximum Yield	898 gpm*

*Note that no pump in currently installed - hypothetical yield used based on engineer's data from the well's certificate of appropriation.

The 600 South well has a 0.375-inch thick steel casing with an internal diameter of 16 inches and is 504 feet deep. Ken Wright of Wright Drilling Company drilled this well with a cable tool rig and completed the well on November 30, 1977. The well has three intervals along the casing with 0.5 inch by 3 inch perforations: (1) 270 perforations from 150 to 185 feet below land surface, (2) 512 perforations from 192 to 156 feet below land surface, and (3) 856 perforations from 397 to 504 feet below land surface. A 0.75 inch gravel pack extends from 110 feet below ground surface to 300 feet below ground surface. The driller installed a cement grout seal from 110 feet below the ground surface to the ground surface. In the well's certificate of appropriation filed with the DWR dated July 1981, engineer John Probasco gives some information about the pump used by the Rhodes Brothers to conduct the specific capacity tests. Probasco wrote that the pump is an eight-stage, 150-horsepower Byron Jackson Deepwell pump capable of pumping a maximum of 898 gallons per minute. Probasco made no mention of the depth that the pump was set, but his information provides some evidence as to the maximum pumping rate of the well. It is worth noting that a pumping rate of 898 gallons per minute is not currently possible because (1) there is no pump in the well, and (2) the water in the well is too turbid to pump.

d. WCDI or Dairy Well - WS-004 - The below table summarizes the construction information of the WDCI or Dairy well. The well driller's log lists the well elevation at 4525 feet (NGVD 1929 datum). The wellhead elevation (NAVD 88 datum) is 4529 feet. The National Elevation Dataset (root mean squared error of 8 ft) verifies this elevation value, which is likely accurate to within 3 feet (Gesch, 2007). This well has a 0.375-inch-thick steel casing with an internal diameter of 12 inches and a 150-foot depth. Although the driller's log reports the casing as 12.5-inch diameter (50 pounds per foot), physical observation of the casing and standard pipe weights and diameters (Driscoll, 1986) support that the pipe is 12-inch internal diameter with 0.375-inch thickness. The driller (unknown) completed the well on December 15, 1934. Based on the thick steel casing, the geologic material, the well depth, and knowledge of the dominant drilling practices in Cache Valley during the 1930s, this well was most likely drilled with a cable tool rig. The lack of grout also supports this method, as the driller probably drove the casing as the drilling proceeded. The well has three intervals along the casing with 1.25 inch by 4 inch perforations: (1) 20 perforations from 70 to 75 feet below land surface, (2) 105 perforations from 81 to 105 feet below land surface, and (3) 95 perforations from 107 to 147 feet below land surface. Qi and Yang (1999) identified the current pump as a Crown submersible pump model 8L-600-4. It is a 75-horsepower pump capable of pumping a maximum of 720 gallons per minute (Qi and Yang, 1999). The pump is set 118 feet below ground surface. At the maximum pumping rate, based on the aquifer test from Bush and Gudgell, Inc. (1992), the well efficiency is approximately 38%. This efficiency is justifiable, as the well was 57 years old at the time of the test and is perforated as opposed to having a screen.

Summary of well construction and pump information.

WELL	Elevation (NAVD 1988 datum) Completed Completed Depth (below surface) Likely drilling method	4529 feet December 15, 1934 150 feet Cable Tool
CASING	Internal Diameter Type Steel Thickness	12 inches Steel 0.375 inches
PERFORATIONS	Depths (below ground suface) Size Total number	70-75; 81-105; 107-147 feet 1.25 inches x 4 inches 220
PUMP	Maximum Yield Type Brand Model Power Depth Installed (below surface)	720 gallons per minute Submersible Crown Model 8L-600-4 75 horse power 118 feet

e. Cherry Creek Well - non-permitted - Since the existing well will need to be extensively re-worked before it can be permitted to Municipal use, any extant data will probably not reply. Once this well has been permitted for Municipal use, this ordinance will be amended to reflect the up-to-date information relative to construction data.

3. Aquifer Data.

a. Cherry Creek Springs - WS-001 - The methods used to delineate the spring protection zones did not require aquifer data. Lack of direct subsurface hydraulic connection among the springs in the Bear River Range and structural controls make the determination of a quantitative hydraulic gradient difficult. Variation in the thickness of the Quanternary deposits make a single thickness value for each aquifer have little meaning. No aquifer tests have been conducted in Quanternary alluvium and colluvium. The Utah Geological Survey, therefore, did not determine hydraulic conductivity, aquifer thickness, or regional hydraulic gradient.

b. City Creek Springs - WS-002 - The methods used to delineate the spring protection zones did not require aquifer data. Lack of direct subsurface hydraulic connection among the springs in the Bear River Range and structural controls make the determination of a quantitative hydraulic gradient difficult. Variation in the thickness of the Quanternary deposits make a single thickness value for each aquifer have little meaning. No aquifer tests have been conducted in Quanternary alluvium and colluvium. The Utah Geological Survey, therefore, did not determine hydraulic conductivity, aquifer thickness, or regional hydraulic gradient.

c. 600 South Well - WS-003 - Several hydrogeologic units interact in the area of the well. This section summarizes the properties of the aquifers from which the well procures water. This well pumps water from the Salt Lake Formation and from Paleozoic limestone bedrock. The producing aquifers to which the well is open are 206 feet thick, have a combined hydraulic conductivity of 8 feet per day, and an effective porosity of 20 percent. The below table summarizes the properties of the aquifers combined. An explanation as to how these figures were derived in contained in the Utah Geological Survey retained on file at the Richmond City offices.

Summary of aquifer parameters.

Parameter	*Value*	*Source*
Aquifer Thickness	206 feet	Well logs
Hydraulic Conductivity	8 feet per day	Specific capacity (well log)
Effective Porosity	20%	Fetter (2001)
Direction of ground-water flow	70° West of North	Kariya and others (1994)
Hydraulic Gradient	0.04	Kariya and others (1994)

d. WCDI or Dairy Well - WS-004 - Several hydrogeologic units interact in the area of the well. This section summarizes the properties of the aquifers from which the well procures water. This well pumps water from the lower confined gravel unit of Cache Valley basin-fill material. The lower confined gravel in the area of the well is 172 feet thick, has a hydraulic conductivity of 25 feet per day, and an effective porosity of 25.7 percent. The below table summarizes the properties of the lower confined gravels. An explanation as to how these figures were derived in contained in the Utah Geological Survey retained on file at the Richmond City offices.

Summary of aquifer parameters.

Parameter	*Value*	*Source*
Aquifer Thickness	172 feet	Well logs
Hydraulic Conductivity	25 feet per day	Aquifer test
Effective Porosity	26%	Fetter (2001)
Direction of ground-water flow	70º West of North	Kariya and others (1994)
Hydraulic Gradient	0.04	Kariya and others (1994)

e. Cherry Creek Well - non-permitted - Several hydrogeologic units interact in the area of the well. This section summarizes the properties of the aquifer from which the well receives water. The existing, non-permitted well and other wells in the area pump water from the Salt Lake Formation. The producing aquifer to which the well is open is 73 feet thick, has a hydraulic conductivity of 4 feet per day, and an effective porosity of 20 percent. The below table summarizes the properties of the aquifer. An explanation as to how these figures were derived in contained in the Utah Geological Survey retained on file at the Richmond City offices.

Summary of aquifer parameters.

Parameter	*Value*	*Source*
Aquifer Thickness	73 feet	Well logs
Hydraulic Conductivity	4 feet per day	Specific capacity (well log)
Effective Porosity	22%	Fetter (2001)
Direction of ground-water flow	70º West of North	Kariya and others (1994)
Hydraulic Gradient	0.083	Kariya and others (1994)

4. Hydrogeologic Methods and Calculations.

a. Cherry Creek Springs - WS-001 - Proterozoic and Paleozoic quartzite underlies most of the Cherry Creek topographic basin, especially in the areas of the Cherry Creek Springs. The Cherry Creek Springs issue from alluvium and colluvium overlying and composed of the Mutual Formation (quartzite). The Mutual Formation has interlocking crystals and therefore has low primary porosity. Spangler (2001) documented flow along the plunge of the Logan Peak Syncline through karst-expanded fractures in the Paleozoic carbonate rocks of the Bear River Range. All of the flow that he documented is southward and most of the related springs fed by the karst systems issued along the axis of the syncline or nearby on the east limb. Fracture patterns from Wilson (1976) are consistent with the flow patterns measured by Spangler (2001). The Cherry Creek Springs are north of the karst spring recharge areas that Spangler (2001) delineated. Estimated area of recharge for Cherry Creek Springs is spring discharge divided by annual precipitation infiltrated. Cherry Creek Springs produce a combined average flow of 1300 gpm. Annual precipitation infiltrated is the estimated recharge rate multiplied by the annual precipitation. Using a Maxey and Eakin (1949) method, it is estimated that 20% of the precipitation infiltrated. Infiltration estimates from Bjorklund and McGreevey (1971) support this rate. The mean precipitation from 1971 to 2000 for the mountainous area that contributes water to Cherry Creek is 46.2 inches per year (PRISM Climate Group, 2010). Most of the precipitation in this area is from snowfall (Utah Climate Center, 2010). The resulting estimated catchment area of Cherry Creek Springs (2730 acres) is very close to the actual topographic catchment area of Cherry Creek (2780 acres). Field observations of the springs emitting from alluvium and colluvium support results of the catchment calculations.

b. City Creek Springs - WS-002 - Water from precipitation falling directly onto the Salt Lake Formation in the foothills of the Bear River Range may contribute to the flow of the springs, but recharge from snowmelt in the mountains is likely the greatest contributor. In the underground water claim for the City Creek Springs, former Richmond City Mayor Dean Andrus, remarked that the flow of the springs usually peaks in early July. Relatively high spring discharge in early July suggests that water from snowmelt significantly contributes to the flow of the springs. The timing of the flow increase could indicate that irrigation practices (i.e., unused irrigation water return flow) influence spring flow, but there are no recorded irrigated properties or canals upgradient of the springs. Average monthly precipitation records from the Richmond City weather station indicate precipitation is lowest in the month of July. Soil moisture data from the Tony Grove SNOTEL station, 3 miles southeast of Cherry Peak, indicate that snow melt is greatest from May to late June (Utah Climate Center, 2010). It is estimated the area that recharges City Creek Springs by dividing the spring discharge by annual precipitation infiltrated. City Creek Springs produce a combined average flow of 100 gpm according to records provided by the DWR. It is estimated the annual precipitation infiltrated by multiplying the recharge rate by annual precipitation. UGS authority determined the recharge rate of 12% based on infiltration rates from the Maxey and Eakin (1949) method. Infiltration estimates from Myers (2003) and Bjorklund and McGreevey (1971) support this rate. The mean precipitation from 1971 to 2000 for the area that contributes water to City Creek is 23.9 inches per year (PRISM Climate Group, 2010). The estimated catchment area (625 acres) is smaller than the topographic catchment area.

Contributing area estimation parameters.

Variable	**Cherry Creek Springs**	**City Creek Springs**	**Units**	**Source**
Spring discharge	1,300 91,500,000	100 7,030,000	gpm ft^3/yr	DWR
Recharge rate	20	12	%	Maxey & Eakin, 1949
Precipitation	46.2 3.85	23.9 1.99	in/yr ft/yr	PRISM Climate Group, 2010

Contributing area estimation parameters, continued.

Variable	***Cherry Creek Springs***	***City Creek Springs***	***Units***	***Source***
Precipitation infiltrated	0.77	0.24	ft/yr	
Estimate catchment area	119,000.000 2730	29,400,000 675	ft^2 acres	
Topographic catchment area	2780	835	acres	Richmond & Naomi Peak USGS 7.5' topographic maps

c. 600 South Well - WS-003 - *The following data is drawn from the Utah Geologic Survey report prepared by Mr. Paul Inkenbrandt for Richmond City. Whenever the term "I" is used in the following data, it refers to Mr. Inkenbrandt.*

1) **Hydraulic Gradient and Flow Direction.** The hydraulic gradient for the area is 0.04 and the flow direction is 290 degrees from north (almost due west). The gradient and flow are based on water-level data from both Bjorklund and McGreevy (1971) and Kariya and others (1994). I examined the gradients and flow directions from Bjorklund and McGreevy (1971) and Kariya and others (1994) by plotting the contours made by each using GIS software (ESRI, 2009). I also added water level elevation data from several springs in the Bear River Range. Bjorklund and McGreevy (1971) show a gradient of 0.083 in the area of the well. Kariya and others (1994) show a gradient of 0.04 in the area of the well. I used the gradient of Kariya and others (1994) as theirs is a more recent examination of the potentiometric surface. The well is near the valley margin, which is an area of significant change in the hydraulic gradient. Gradient decreases from east to west and is greatest in the low hydraulic conductivity Proterozoic and Paleozoic bedrock adjacent to the Salt Lake Formation. Potentiometric surface contours are closer to each other in the higher relief, lower horizontal hydraulic conductivity Salt Lake Formation than farther west in the Quaternary basin-fill sediments. Because the ground-water levels in the consolidated units closely follow the levels found in wells tapping basin-fill units, I can assume that the unconsolidated and consolidated units are hydrologically connected.

2) **Saturated Thickness.** The 600 South well penetrates a confined aquifer, and has a static water level measured on December 8, 1978, at 44 feet below ground surface. The well fully penetrates permeable sections of the Salt Lake Formation and fractured Paleozoic bedrock. The total saturated thickness for this well is estimated to be the length of the perforated interval – 206 feet.

3) **Transmissivity and Hydraulic Conductivity.** Richmond City or its associated contractors has yet to conduct a 24-hour constant rate test for this well. Because it currently does not have a pump and has turbidity problems, I did not conduct a pump test on this well. The best available data for the hydraulic conductivity of the aquifer units from which this well derives water is specific capacity data. The 600 South well driller's record indicates that the Rhodes Brothers conducted a specific capacity test in December 1977. The driller's record reports 111 feet of drawdown after pumping 751 gallons per minute for 26 hours and 70 feet of drawdown after pumping 477 gallons per minute for 26 hours. I used the following Theis and others (1963) equation to estimate transmissivity from specific capacity:

T equals S_c over 4 pi times quantity ln times quantity $2.25Tt_p$ over r^2over $_w$S

where:
T = transmissivity
S_c = specific capacity
t_p = pumping time
r_w = well radius
S = storativity of the aquifer

I used a spreadsheet to solve the equation iteratively. The equation assumes that (1) the well fully penetrates the aquifer, (2) the aquifer is homogeneous, (3) well loss is negligible, and (4) the effective radius is equal to the well radius. The resulting estimate for transmissivity from the Theis and others (1963) equation is 1700 ft^2/day. I used the estimate from the higher discharge specific capacity because this is closer to the maximum estimated discharge for the well. Although the material that this well produces from is not necessarily homogeneous, the estimate of transmissivity is the best available for this well and compares favorably to other area aquifer tests. Modeling of the drinking water source protection zones requires hydraulic conductivity estimates of the confined gravel aquifers overlying the material in which the well is open. Bush and Gudgell, Inc. conducted a variable-rate, single-well, 24-hour, aquifer test on the WDCE or Dairy well with a resulting transmissivity of 4300 ft_2/day with a confidence interval of ±1470 ft_2/d. The estimated transmissivity is within an order of magnitude of the Beer (1967) transmissivity estimate of 2200 ft_2/d. Beer (1967) used a Cooper-Jacob (1946) analysis on recovery data from a well 1500 feet southwest of the 600 South well. Using Robinson's (1999) value for aquifer thickness of 150 feet and the transmissivity from the New City Well, I estimated hydraulic conductivity of the confined gravels as 20 feet per day.
Modeling of the drinking water source protection zones (see section 2.4.5) required hydraulic conductivity estimates of the Salt Lake Formation to the east of the 600 South well. Because of displacement, fracturing, and fault gouge created by the normal fault to the east, the Salt Lake Formation that the well is screened in is hydrologically distinct from the Salt Lake Formation farther east, on the other side of the fault. Inkenbrandt (2010) conducted an aquifer test in a similar setting 4 miles northeast of the well in Cove, Utah, and estimated transmissivity of the Salt Lake Formation in this area as 2200 ft^2/d. Brummer and McCalpin (1995) show the Salt Lake Formation as 1200 feet thick in the area east of the well. Dividing the transmissivity (2200 ft^2/d) by the thickness (1200 ft) yields a hydraulic conductivity of 1.8 feet per day. I needed the hydraulic conductivity of the Proterozoic/Paleozoic bedrock to construct a geologically accurate

model. The flow paths within the Paleozoic and Proterozoic quartzite are fractures (Bjorklund and McGreey, 1971), as the crystal grains are tightly interlocking and negligible amounts of dissolution have occurred. To simulate the relatively impermeable nature of the bedrock in this area, I assigned a hydraulic conductivity of 0.1 ft/day, based on the permeability of a similar material described by Bear (1972).

4) **Estimated Effective Porosity.** The 600 South well derives its water from consolidated Salt Lake Formation and Paleozoic bedrock. Fetter (2001) reports that porosity in unconsolidated sand and gravel ranges from 20 to percent. Because the Salt Lake Formation is weakly cemented, it likely has a lower porosity value than unconsolidated sand and gravel. An appropriate estimate for the Salt Lake Formation is 20%. Driscol (1986) reports a value of porosity for fractured limestone of 20%. To facilitate modeling, I applied a porosity of 20% to the material around the well.

d. WCDI or Dairy Well - WS-004 - *The following data is drawn from the Utah Geologic Survey report prepared by Mr. Paul Inkenbrandt for Richmond City. Whenever the term "I" is used in the following data, it refers to Mr. Inkenbrandt.*

1) **Hydraulic Gradient and Flow Direction**. The hydraulic gradient for the area is 0.04 at a flow direction 290 degrees from north (almost due west). The gradient and flow are based on water-level data from both Bjorklund and McGreevy (1971) and Kariya and others (1994). The direction of flow used by Sunrise Engineering in the original source protection plan is N68.6°W (Qi and Yang, 1999), which is very close to 290 degrees from north, and the gradient is similar to their upgradient value. I examined the gradients and flow directions from Bjorklund and McGreevy (1971) and Kariya and others (1994) by plotting the contours made by using geographic information systems software (ESRI, 2009). I also added water-level elevation data from several springs in the Bear River Range. Bjorklund and McGreevy (1971) show a gradient of 0.083 in the area of the well. Kariya and others (1994) show a gradient of 0.04 in the area of the well. I used the gradient of Kariya and others (1994) as it is a more recent examination of the potentiometric surface. The well is near the valley margin, which is an area of significant change in the hydraulic gradient. Gradient decreases from east to west and is greatest in the low hydraulic conductivity Paleozoic material adjacent to the Salt Lake Formation. Potentiometric surface contours are closer to each other in the lower horizontal hydraulic conductivity Salt Lake Formation than farther west in the Quaternary sediments.

2) **Saturated Thickness.** The New City well penetrates a confined aquifer, and has a static water level 3.5 feet below ground surface. The well fully penetrates all 5 feet of the upper confined aquifer (A1) and partially penetrates the lower confined aquifer (A2). The lower confined aquifer in the area of the New City well is 167 feet thick. This thickness is the difference between the top of the lower screened interval (81ft) in New City well to the top of Salt Lake Formation (248 ft) in the nearby well (WIN 26067). Cross section A from Robinson (1999) and cross section A from Brummer and McCalpin (1995) support this thickness. The total saturated thickness is the sum of the upper and lower confined aquifers – 172 feet.

3) **Transmissivity and Hydraulic Conductivity.** Richmond City commissioned Sunrise Engineering, Inc. to conduct a constant rate aquifer test on November 13, 2002. The test continued until the pump automatically shut off at 15:27, 5 hours and 12 minutes after pumping commenced. Mr. Gavin Little, Richmond City Maintenance Supervisor at the time informed Sunrise Engineering personnel that the pump cannot continuously run 24 hours due to the capacity of the water storage tank and the design of the telemetry system, which is controlled by a computer. Due to the short duration of the 2002 test, I analyzed existing aquifer test data from a longer duration test performed by Bush and Gudgell, Inc. (1992) instead. I examined the variable-rate, single-well, 24-hour aquifer test conducted by Bush and Gudgell, Inc. using AQTESOLV 4.50 (Duffield, 2006). A summary of the test and the associated data are in appendix C. AQTESOLV analyzed both step-drawdown and recovery data using a Theis (1935) solution. The resulting transmissivity for the aquifer is 4300 square feet per day (ft^2/d) with a confidence interval of ±1470 ft^2/d. The estimated transmissivity is within an order of magnitude of the Beer (1967) transmissivity estimate of 2200 ft^2/d. Beer (1967) used a Cooper-Jacob (1946) analysis on recovery data from a well 4500 feet southeast of the New City well. The transmissivity (4300 ft^2/d) divided by the aquifer thickness (172 ft) yields a hydraulic conductivity of 25 feet per day. Modeling of the drinking water source protection zones required a hydraulic conductivity estimate for the deeper basin fill material west of the well. Bjorklund and McGreevy (1971) and Robinson (1999) state that hydraulic conductivity of the basin fill materials decreases toward the center of Cache Valley. To accommodate for the change in hydraulic conductivity, I used an estimate of 20 feet per day for the area west (downgradient) of the well. Modeling of the drinking water source protection zones required hydraulic conductivity estimates of the Salt Lake Formation east of the New City well. Inkenbrandt (in review) conducted an aquifer test in a similar setting 4 miles northeast of the well, near Cove, Utah, and estimated transmissivity of the Salt Lake Formation as 2200 ft^2/d. Cross section A from Brummer and McCalpin (1995) shows the Salt Lake Formation as 1200 feet thick in the area east of the well. Dividing the transmissivity (2200 ft^2/d) by the thickness (1200 ft) yields a hydraulic conductivity of 1.8 feet per day. In addition to the Salt Lake Formation estimates, I also required the hydraulic conductivity of the Proterozoic/Paleozoic bedrock to construct a geologically accurate model. Ground-water flow within the Paleozoic and Proterozoic quartzite is in fractures (Bjorklund and McGreey, 1971), as the crystal grains are interlocked and negligible amounts of dissolution have occurred. To simulate the relatively impermeable nature of the bedrock in this area, I assigned a hydraulic conductivity of 0.1 ft/day, based on a semi-pervious relative permeability material from Bear (1972).

4) **Estimated Effective Porosity.** The New City well derives its water from unconsolidated gravel that has intermittent intervals of sandy/silty gravel. Fetter (2001) reports that porosity of unconsolidated sand and gravel ranges from 20 to 35 percent. I selected the middle value of this range, 27.5%, as the porosity. Modeling requires the porosity of the Salt Lake Formation. Because the Salt Lake Formation is weakly cemented, it likely has a lower porosity value than the unconsolidated basin fill. An appropriate estimate for the Salt Lake Formation is 20%.

5) **DWSP Zone Delineation.** I used the U.S. Environmental Protection Agency's (EPA) Wellhead Analytic Element Model (WhAEM) version 3.2.1 (Haitjema and others, 1994) to delineate DWSP zones. This model uses a Dupuit-Forchheimer approximation to calculate the effects of the New City well pumping at its maximum rate in a uniform flow field. The uniform flow tool of the model required the aquifer properties listed in table 1 and the maximum pump rating of 720 gallons per minute. This model assumes that the aquifer is of infinite areal extent. Although the aquifer is not of infinite areal extent, the addition of areas of varying hydrologic properties (inhomogeneities) allows us to treat the area as an infinite aquifer with spatially variable properties. This model assumes conditions are steady state. Although there are some minor, short-term fluctuations, water levels have remained relatively stable over several decades (Burden, 2009). Addition of the inhomogeneities allows the model to account for the deepening of the aquifer to the west, the presence of the Salt Lake Formation, and presence of the Proterozoic/Paleozoic bedrock. I defined the inhomogeneity boundaries based on a 1:24,000-scale Utah Geological Survey geologic quadrangle map (Brummer and McCalpin, 1995). I also added recharge over the area of 0.0044 feet per day (Kariya and others, 1994) and an additional 0.001feet per day (Myers, 2003) from the Paleozoic bedrock. The below table summarizes the parameters I used in the model.

Parameters used in the ground-water flow model

Thickness

Quaternary basin fill	172 ft
Deeper basin fill (to the west)	1000 ft
Tertiary Salt Lake Formation	1200 ft

Effective Porosity

Quaternary basin fill	27.5 %
Deeper basin fill (to the west)	27.5 %
Tertiary Salt Lake Formation	20 %

Parameters used in the ground-water flow model, continued

Hydraulic Conductivity

Quaternary basin fill	25 ft/day
Deeper basin fill (to the west)	20 ft/day
Tertiary Salt Lake Formation	1.8 ft/day
Paleozoic bedrock	0.1 ft/day

I examined the area for wells that could cause interference with the WDCI or Dairy well. The Calvin Funk well mentioned in the Sunrise Engineering drinking water source protection plan (Qi and Yang, 1999) appears to be screened in an upper unconfined aquifer and is assumed hydrologically separate from the WDCI or Dairy well. Another well mentioned in the Sunrise Engineering report, the Old City Well [now called the 600 South Well], is 3500 feet southeast of the WDCI or Dairy well. Based on our flow lines, the protection areas do not intersect.

e. Cherry Creek Well - non-permitted - *The following data is drawn from the Utah Geologic Survey report prepared by Mr. Paul Inkenbrandt for Richmond City. Whenever the term "I" is used in the following data, it refers to Mr. Inkenbrandt. As noted in Mr. Inkenbrandt's narrative, Richmond City at this writing is considering a Point of Diversion change in close proximity to the existing well. The data stated below should be applicable due to the proximity of the site being investigated. As noted previously, once this well has been permitted as a Municipal source, this ordinance will be appropriately modified.*

1) **Hydraulic Gradient and Flow Direction**. I examined the gradients and flow directions from Bjorklund and McGreevy (1971) and Kariya and others (1994) by plotting their contours using GIS software (ESRI, 2009). I also examined water level elevation data from several springs in the Bear River Range. I used 0.083 as the hydraulic gradient and a flow direction of 70° west of north in the model, based on data from Bjorklund and McGreevey (1971), because it better represents the gradient of the potentiometric surface in the Salt Lake Formation. The well is near the valley margin, which is an area of significant change in the hydraulic gradient. Gradient decreases from east to west and is greatest in the low hydraulic conductivity Proterozoic and Paleozoic bedrock adjacent to the Salt Lake Formation. Potentiometric surface contours are closer to each other in the higher relief, lower horizontal hydraulic conductivity Salt Lake Formation than farther west in the Quaternary basin-fill sediments. Because the groundwater levels in the consolidated units closely follow the levels found in wells tapping basin-fill units, I can assume that the unconsolidated and consolidated units are hydrologically connected.

2) **Saturated Thickness**. The existing well penetrates a confinded aquifer, and has a static water level measured on December 8, 1978, at 44 feet below ground surface. The well partially penetrates permeable sections of the Salt Lake Formation. The estimated total aquifer thickness for this well is the sum of the lengths of the two perforated intervals – 73 feet. Brummer and McCalpin (1995) show that the thickness of the Salt Lake Formation in the area of the well is approximately 800 feet (figure 2). However, heterogeneities within the Salt Lake Formation, especially in the tuffaceous unit, could limit the usable extent of the aquifer to the perforated interval of the well.

3) **Transmissivity and Hydraulic Conductivity.** Richmond City has yet to conduct a 24-hour constant-rate aquifer test for the existing well. Because it currently does not have a pump and may not be the site selected as the source, I did not conduct an aquifer test on this well. Modeling of the drinking water source protection zones (see section 2.4.5) required

hydraulic conductivity estimates of the Salt Lake Formation between the existing well and the 600 South well (figure 2). Because of displacement, fracturing, and fault gouge created by the normal fault between the wells, the Salt Lake Formation to which the well is perforated is hydrologically distinct from the Salt Lake Formation in which the 600 S well is completed, on the other side of the fault. Inkenbrandt (2010) conducted an aquifer test in a similar setting 3 miles northeast of the well in Cove, Utah, and estimated transmissivity of the Salt Lake Formation in this area as 2200 feet squared per day (appendix D). Brummer and McCalpin (1995) show the conglomeratic Salt Lake Formation as 1200 feet thick in the area of the aquifer test. Dividing the transmissivity (2200 feet squared per day) by the thickness (1200 ft) yields a hydraulic conductivity of 2 feet per day. The well driller's record for the Cherry Creek well has specific capacity information. I used the equation revised from Theis and others (1963) to estimate transmissivity from specific capacity:

T equals S_c over 4 pi times quantity ln times quantity $2.25Tt_p$ over r^2over $_w$S

where:
T = transmissivity
S_c = specific capacity
t_p = pumping time
r_w = well radius
S = storativity of the aquifer

I used a spreadsheet to solve the equation iteratively. The equation assumes that (1) the well fully penetrates the aquifer, (2) the aquifer is homogeneous, (3) well loss is negligible, and (4) the effective radius is equal to the well radius. The resulting estimate for transmissivity from the Theis and others (1963) equation is 300 ft_2/day. The transmissivity divided by the estimated aquifer thickness is the hydraulic conductivity, 4 ft/d. Although the aquifer from which this well produces is likely not homogeneous, the estimate of hydraulic conductivity is the best available for this well and compares favorably to other area aquifer tests.

4) **Estimated Effective Porosity**. The potential source well would derive its water from consolidated Salt Lake Formation. Fetter (2001) reports that porosity in unconsolidated sand and gravel ranges from 20 to 35 percent. Because the Salt Lake Formation has more cementation than typical unconsolidated sand and gravel, it likely has a porosity near the lower end of Fetter's (2001) range. An appropriate estimate for the Salt Lake Formation is 20%. Driscoll (1986) reports a value of porosity for fractured limestone of 20%. I applied a porosity of 20% to the material around the well.

5) **DWSP Zone Delination.** I used the U. S. Environmental Protection Agency's (EPA) Wellhead Analytic Clement Model (WhAEM) version 3.2.1 (Haitjema and others, 1994) to delineate DWSP zones. This model uses a Dupuit-Forchheimer approximation to calculate the effects of a well pumping at its maximum rate in a uniform flow field. The uniform flow tool of the model required the aquifer properties listed in table 3 and the maximum pump rating of 1300 gallons per minute. Other than the well locations, I used the same model

parameters to delineate the protection zones for both the existing and proposed Cherry Creek well. This model assumes that the aquifer is of infinite areal extent. Although the aquifer is not of infinite areal extent, the consideration of areas of varying hydrologic properties allows us to treat the area as an infinite aquifer with spatially variable properties. This model assumes conditions are steady state. Although there are some short-term (a few months) fluctuations in water level, water levels have remained relatively stable over longer periods (several years) (Burden and others, 2009). The east Cache fault and the Proterozoic and Paleozoic quartzites likely act as a low permeability boundary in the vicinity of the well, as observed in the aquifer test conducted in Cove. I considered the presence of this boundary during the protection area delineation. The protection areas with boundary modifications are shorter and wider than they would be without the boundary. I modeled the protection areas using a conservative modeling approach to account for variations in location and pumping rates that are not yet certain. If the city drills a new well, it should also conduct an aquifer test to determine site-specific aquifer properties, which can better simulate protection areas.

5. Drinking Water Source Protection Zone maps. Copies of maps produced by the Utah Geological Survey showing visual representations of the Time of Travel (TOT) zones are included in this ordinance. Original maps are on file at the Richmond City Office.

a. Note that on the map for the Spring, UGS included a spring marked “North Cache.” This spring provides water only for irrigation purposes and is not a part of the culinary water supply system.

6. Well Aquifer Classifications.

a. 600 South Well - WS-003 - This well meets the protected aquifer classification based on the following criteria: (1) it is overlain by a naturally protective layer of clay, having a thickness of 38 feet, (2) based on well logs the clay is laterally continuous throughout zone 2, and (3) the well is constructed with a grout seal that extends from the ground surface down to at least 110 feet below the surface, and that seal extends at least 5 feet through the protective clay layer.

b. WCDI or Dairy Well - WS-004 - The well log indicates that 21 feet of thick yellow clay and 19 feet of thick blue clay with a combined thickness of 40 feet are above the first screened interval. Another 16 foot thick layer also overlies the first screened interval. The well log indicates that the driller first encountered ground water below the clay layers. Later the water level rose to 3.5 feet below ground surface, meaning that the aquifer is under confined conditions. Artesian conditions also suggest that the clay layers are laterally extensive. Both and Bush & Gudgell (1992) and the well log indicate that the well was drilled and cased without a surface seal. This well does not fit the protected aquifer classification due to its lack of a grout seal, but the aquifer and well settings do allow for some protection from contamination. The confining layers above aquifer appear to be continuous and thick. This well was likely drilled using cable-tool methods and driven casing, which usually produces a tight seal between the casing and the clay layers.

c. Cherry Creek Well - non-permitted - The Cherry Creek (existing) well meets the protected aquifer classification based on the following criteria: (1) it is overlain by two naturally protective clay layers, having thicknesses of 118 and 41 feet, (2) the clay observed in the well log is laterally continuous, based on a well log located at the margin of zone 2, (3) the well is constructed with a grout seal that extends from the ground surface down to 100 feet below the surface, and for 33 feet through the upper protective clay layer. Also, a lack of a gravel pack, use of a mill's knife to create perforations, telescoping casing intervals, and the cable-tool drilling technique are good evidence that the driller drove the casing into the ground, which would create a good seal between the casing and the 41 feet of blue clay mentioned in the driller's record. Because there is no well at the other proposed site and no well records to the east of that location in zone two, there is no evidence to support that a well at this site would meet the protected aquifer criteria. Richmond City would have to conduct further study into the nature of the continuity of the clay layers observed in the nearby driller's record to verify the aquifer at the site is protected.

C. Inventory of Potential Contamination Sources and Hazards.

Water Source	Potential Hazard Location	Potential Hazard Type
WS-001	None discernable.	This source is located in and immediately adjacent to a Federally designated Wilderness area. Routinely checked for coliform and e-coli from wild animals as no grazing is allowed.
WS-002	None discernable	This source is partially located in a minimal grazing area with the bulk of the area located in a Federally designated Wilderness area. Routinely checked for coliform and e-coli from animals.

Inventory of Potential Contamination Sources and Hazards, Continued

Water Source	Potential Hazard Location	Potential Hazard Type
WS-003	1. Highway - US 91	Crosses both zone 2 and 3 going north-south. Specific known potential hazards would include diesel fuel, gasoline, oil, engine antifreeze compounds and windshield wiper fluids (from accidents) plus unknown hazardous cargoes that traverse the highway system.
	2. Animal feeding unit - Ogden Dairy Enterprise - 300 West 600 South	Dairy operation in zone 2. Standard soaps and cleaners used in the process plus fecal and urine discharges.
	3. Food Processor - Lower Foods, Inc. - Deli-meat, non-slaughtering. 700 South US 91 (200 West)	Industrial strength cleaning materials and compounds, generally in the "soap" category.
	4. Machine Shop - Alpine Industries - 700 South 100 West	Remote chance of metal filings - steel and aluminum.
	5. Municipal Sewer lines - throughout the City portion of the zones	Minimal hazard as specialized government contract work is carefully isolated. Standard human waste contaminants.
WS-004	1. Union Pacific Railroad tracks - in zone 1.	Rail traffic limited to 10 mph. Known cargoes are plastic pellets for Presto Products; agricultural items for IFA (known are fertilizer, insecticides and fungicides for agriculture use). Other cargoes going into Preston, ID are unknown.
	2. Abandoned animal feed lot - in zone 2 south of wellhead - 240 South 300 West.	Out of active use for a decade. Water from WS-004 is routinely checked for Nitrates/Nitrites whenever being used.

Inventory of Potential Contamination Sources and Hazards, Continued

Water Source	Potential Hazard Location	Potential Hazard Type
WS-004, cont.	3. Highway, US 91	Crosses both zone 3 and 4 going north-south. Specific known potential hazards would include diesel fuel, gasoline, oil, engine antifreeze compounds and windshield wiper fluids (from accidents) plus unknown hazardous cargoes that traverse the highway system.
	4. Municipal Sewer lines - throughout the City portion of the zones.	Standard human waste contaminants.

D. Hazard Controls.

1. Due to the positioning of the Protection Zones and the Potential Contamination Sources, only two locations pose a serious hazard and both are uncontrolled. To wit, contamination caused by a rail derailment or other accident resulting in the loss of cargo within Zone 1 for WS-004 and motor vehicle accidents on U. S. 91 through accident resulting in loss of vehicle fluids or cargo within Zones 2, 3, and/or 4 for WS-003 and WS-004.

2. Richmond City is serviced by a well-trained Fire Department with an associated Emergency Medical Technician resource. Due to an interlocal agreement between all communities in Cache Valley, additional hazardous material specialists are on-call.

a. Richmond City deems reliance upon the above specialists as our only practical hazard controls in these two areas affecting culinary water sources at this time.

b. Based upon the findings of specialists on scene, Richmond City will activate all or portions of its Emergency Response Plan as required.

3. Less hazardous locations are periodically monitored by City staff utilizing best management practices.

a. Lower Foods has installed a SCADA device which enable remote monitoring of their discharge into our sewer system.

b. The Ogden Dairy enterprise, although in very close proximity to WS-003, uses proper best management practices.

1) Since WS-003 is not currently being used for turbidity, additional features are not deemed necessary at this time. Should WS-003 be activated, a re-evaluation of hazard controls will be undertaken.

c. As noted in the chart above, an abandoned cattle feed lot (out of service for over a decade) is within Zone 2 and just south of WS-004. Whenever WS-004 is being actively used, periodic testing for nitrates/nitrites is undertaken as a best management practice.

d. Municipal sewer system is serviced by the same maintenance staff as handles the culinary water distribution system

1) All maintenance staff members are well trained in best management practices for both water and sewer, including the location and requirements of the Source Protection Zones.

E. Management Program for Existing Potential Contamination Sources.

1. Refer to D.1 through D.3 above.

F. Management Program for Future Potential Contamination Sources.

1. Any and all enterprises that could involve contaminants within Richmond City must first pass through approval by both the Richmond City Planning & Zoning Commission and the Richmond City Council.

a. Both the Commission and the Council are aware of the requirements of the Source Protection Ordinance.

b. At the writing of this ordinance, Richmond City is developing an up-dated Land Use Development and Management ordinance. This ordinance will contain specific instructions relative to the provisions and requirements of the Source Protection Ordinance including a step-by-step check-off procedure to ensure hazardous operations are either kept out of the source protection areas or fulfill stringent safety requirements before being allowed to proceed.

c. The current Richmond City limits to the east is limited by land controlled by the Division of Wildlife Resources and/or the Mt. Naomi Wilderness Area.

1) It is extremely doubtful that any potentially hazardous operations would have sufficient land area to develop within the eastern portion of the City, the area affected by the source protection zones for WS-003 and WS-004.

d. Most of the respective source protection zones are outside of the Richmond

City limits, therefore, Richmond City will seek close cooperation with the Cache County Planning Office to coordinate County development within the respective source protection zones.

G. Implementation Schedule. This requirement was satisfied with the submission of the first Source Protection Plan.

H. Resource Evaluation. This requirement was satisfied with the submission of the first Source Protection Plan.

I. Record keeping. All ordinances, agreements, and other documents pertaining to any of the culinary water source locations are maintained by the Richmond City Office, 6 West Main, Richmond, UT 84333.

J. Contingency Plan. This requirement was satisfied with the submission of the first Source Protection Plan, but is also up-dated with our Emergency Response Plan as personnel depart or are added.

K. Public Notification. This requirement was satisfied with the submission of the first Source Protection Plan.

L. All maps required, initially prepared by the Utah Geological Service and modified to fit the format of this ordinance, follow as Figures 1 through 4 showing the respective source protection zones; Figure 5 and 6 showing the location of potential contamination hazards for WS-003 and WS-004 respectively. Note that Figure 4 applies to the non-permitted well site.

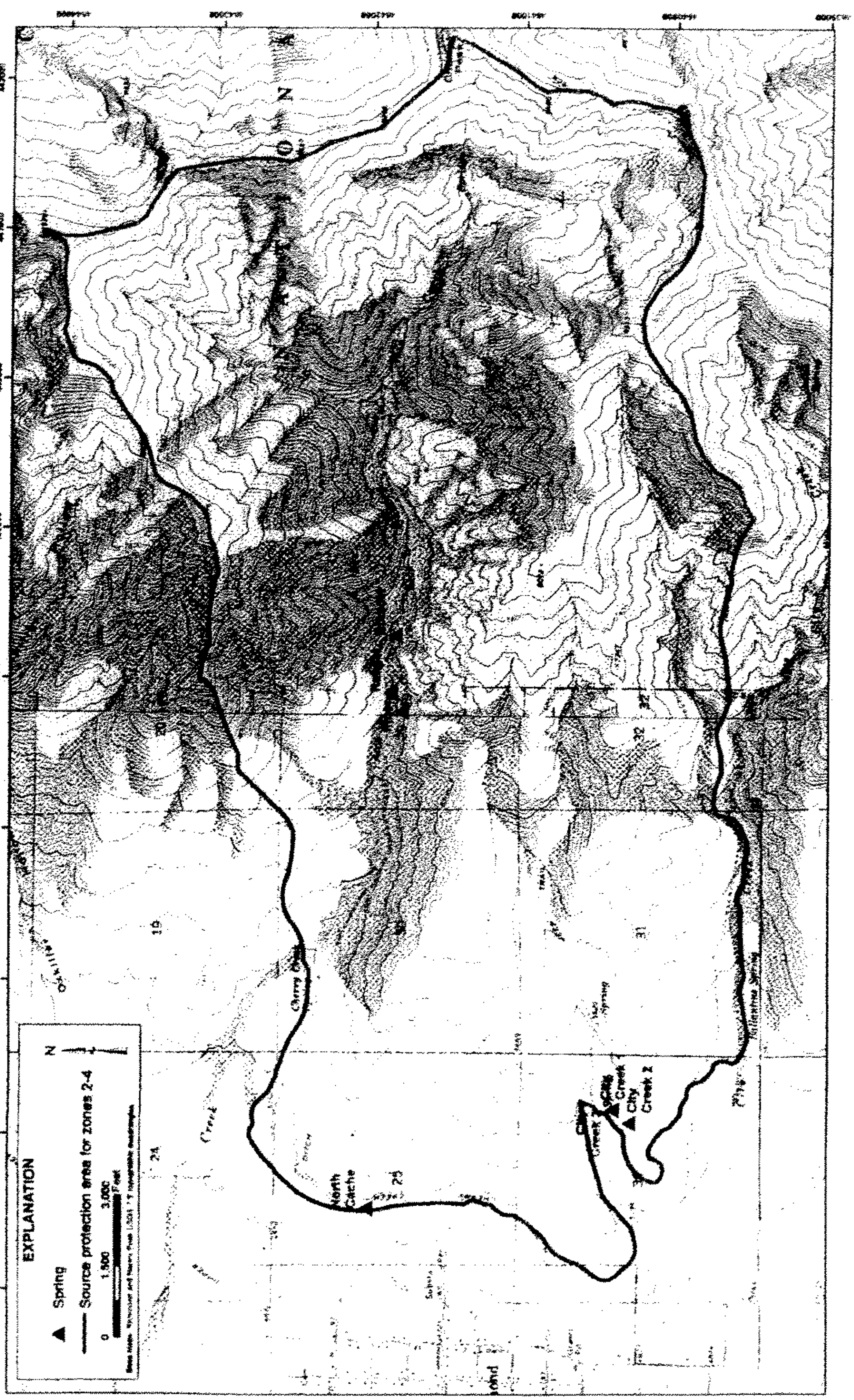

FIGURE 1
Source Protection Zone - Cherry Creek Springs WS-001 and City Creek Springs WS-002
"North Cache Springs" is for irrigation only, not included in the Culinary Water Source

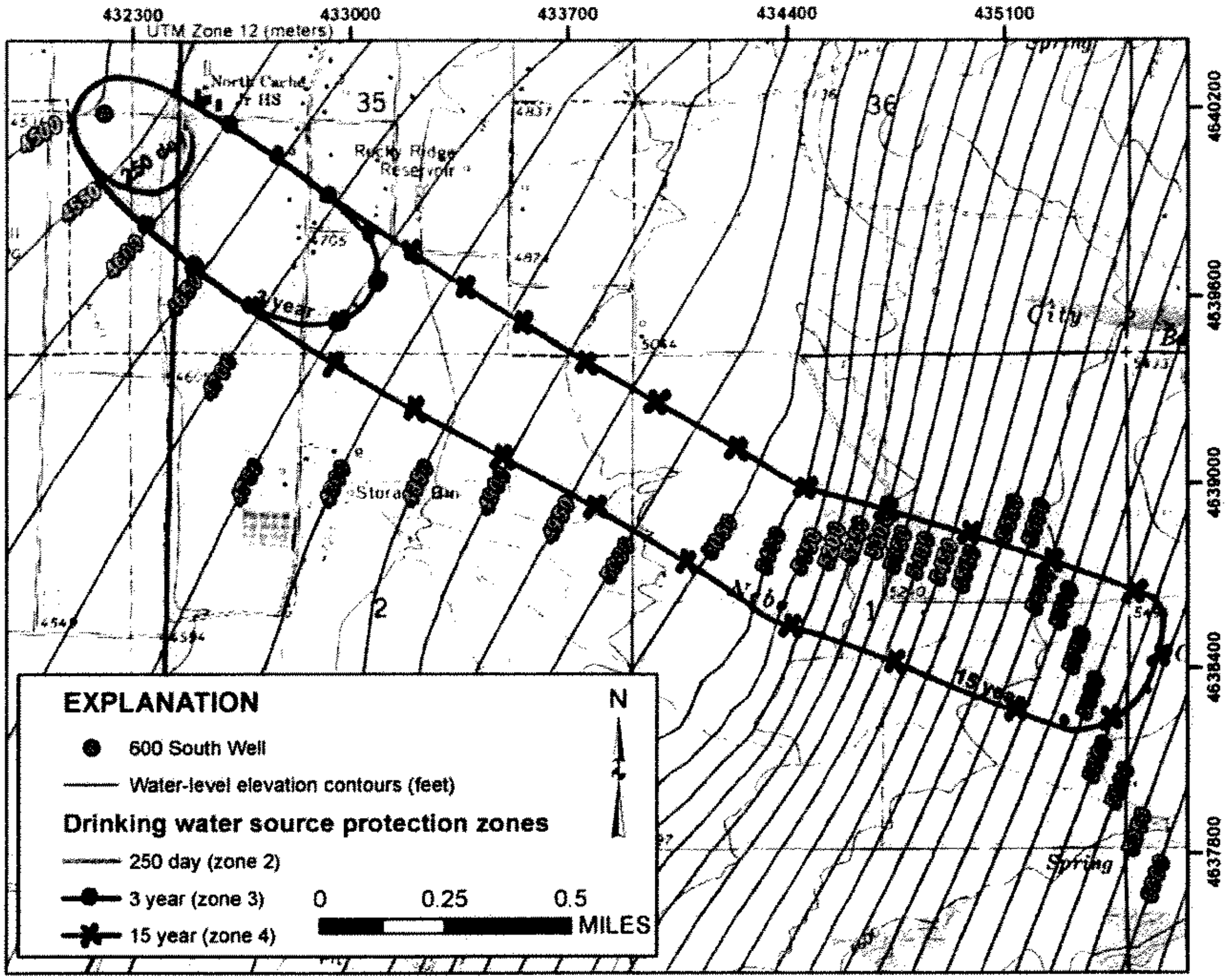

FIGURE 2
600 South Well - WS-003

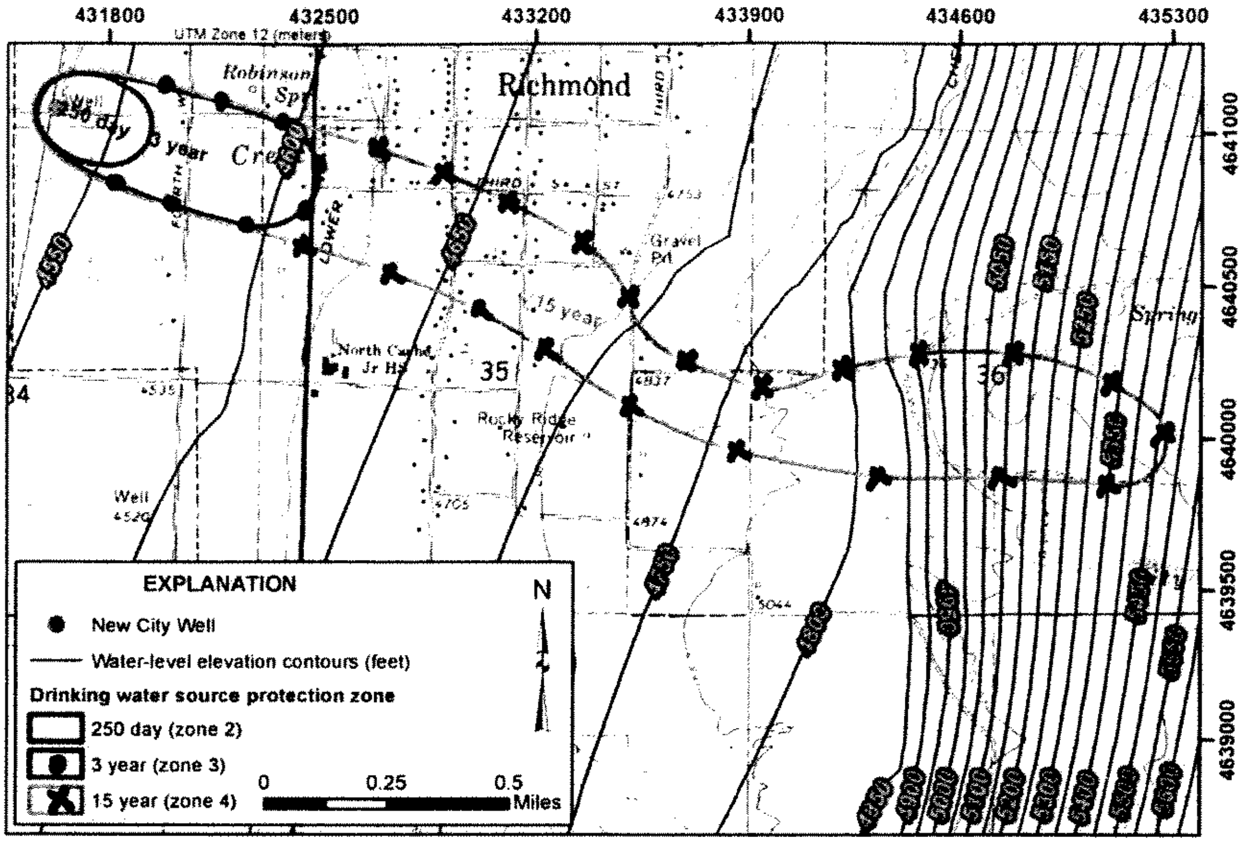

FIGURE 3
WCDI or Dairy Well (mis-labeled on map as "New CityWell"

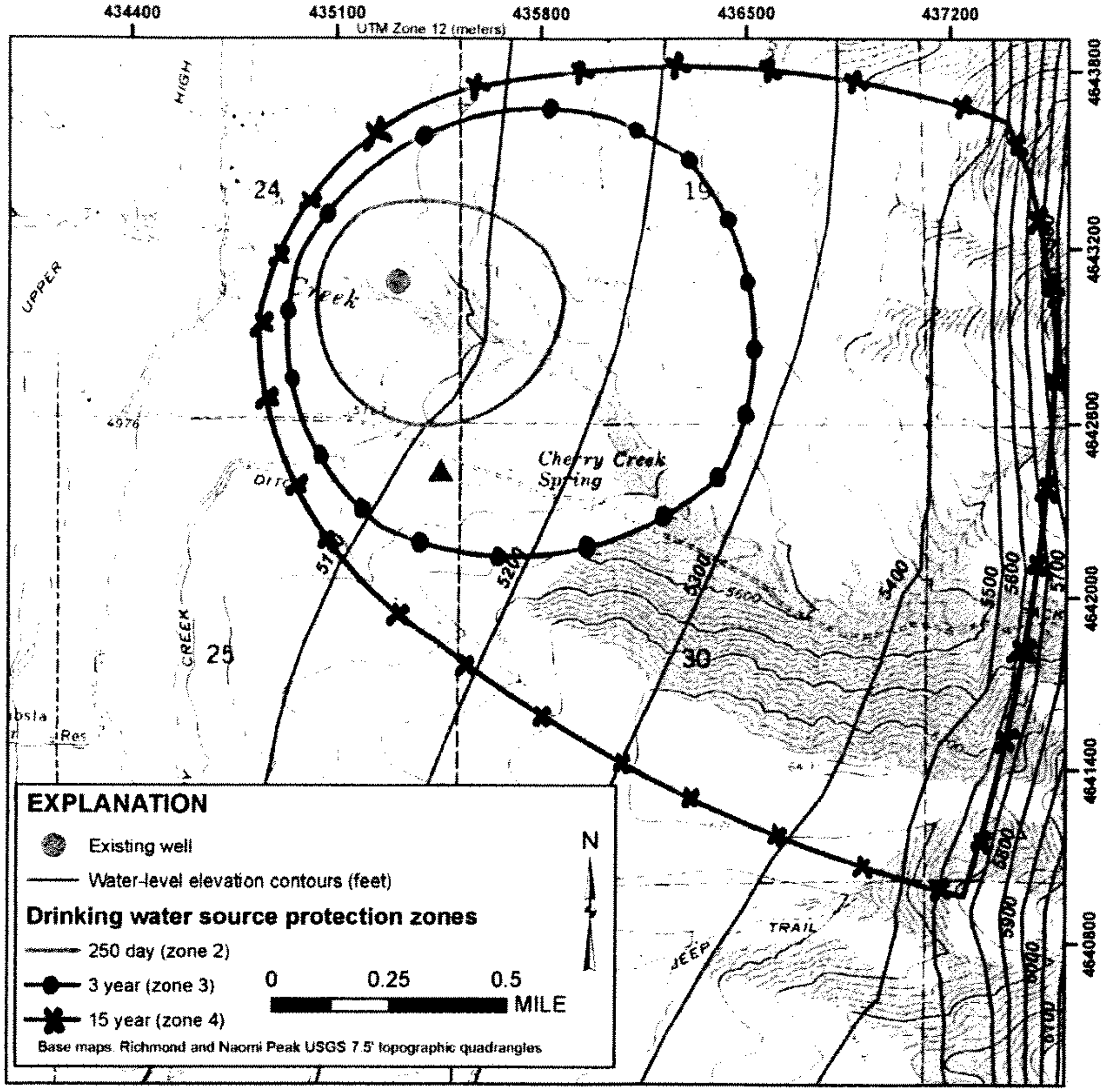

FIGURE 4
Cherry Creek Well
This is a currently non-permitted well that is scheduled to be brought up to Municipal Culinary Standards and eventually incorporated into the system with an as yet to be designated WS number.

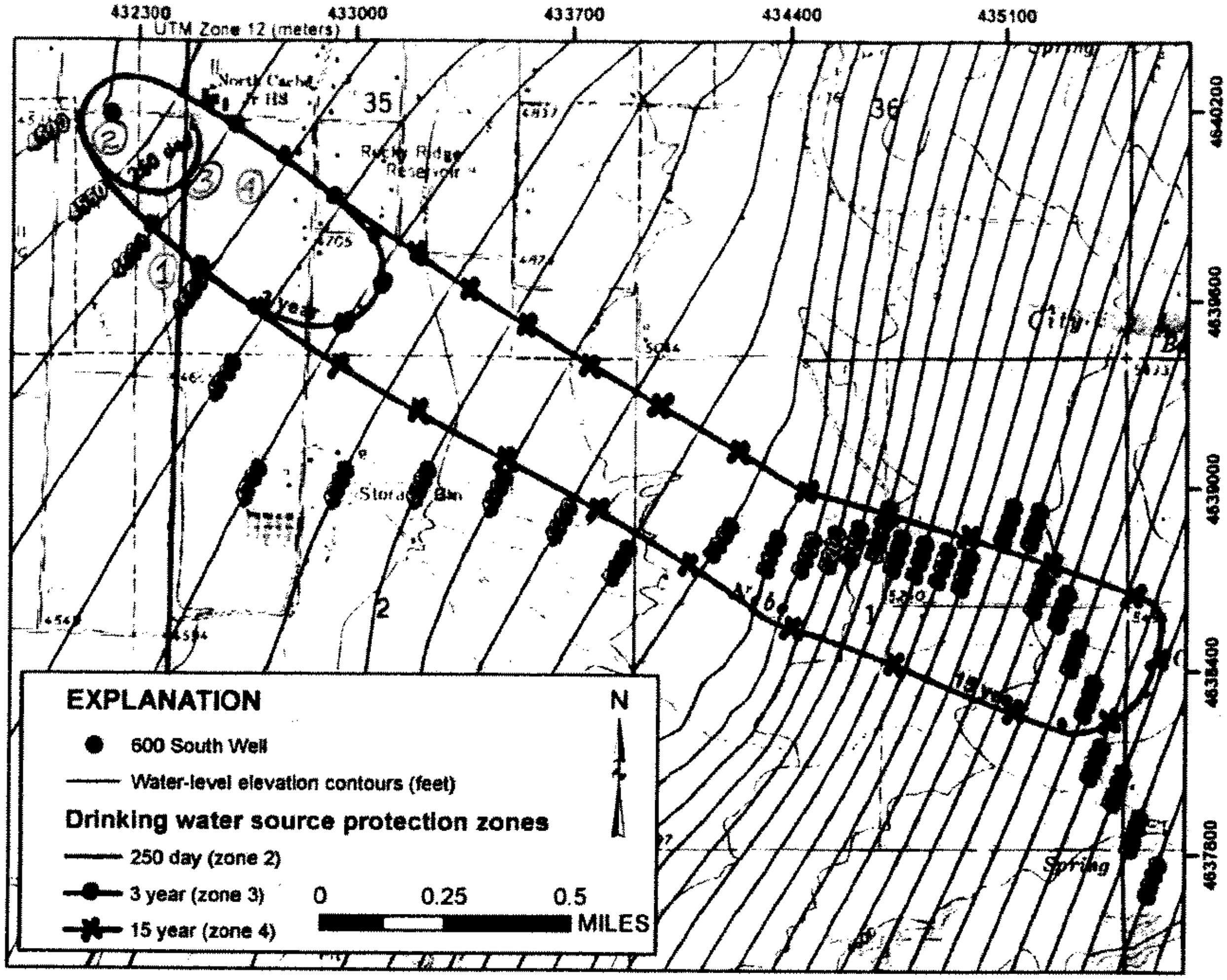

FIGURE 5
600 South Well - WS-003 Potential Hazards Locations
1 - U. S. 91
2 - Ogden Dairy
3 - Lower Foods, Inc.
4 - Alpine Industries
5 - Municipal sewer system throughout the City limits

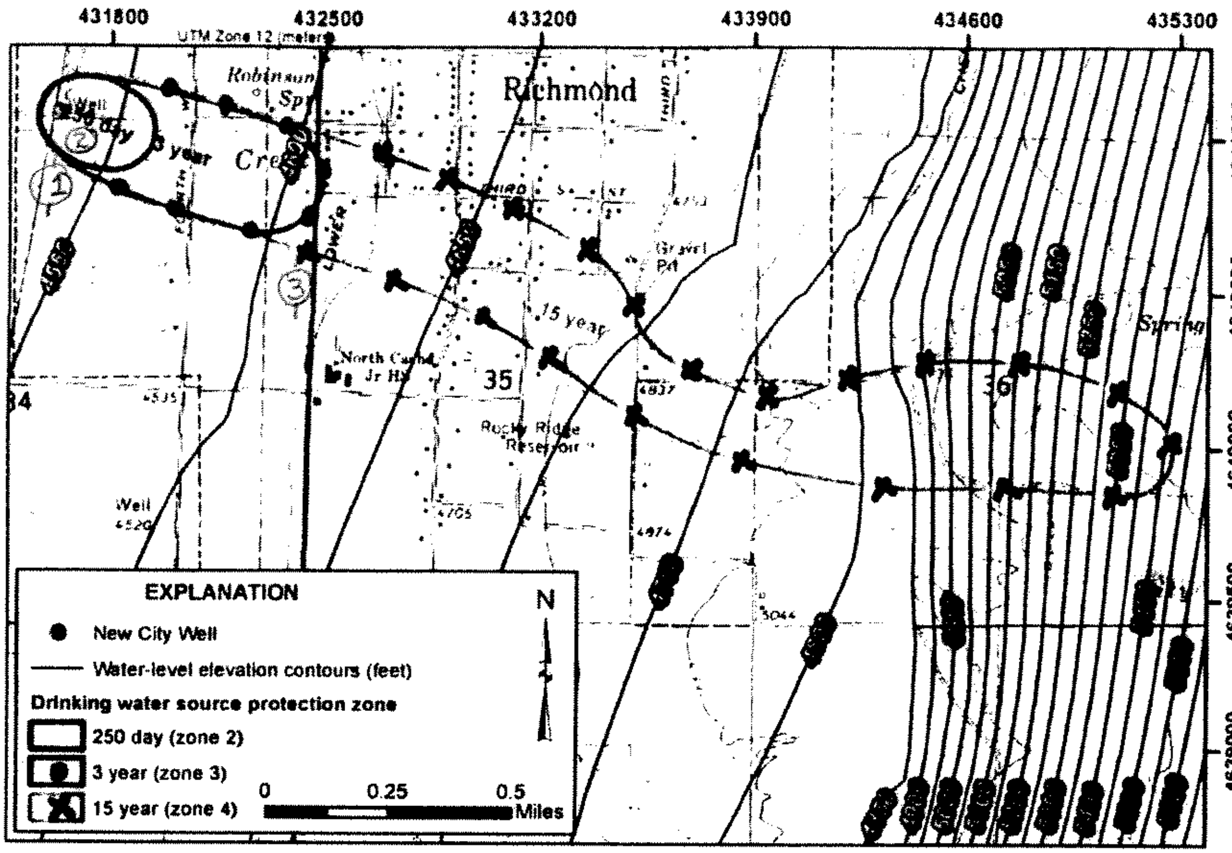

FIGURE 6
WCDI or Dairy Well - WS-004 Potential Hazards Locations

1 - Union Pacific Railroad tracks
2 - Abandoned cattle feed lot (abandoned 1999)
3 - U. S. 91
4 - Municipal sewer system throughout the City limits

Upon passage of this ordinance, Richmond City Ordinance 2000-1, 2002-4, and 2010-4 are deemed historic.

ADOPTED AND PASSED by the Richmond City Council this 18th day of October, 2011.

____
Michael E. Hall
Mayor

ATTEST:

____
Justin B. Lewis
Recorder

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Posting Date: October 18, 2011

CERTIFICATE OF DUE POSTING

I, Justin B. Lewis, City Recorder of Richmond, Cache County, Utah, do hereby certify that on the 18th day of October, 2011, in the City of Richmond, County of Cache, State of Utah, was posted the foregoing Ordinance 2011-6 in a likely manner, a copy of which is hereunto attached, in each of the three most public places in the said City of Richmond, to wit:

1. Richmond City Office.
2. Richmond Public Library.
3. Richmond City Post Office.

WITNESS my hand this 18th day of October, 2011.

____
Justin B. Lewis
Richmond City Recorder