Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Matthew H. Mead, Governor **Todd Parfitt, Director**

Date: May 14, 2014

Thomas McLaughlin, Ph.D.,
Project Manager
U. S. Nuclear Regulatory Commission
Mail Stop T-8F5
Washington, DC 20555-0001

RE: ANC Tailing Pond 1 Analysis, ANC Reclamation Project, Mine Permit 352 (forfeited)

Dear Dr. Mclaughlin:

As discussed, enclosed is the final report prepared by the Land Quality Division, Department of Environmental Quality, Wyoming on the ANC tailing pond 1 analysis. Please feel free to contact me should you have any questions regarding the report.

Sincerely,

M. P. Muthu
May 14, 2014

Muthu Kuchanur
Geology Supervisor
Land Quality Division

Enclosure: Report on summary of ANC tailing pond 1 analysis

cc: File (Permit 352, forfeited)
Tanya King, District 2 Supervisor, Lander

SUMMARY OF ANC TAILING POND 1 ANALYSIS

Prepared by

Wyoming Department of Environmental Quality

Land Quality Division

Cheyenne, Wyoming

May 5, 2014

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SUMMARY OF THE ANC TAILING POND 1 ANALYSIS

1. BACKGROUND:

The American Nuclear Corporation (ANC) Uranium Mill Tailings Site is located in Gas Hills, eastern Fremont County, Wyoming. The Site is about 45 miles east of Riverton and about 70 miles west of Casper. The ANC permit boundary is about 550 acres and has two tailing ponds, Tailing Pond 1 and Tailing Pond 2. Tailing Pond 1 is about 40 acres and Tailing Pond 2 is about 120 acres (Figure 1). The ANC mill operated from 1960 through 1982. Some of the closure activities conducted include:

a. 1983 – Willow Springs Draw diversion around Tailing Pond 2
b. 1988 – Interim cover was placed in Tailing Pond 1
c. 1989 – The mill was decommissioned and buried at the south end of Tailing Pond 2
d. 1990 – Interim cover was placed in Tailing Pond 2

ANC became insolvent and forfeited its reclamation performance bond (Permit 352) in October 1994. The Wyoming Department of Environmental Quality Land Quality Division (WDEQ/LQD) subsequently assumed responsibility for redesigning and implementing the closure plan for the Site. A confirmatory order between NRC and the WDEQ describing the requirements for reclamation activities was agreed upon by both parties and was issued in October 1996. Tailings Pond 2 reclamation activities were completed and approved by NRC in February 1998. The tailings at the Site have mixed private and federal tailings and therefore, the Site closure work qualifies for reimbursement of closure funds under Title X of the Energy Policy Act. The ANC tailings are 36.7 percent federal tailings. Pathfinder Lucky Mc uranium mine (Pemit 356C) is located about one mile northeast of ANC (Figure 1). ANC conducted investigations on the seepage from Tailing Pond 1 in 1979 and 1989. In addition, the LQD performed an investigation in 1997.

2. OBJECTIVES

The two primary objectives of this study are:

1. Determine the current extent of the groundwater contamination
    - Evaluate the data adequacy and availability to characterize the current extent of the groundwater contamination
2. Outline the potential next steps for the discussion on Site remediation

3. HYDROGEOLOGY

Poorly differentiated hydrostratigraphic units of the Wind River Formation underlie the tailing ponds. The upper Wind River Formation overlies the lower Wind River Formation disconformably at the Site. The upper Wind River Formation comprises of sandstones, granite-pebble conglomerates and lenses of siltstone and mudstone. The lower Wind River Formation is composed predominantly of fine-grained sandstone, clay-stones and siltstones with interbedded lenses of coarser of materials. The entire formation dips slightly in a southwesterly direction. The ANC Site is drained by ephemeral

Willow Springs Draw, which flows to the north and northwest to Muskrat Creek, which is a tributary to the Wind River. Two minor draws to the north of Tailing Pond 1, the Gas Draw (west) and FAP Draw (east) drain to the Willow Springs Draw. Near the tailing ponds, alluvial deposits of Willow Springs Draw are present. The 500K bedrock geology map from Wyoming State Geological Survey (WSGS) indicates the approximate extent of alluvial deposits. Given the coarser scale of the map, it does not exactly delineate the alluvium in the Gas and FAP draws (Figure 10). Approximately one mile north of the tailing ponds, the upper Wind River Formation is removed by erosion. Alluvium of the Willow Springs Draw lies directly on the lower Wind River Formation. Evidences of groundwater discharge are observed at Willow Springs, approximately 3,500 feet north of Tailing Pond 2.

4. PUMP BACK CONTROL SYSTEM

A pump back system was installed in the early 1980's to help control the migration of the contamination from the tailings. The pump back system has been operating for about five months a year for the past 33 years. Groundwater is pumped from well R4 and the pumped water is sprayed along the west side of Tailing Pond 1 through six sprayers. The pump back system pumps about an average of 400,000 gallons per year (~1.2 acre-feet per year).

5. MONITORING NETWORK

There are 16 existing groundwater monitor wells. Monitor well depths range from 35 (MW-2 and MW-17) to 105 feet (MW-1) (Figure 12). Typically, the bottom ten feet of these wells is screened. Well logs are not available for the monitor wells. The earliest available water level data is from September 1989. On an average, 12 samples were collected from each monitor well. It is important to note that not all the wells were sampled during each sampling event. In addition, not all the water quality parameters were analyzed from each collected sample.

Out of the 16 wells, three wells (MW-15, MW-16 and MW-17) were drilled in 2001 and the data from these wells are available from April 2002. There are two surface water stations: Willow Springs South and Willow Springs North (Figure 2). Willow Springs South has water quality data from 1979 to the present and Willow Springs North has water quality data from 1997 to the present. Surface water flows were not measured at both the stations. There are no other existing monitor wells except MW-14A down gradient of Tailing Pond 2. Therefore, it is difficult to address the possibility of any seepage to groundwater from Tailing Pond 2.

6. WATER LEVELS

Hydrographs of the exisiting 16 wells show that the general fluctuations at all these wells are less than about 2 feet during the past 24 years (Figure 2). Therefore, an average groundwater level was calculated from each well and was used to construct a potentiometric surface that is representative of the average groundwater level conditions at the Site. Figure 2 also shows the hydrographs for select monitor wells. The general flow direction follows the topography to the north and the hydraulic gradient is approximately 0.027 feet/feet. During the operation of the mill, the rate of discharge to the Tailing Pond 1 was higher than the rate of ambient groundwater flow. Therefore, a groundwater mound would have formed below the Tailing Ponds. However, Figure 2 does not show any indication of a mounding near Tailing Pond 1. Therefore, if there was any groundwater mound, it must have dissipated before 1989.

Pumping well R-4 as part of the pump-back control system is in operation for the past 30 years. However, hydrographs of the adjacent wells do not show any drawdown trends that are indicative of R-4 pumping. In addition, there is no observed cone of depression that is centered on well R-4. The lack of drawdown in the hydrographs and a cone of depression caused by well R-4 pumping, warrants a detailed analysis on the effectiveness of the pump-back control system. There are no readily available well logs for the monitor wells and well R-4. Therefore, it is not clear if well R-4 is screened in the same hydrostratigraphic zone as the monitor wells.

7. WATER QUALITY

About 45 groundwater quality parameters were analyzed from the samples collected from the monitor wells. Chloride was selected as a good indicator of the groundwater contamination and its migration for the following three reasons:

a. Chloride is a conservative analyte. Physical or chemical processes in the groundwater do not typically retard its movement. It is expected that chloride will move at the same velocity as groundwater.
b. There are no significant, identified natural sources of chloride in the Gas Hills area. Therefore, chloride was likely added to the groundwater through the seepage from the tailing ponds.
c. Every water quality sample collected was analyzed for chloride. For example, radium or uranium was not analyzed for all the collected samples.

Other constituents like sulfate, radium, gross alpha and uranium were also considered to make sure the interpreted extent of the contamination using chloride as the indicator is conservative. In other words, all available water quality data was considered and analysed to make sure that the usage of any other water quality parameter as a contamination indicator will not result in a more extensive groundwater plume.

7.1 CHLORIDE CONCENTRATIONS - 1989

The baseline water quality that existed before the mine is not known. The earliest readily available data for the existing monitor wells is 1989. It is important to note that the groundwater and surface water discharges might have already been contaminated with the seepage from the tailing ponds pre-1989. Twelve out of the 16 existing monitor wells and the Willow Springs South surface water station had chloride concentrations measured in 1989. MW-14A, MW-17, MW-15 and MW-16 are the four wells that did not have measured chloride concentrations in 1989.

The lowest 1989 chloride concentration is 16.9 mg/l at MW-9. The wells in Group 1 (Section 7.2) show chloride concentrations less than 20 mg/l during the period of record. Therefore, it is conceivable the background chloride concentration near Tailing Pond 1 is about 10 to 20 mg/l. The interpreted extent of the groundwater contamination using chloride as an indicator is depicted in Figure 3. Figure 3 shows the possibility that the seepage migrated northward from the tailing ponds along heterogeneities within the Alluvium indicating zones of higher hydraulic conductivity. The lack of well logs and characterization of the aquifer properties are not of sufficient detail to delineate these zones of higher hydraulic conductivity. Ten out of the 12 wells (except MW-3 and MW-9) show chloride concentrations that are higher than the estimated background concentrations. The extent of the groundwater contamination between the FAP draw and the Willow Springs cannot be delineated with certainty, as there are no monitor wells in that area. Dashed lines in Figure 3 represent the uncertainty in the interpretation of the extent of the groundwater contamination.

The gaging station at Willow Springs has the longest period of record starting from 1979. The lowest measured chloride concentration at Willow Spring South is 35 mg/l in 1980. It is possible that the contamination migrated from the Tailing Ponds to Willow Springs before 1980. Therefore, it is conceivable the background chloride concentrations in Willow Springs are similar to the background groundwater chloride concentrations of about 10 to 20 mg/l. No water quality samples were collected at Willow Springs North gaging station until 1997.

In addition to the subsurface transport of the groundwater contamination, the contaminated groundwater also discharges to the surface along Willow Springs. Once the groundwater contamination emanates to the surface, then the contaminants will migrate at a faster rate than subsurface contaminant migration. It is a strong possibility that seasonal runoff events would have transported the contaminants downstream along Willow Springs at a greater velocity.

Given the lack of well logs and wells at different depths at the same location, the vertical extent of the groundwater contamination is unknown.

7.2 CHLORIDE CONCENTRATIONS - 2013

The interpreted extent of the groundwater contamination as of 2013 is shown in Figure 4. Dashed lines in Figure 4 represent the uncertainty in the interpretation of the extent of the groundwater contamination. Based on the plots of chloride concentration over time, the existing 15 wells (MW-5 has only two samples) and the surface water stations were grouped into five categories for ease of presentation and analysis.

- Group 1 (MW-3, MW-9, MW-17 and MW-14A) – The chloride concentration of wells under this group are generally in between 5 and 30 mg/l. These four wells have relatively stable chloride concentrations since 1989. MW-17 had the lowest chloride concentration of 5.7 mg/l measured in 2002. MW-14A had the highest chloride concentration of 28.2 mgl/ measured in 2002. The three wells: MW-3, MW-9 and MW-17 are located in between the Gas and FAP draws and appear to be not affected by the groundwater groundwater contamination. Additional investigations are needed to confirm the presence or absence of Willow Springs Alluvium in this area between the draws (Figure 4).

- Group 2 (MW-2, MW-6, MW-10, MW-15 and MW-16) - The chloride concentration of wells under this group are in general more than 50 mg/l. These five wells have relatively stable chloride concentrations since 1989. MW-16 had the lowest chloride concentration of 70 mg/l measured in 2002. MW-2 had the highest chloride concentration of 351 mgl/ measured in 2011.No significant consistent trends observed in the chloride concentrations at these wells. There is a slight upward trend in the chloride concentrations at wells MW-15 and MW-16 since 2009. Additional measurements are needed to determine if the chloride concentrations are showing a consistent increase with time and if this is an indicator of groundwater contamination migration further north-west from these wells.

- Group 3 (MW-11 and MW-13) - The chloride concentration of wells under this group have showed a consistent increase since 1989. MW-11 and MW-13 are located to the west of Gas draw. The chloride concentration at MW-11 has increased from 63 mg/l in 1989 to 129 mg/l in 2013. The chloride concentration at MW-13 has increased from 24 mg/l in 1989 to 113 mg/l in 2013. Both the wells show relatively stable concentrations since 2010. However, additional measurements are needed to evaluate if this is temporary.

- Group 4 (R-4, MW-1, MW-4 and MW-7) - The chloride concentration of wells under this group have showed an overall declining trend since 1989. R-4 showed the maximum decline of more than 100 mg/l among all the wells.

- Group 5 (Surface water stations – Willow Springs North and Willow Springs South) – The chloride concentrations at Willow Springs South showed a steady increase from 1980 to about 1992 and started showing a declining trend from 1992 to the present. The chloride concentrations measured in 2013 at Willow Springs North are similar to the chloride concentrations in the early 1980's. Twelve water quality samples were collected at Willow Springs North since 1997. This limited data indicates that the observed general trend and the magnitude of the chloride concentrations at Willow Springs North are very similar to Willow Springs South. This is a potential indication, that the contaminants were transported through surface water with a greater velocity than an exclusive subsurface transport of the groundwater contamination.

The interpreted extent of the groundwater contamination using the available data is presented below.

8. INTERPRETED EXTENT OF THE GROUNDWATER CONTAMINATION - 2013

The chloride concentrations in the 16 existing groundwater wells and the two surface water gaging stations show that the elevated chloride concentrations greater than 20 mg/l is an indicator of groundwater contamination from the Tailing Ponds. The area between Gas and FAP draws (MW-3, MW-9 and MW-17) appears not to be impacted by the groundwater contamination. The western extent of the groundwater contamination is at least until MW-11 and MW-13. The eastern extent of the groundwater contamination is until at least the Willow Springs Draw. The northern extent of the groundwater contamination is until at least MW-16 (Figure 4).

An effort was made to delineate the current extent of the groundwater contamination (Figure 4). Given the uncertainty in the geologic characterization and lack of groundwater data multiple evidences were used in guiding the interpretation of the current extent of the groundwater contamination including:

8.1 OTHER WATER QUALITY PARAMETERS

Sulfate was also used as an indicator of the groundwater seepage from the Tailing Ponds. Analysis of background and current sulfate concentrations were carried out in a similar manner to the analysis of chloride (Section 7). The lowest observed sulfate concentration in 1989 was 733 mg/l observed at MW-3. It is conceivable the background sulfate concentration in the vicinity of Tailing Pond 1 is less than 700 mg/l. In addition, MW-9, MW-17 and MW-14A have measured sulfate concentrations less than 700 mg/l during the period of record. Similar to the chloride contours, the 1989 sulfate contours (Figure 5) show potential migration through the high permeable aquifer materials along the Gas and FAP draws. The extent and magnitude of sulfate concentrations relative to chloride appears to be retarded and it is not uncommon for sulfate transport to be slower than chloride under certain geologic conditions.

The interpreted extent of the groundwater contamination using sulfate as an indicator as of 2013 is shown in Figure 6. Dashed lines in figure 6 represent the uncertainty in the interpretation of the extent of the groundwater contamination. In general, the well groups and their sulfate concentrations are consistent with the interpretation of the groundwater contamination using chloride as the indicator.

Gross alpha, Radium 226+ Radium 228 and Uranium were also considered in the delineation of the groundwater contamination. Given the variability in these parameters, the limited number of samples and other factors, detailed analyses similar to chloride and sulfates were not conducted. However, summary tables and time series plots of the each of these parameters (Figures 7, 8 and 9) were analyzed to make sure these water quality parameters are consistent with the interpreted extent of the groundwater contamination.

Irrespective of the water quality parameter used, the interpreted extent of the groundwater contamination using chloride as an indicator appeared to be conservative. In other words, usage of any other water quality parameters as a groundwater contamination indicator will not result in a more extensive plume.

8.2 GEOLOGY

The 500K bedrock geology map from WSGS indicates the approximate extent of alluvial deposits. Given the coarser scale of the map, it does not exactly delineate the alluvium in the Gas and FAP draws (Figure 10). Looked together with the interpreted extent of the groundwater contamination, it appears that the groundwater contamination primarily migrated through the more permeable Willow Creek Alluvium. About a mile north of MW-16, the alluvium thins out and is bounded by Cody shale. Typically, Cody shale is of lower permeability and therefore, the groundwater contamination might potentially be limited to the alluvial deposits. In addition, the alluvium north of MW-16 might be getting additional recharge from areas not impacted by the Tailing Ponds and therefore diluting the contaminants. However, additional investigations are needed to delineate the alluvium and the extent of the groundwater contamination.

8.3 TOPOGRAPHY

Topography often is used as a quick and preliminary method to identify shallow ground water flow patterns within the upper-most saturated interval. The presence of Willow Springs that flows most of the year indicate that the springs gets at least part of its flow from groundwater discharge. Though the local groundwater regime might be variable, the topography looked together with the chloride concentrations and geology appears to be a good indicator of the preferential migration of the groundwater contamination. The topography along the Gas, FAP and the Willow Springs draws indicate that the groundwater flow might potentially follow the topography along the more permeable alluvium. The topography (Figure 11) flattens immediately north of highway 136 (~ north of 6,300 feet topographic contour) where the alluvium also widens. Closer to the 6,180 feet msl topographic contour, the gradients are steep on either side of the Willow Springs Draw. This is also the area where the alluvium is absent or limited and is bound by the Cody Shale. Therefore, the topography presents insights that are consistent with the interpreted extent of the groundwater contamination using chloride concentrations.

8.4 VEGETATION

The 2011 satellite imagery map (Figure 12) shows the presence of vegetation along the alluvium and the draws. There is very minimal vegetation on areas where the Wind River Formation or Cody shale is at the top of the stratigraphy.

A collective look at the water quality parameters, geology, topography and vegetation support the reasonableness of the interpreted extent of the groundwater contamination that originated from the Tailing Ponds. However, it is important to acknowledge that this estimated extent of groundwater contamination is uncertain and needs to be verified in the field with additional data.

There are several unknowns to make a reasonable estimate of the groundwater groundwater contamination migration rate including: (i) baseline data, (ii) well logs, (iii) aquifer properties (hydraulic conductivity, porosity, storage etc.), (iv) details on the operation of the Tailing Ponds (amount of water seeped) and (v) adequate characterization of geology (extent of Willow Springs alluvium and Wind River Formation). Therefore, no estimates on the rate of migration of the groundwater groundwater contamination are presented in this report.

9. CONSTITUENTS OF CONCERN

It is important to establish restoration goals and understand the regulatory framework for remediating the Site. Assuming that the restoration goal is to meet the livestock use, a comparison of the September 2013 measurements against the Class III groundwater standards is presented in Table 1. The highlighted values in the table show the parameters that exceed the Class III groundwater standard. The parameters that exceed the standards are (i) Aluminum, (ii)Cadmium, (iii) Nitrate + Nitrite as Nitrogen, (iv) Selenium, (v) Sulfate, (vi) Total Dissolved Solids, (vii) pH, (viii) Radium 226 +Radium 228 and (ix) Gross alpha particle (including Ra 226 but excluding Radon and Uranium).

Monitor wells R-4, MW-1, MW-2 and MW-4 are within the ANC permit boundary. Though there are nine parameters that exceed the standards, not all of them are prevalent in the existing monitor network.

The contaminants that are prevalent in most monitor wells outside the permit boundary are (i) Sulfate, (ii) Radium 226 +Radium 228 and (iii) Gross alpha particle (including Ra 226 but excluding Radon and Uranium). In addition, the measure uranium concentrations in most wells exceed the EPA primary drinking water standard of 0.03 mg/l. Therefore, these are the four primary groundwater constituents of concern (COC).

The Water Quality Division (WQD) of WDEQ has classified the Willow Springs Draw as Class 4B. Additional details on the classification by the WQD can be found at http://deq.state.wy.us/wqd/watershed/surfacestandards/Pages/Downloads/UAA/Willow_Springs/Complete%20UAA%20Report.pdf . Class 4B waters are intermittent and ephemeral stream channels that have been determined to lack the hydrologic potential to normally support and sustain aquatic life. The only standard that is applicable from the WQD surface water quality standards is that the the total radium-226 concentration shall not exceed 60 pCi/L (Page 1-20, Chapter 1, WQD retrieved from http://deq.state.wy.us/wqd/WQDrules/Chapter_01.pdf). Both the surface water gaging stations show total radium measurements less than 60 pCi/L.

Therefore, the constituents of concern at the Site and its vicinity are groundwater quality parameters and are not surface water.

10. RECOMMENDATIONS - POTENTIAL NEXT STEPS

The outlined four steps below are preliminary thoughts on the path forward and are intended to initiate further discussions in no particular order.

1. Understand the regulatory framework including the constituents of concern, restoration goals and reporting requirements of NRC. Develop an outline of the steps to be followed.

2. Characterize the Site with additional data including:
    a. Characterizing the extent of groundwater contamination by drilling additional wells and sampling additional surface water locations along the Willow Springs Draw
    b. Consult with NRC to select the required number and locations of these additional wells and surface water sampling locations.
    c. Geologic interpretation of the horizontal and vertical extent of the Alluvium in the Willow Springs Draw
    d. Recharge discharge relationships of the alluvial water in Willow Springs Draw to (i) the Wind River Formation; (ii) ANC tailings pond and (iii) upstream recharge from the Willow Springs Basin
    e. Hydrogeologic interpretation of the extent of the groundwater contamination

3. Consider eliminating the pump back control system. This recommendation is based on:
    a. Hydrographs of the adjacent wells near the R-4 pumping well do not show any drawdown trends that are indicative of R-4 pumping.
    b. There is no observed cone of depression that is centered on well R-4.

c. The observed concentrations of the groundwater quality parameters of interest at the farthest down gradient wells (Example: MW-15 and MW-16) are not showing any significant decreasing trends.

The above three observations cast significant doubts about the effectiveness of the pump-back control system. Therefore, it is recommended to shut down the pump back control system.

4. Prioritize the best use of the available funds for remediation at the Site including:
   a. Elimination or minimization of all factors that could lead to continued seepage including:
      i. Preventing upstream surface water flows reaching Tailing Pond 1
      ii. Divert the surface water drainage
      iii. Preventing any infiltration from precipitation events recharging the Tailing Pond
         - Cover/cap to prevent infiltration
         - Minimize wind-blown contamination
      iv. Installation of down gradient interceptor/treatment systems
         - Pump and treat systems
         - Permeable reactive barriers
         - in-situ chemical / bio remediation
         - Physical barriers
         - Phytoremediation

   b. Remediation of the existing down-gradient groundwater contamination

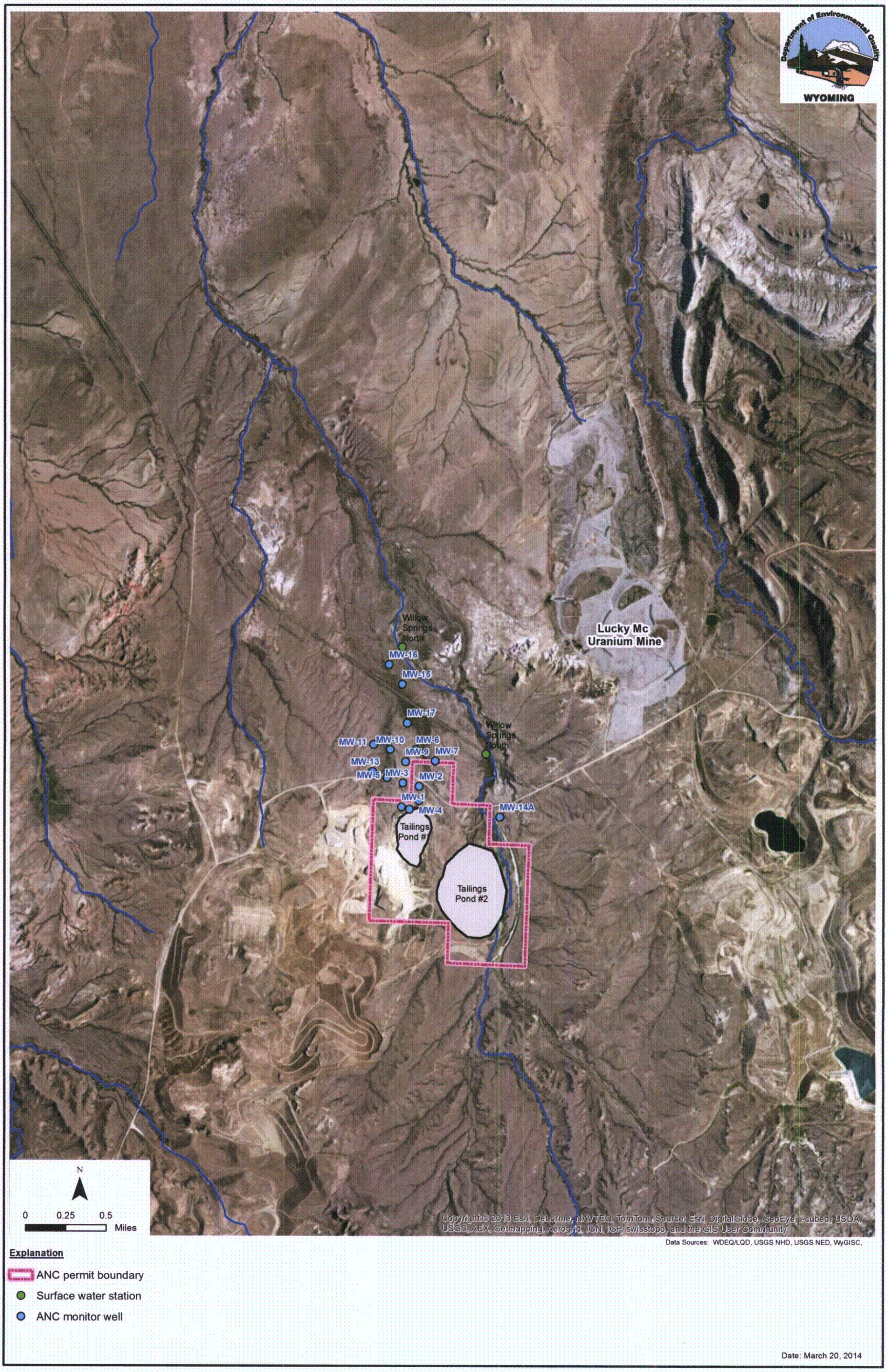


Figure 1: ANC site location

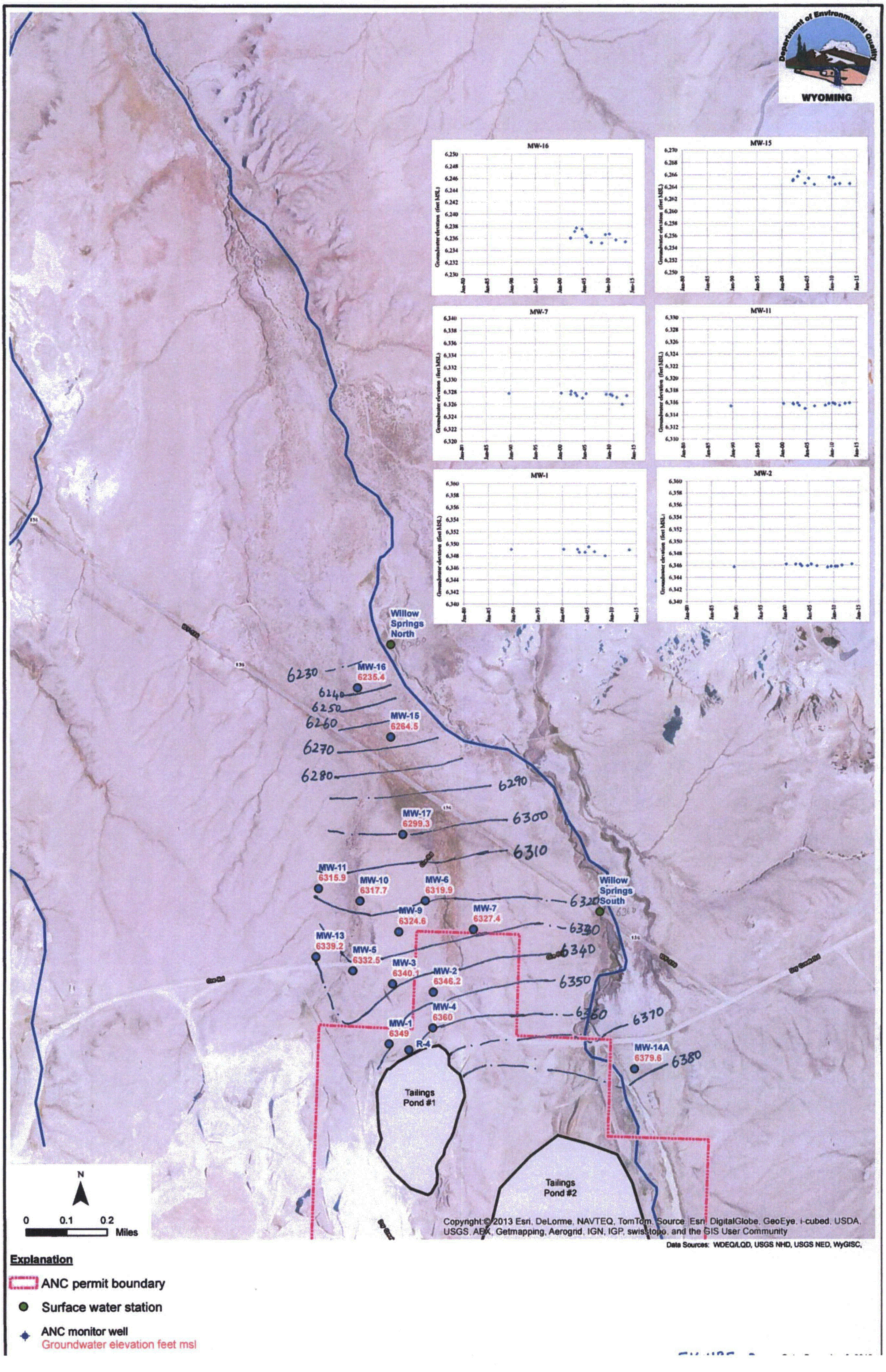


Figure 2 – Average potentiometric surface

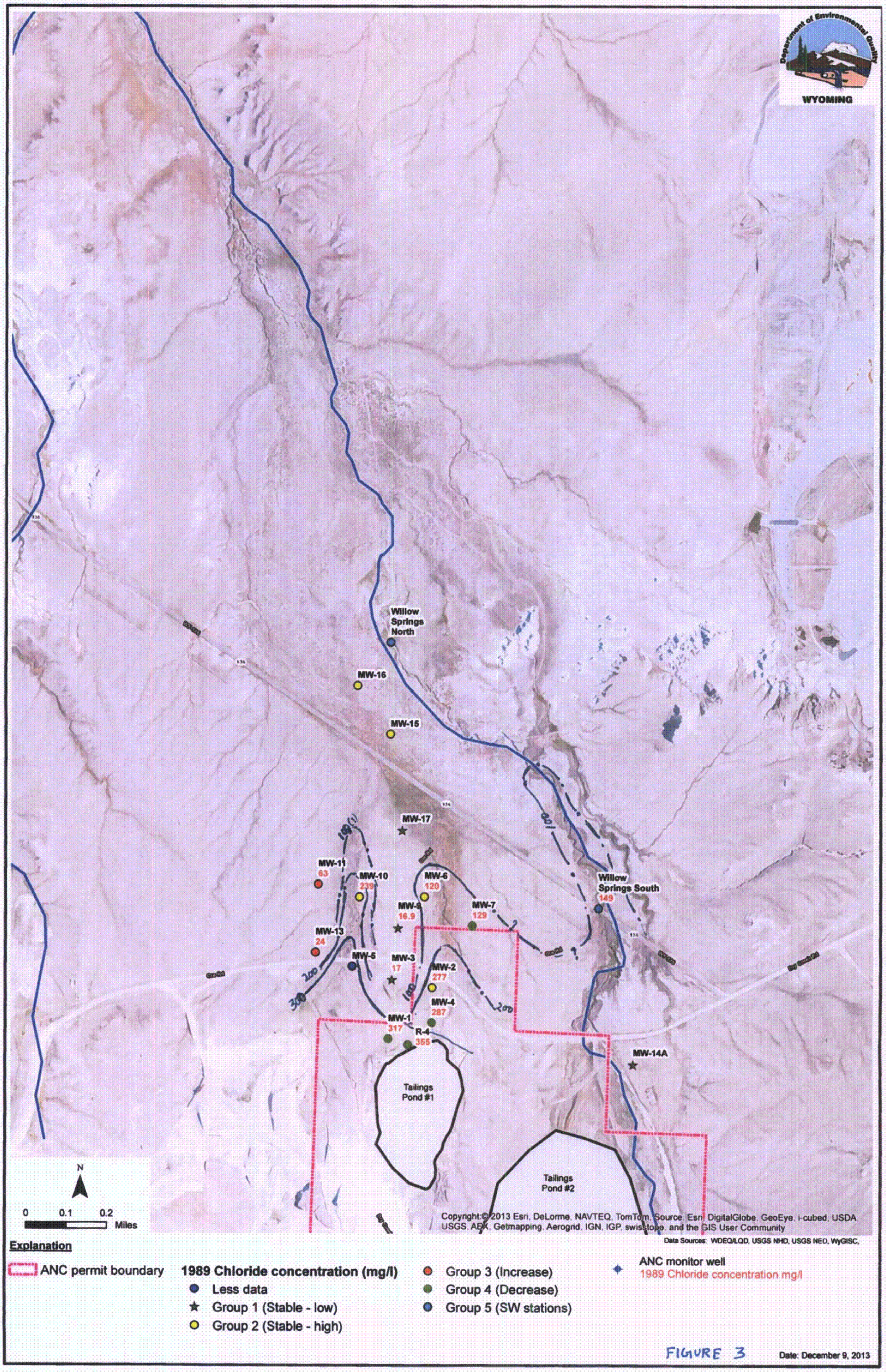


Figure 3 – 1989 chloride concentration

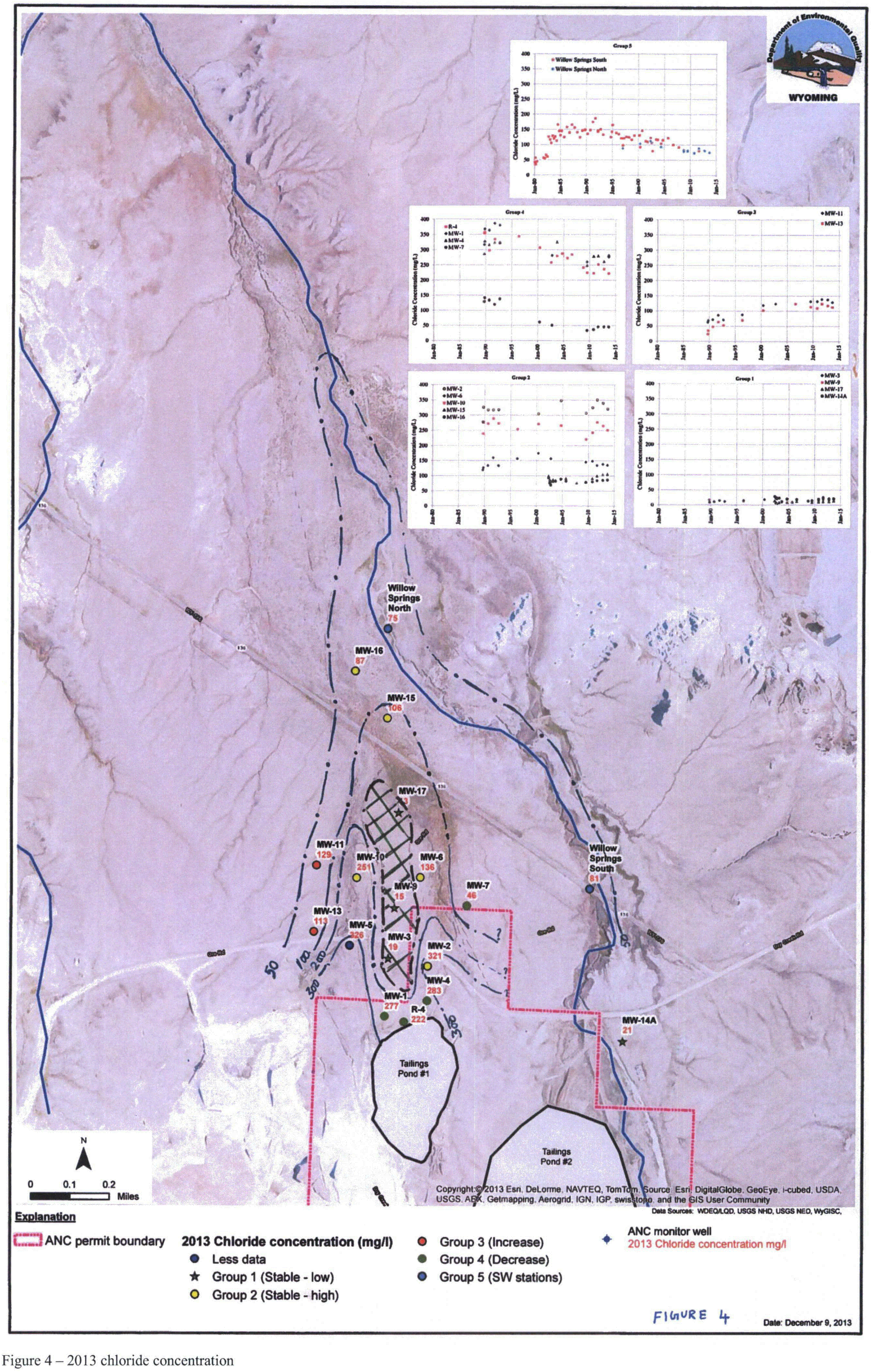


Figure 4 – 2013 chloride concentration

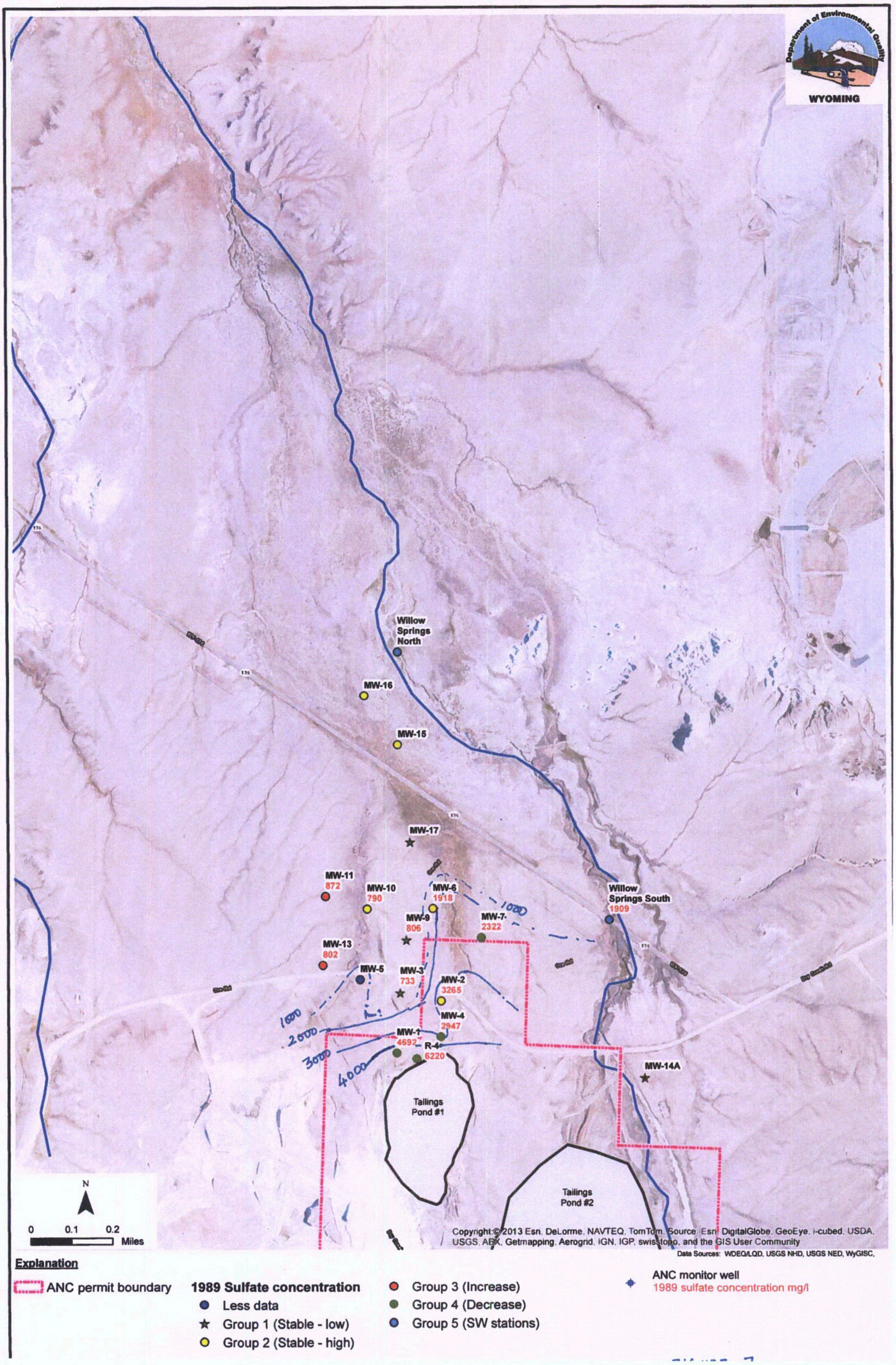


Figure 5 – 1989 sulfate concentration

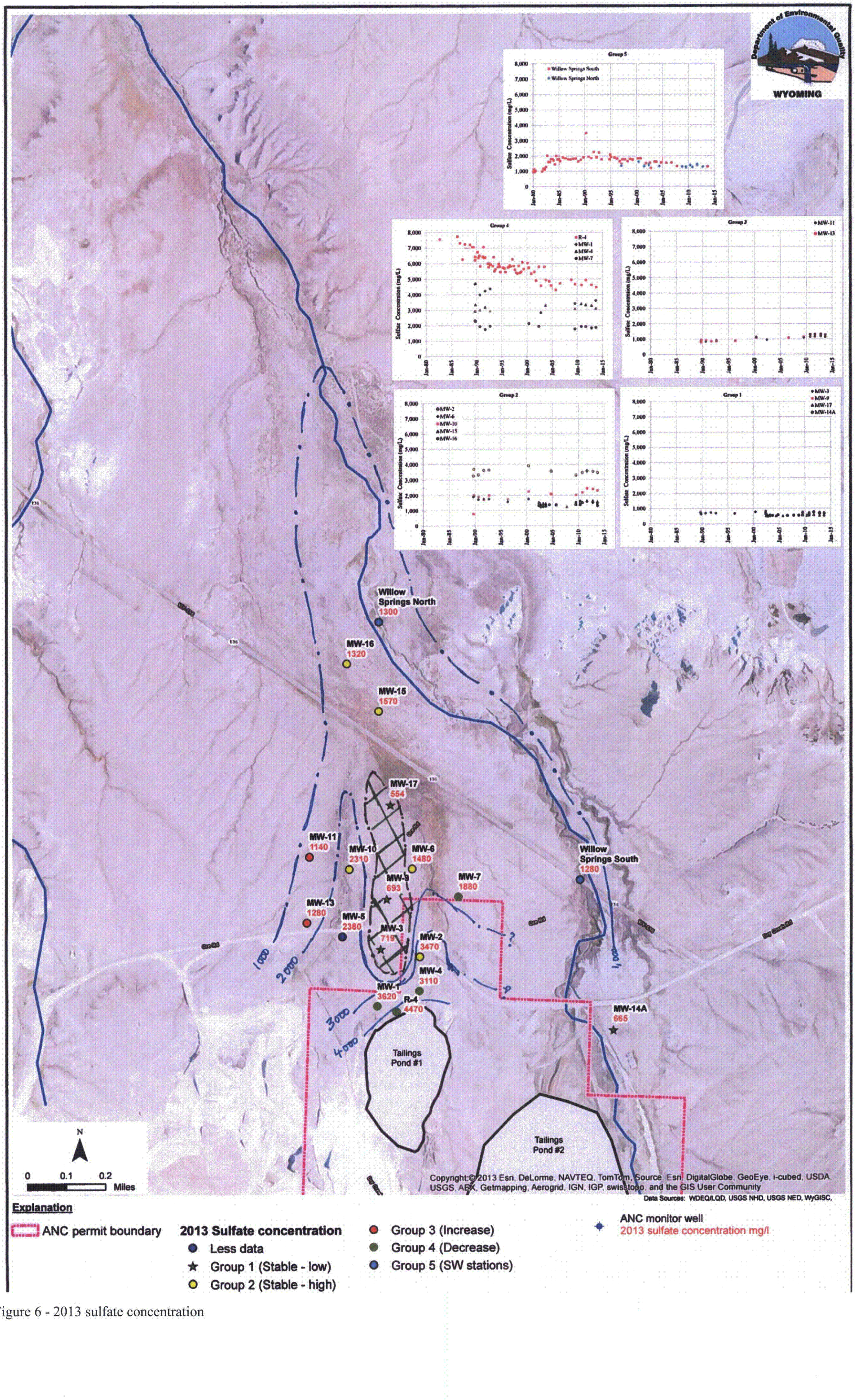


Figure 6 - 2013 sulfate concentration

Monitor well	Number of Samples		
	Chloride	Gross Alpha	Gross Alpha > 15 pCi/L
MW-1	8	7	7
MW-2	13	8	8
MW-3	13	7	4
MW-4	12	9	5
MW-5	2	1	1
MW-6	14	8	4
MW-7	13	8	3
MW-9	8	4	1
MW-10	13	8	3
MW-11	13	8	3
MW-12	12	6	4
MW-13	13	8	2
MW-14A	14	6	6
MW-15	13	5	5
MW-16	13	5	4
MW-17	13	3	0
R-4	79	35	35
Willow Springs North	12	3	3
Willow Springs South	79	6	6
Total	**357**	**145**	**104**

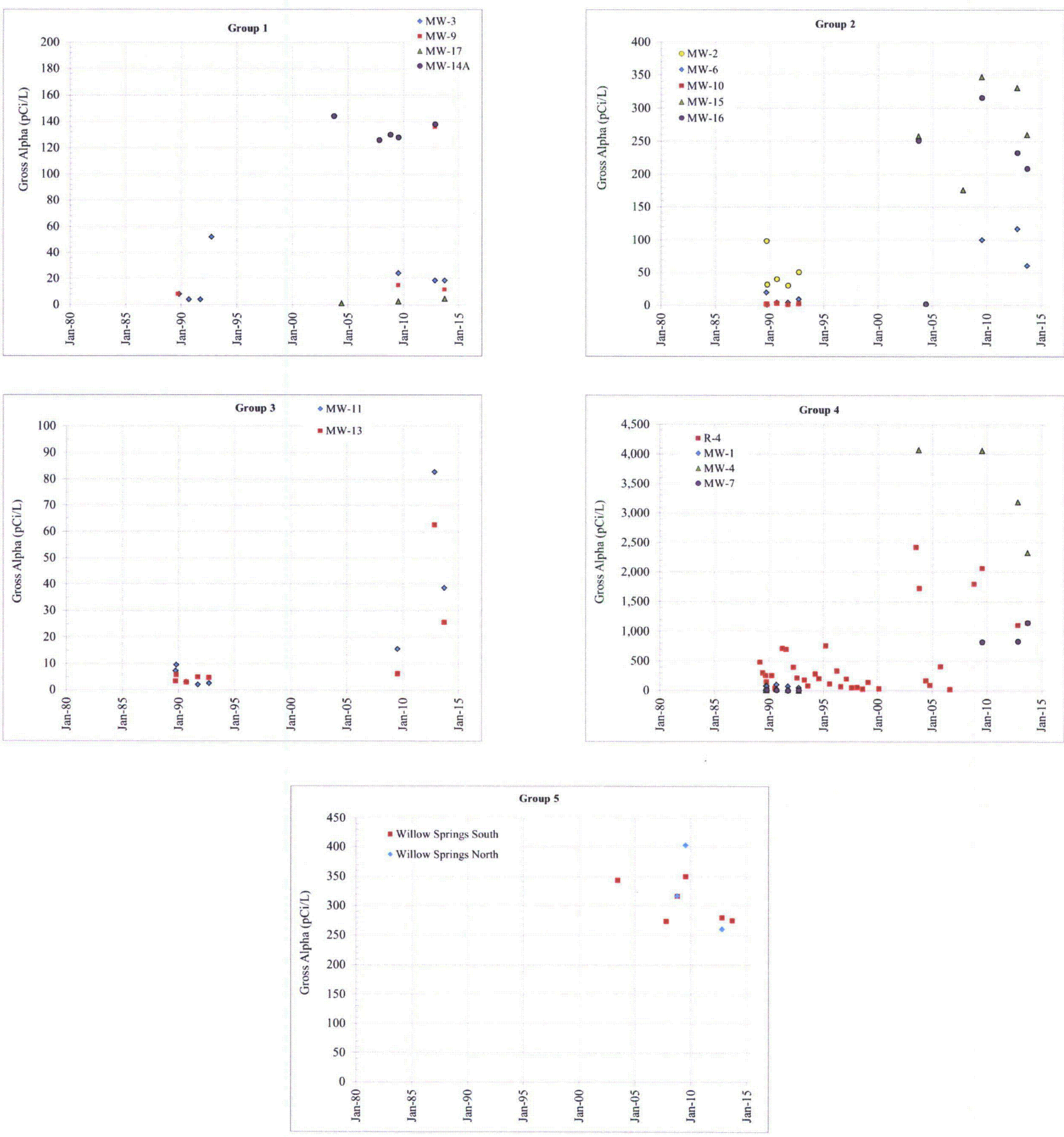
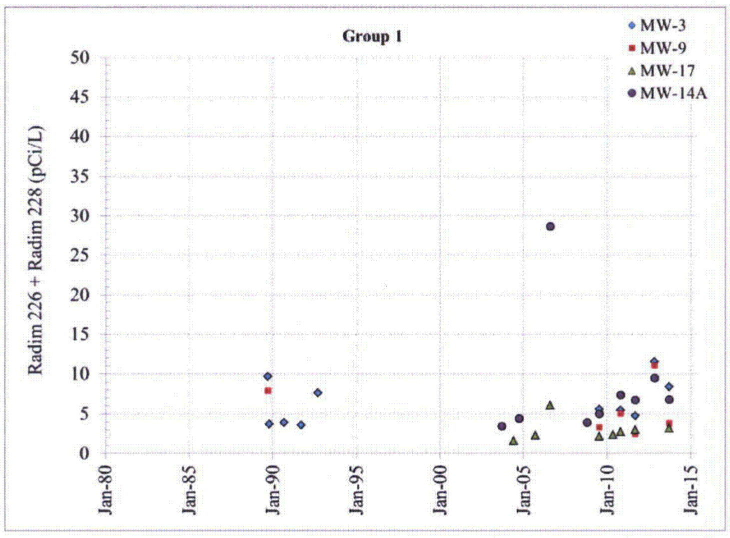
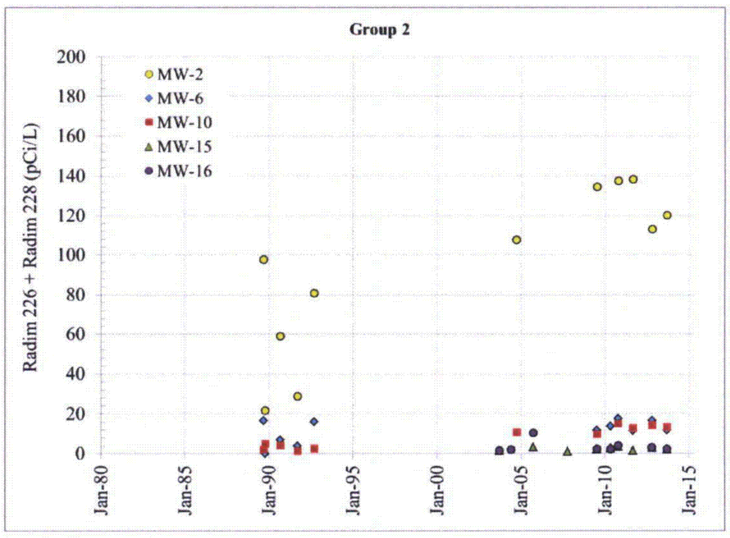
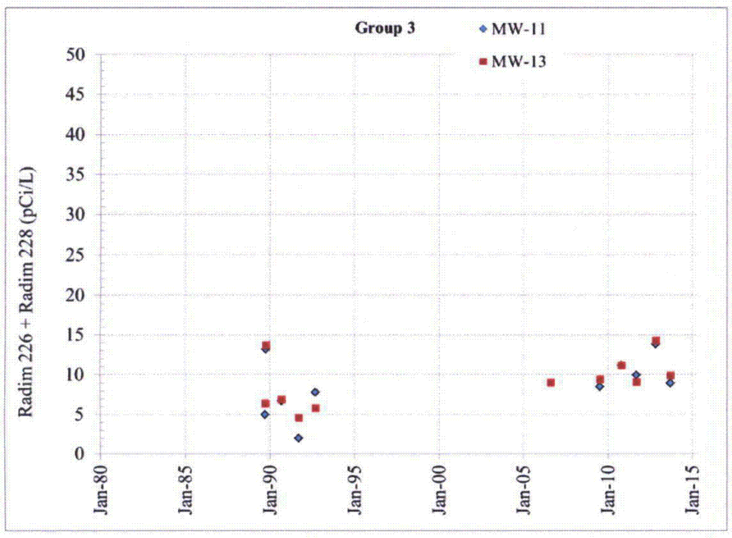


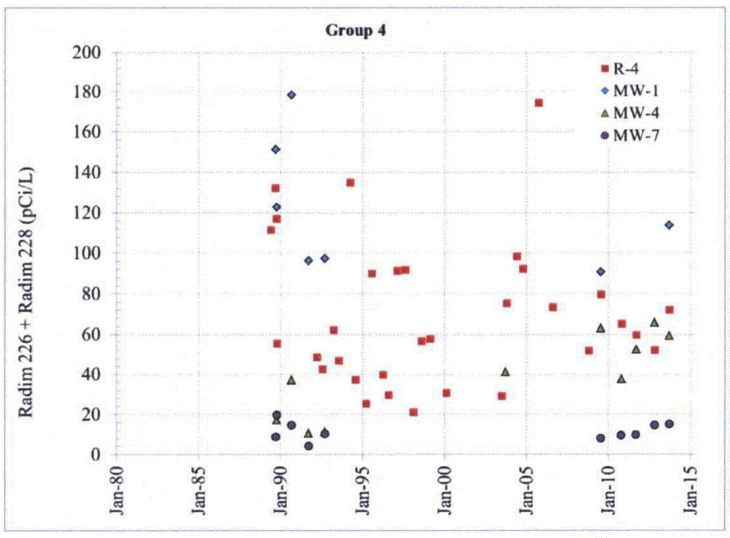
Figure 7 – Gross alpha analysis

Monitor well	Number of Samples		
	Chloride	Ra 226 +Ra 228	Radium > 5 pCi/L
MW-1	8	7	7
MW-2	13	11	11
MW-3	13	10	6
MW-4	12	10	10
MW-5	2	1	1
MW-6	14	11	9
MW-7	13	10	9
MW-9	8	6	2
MW-10	13	11	6
MW-11	13	10	8
MW-12	12	9	9
MW-13	13	11	10
MW-14A	14	10	6
MW-15	13	9	0
MW-16	13	8	1
MW-17	13	8	1
R-4	79	32	32
Willow Springs North	12	7	0
Willow Springs South	79	14	1
Total	**357**	**195**	**129**









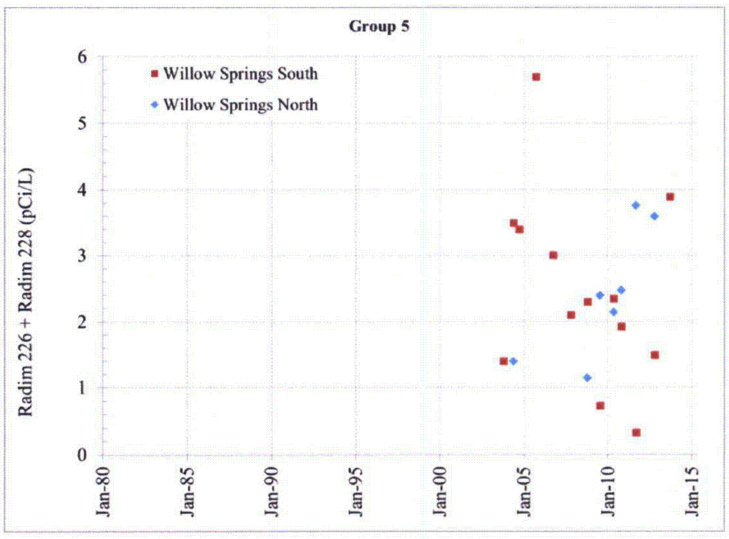


Figure 8 – Radium 226 + Radium 228 analysis

Monitor well	Number of Samples		
	Chloride	Uranium	Uranium > 0.03 mg/l
MW-1	8	8	8
MW-2	13	12	12
MW-3	13	10	1
MW-4	12	11	11
MW-5	2	1	1
MW-6	14	12	12
MW-7	13	10	10
MW-9	8	6	1
MW-10	13	11	11
MW-11	13	10	0
MW-12	12	9	9
MW-13	13	11	1
MW-14A	14	14	14
MW-15	13	13	13
MW-16	13	13	13
MW-17	13	9	3
R-4	79	16	19
Willow Springs North	12	9	9
Willow Springs South	79	40	23
Total	**357**	**225**	**171**

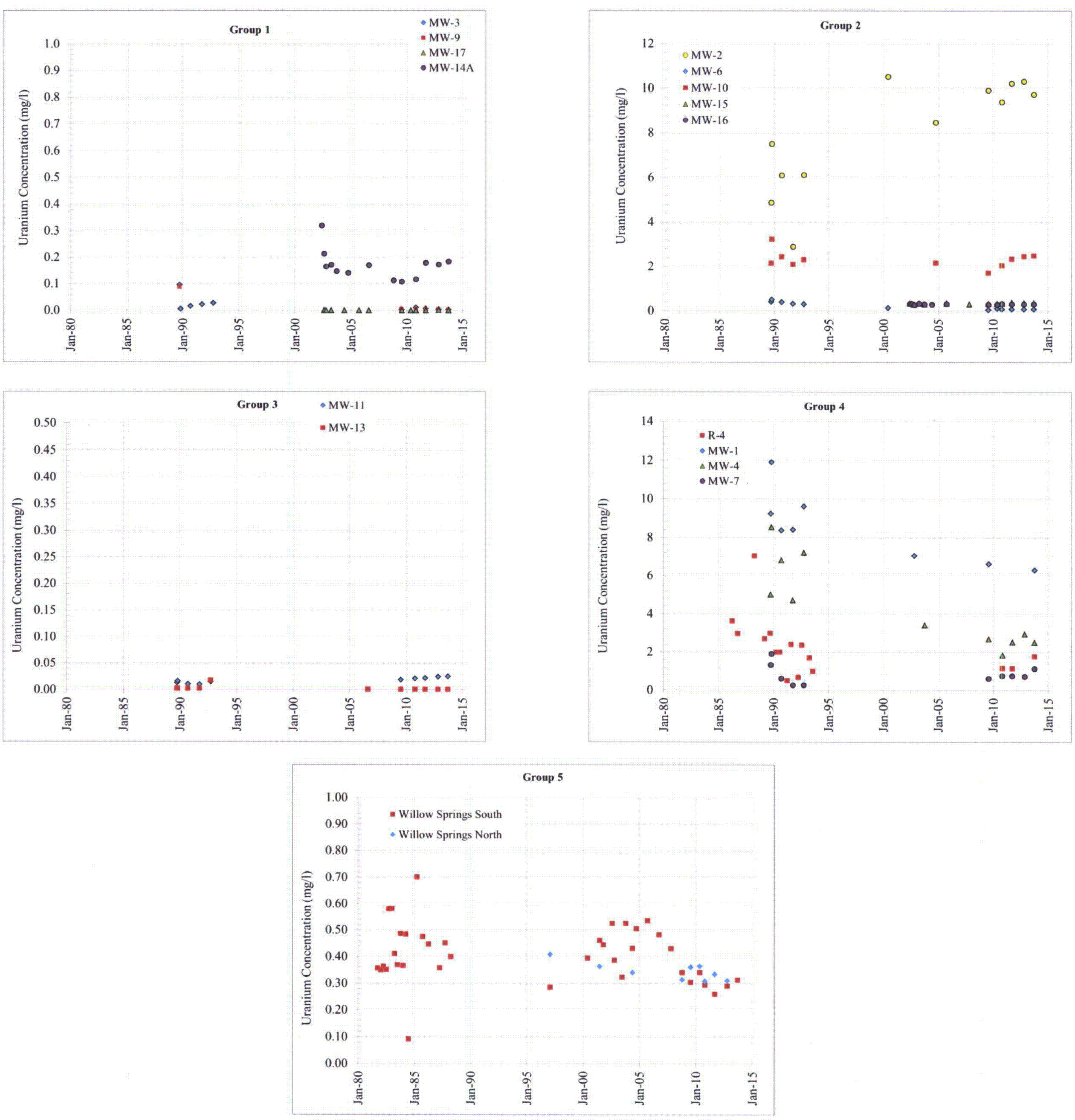


Figure 9 – Uranium analysis

Figure 10 – Regional bedrock geology

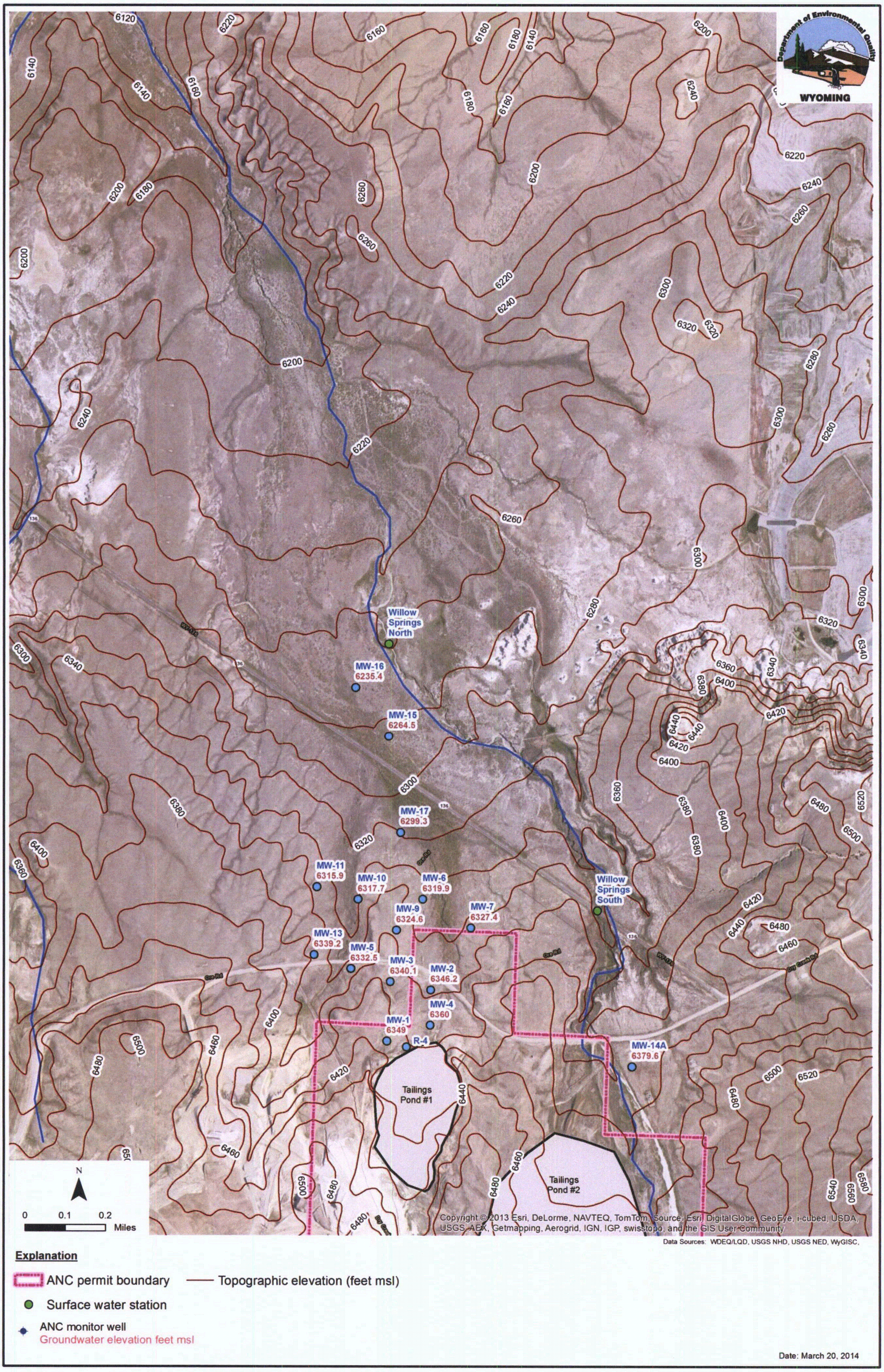


Figure 11 – Topographic elevation

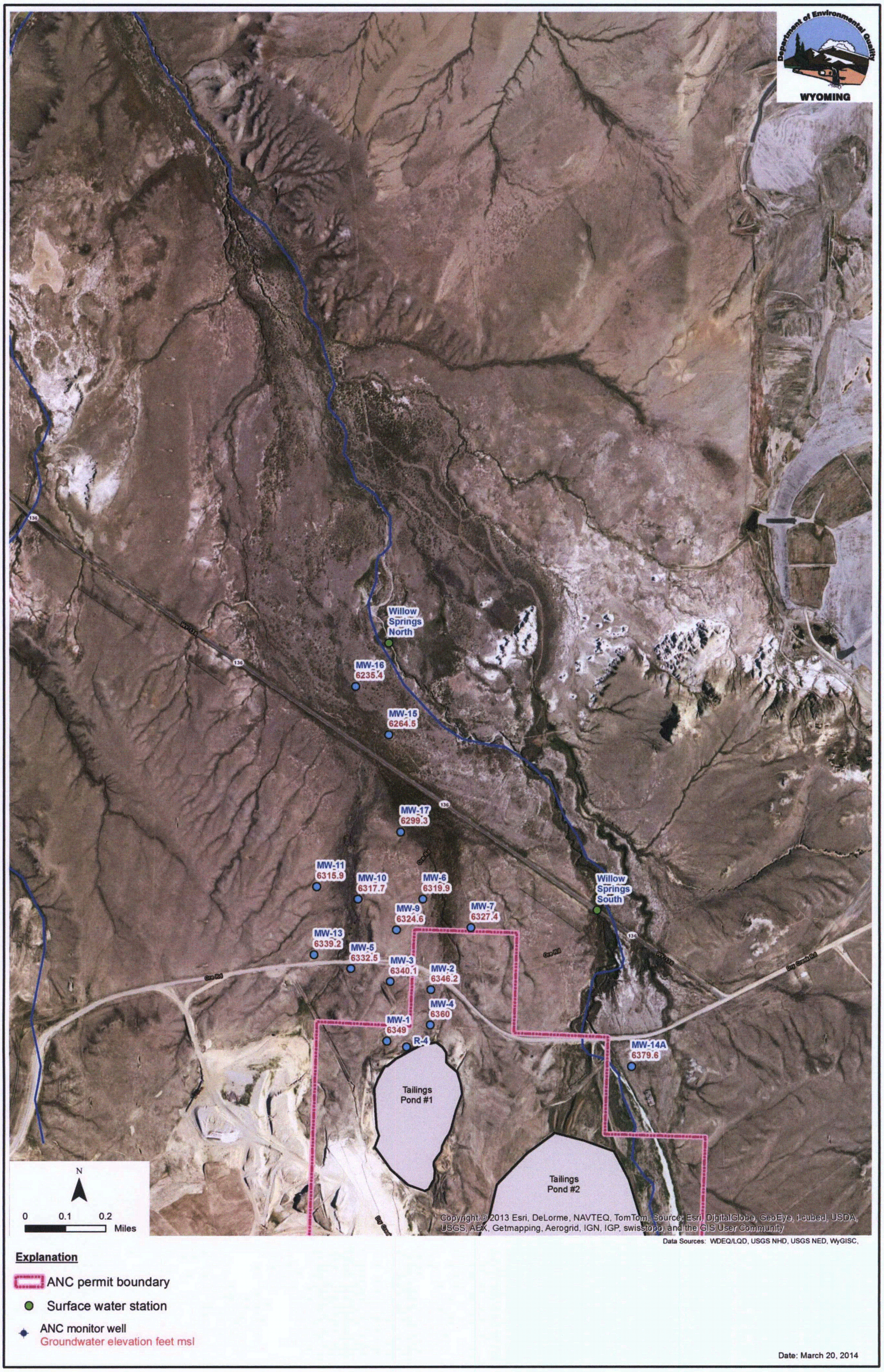


Figure 12 – Aerial map showing vegetation near the Site

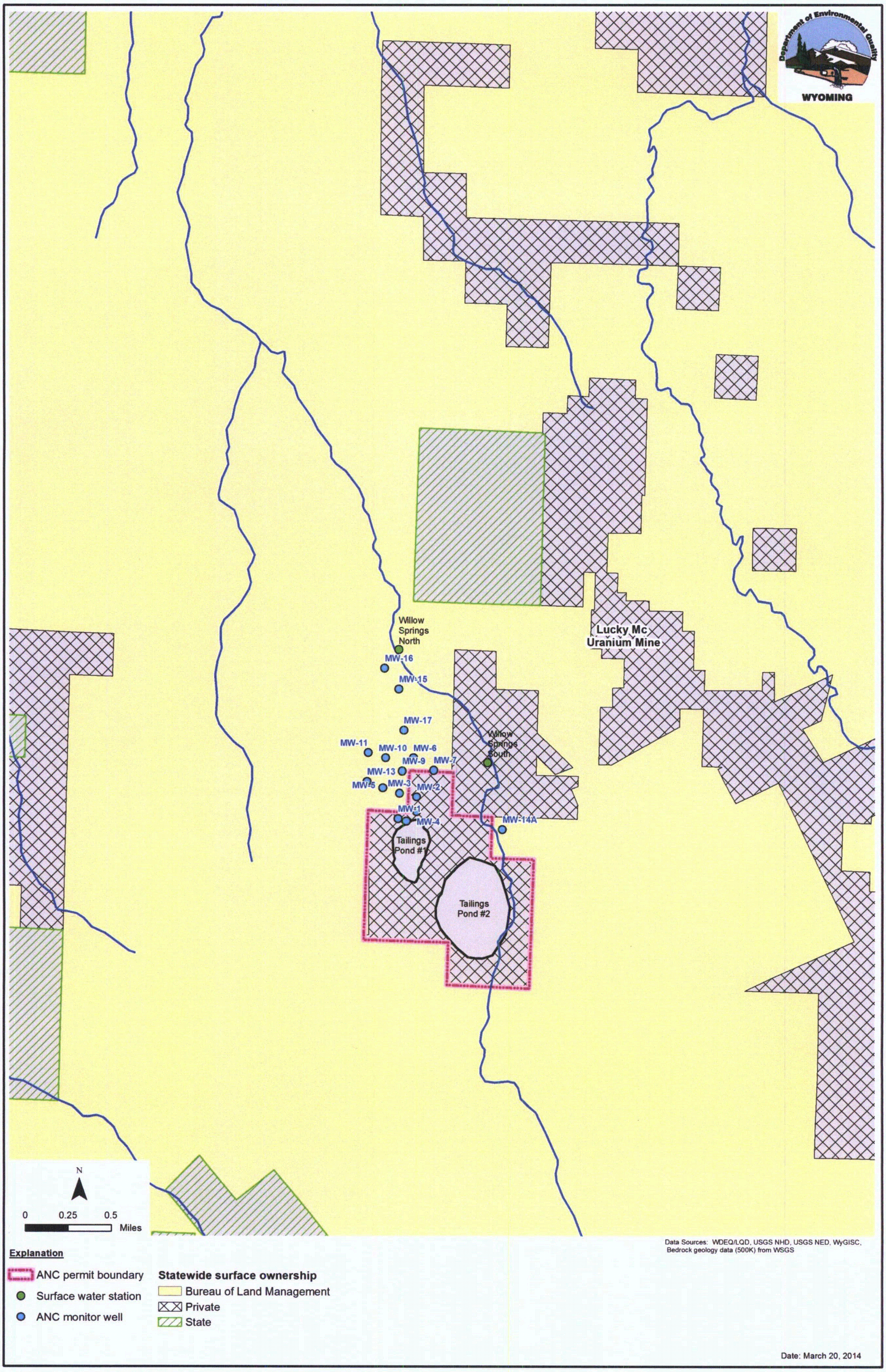


Figure – Surface ownership

Table 1 - Comparison of September 2013 measurements against WDEQ/WQD Class III standards

Constituent	Class III, Livestock	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-9	MW-10	MW-11	MW-13	MW-14A	MW-15	MW-16	MW-17	R-4
Aluminum	5	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	89.6
Arsenic	0.2	0.019	0.003	0.001	0.011	0.007	0.003	0.005	0.001	0.003	0.002	0.002	0.006	0.011	0.011	<0.001	0.011
Boron	5	<0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.3	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.3	0.2
Cadmium	0.05	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.058
Chloride	2,000	277	321	19	283	326	136	46	15	251	129	113	21	106	87	13	222
Chromium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.19
Lead	0.1	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.034
Mercury	0.00005	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate + Nitrite (NO_3 + NO_2 as N)	100	<0.1	<0.1	<0.1	0.1	102	<0.1	<0.1	<0.1	13	<0.1	<0.1	0.1	2.8	6.3	<0.1	10
Selenium	0.05	0.002	0.002	<0.001	0.003	0.052	<0.001	<0.001	<0.001	0.011	<0.001	<0.001	0.007	0.002	0.002	<0.001	0.107
Sulfate	1000	3620	3470	719	3110	2380	1480	1880	693	2310	1140	1220	665	1570	1320	554	4470
Total Dissolved Solids	5,000	5450	5630	1380	4770	4830	3020	2940	1310	4300	2180	2280	1330	2890	2490	1090	6040
Vanadium	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	25	0.02	0.03	<0.01	0.11	0.02	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.01	0.02	<0.01	1.60
pH	6.5-8.5 s.u.	6.37	6.21	7.24	6.27	6.14	6.88	6.77	7.31	6.36	7.13	6.9	7.3	7.31	7.33	7.62	3.92
Radium 226+ Radium 228	5 pCi/L	113.8	120.3	8.4	59.5	9.4	11.8	15.3	3.8	13.4	8.9	9.7	6.8	2.26	2.34	3.2	72
Gross alpha particle (including Ra 226 but excluding Radon and Uranium)	15 pCi/L	5540	8710	18.6	2330	315	60.6	1150	11.5	1650	38.6	<13.3	183	260	209	4.6	1150
Uranium*	---	6.28	9.71	0.0023	2.50	0.449	0.0648	1.11	0.0024	2.48	0.0251	0.0005	0.184	0.346	0.301	<0.0003	1.78

* EPA primary drinking water standard for uranium is 0.03 mg/l. There is no Class III standard.