Hydrology and Geochemistry of Perched Saturation at Solid Waste Management Unit 03-010(a) and Area of Concern 03-001(e)

Introduction

Three single completion wells (03-B-09, 03-B-10, and 03-B-13) access perched water beneath Solid Waste Management Unit (SWMU) 03-010(a) and Area of Concern (AOC) 03-001(e). The wells were installed in 2005 to monitor contamination that originated from former vacuum repair shop operations. The three wells are located relatively close to one another (15 to 20 ft) and are completed at the same depths (31 to 32 ft below ground surface [bgs]). Data from two of the wells, 03-B-10 and 03-B-13, have consistently shown very similar water levels and geochemistry. The third well, 03-B-09, is currently damaged from snow-removal equipment and is used only for water-level measurements. This well is frequently dry or is purged dry during sampling and does not yield enough water for geochemical analysis.

In a letter dated February 20, 2009, Los Alamos National Laboratory (the Laboratory) proposed plugging and abandoning two of these monitoring wells, 03-B-09 and 03-B-10. This report presents hydrologic and geochemical data to support the case that contaminant monitoring at SWMU 03-010(a) and AOC 03-001(e) can be accomplished with a single well, 03-B-13. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department in accordance with U.S. Department of Energy (DOE) policy.

Site History

SWMU 03-010(a), the outfall area from a former vacuum repair shop, is located on a steep slope on the edge of a tributary to Twomile Canyon about 30 ft west of a general warehouse (building 03-30, also known as the SM-30 warehouse) at Technical Area 03 (TA-03). Vacuum pump oil from the vacuum repair shop was discarded at this site in the 1950s. The oil contained residual tritium and mercury. Former workers estimated that more than 100 lb of mercury was disposed of at this SWMU.

AOC 03-001(e) is a former storage area that served the vacuum repair shop. From 1957 to the early 1960s, waste was discharged from a sink and flowed directly to containers located in the outdoor storage area. Interviews with former site workers indicate that containers often overflowed before they were removed for disposal. In the early 1960s, the containers were replaced by a 100- to 200-gal. holding tank with a concrete secondary containment berm. The vacuum repair operation was discontinued in 1992.

An investigation report for SWMU 03-001(a) and AOC 03-001(e) was submitted by DOE in August 2005 in which it was proposed that quarterly monitoring of the three wells take place for 2 yr. As of December 2008, 11 sampling rounds have been completed, thereby fulfilling the requirement of the investigation report.

Hydrology

A small body of perched water fills a depression in the tuff bedrock that was backfilled to provide a foundation for the SM-30 warehouse. This small zone (approximately 0.1 acre) of perched saturation is located on the west side of the building, toward the southwest corner, almost entirely under the building and adjacent fire lane. Water levels respond very rapidly to precipitation events, with maximum elevations during summer monsoons and winter snowmelt events. Figure 1 shows total daily precipitation from March 2006 to October 2008; Figure 2 shows water levels through the same time period. Generally, rain events are characterized by rapid runoff, whereas winter and spring snowmelt infiltration is slower but may result in greater volume. Snow-removal crews pile snow from parking lots next to the north side of SM-30; infiltration and runoff from these piles are also postulated to recharge the perched water beneath SM-30.

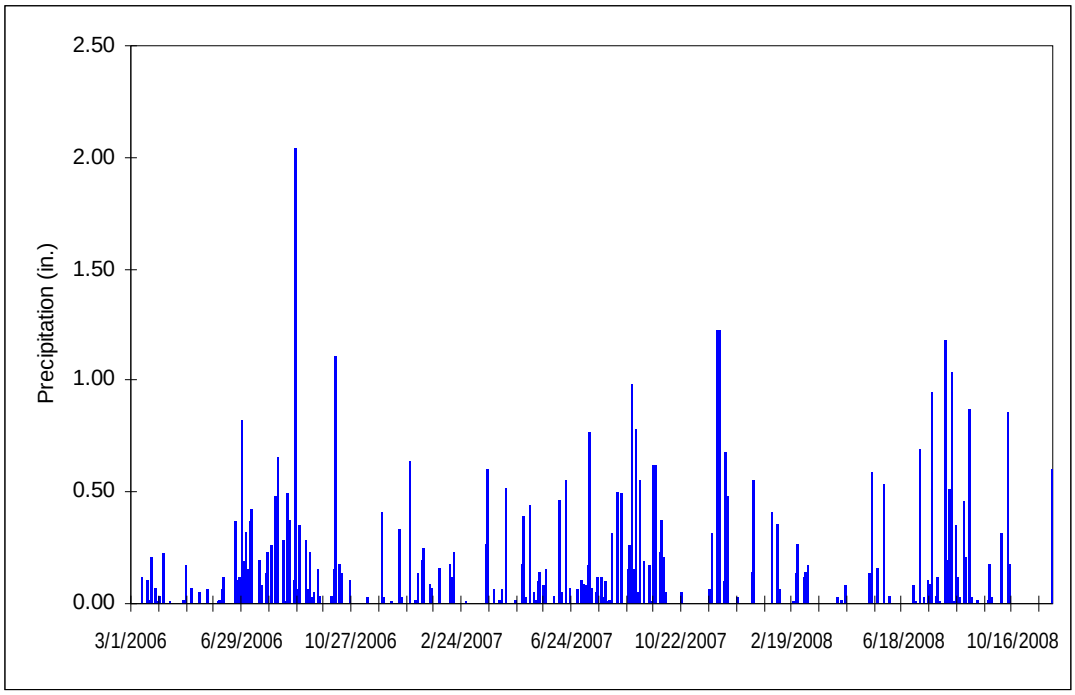

Figure 1 Precipitation in the area of SM-30 from March 2006 to October 2008.

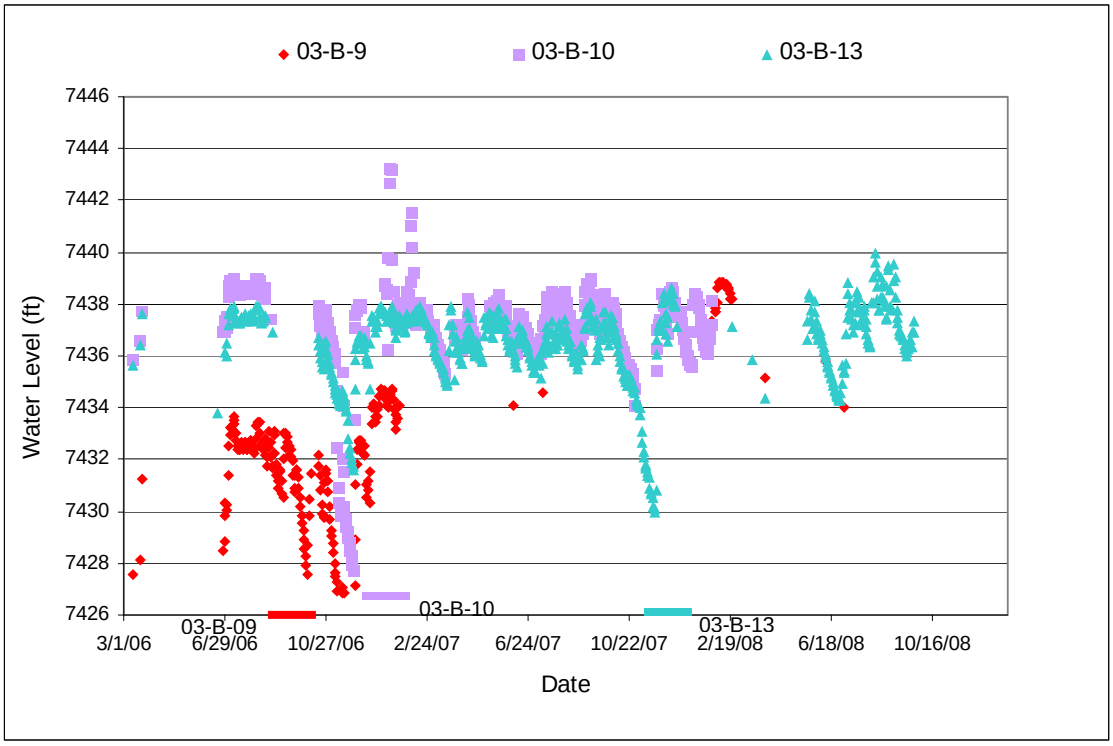

Figure 2 Water levels in wells 03-B-09, 03-B-10, and 03-B-13 from March 2006 through October 2008. The heavy colored lines approximate the bottoms of the screened intervals.

Wells 03-B-10 and 03-B-13 exhibit fluctuations in water levels indicating a strong link between precipitation and recharge. Water levels measured in monitor well 03-B-09 range from 0 to approximately 6 ft above the bottom of the screened interval and have dropped below the screen several times since March 2006. The part of the perched water body penetrated by 03-B-09 shows lower water levels compared to 03-B-10 and 03-B-13 and frequently goes dry when sampled. These data indicate that 03-B-09 receives less recharge compared to the other two wells, probably because of its location in the distal portion of the saturated zone.

Geochemistry

Road salt is frequently used for snow and ice mitigation at the Laboratory and can be used as a tracer for shallow infiltration. Generally, concentrations of sodium and chloride in the perched zone beneath SM-30 fluctuate throughout the year, with higher values observed in the winter months (Figure 3), indicating impacts from road salt. Figure 4 presents a piper diagram of major cations and anions in samples collected from June 2006 to March 2009 from the three wells. Major cation and anion results for wells 03-B-10 and 03-B-13 show similar chemical characteristics, suggesting similar recharge sources. Geochemical data from 03-B-09 are limited and differ slightly from that of 03-B-10 and 03-B-13, particularly in cation abundances. This difference probably reflects varying water/rock reaction processes and is consistent with the location of 03-B-09 in the distal portion of the saturated zone. For all three monitoring wells, the water chemistry is dominated by sodium and chloride, pointing to infiltration of surface water containing road salt.

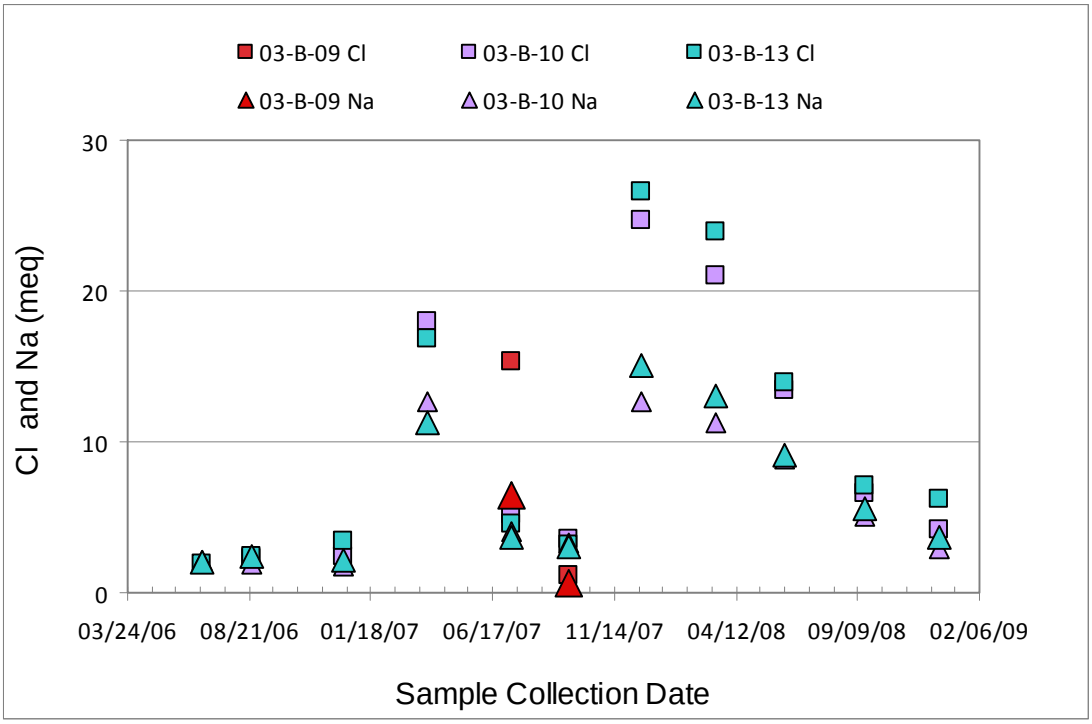

Figure 3 Variation of chloride and sodium (milliequivalents [meq]) through time

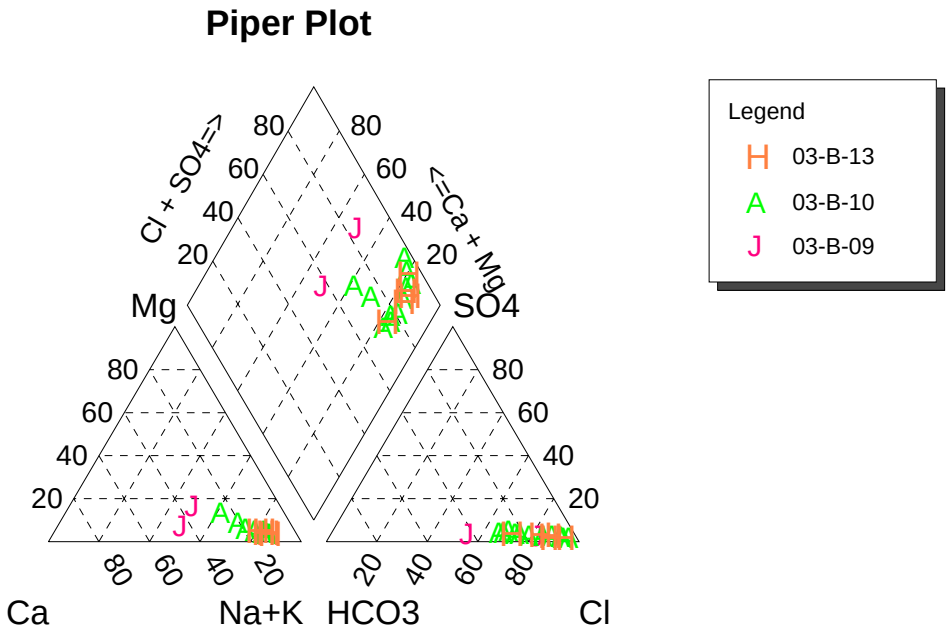

Figure 4 Diagram of major cation and anion results from wells 03-B-09, 03-B-10, and 03-B-13 from June 2006 to March 2009

Contaminant Trends

Tritium results from 10 sampling rounds are shown in Figure 5. Tritium is associated with vacuum pump oils and solvents previously used in repair and refurbishing processes. Tritium is observed above background levels in precipitation and intermediate groundwater. Tritium results are consistent in all three wells.

Organic solvents, including 1,1,1-trichloroethane; 1,1-dichloroethane; 1,1-dichloroethene; and trichloroethene, are moderately stable in anoxic water and have been detected in samples from all three wells. The conceptual model at this site indicates residual solvents and other contaminants are present on vadose zone sediments and are flushed to the perched zone during infiltration events, thus representing a persistent source for contamination. The analyte 1,1,1-trichloroethane, shown in Figure 6, has been detected frequently above the New Mexico groundwater standard of 60 µg/L in samples collected from the perched zone. Concentrations of 1,1,1-trichloroethane are relatively consistent among the three wells.

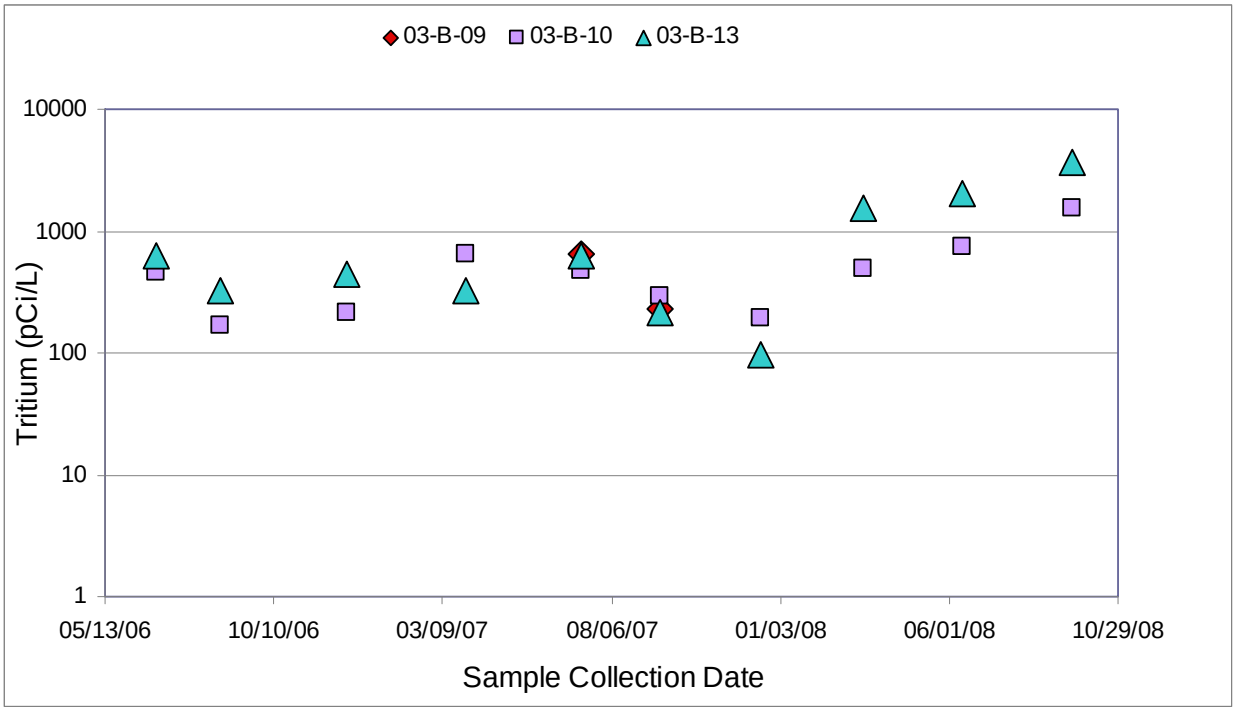

Figure 5 Detections of tritium in perched zone

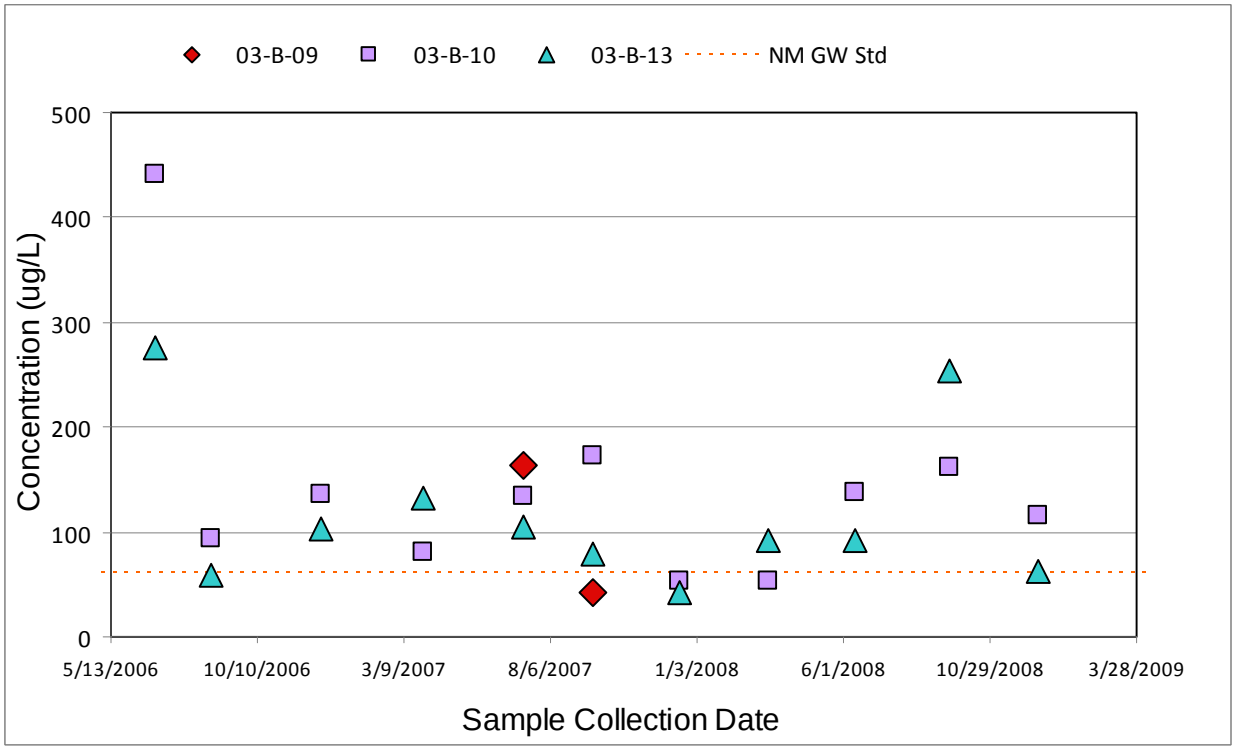

Figure 6 Detections of 1,1,1-trichloroethane in perched zone

Evidence of Damage to Monitoring Well 03-B-10

Results from a double-mass analysis (cumulative summed tritium activities of wells 03-B-10 and 03-B-13 over time) are shown in Figure 7. In this analysis, cumulative summed tritium concentrations from well 03-B-10 are plotted against cumulative results from 03-B-13. Tritium acts as a conservative tracer; therefore, if both wells sample the same contaminant source, they will follow a 1:1 trend. Results before winter 2007 follow the 1:1 (x = y) trend line, as they should if the system is not perturbed. However, the plot shows a distinct break in the trend beginning in winter 2007, with well 03-B-10 showing smaller tritium values relative to those of 03-B-13. This break in the slope occurs during the same period when damage to 03-B-10 from the snow plow was reported. The geochemical data shown in Figure 7 are consistent with dilution of water from well 03-B-10 because of fast-path infiltration through the compromised well casing of 03-B-10. Tritium concentrations (Figure 5) are slightly lower in well 03-B-10 than in well 03-B-13 after January 2008, further supporting this observation.

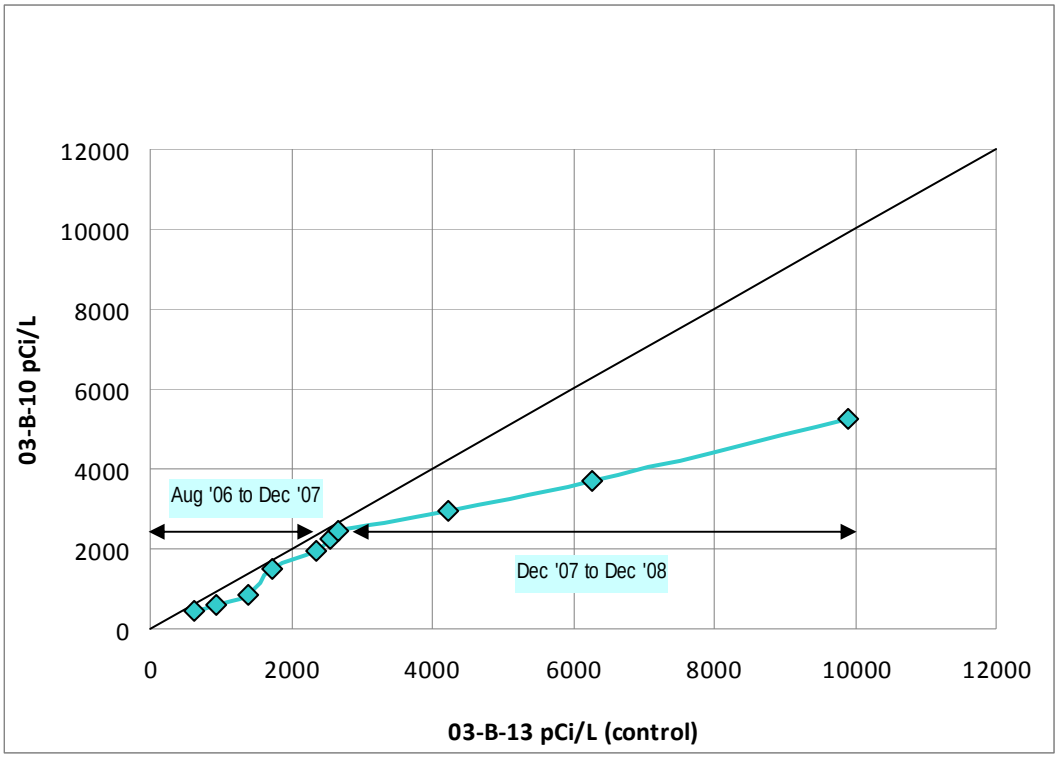

Figure 7 Tritium double-mass analysis results from wells 03-B-10 and 03-B-13

Summary and Conclusions

The following is a summary of the hydrology and geochemistry of the perched zone beneath SM-30.

- All three wells respond rapidly to infiltration events and are seasonally transient. Wells 03-B-10 and 03-B-13 have very similar responses and water levels. Well 03-B-09 rarely yields enough water to collect samples.
- All three wells are recharged in part by parking lot runoff as evidenced by the sodium and chloride signatures.
- The geochemistry for wells 03-B-10 and 03-B-13 is very similar. Slight differences in cation concentrations for well 03-B-09 may reflect its location near the boundary of the saturated zone.

- All three monitoring wells show similar levels and trends of contaminant concentrations.
- Geochemical evidence indicates damage to well 03-B-10 is allowing infiltration through the wellhead, resulting in a dilute geochemical signature.

In conclusion, a total of 11 rounds of samples have been collected from this site, and temporal and spatial trends are well-documented. Wells 03-B-10 and 03-B-13 provided redundant hydrologic and geochemical data before well 03-B-10 was damaged. The data for well 03-B-10 indicate dilution resulting from infiltration of surface water following damage from snow-removal equipment. Monitoring well 03-B-09 has also sustained damage from snow-removal equipment and is currently used only to measure water levels. Furthermore, it is an unreliable sampling well because of its location near the boundary of the perched zone. Well 03-B-13 yields water consistently, provides representative hydrologic and geochemical data, and is located out of the path of snow-removal equipment. Therefore, wells 03-B-09 and 03-B-10 are proposed for plugging and abandonment, and well 03-B-13 is proposed to be retained for monitoring the hydrology and geochemistry at SWMU 03-010(a) and AOC 03-001(e).