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Results of Tritium Tracking and Groundwater Monitoring at the Hanford Site 200 Area State Approved Land Disposal Site, Fiscal Year 2018

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Abstract: This report presents the results of groundwater monitoring of proximal wells and tracking wells for evidence of the tritium plume from the SALDS facility during FY 2018. This annual report addresses groundwater samples collected and analyzed from October 1, 2017, through September 30, 2018.

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EXECUTIVE SUMMARY

The 200 Area Effluent Treatment Facility (ETF) at the Hanford Site processes contaminated aqueous wastes derived from Hanford Site facilities and waste management areas. The treated wastewater contains tritium which cannot be removed by the ETF process prior to discharge to the soil column at the 200 Area State-Approved Land Disposal Site (SALDS). During fiscal year (FY) 2018 (October 1, 2017 to September 30, 2018), approximately 8.44 M L (2.23 M gals) of water containing 6.59 Ci of tritium was discharged. The SALDS is authorized to receive the discharge by State Waste Discharge Permit Number ST0004500 (Ecology, 2014) (hereafter referred to as the "Permit"). The Permit requires groundwater monitoring for tritium and an annual report of the monitoring results.

The SALDS monitoring network consists of three proximal (compliance) monitoring wells (699-48-77A, 699-48-77C, and 699-48-77D) and eight tritium-tracking wells. The proximal wells are sampled quarterly except for well 699-48-77A, which is intermittently dry. Information from well 699-48-77A is included for historical trending. All of the tritium-tracking wells are sampled at least annually, while several wells are sampled semi-annually.

Proximal wells 699-48-77C and 699-48-77D showed small (0.1 m [0.33 ft]) increases in water elevations in early FY 2018 due to late inputs of 4.12 M L to SALDS in August and September of 2017. These inputs caused a brief rise in water elevations which subsequently decreased ~0.2 m (0.66 ft) from February to October of 2018. These downward trending water elevations occurred despite ETF discharges to SALDS in April, June, July, and August of 2018 of 1.33, 2.30, 3.25, and 1.56 M L, respectively. These decreased elevations in proximal wells were consistent with the regional trend of decreasing groundwater elevations. The maximum tritium concentrations in the proximal wells were 56,000 pCi/L in 699-48-77C and 57,400 pCi/L in 699-48-77D.

Three tritium-tracking wells also showed slowly decreasing water elevations consistent with the regional trend. Tracking wells 299-W6-6, 699-48-71, and 699-51-75 showed gradually decreasing water levels. Two other tracking wells, 299-W6-11 and 299-W6-12, remained nearly constant over the fiscal year exhibiting only minor water elevation drops relative to the preceding March (2017). The tracking wells 299-W7-3 and 299-W8-1 showed modest water elevation gains due to injections at an injection well of the 200 West Pump and Treat system (299-W7-14). The slight water elevation gain observed at well 699-49-79 is not directly attributable to injection well 299-W7-14.

Tritium continues to be detected in the tritium tracking wells 299-W6-6, 299-W6-11, 299-W6-12, 299-W8-1, and 699-48-71. However, as noted in previous annual reports the tritium in these tracking wells is derived from 200 West Area Pump and Treat system injection wells. This 200 West Pump and Treat system discharges treated effluent containing tritium into injection wells located along the northern margin of the 200 West Area. To date, tritium originating from ETF discharges to the SALDS has not been detected in any of the tritium-tracking wells.

The numerical groundwater flow and contaminant transport model of the SALDS tritium plume was updated this fiscal year (FY 2018). The modeling results showed that some locations along the northern margin of the 200 West Area are expected to exhibit measurable concentrations of SALDS-derived tritium by the year 2030, although the model indicates that concentrations would be below the drinking water standard of 20,000 pCi/L. The eastern end of the tritium plume is also predicted to migrate to the south toward the 200 West Pump and Treat system extraction wells by 2030. Tritium concentrations in SALDS monitoring network wells (proximal and tritium tracking) in FY 2018 match the predicted behavior from the model. Hydrologic modeling, as well as analyses of groundwaters, continues to support the conclusion that disposal of tritium-containing waters to the SALDS facility is protective of the Columbia River.

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LIST OF TERMS

Abbreviations, Initialisms, and Acronyms

A	annually
AEA	Atomic Energy Act of 1954
B	Data flag denoting detection in both the associated quality control blank and in the sample
CCU	Cold Creek Unit
CP	Central Plateau
DOE	U.S. Department of Energy
DWS	Drinking Water Standard
Ecology	Washington State Department of Ecology
ETF	Effluent Treatment Facility
ERDF	Environmental Restoration Disposal Facility
FY	fiscal year
HEIS	Hanford Environmental Information System
J	Data flag denoting detection at less than the contract-required detection limit but greater than or equal to the instrument/method detection limit, as appropriate (i.e., a low-level detection)
LERF	Liquid Effluent Retention Facility
LLWMA	Low Level Waste Management Area
OU	operable unit
PNL or PNNL	Pacific Northwest National Laboratory
NAVD88	North American Vertical Datum of 1988
P&T	pump-and-treat
Q	quarterly

S	semiannually
SALDS	State-Approved Land Disposal Site
TDS	Total dissolved solids
TU	Data flag denoting the spike and/or spike duplicate sample recovery is outside control limits, not detected
U	Data flag denoting the analyte was not detected; detection limits (for nonradionuclides) or minimum detectable activity (for radionuclides) are indicated, as applicable
WMA	Waste Management Area

Units

ºC	degrees Centigrade
Ci	Curies
cm	centimeter
ft	foot/feet
gal	gallons
in.	inch
km	kilometers
L	liters
m	meters
mg/L	milligrams per liter
M	million
min	minutes
NTU	Nephelometric Turbidity Units
pCi/L	pico Curies per liter
µg/L	micrograms per liter
µS/cm	micro-Siemens per centimeter

1 INTRODUCTION

The 200 Area Effluent Treatment Facility (ETF) on the Hanford Site processes contaminated aqueous wastes derived from Hanford Site facilities and waste management areas (WMA). Treated water from ETF is discharged to the State-Approved Land Disposal Site (SALDS), which is authorized to receive the discharge by *State Waste Discharge Permit Number ST0004500* (Ecology, 2014) (hereafter referred to as the "Permit"). The Permit allows disposal of ETF effluents to the SALDS drain field, located 360 m (1,200 ft) north of the 200 West Area (Figure 1-1). The Permit requires groundwater samples be collected quarterly from the point of proximal compliance monitoring wells 699-48-77C and 699-48-77D located at the SALDS. Sampling of a third proximal well, 699-48-77A, was discontinued when the well became dry during fiscal year (FY) 2012.[1] The current revision of the Permit requires that samples be analyzed for tritium, pH, and specific conductivity. Samples were also analyzed for 16 other constituents per the groundwater monitoring plan (PNNL-13121, *Groundwater Monitoring and Tritium-Tracking Plan for the 200 Area State-Approved Land Disposal Site*). Water-level measurements are also collected.

The Permit addresses the tritium plume associated with ETF effluent discharges to SALDS. The ETF effluent disposed to SALDS contains tritium because no cost effective treatment technology exists to remove tritium from wastewater (DOE/RL-2014-10, *2014 Evaluation of Tritium Removal and Mitigation Technologies for Wastewater Treatment*). The location of SALDS was chosen because of the long travel time required for tritium to migrate from this location to the Columbia River. This allows tritium concentrations to decrease to below the Drinking Water Standard (DWS) of 20,000 pCi/L by dispersion and radiological decay before the plume reaches the river.

The U.S. Department of Energy (DOE) has taken the position that its groundwater monitoring and provision of data reporting to the State of Washington Department of Ecology (Ecology) is a matter of intergovernmental comity and cooperation, and that the Permit has no jurisdiction over radionuclides, which are regulated by DOE under Atomic Energy Act of 1954, 42 U.S.C. 2011 et seq. (AEA) authority, in the same way that permits for wastewater discharge to surface waters issued by the Environmental Protection Agency under Section 402 of the Clean Water Act are preempted by the AEA from regulating radionuclides.[2] DOE shares its monitoring data with Ecology consistent with this policy of cooperation.

The wells used to monitor the tritium plume and ensure it is migrating and dispersing as predicted are located farther from the facility than the proximal wells; they are referred to as the tritium-tracking wells. These wells are sampled either annually or semiannually. In accordance with the Permit, DOE also performs computer modeling of the tritium plume at least once every Permit cycle and submits an annual groundwater monitoring and tritium-tracking report to Ecology.

In addition to the annual report, results of groundwater sampling and analysis of proximal wells during FY 2018 were also reported in quarterly discharge monitoring reports submitted electronically to Ecology.[3] Details of the SALDS groundwater monitoring program are described in the current groundwater monitoring plan (PNNL-13121). Computer modeling of fate and transport of tritium from SALDS was completed earlier in FY 2018 using an updated Central Plateau (CP) model approved by DOE. The modeling, its inputs, and its predictions can be found in the document RPP-CALC-61950,

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[1] The permit revision in 2014 removed well 699-48-77A as a required sampling point because the well is dry. No samples were taken from well 699-48-77D in the last two quarters of FY 2016 because of low water level. That well is expected to become dry sometime in FY 2017. The Permit states that sampling of wells 699-48-77C and 699-48-77D is required until they no longer produce representative data.

[2] Environmental Protection Agency Clean Water Act, 40 CFR Section 122.2. Available here.

[3] Quarterly discharge monitoring reports can be obtained by accessing the Water Quality Permitting and Reporting Information System (PARIS) at Ecology's website (www.ecy.wa.gov) and searching for the permit number, "ST0004500."

Fate and Transport Analyses of Historical and Future Tritium Releases from the State Approved Land Disposal Site, FY 2018.

1.1 Objective and Scope

This report presents the results of groundwater monitoring of proximal wells and tracking wells for evidence of the tritium plume from the SALDS facility during FY 2018. This annual report addresses groundwater samples collected and analyzed from October 1, 2017 through September 30, 2018.

1.2 Background

Background information presented in this section is based on the groundwater monitoring plan (PNNL-13121) published in 2000. The conceptual model, groundwater monitoring program, SALDS discharges, and plume modeling are presented.

1.2.1 Hydrogeological Setting and Conceptual Model

The hydrogeological setting and conceptual model for SALDS have been described in previous documents (e.g., SGW-38802, *Results of Tritium Tracking and Groundwater Monitoring at the Hanford Site 200 Area State-Approved Land Disposal Site Fiscal Year 2008*) and are not repeated here. Figure 1-2 shows the conceptual model and depicts ETF effluent migrating through the sediment profile to groundwater. A key aspect of this conceptual model is the lateral migration of effluent in the vadose zone along the fine-grained Cold Creek unit (CCU), which dips toward the south. Most of the ETF effluent is interpreted to enter groundwater to the south of the SALDS, near monitoring well 699-48-77A.

1.2.2 Groundwater Monitoring Program

The primary objectives listed in the groundwater monitoring plan (PNNL-13121) are to compare groundwater sampling results for nonradionuclides in the proximal wells to the Permit concentration limits and track migration of the tritium plume from the SALDS. The following objectives are also listed in the monitoring plan:

- Track changes in groundwater quality associated with SALDS discharges.
- Determine why changes (if any) have occurred.
- Compare model predictions with observed results to refine predictive model capability.
- Correlate discharge events at SALDS with analytical results from groundwater monitoring.
- Assess the hydraulic response of the aquifer to SALDS discharges.

The groundwater monitoring well network (Figure 1-3) was designed to address these objectives using existing wells shared with other monitoring programs and the dedicated proximal wells drilled specifically to monitor SALDS.

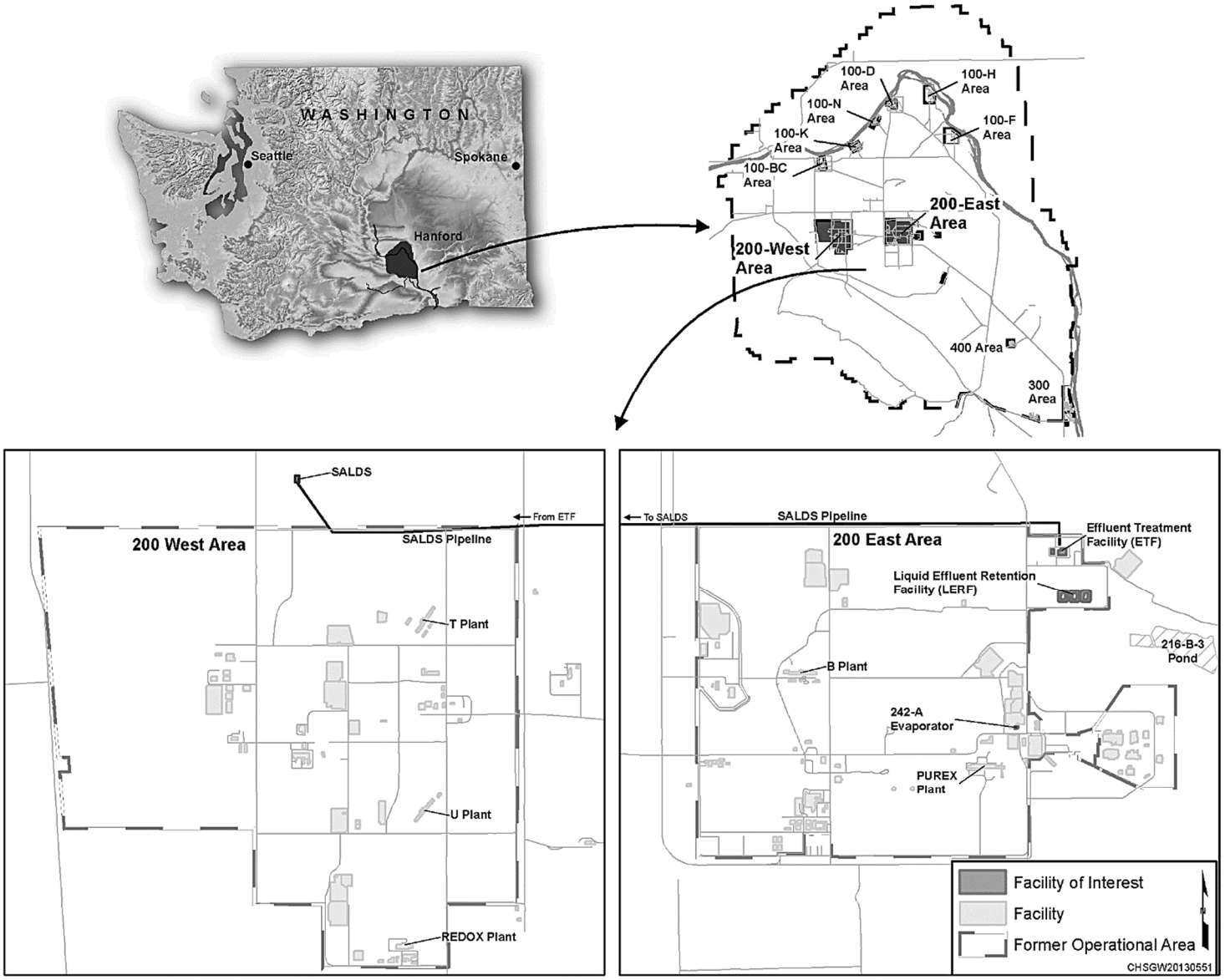

Figure 1-1. Location of SALDS and Related Infrastructure

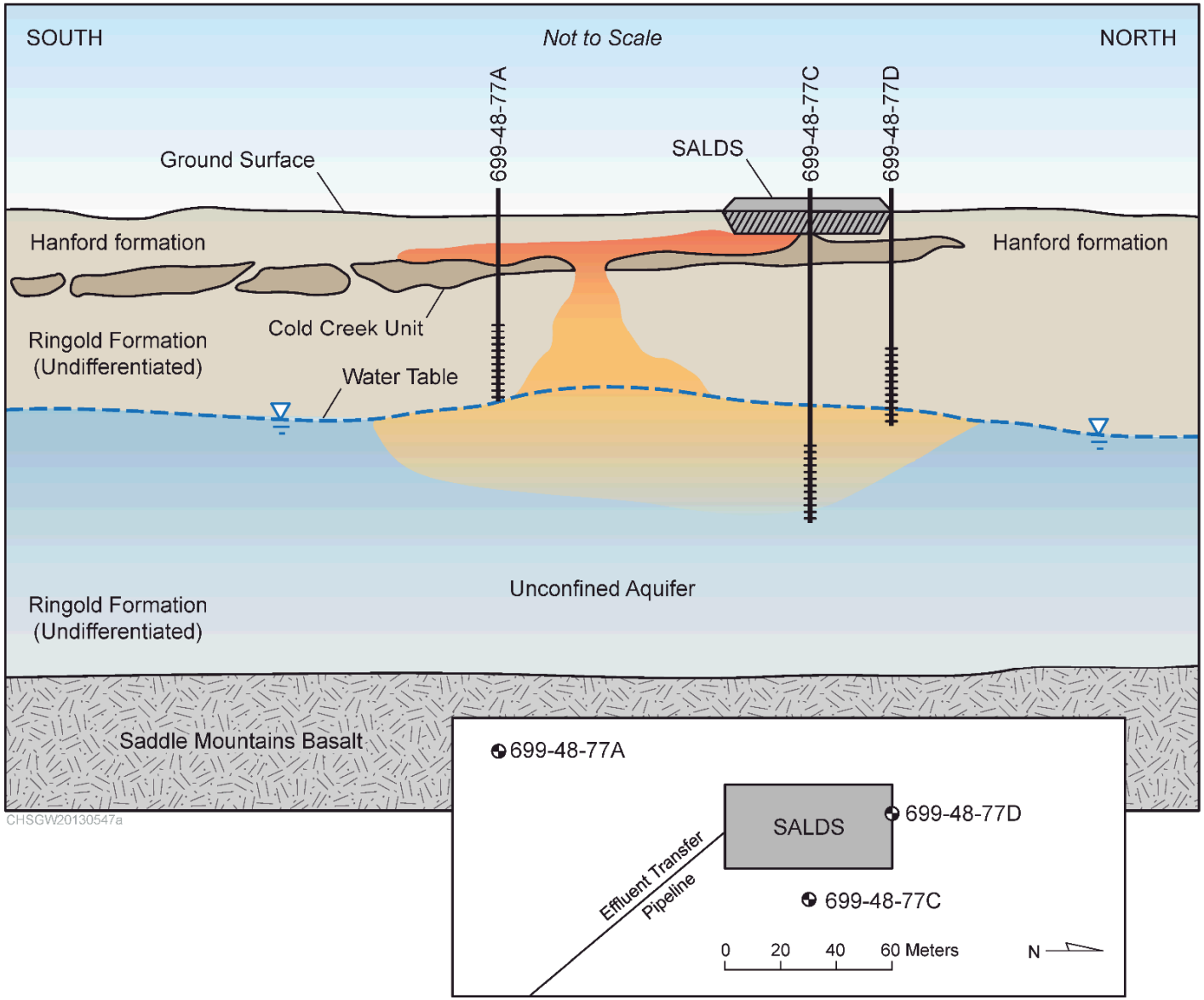

Figure 1-2. Conceptual Model Diagram of SALDS Operational Effects

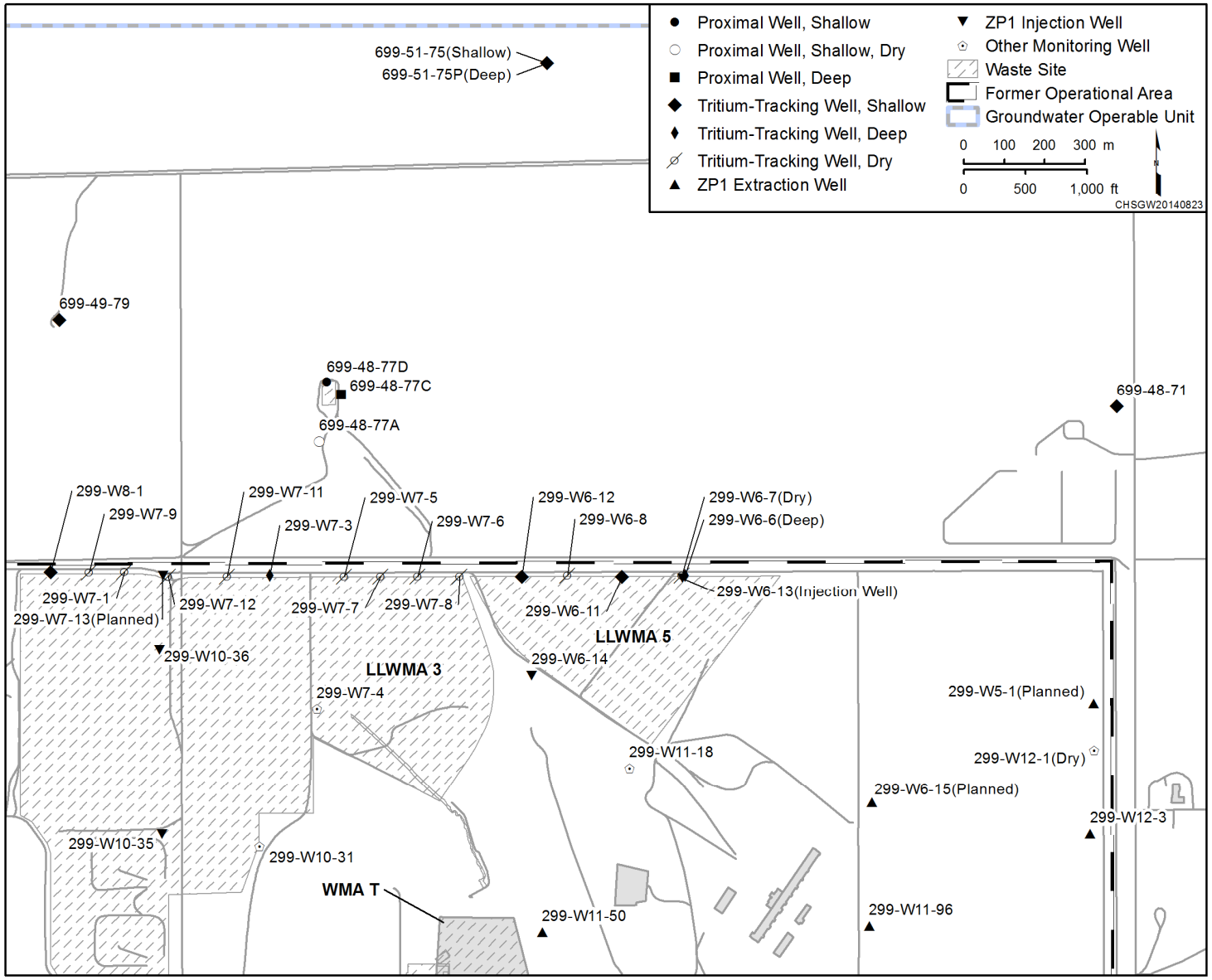

Figure 1-3. Locations of SALDS Groundwater Monitoring and Tritium-tracking Network Wells

1.2.3 Groundwater Modeling

DOE provides an update to the tritium plume numerical model at least once every Permit cycle to predict the distribution and movement of tritium in the aquifer as a result of discharges to SALDS. The Permit directs that the model be updated "within 6 months of detection of a tritium plume from SALDS in a new monitoring well," (i.e., in a location not predicted by the most recent model or within a well not previously affected by SALDS-derived tritium). To date, no positive indications of SALDS-derived tritium have been detected in a new monitoring well. Groundwater modeling was performed this fiscal year and the results captured in the document RPP-CALC-61950, which predicts the direction and fate of groundwater containing tritium. The modeling incorporated refinements in 2017 to the CP Groundwater Model, CP-47631, Rev. 4, *Model Package Report: Central Plateau Groundwater Model Version 8.4.5*. The model included reported discharge volumes and tritium activities sent to SALDS through September 2017, as well as projected volumes and tritium activities from 2017 to the end of ETF operations in 2065. The model also included the latest forecast operations of the 200 West Pump and Treat (P&T) system of the 200-ZP-1 Operable Unit (OU) in the 200 West Area. The model also included projected waste volumes from the Waste Treatment Plant (WTP) operations, including the 242-A Evaporator, as presented in the document RPP-RPT-57991, *One System River Protection Project Integrated Flowsheet*. The document RPP-CALC-61876, *Estimated Tritium Discharges to the State Approved Land Disposal Site for Use in Groundwater Modeling,* describes in detail the estimation of these waste streams.

1.2.4 State-Approved Land Disposal Site Discharge Information

The ETF effluent infiltrates into the SALDS, which is a 35 m by 61 m (116 ft by 200 ft) rectangular drain field with 10.2 cm (4 in.) diameter porous pipe laterals coming from a 20.3 cm (8 in.) diameter header at 1.8 m (6 ft) intervals. The drain field pipes are 15 cm (6 in.) below the surface of a 1.8 m (6 ft) deep gravel basin. The gravel basin is covered by at least 30 cm (12 in.) of natural, compacted cover soil. Discharge of tritium-laden water to SALDS began in December 1995, with 220 Ci of tritium released in the first 7 months (accounting for approximately 51% of the activity released to date). Discharge volumes from ETF were about 80 M L (21 M gal) each year until FY 2004. Discharges between March 2005 and August 2007 were sporadic and included intermittent ETF campaigns to treat 242-A Evaporator Process Condensate and K Basins project waste streams, both of which supplied much of the tritium discharged to SALDS. Discharge volumes increased in September 2007 when ETF began treating groundwater from the interim action P&T system at the T Tank Farm, however, tritium activity in this stream was low. The interim action P&T system was shut down on June 5, 2012, when the 200 West P&T system began operating. Discharge volumes from August 2013 to September 2017 were again intermittent. The facility did not operate between February 2014 and May 2016 because of a major equipment failure (the ETF evaporator heat exchanger).

The ETF facility restarted in December 2016 and operated through early May 2017, treating leachate waste from the Environmental Restoration Disposal Facility (ERDF). The ETF restarted in September 2017 to treat wastewater from Liquid Effluent Retention Facility (LERF) Basin 42, which contained 242- A Evaporator process condensate. This waste had a much higher tritium concentration than ERDF leachate. The facility operated through September 2018, discharging 8.44 M L (2.23 M gal) and 6.59 Ci of tritium in FY 2018. The total volume discharged to SALDS from startup in December 1995 through September 2018 is approximately 1,240 M L (325 M gal) (Figure 1-4). Figure 1-5 shows the monthly and cumulative activity of tritium discharged to SALDS through September 2018. The cumulative tritium activity discharged to SALDS was 440 Ci (not decay corrected).

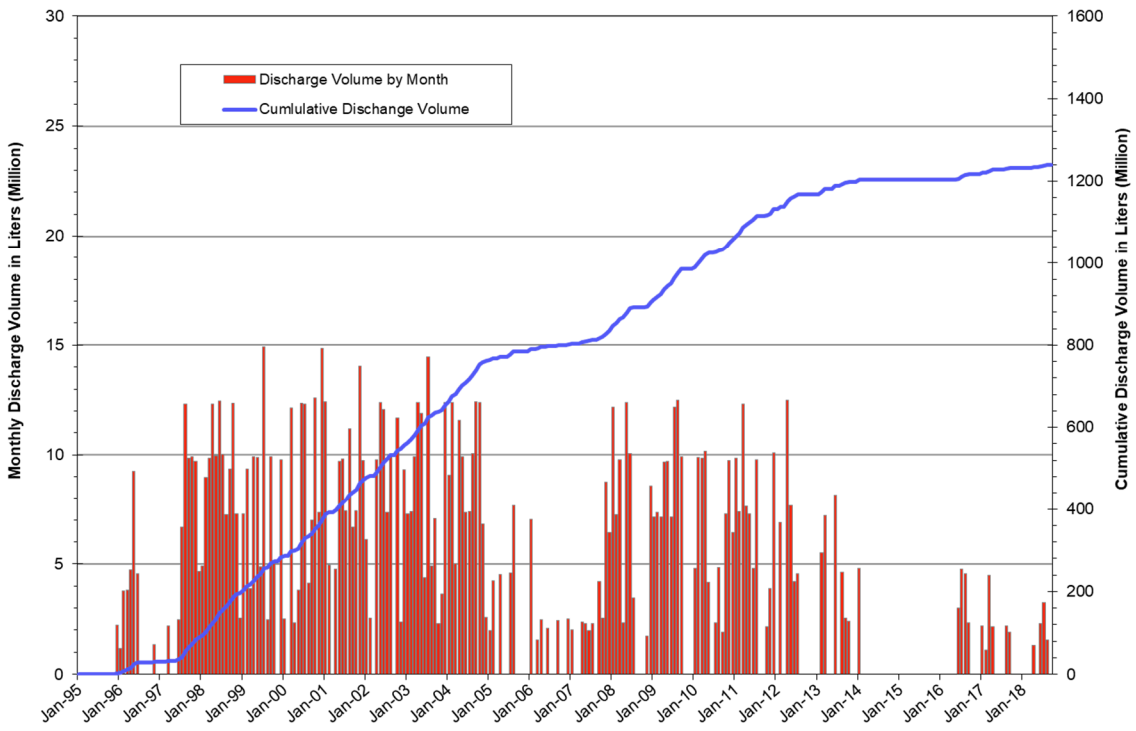

Figure 1-4. Monthly and Cumulative Discharge Volumes to SALDS from Inception through September 2018

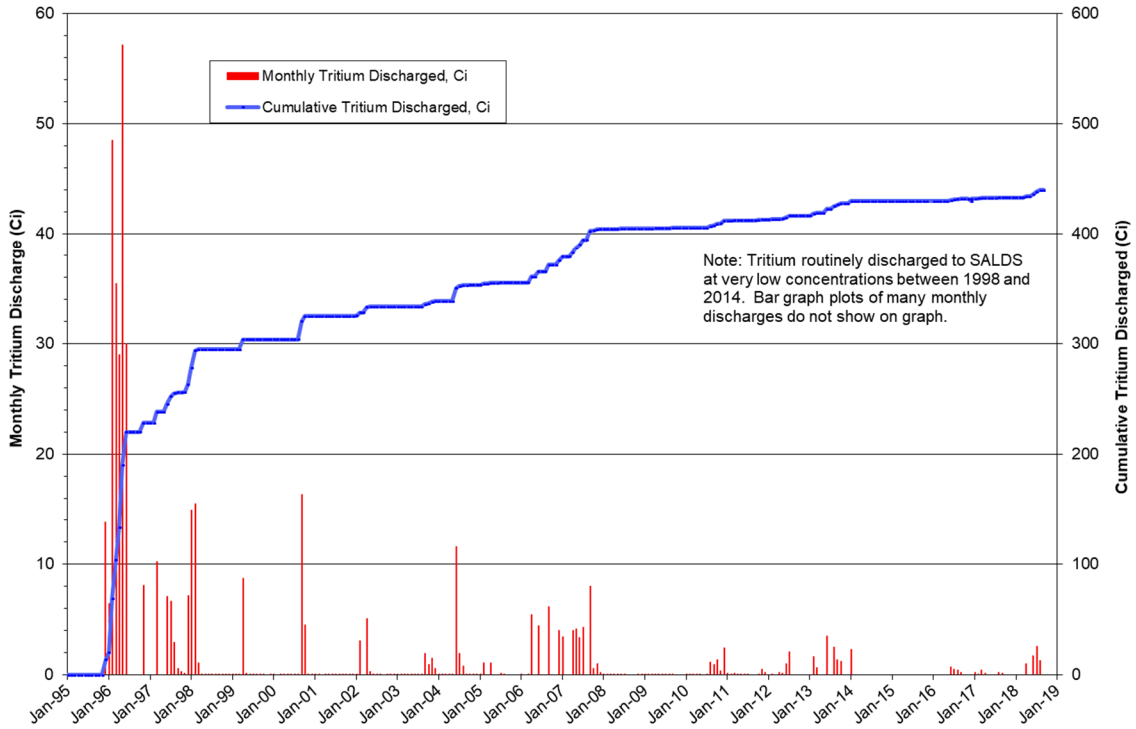

Figure 1-5. Monthly and Cumulative Tritium Activity Discharged to SALDS from Inception through September 2018

2 RESULTS OF FISCAL YEAR 2018 WATER-LEVEL MONITORING

Measurements of water levels in wells surrounding SALDS are performed to assess the hydraulic response of the aquifer to SALDS discharges, to interpret local and regional water table elevation changes, and to determine the groundwater flow direction. These measurements are used in combination with groundwater chemistry analyses to update conceptual and predictive models and forecast the movement of tritium from the SALDS.

2.1 200 West Pump and Treat System

The 200 West P&T system continues to influence the water table in the SALDS vicinity. The system consists of extraction and injection wells, piping, transfer stations, and a treatment plant (200 West Groundwater Treatment Facility). The system began operating in July 2012 (DOE/RL-2014-26, *Calendar Year 2013 Annual Summary Report for the 200-ZP-1 and 200-UP-1 Operable Unit Pump-and-Treat Operations*) and has a processing capacity of 9,500 L/min (2,500 gal/min). The 200 West Groundwater Treatment Facility treats groundwater from the 200-ZP-1 OU to remove carbon tetrachloride, chromium, iodine-129, nitrate, technetium-99, and trichloroethylene. Similarly to ETF, tritium is not removed because there is no cost effective treatment technology for tritium. As a result, the water injected into the aquifer contains tritium. The selected remedy for tritium in the 200 West P&T system is monitored natural attenuation and radiological decay.

Several 200-ZP-1 extraction and injection wells are located along the north side of the 200 West Area, and it is these wells that are affecting the water table in the SALDS vicinity. The P&T system wells nearest to SALDS are injection wells 299-W6-13, 299-W6-14, and 299-W7-14 (Figure 2-1). In particular, injection well 299-W6-13 is located only 9.8 m (32 ft) from tritium-tracking well 299-W6-6. Numerical modeling indicated that a slight water table elevation increase would occur in the SALDS vicinity due to operation of these injection wells (SGW-50907, *Predicted Impact of Future Water-Level Declines on Groundwater Well Longevity within the 200 West Area, Hanford Site*), and this has been confirmed by water-level measurements (see Sections 2.3 and 2.4). Three extraction wells (299-W11-50, 299-W11-96, and 299-W12-3) are located 1.4 km (0.9 miles), 1.9 km (1.2 miles), and 2.2 km (1.4 miles) to the south and southeast of the SALDS well 299-W6-6. Two new extraction wells (299-W6-15 and 299-W5-1) have been installed approximately midway between these extraction wells (Figure 2-1) and the SALDS well 299-W6-6. These new wells began extracting groundwater in late December of 2015.

2.2 Groundwater Flow

Water-level measurements were collected across the 200 West Area over the past year, and the water table map constructed from these measurements for the northern portion of the 200 West Area is shown in Figure 2-1.[4] This map shows the effect of the 200 West P&T system with groundwater mounds occurring where injection wells are located (circular features) and a large area where the water table has been drawn down along the east side of the 200 West Area in response to groundwater extraction. This groundwater extraction has caused the groundwater flow direction in the northeastern 200 West Area to be southeast toward the extraction wells, whereas prior to operation of the 200 West P&T system, the flow direction was toward the east-northeast. Due to the influence of the injection wells along the north side of the 200 West Area, the regional groundwater flow direction in the immediate vicinity of the SALDS continues toward the northeast.

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[4] All elevations in this document are in NAVD88, *North American Vertical Datum of 1988*.

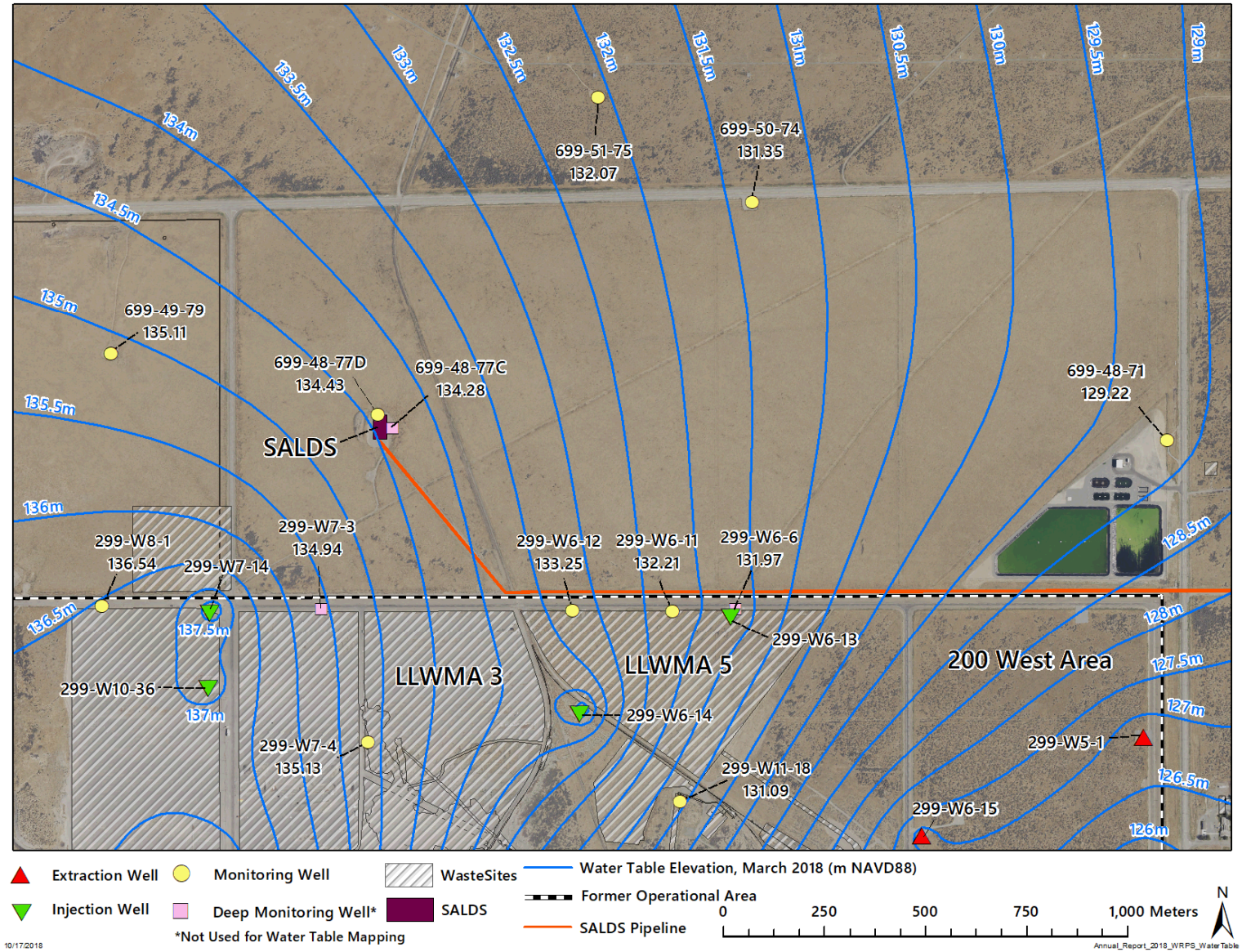

Figure 2-1. Water Table Map for the SALDS Area, Fiscal Year 2018

In previous years, hydraulic mounding has been observed around the SALDS due to discharges to the SALDS drain field. When the groundwater mound was higher, such as during 2011 (SGW-51085, *Results of Tritium Tracking and Groundwater Monitoring at the Hanford Site 200 Area State Approved Land Disposal Site, Fiscal Year 2011*), groundwater flow suggested effluent from SALDS may approach tritium-tracking wells to the southeast and may reach these wells if dispersion is taken into account. Current conditions continue to indicate that groundwater beneath SALDS will not migrate within the next six months to the tritium-tracking wells along the north side of the 200 West Area. Whether the tritium plume reaches these tracking wells depends on future discharge volumes to SALDS and the influence of injection wells proximal to these wells.

The recently completed (FY 2018) groundwater modeling (RPP-CALC-61950) predicts the tritium plume at the 500 pCi/L concentration will migrate south toward the 200 West P&T system extraction wells during their predicted operation until 2037. It's also predicted that the tritium plume at the DWS concentration will remain in the SALDS vicinity and that this plume will decay to below the DWS shortly after the year 2088. See the modeling report RPP-CALC-61950 and associated documents for complete information.

2.3 Water-Level Trends

Water elevations are measured in SALDS wells prior to sampling events. Additional measurements are collected regularly in proximal wells 699-48-77A, 699-48-77C, and 699-48-77D in accordance with the groundwater monitoring plan (PNNL-13121). For simplicity, designation of proximal wells 699-48-77A, 699-48-77C, and 699-48-77D in this report will subsequently drop the 699 prefix and be referred to as wells 48-77A, 48-77C, and 48-77D, respectively. The water table in the northern portion of the 200 West Area has declined in recent years to the point where a number of the SALDS tritium-tracking wells have become dry. Attempts to sample well waters are discontinued when wells are dry, however, water elevations are measured when possible.

Water levels in all wells in the 200 West Area have exhibited declining trends since effluent discharges associated with process operations were terminated at U Pond in 1985 and at all non-permitted facilities in 1995. Water elevation trends in proximal wells and tritium-tracking wells are shown in Figure 2-2 through Figure 2-5. Wells depicted on these graphs are grouped to show similar water elevation changes and are grouped by relative location to SALDS. Figure 2-2 shows declining water levels in proximal wells, in agreement with tritium-tracking wells which are also trending downward (Figure 2-4, and Figure 2-5). Intermittent ETF discharges to SALDS occurred from February 2014 to June 2016 causing proximal well water elevations to decline from October 2014 to July 2016 (Figure 2-2). However, relatively recent discharges in FY 2016 (14.7 M L) and FY 2017 (14.0 M L) increased groundwater levels in proximal wells 48-77C and 48-77D by ~0.5 m from July 2016 to November 2017 (Figure 2-3). Subsequently, relatively small discharges in FY 2018 (8.4 M L) led to decreased ground water elevations (~0.2 m) from January to September 2018 (Figure 2-3). Thus, water elevations in proximal wells 48-77C and 48-77D continue to respond directly to SALDS discharges but with varying time-delays.

Like the proximal wells, the tritium-tracking wells continued to exhibit declining water elevations in FY 2018, consistent with long-term regional trends (Figure 2-4 and Figure 2-5). However, temporary increases in water elevations in some tracking wells are directly attributable to discharges from deep injection wells of the 200 West P&T system which lie at the northern edge of the 200 West Area. Similar to the proximal wells, tracking well designations in this report will subsequently drop the three number prefix (299 or 699) for simplicity. Water elevations in wells W6-6, W6-11, and W6-12 had temporary increases beginning in January 2012, which were directly attributable to the injection wells (Figure 2-5). Water elevations subsequently trended downward for these wells from January 2015 to present. Wells W7-3 and W8-1 showed similar increases in water elevations, albeit delayed, from April 2012 and from

March 2013 respectively. However, neither well has shown clearly-defined water level declines like the other tracking wells. The water elevation in well W8-1 increased very slowly from January 2016 to January 2018 (Figure 2-5) and has remained stable at ~136.5 m. Water in well W7-3 dropped 1 m between January 2015 to May 2016 but then increased 0.7 m in January 2017. The water level in well W7-3 has remained nearly constant (135 m) from January 2017 to January 2018, showing only a very small (0.16 m, 0.52 ft) water level decrease from January to June in 2018. Well W7-3 is a deep well yet it shows somewhat greater variability in water elevations than well W8-1 (Figure 2-5). This greater variability at W7-3 is attributed to higher water mounding at the well creating higher water conductances to deeper portions of the aquifer and thus more fluctuations in water elevation. Changes in groundwater elevations in proximal and tracking wells from March 2016 to March 2017, and to March 2018, are shown in Table 2-1. These values are a snapshot in time and do not reflect the aforementioned variabilities in water elevations observed in FY 2017 and FY 2018. In FY 2018, discharges to SALDS totaled 8.43 M L containing 6.59 Ci of tritium which was twice the tritium activity discharged in both FY 2016 and FY 2017 (3.16 Ci).

2.4 Well Longevity

Groundwater modeling conducted in 2011 evaluated the effects of the regional water table decline and the operation of the 200 West P&T system on groundwater levels in the 200 West Area and vicinity (SGW-50907). The model compared predicted water levels to measured water elevations in completed shallow wells in use at that time. The model represented the best forecast of well longevity of 200 West Area monitoring wells through the year 2020. Modeling indicated water levels would increase in all but two of the shallow-screened wells between 2011 and 2013 in response to the 200 West P&T system. Water levels in wells 48-71 and 51-75 were predicted to continue a downward trend (Figure 2-4), which they did, because they lie a significant distance from the injection wells. Although well 49-79 lies a significant distance from injection wells, it shows a slight water level increase (Figure 2-4) not explained by injection wells. This slight elevation increase from May 2012 may suggest natural recharge of groundwater from the west-southwest. Wells W7-3 and 49-79 have nearly identical groundwater elevations. Overall, injections by the 200 West P&T system has made several tracking wells useable longer than would have been possible without these injections.

Groundwater modeling, not incorporating 200 West P&T system injections, predicted shortened well longevities of shallow-completed proximal and tritium-tracking wells. The predicted drop in water levels was observed in most tritium-tracking wells until February 2012, at which time some water elevations increased. Water elevations in wells W6-6, W6-11, W6-12, and possibly wells W7-3 and W8-1 increased due to 200 West P&T system injections (Figure 2-5). Figure 2-6, Figure 2-7, Figure 2-8, and Figure 2-9 show water elevations in wells 48-77A, 48-77D, W6-11, and W6-12 compared to the elevations of their bottom screens. Proximal well 48-77A became dry in 2012, and recent water elevation measurements have plateaued below the lower screened interval (Figure 2-6), returning only a muddy probe. Water elevations in proximal wells 48-77C and 48-77D increased approximately 0.5 m from July 2016 to January 2018 but subsequently decreased to the same elevation in March 2018 as measured in March 2017 (Table 2-1). The episodic fluctuations of water elevations observed in Figures 2-2 through Figure 2-5 are not revealed in Table 2-1.

Only three of the shallow-screened SALDS monitoring wells (tracking wells 48-71, 49-79, and 51-75) were predicted, by the 2011 modeling, to have more than 0.3 m (1 ft) of water after calendar year 2016. Wells W6-6, W7-3, 48-77C, and 51-75P are screened relatively deeply in the aquifer and should be usable indefinitely.

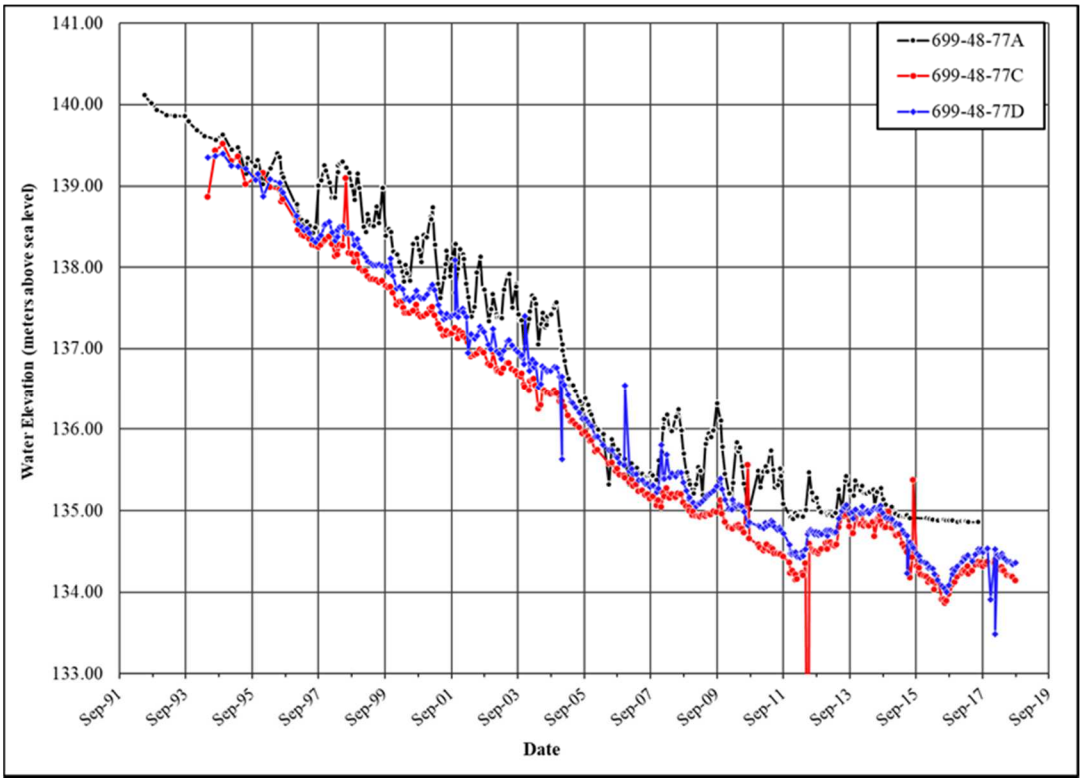

Figure 2-2. Water Levels in the SALDS Proximal Wells

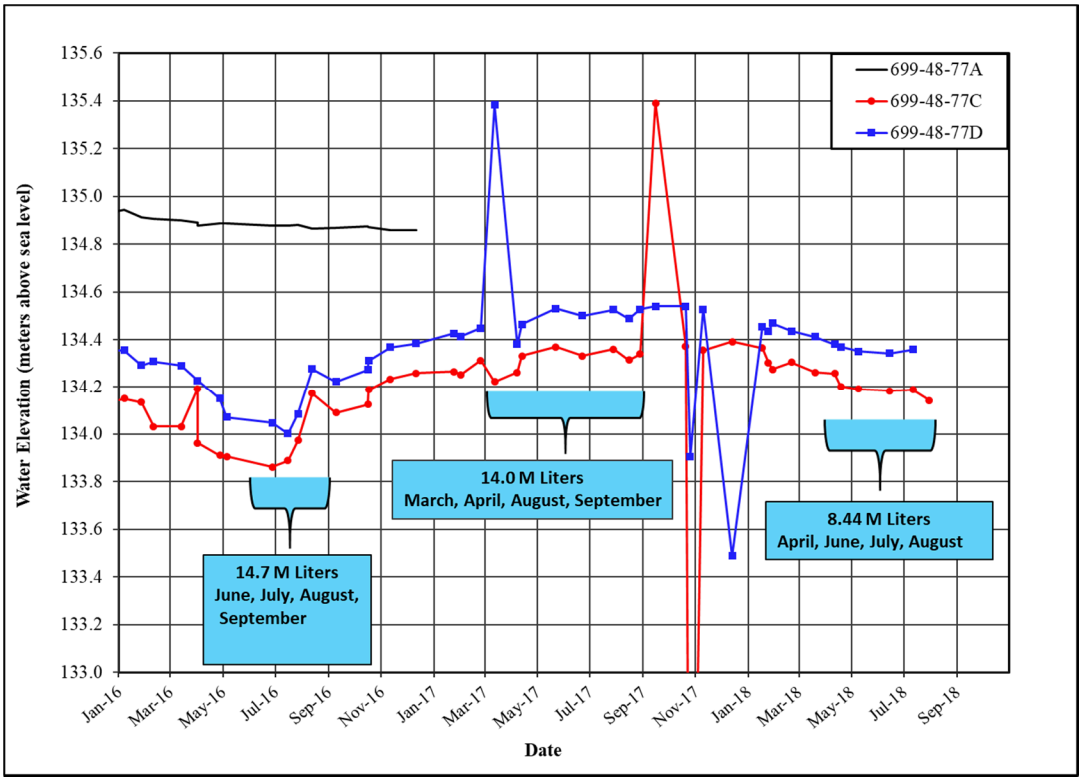

Figure 2-3. Expanded View of Recent Water Levels in the SALDS Proximal Wells

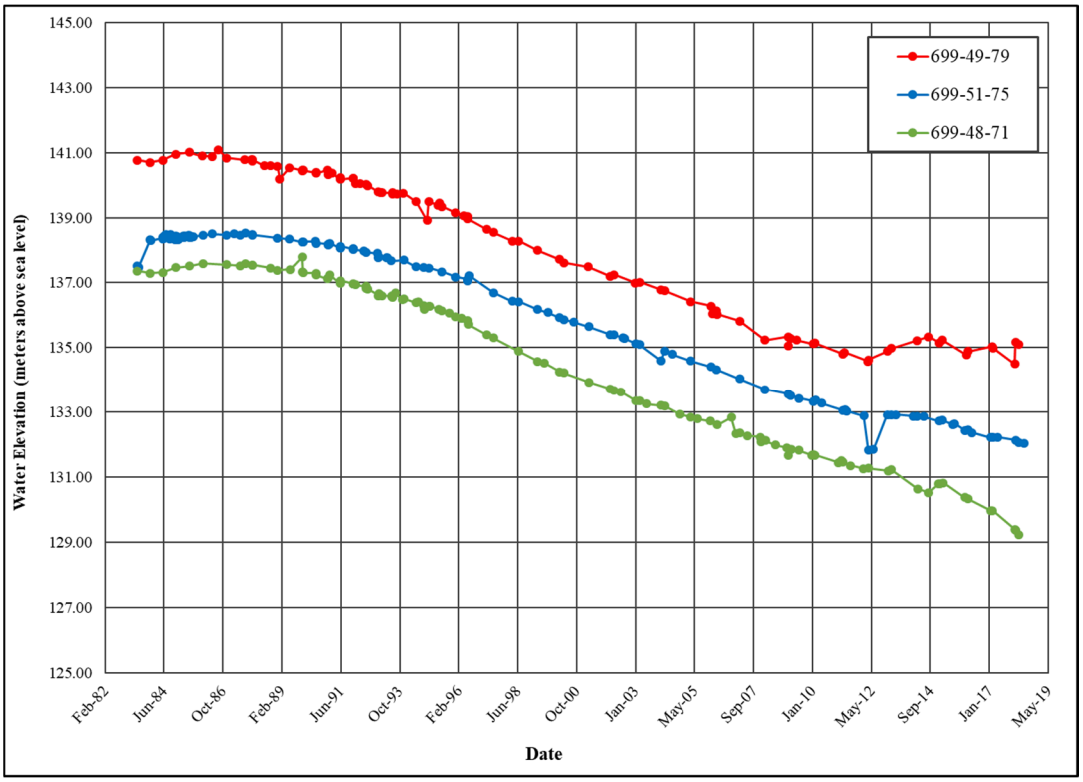

Figure 2-4. Water Levels in Tritium-Tracking Wells – West, North, and East of SALDS

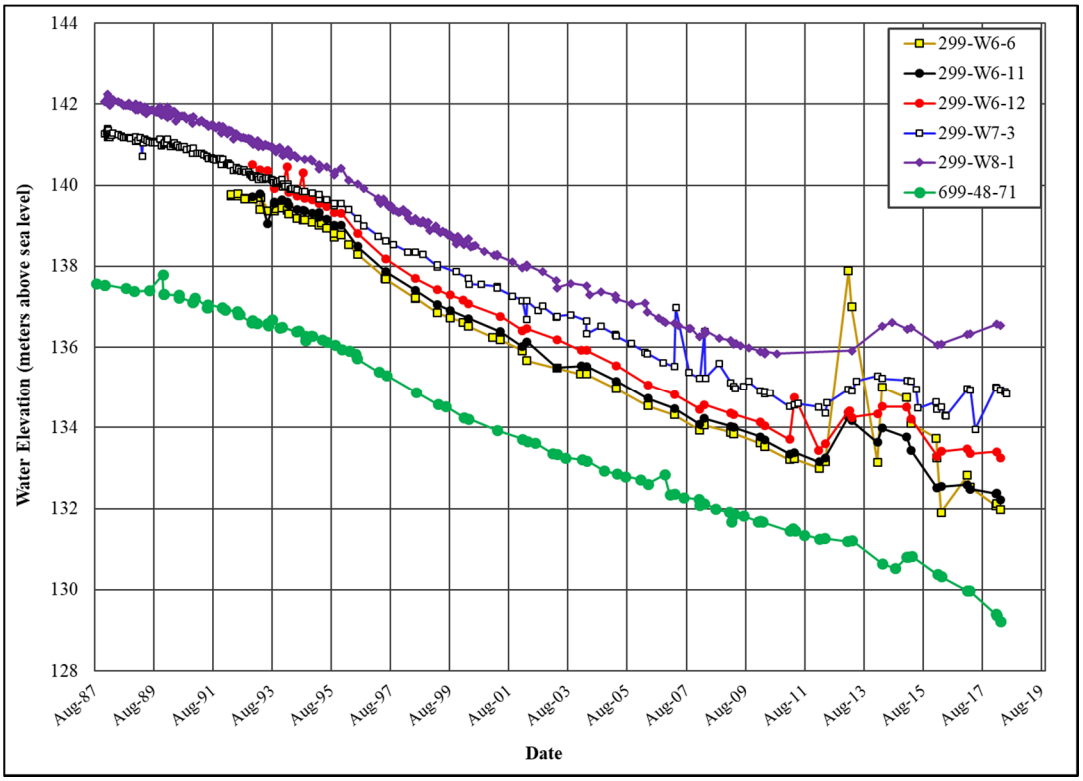

Figure 2-5. Water Levels in Tritium-Tracking Wells to the South and East of SALDS

Table 2-1. Annual Changes in Water-Level Elevations

Well	March 2016 Elevation (m)	March 2017 Elevation (m)	March 2018 Elevation (m)	Annual Rate of Change 2017 to 2018 (m/yr.)
Proximal Wells				
699-48-77A	134.89	134.87	Dry	-
699-48-77C*	134.13	134.25	134.28	+ 0.03
699-48-77D	134.29	134.41	134.43	+ 0.02
Tritium-Tracking Wells				
299-W6-6*	131.90	132.52	131.97	- 0.55
299-W6-11	132.54	132.48	132.21	- 0.27
299-W6-12	133.41	133.36	133.25	- 0.11
299-W7-3*	134.51	134.92	134.94	+ 0.02
299-W8-1	136.08	136.33	136.54	+ 0.21
699-48-71	130.33	129.97 †	129.22	- 0.75
699-49-79	134.89	134.99	135.11	+ 0.12
699-51-75	132.45	132.22	132.07	- 0.15
699-51-75P*	132.50	132.23	132.09	- 0.14
Average, All Wells (m/ yr.)				**- 0.15**
Average, Tritium-Tracking Wells Only (m/ yr.)				**- 0.18**
Average, Proximal Wells Only (m/1 yr.)				**+ 0.01**

* Well has an open interval below the water table (i.e., deep completion).
† Measured February 2017

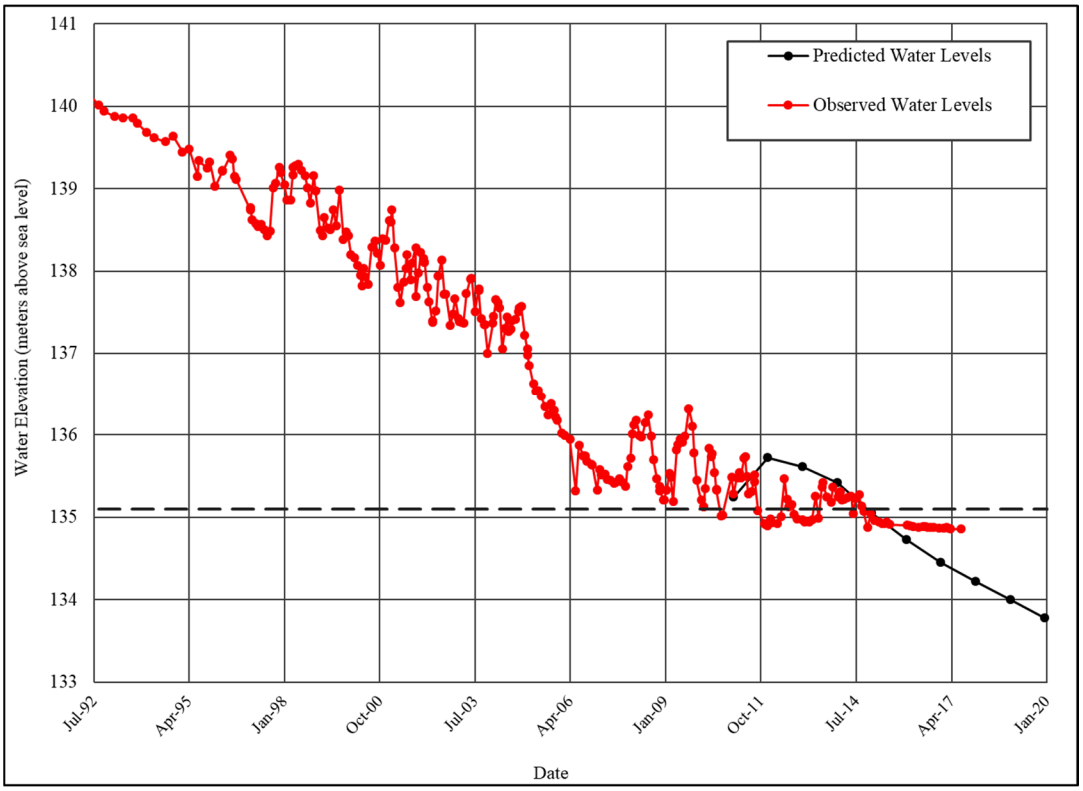

Figure 2-6. Water Remaining in Proximal Well 699-48-77A

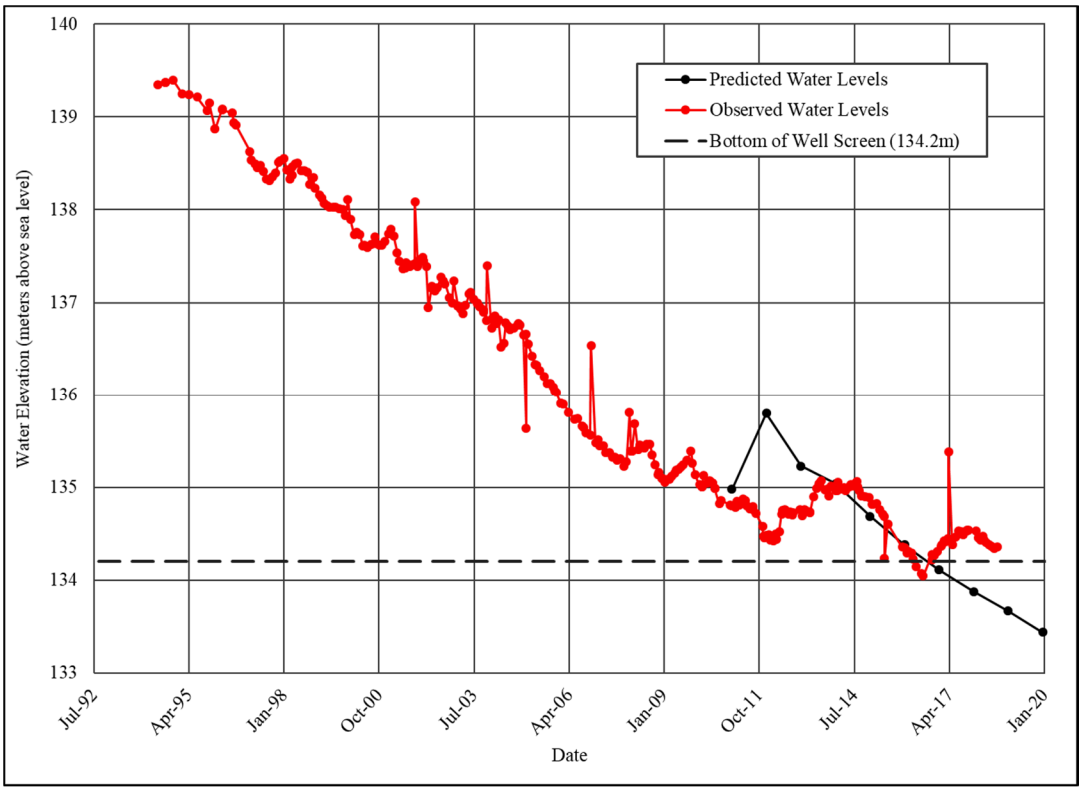

Figure 2-7. Water Remaining in Proximal Well 699-48-77D

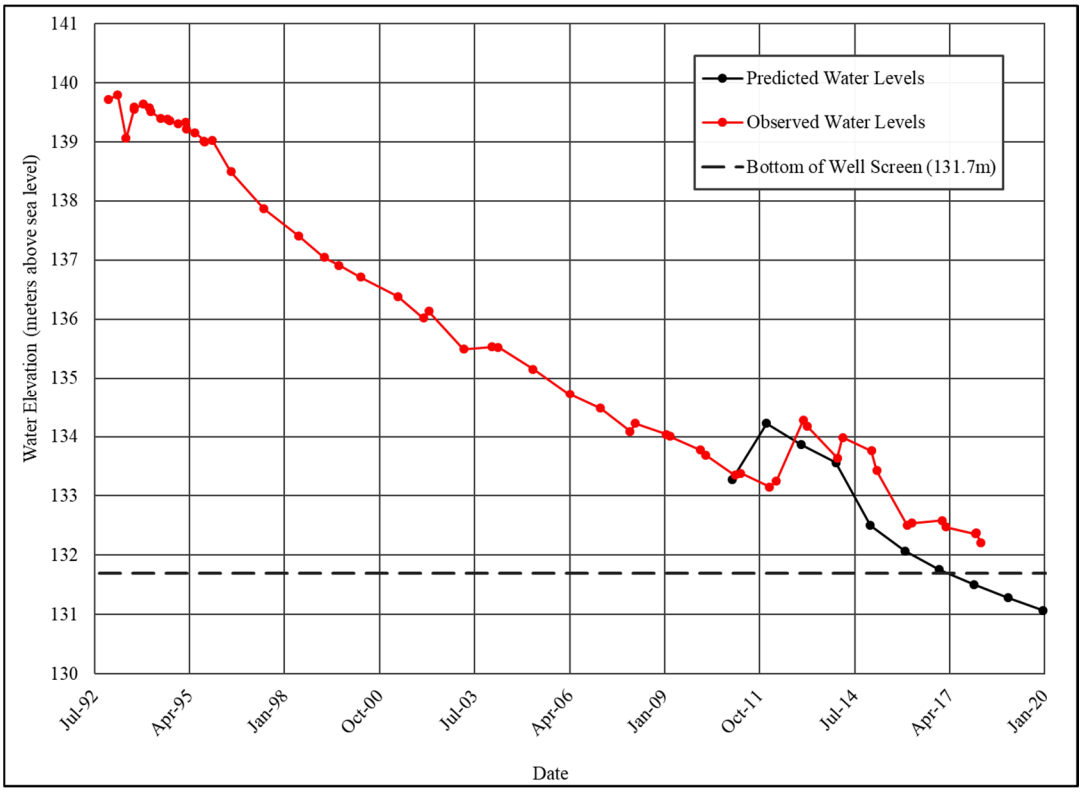

Figure 2-8. Water Remaining in Tritium-Tracking Well 299-W6-11

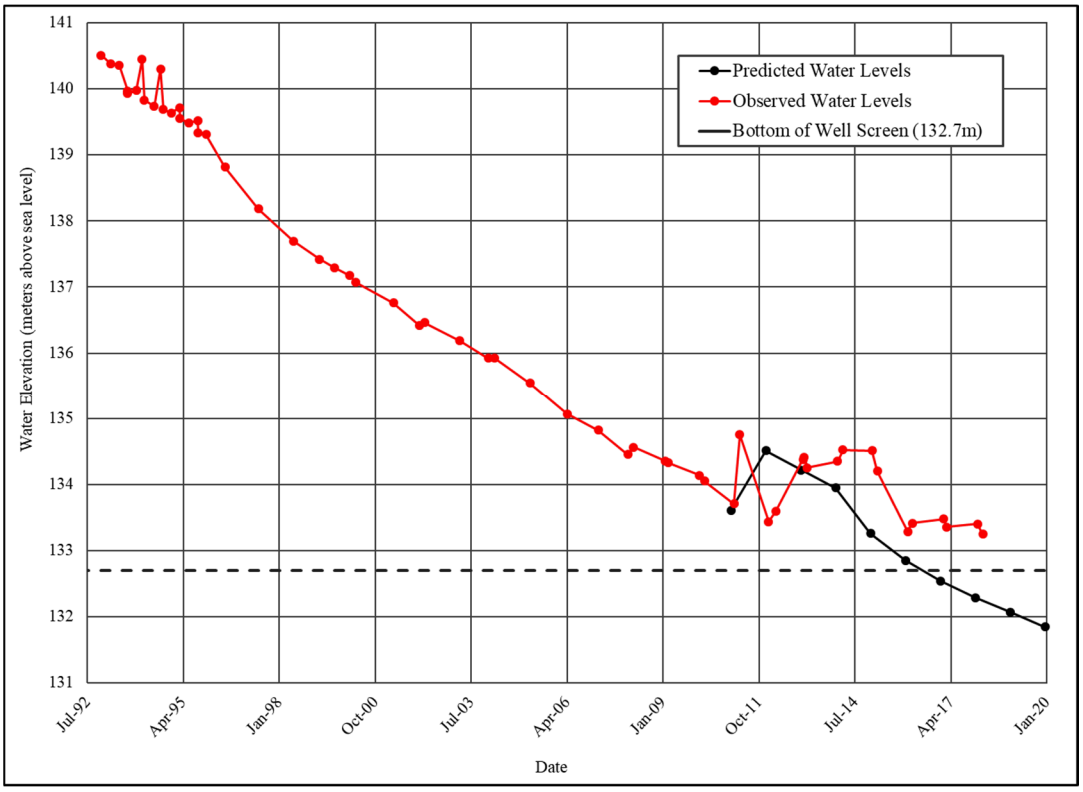

Figure 2-9. Water Remaining in Tritium-Tracking Well 299-W6-12

3 RESULTS OF FISCAL YEAR 2018 GROUNDWATER SAMPLING

Groundwater sampling was performed quarterly in proximal wells 48-77C and 48-77D and annually to semiannually in tritium-tracking wells located in the SALDS vicinity (Table 3-1). Proximal well 48-77A was not sampled because it was dry or had too little water remaining to sample. Sampling of this well was removed from the Permit in 2014. Per the Permit, sampling of the SALDS proximal wells will continue only until they no longer produce representative data. Ecology has also agreed that no replacement wells are needed when a proximal well becomes dry because monitoring of ETF effluent provides assurance that the Permit discharge limits will not be exceeded (12-NWP-035, "Status of Compliance Monitoring Wells at State Approved Land Disposal Site as Required by State Waste Discharge Permit ST-4500").

Although proximal well 48-77D had been predicted to become dry before FY 2017, it was successfully sampled in FY 2017 and FY 2018. Proximal well 48-77C is completed deeper in the aquifer and is not expected to go dry. Samples were taken from both well 48-77C and well 48-77D in October 2017, and January, April, and July of 2018 (Table 3-1). Samples collected for this annual report were analyzed by either TestAmerica (Richland, Washington, or St. Louis, Missouri) or GEL Laboratories (Charleston, South Carolina). TestAmerica Richland is typically used for anion and low-activity tritium analyses, while TestAmerica St. Louis or GEL are used for all other analyses.

Section 3.1 summarizes FY 2018 groundwater sampling results for proximal wells 48-77C and 48-77D. Section 3.2 summarizes the results of tritium analyses in proximal and tritium-tracking wells. Tritium concentrations in well samples are shown in Table A-1.

3.1 Proximal Well Sampling and Analyses for Fiscal Year 2018

Quarterly samples from proximal wells 48-77C and 48-77D were analyzed for tritium and 16 other constituents or parameters listed in the groundwater monitoring plan (PNNL-13121). The earlier revision of the Permit from FY 2000 set concentration limits for acetone, benzene, cadmium (total), chloroform, copper (total), lead (total), mercury (total), field pH, sulfate, tetrahydrofuran, and total dissolved solids (TDS). Gross alpha, gross beta, strontium-90, tritium, specific conductance, and temperature were also listed in the Permit but were not assigned concentration limits; they were reported for informational purposes. Results of all of these parameters are reported quarterly by the ETF in discharge monitoring reports. Additional parameters (i.e., alkalinity, dissolved oxygen, turbidity, chloride, calcium, and sodium) are used to determine general groundwater characteristics and verify the quality of analytical results. Table 3-2 lists measured concentrations of these constituents in proximal wells 48-77C and 48-77D, as well as their sampling months in FY 2018.

Acetone, benzene, cadmium, lead, mercury, and strontium-90 (^{90}Sr) were reported below detection levels in both proximal wells for all samples collected in FY 2018 (Table 3-2). Tetrahydrofuran was detected in the laboratory blanks and field samples in April 2018 and was therefore appropriately flagged as potentially contaminated in the laboratory. All other tetrahydrofuran results were below detection levels. Very low concentrations of copper were detected in both proximal wells in FY 2018.

Table 3-1. Sampling Schedule for Fiscal Year 2018

Well	Sampling Frequency/Months*	Other Sampling Programs	Comments
299-W6-6	A / January	—	Deep well Sampled in January 2018
299-W6-11	A / January	PNLGW	Sampled in January 2018
299-W6-12	A / January	—	Sampled in January 2018
299-W7-3	S / January, May	PNLGW	Deep well Sampled in January and June 2018
299-W8-1	A / January	—	Sampled in January 2018
699-48-71	A / January	PNLGW	Sampled in February 2018
699-48-77C	Q / October, January, April, July	PNLGW	Sampled 17 constituents/parameters, including tritium. Sampled October 2017 and January, April, July 2017
699-48-77D	Q / October, January, April, July	—	Sampled 17 constituents/parameters, including tritium Sampled October 2017 and January, April, July 2017
699-49-79	A / January	PNLGW	Sampled in January 2018
699-51-75	S / January, May	—	Sampled in January and June 2018
699-51-75P	A / January	—	Deep piezometer in well 699-51-75. Sampled in January 2018

* Actual months of sampling may vary due to equipment failure, winter weather conditions, or accessibility restrictions caused by fire hazard; however, the sampling frequency is generally maintained.
A = annually
Q = quarterly
S = semiannually

The measured concentration of sulfate in well 48-77D was 16,000 µg/L, which was the same concentration as measured in FY 2016 and FY 2017. The sample from well 48-77C contained 9,000 µg/L sulfate, which was 1.5 times higher than in FY 2017 (6,000 µg/L) but significantly lower than in well 48-77D. This lower sulfate concentration in well 48-77C reflects significant dispersion of SALDS discharges by groundwater. Total dissolved solids were also lower in 48-77C, measuring 167,000 µg/L versus 183,000 µg/L in 48-77D. This lower TDS concentration in well 48-77C is also attributed to dispersion in groundwater.

Gross beta results from 48-77C and 48-77D measured 4.38 and 5.30 pCi/L, respectively. These concentrations are below the Hanford Site background value of 9.73 pCi/L (95th percentile value provided

Table 3-2. Constituent Concentrations in Groundwater and Corresponding Sampling Month for the SALDS Proximal Wells, Fiscal Year 2018

Constituent	Well 699-48-77C	Well 699-48-77D
Maximum Constituent Concentrations		
Acetone	3.0 (TU) [a]	3.0 (TU) [a]
Benzene	0.30 (U) [a]	0.30 (U) [a]
Cadmium, Total	0.30 (U) [a]	0.30 (U) [a]
Chloroform	0.47 J April 2018	0.39 J April 2018
Copper, Total	1.05 January 2018	1.56 April 2018
Lead, Total	0.50 (U) [a]	0.50 (U) [a]
Mercury, Total	0.067 (U) [a]	0.067 (U) [a]
Field pH, pH Units[b]	8.04 April 2018	8.07 April 2018
Sulfate	9,000 July 2018	16,000 October 2017, January 2018, April 2018
Tetrahydrofuran	2.96 (BJ) April 2018	2.73 (BJ) April 2018
Total Dissolved Solids	167,000 January 2018	183,000 January 2018
Gross Alpha, pCi/L	2.85 (U) [a]	3.01 October 2017
Gross Beta, pCi/L	4.38 July 2018	5.30 October 2017
Strontium-90, pCi/L	1.98 (U) [a]	1.84 (U) [a]
Tritium, pCi/L	56,000 April 2018	57,400 October 2017
Field Specific Conductance, µS/cm[b]	220 July 2018	257 July 2018
Field Temperature, °C[b]	22.8 July 2018	32.2 July 2018
Alkalinity, mg/L	99.8 July 2018	112 July 2018
Dissolved Oxygen, mg/L[b]	9.63 - 9.67 July 2018	12.80 – 12.97 January 2018
Turbidity, NTU[b]	2.28 – 3.68 July 2018	5.79 - 6.95 October 2017
Chloride, µg/L	3,000 July 2018	4,900 April 2018
Calcium, µg/L	24,400 January 2018	29,700 January 2018
Sodium, µg/L	7,260 April 2018	9,090 January 2018

Note: All concentrations are reported in µg/L, unless otherwise indicated.
a. Not detected in any sample.
b. Four analyses were performed per sample event. Values reported are averages of the four analyses, except that maximum values are used for pH, specific conductance, and temperature.

B = detected in both the associated quality control blank and in the sample
J = detected at a value less than the contract-required detection limit but greater than or equal to the instrument detection limit/method detection limit, as appropriate (i.e., a low-level detection)
NTU = Nephelometric Turbidity Unit
TU = Spike and/or spike duplicate sample recovery is outside control limits, not detected
U = Not detected; detection limits (for nonradionuclides) or minimum detectable activity (for radionuclides) are indicated, as applicable

in DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). There was no measurable gross alpha in 48-77C and only 3.01 pCi/L in 48-77D in November 2017. This result is also below the Hanford Site background value of 3.48 pCi/L (95th percentile) in DOE/RL-96-61. All of the strontium-90 analyses in the proximal wells were nondetects in FY 2018.

Specific conductivities in the proximal wells were nearly identical to their respective values measured in FY 2017. Well 48-77C measured 205 µS/cm in FY 2017 and 220 µS/cm in FY 2018. Similarly, well 48-77C measured 260 µS/cm in FY 2017 and 257 µS/cm in FY 2018. Specific conductivities for these wells and the tritium-tracking wells are mapped on Figure 3-7.

Other measured constituents such as chloride, calcium, sodium, and tritium show consistently lower concentrations in well 48-77C than in 48-77D due to groundwater dispersion of SALDS discharges (Table 3-2).

3.2 Tritium in Tritium-Tracking Wells

The SALDS network monitoring wells are sampled annually or semiannually for tritium only (i.e., tritium-tracking wells). Eight tracking wells were sampled in FY 2018 along with the two proximal wells. Due to generally declining water levels throughout the 200 West Area, many tritium-tracking (tracking) wells listed in the monitoring plan (PNNL-13121) are dry and no longer in use. Five wells that were successfully sampled are screened in the upper portion of the aquifer near the water table. The other three wells are screened at greater depths, including one well (51-75P) that is the nested piezometer within well 51-75 and has an open interval that is 41 m (135 ft) deeper in the aquifer than the well. Four tracking wells (W6-11, W7-3, 48-71, and 49-79) and proximal well 48-77C were also sampled for another program (PNLGW) during FY 2018 (Table 3-1). In recent years, tritium concentrations in proximal wells and tritium-tracking wells have declined in response to the overall decrease in the amount of tritium released from SALDS. Tritium concentrations in tracking wells in FY 2018 were not consistently increasing or decreasing regardless of location. Three tracking wells were “non-detects” for tritium including W7-3, 49-79, and 51-75. These latter two wells lie at some distance from SALDS and from 200 West P&T injection wells. Two tracking wells (W8-1 and W6-6) showed increases relative to FY 2017, increasing from 208 to 640 pCi/L and from 2,090 to 2,410 pCi/L, respectively. Conversely, tracking wells W6-11 and 48-71 decreased from 1,400 to 586 pCi/L and from 3,200 to 2,910 pCi/L, respectively. Tracking well W6-12 decreased slightly from 129 to 101 pCi/L in FY 2018. Tritium concentrations in tracking wells in FY 2018 are compared to FY 2017 values in Table A-1.

3.2.1 Tritium in Proximal Wells

This section describes temporal changes in FY 2018 in tritium concentrations in the proximal wells. The maximum tritium concentrations in the proximal wells, measured in FY 2018, are shown in Table 3-2. However, quarterly concentrations varied considerably from November 2017 to July 2018 (Table A-1). Although groundwater elevations in proximal wells correlate to SALDS discharge volumes with a time-lagged response (Figure 2-3), measured tritium concentrations are variable and not as clearly correlated to discharged concentrations in FY 2018 (Figure 3-1). Figure 3-1 shows measured tritium concentrations in proximal wells as well as discharged activities over nearly three fiscal years. The discharges (green bars) in FY 2016 in June, July, August, and September show no effect on measured tritium concentrations. Similarly, discharges in FY 2017 show no increases of measured tritium concentrations in the wells. The much larger activities discharged in FY 2018 (6.59 Ci) are not responsible for the apparent increase in tritium concentrations measured in well 48-77C in January and April 2018, as these increases precede the discharge dates. There is always a lag time between the date of discharge to SALDS and responses in groundwater wells as the tritium plume migrates vertically ~70 m within the sediment column.

3.2.1.1 Long-Term Trends of Proximal Wells

Groundwater in proximal wells has been affected by tritium discharges since 1996 (Figure 3-2). Peak tritium concentrations occurred in September 1997 (2,000,000 pCi/L) and February 1998 (2,100,000 pCi/L) in wells 48-77A and 48-77D, respectively. These peak concentrations were in response to initial discharges to SALDS between December 1995 and June 1996. The tritium concentration trend in well 48-77C is attenuated and time-lagged compared to the other wells. The peak concentration in this well occurred in February 2001, which was 3 years after the peak occurred in 48-77D, and the concentration had decreased to 980,000 pCi/L. The lower concentration was caused primarily by dispersion. Well 48-77C is screened approximately 20 m (65 ft) below the water table, and as the plume migrated to this depth, it mixed with uncontaminated groundwater. Radiological decay would have also contributed to the decreased concentration because tritium has a relatively short half-life (12.3 years). However, aqueous dispersion was the dominant cause of the decreased tritium concentration observed in well 48-77C.

Tritium concentrations have generally trended downward since the initial discharges to the SALDS in 1995 and 1996, although periods of increasing or fluctuating concentrations have occurred. From 1999 to 2005, concentration changes in well 48-77A were irregular (Figure 3-2) with periodic highs and lows of significant magnitude. These fluctuations were likely caused by the ETF performing annual campaigns to treat 242-A Evaporator waste (Process Condensate) containing elevated tritium concentrations. In April 2008, the tritium concentration in well 48-77A was 820,000 pCi/L, the highest level seen in a decade (Figure 3-3). This elevated tritium concentration was likely due to several intermittent ETF campaigns in 2006 and 2007 to treat wastewater from the K Basins project that contained tritium levels similar to the 242-A Evaporator wastewater. These intermittent campaigns restarted in FY 2010 with ETF again treating wastewater from the K Basins project. This is considered to be the basis for the fluctuation in tritium concentration observed during FY 2011, before well 48-77A became dry.

3.2.1.2 Current Trends of Proximal Wells

As described in Section 2-3, tritium concentrations in proximal wells indirectly reflect fluctuating discharge volumes (Figure 2-3) and fluctuating discharge concentrations (Figure 3-1). Figure 3-1 shows graphically the variability of measured tritium concentrations over most of three fiscal years. Discharges to SALDS in FY 2016 contained a low total concentration of tritium (1.90 Ci) in a relatively large total volume (14.7 M L). Fiscal year 2017 was nearly identical to FY 2016 with only 1.26 Ci of tritium discharged in 14.0 M L. In contrast, 6.59 Ci of tritium was discharged in FY 2018 in a total volume of 8.44 M L. The highest concentrations measured in the proximal wells in FY 2018 were 56,000 pCi/L in well 48-77C and 57,400 pCi/L in well 48-77D (Figure 3-1). The proximal wells have very different concentration profiles but similar levels of variabilities. Both wells show slightly decreased (~5,000 pCi/L) tritium concentrations in the latter half of FY 2018. It is expected that the highly concentrated tritium discharges in the latter half of FY 2018 will be reflected in higher measured tritium concentrations in proximal wells in FY 2019 or FY 2020.

3.2.2 Current Trends of Tritium-Tracking Wells

Groundwater analyses in FY 2018 continue to indicate the tritium plume from SALDS has not reached any tritium-tracking wells. Tritium was not detected in the deep well W7-3, nor distal wells 49-79, 51-75, and 51-75P located south, west, and north of SALDS, respectively (Figure 2-1). Tritium, unrelated to SALDS discharges, was detected in tritium-tracking wells W6-6, W6-11, W6-12, W8-1, and 48-71 to the south and east of SALDS (Figure 3-4). This tritium was derived from active injection wells of the 200 West P&T system, as well as past waste disposal sites in the 200 West Low Level Waste Management Areas (LLWMA).

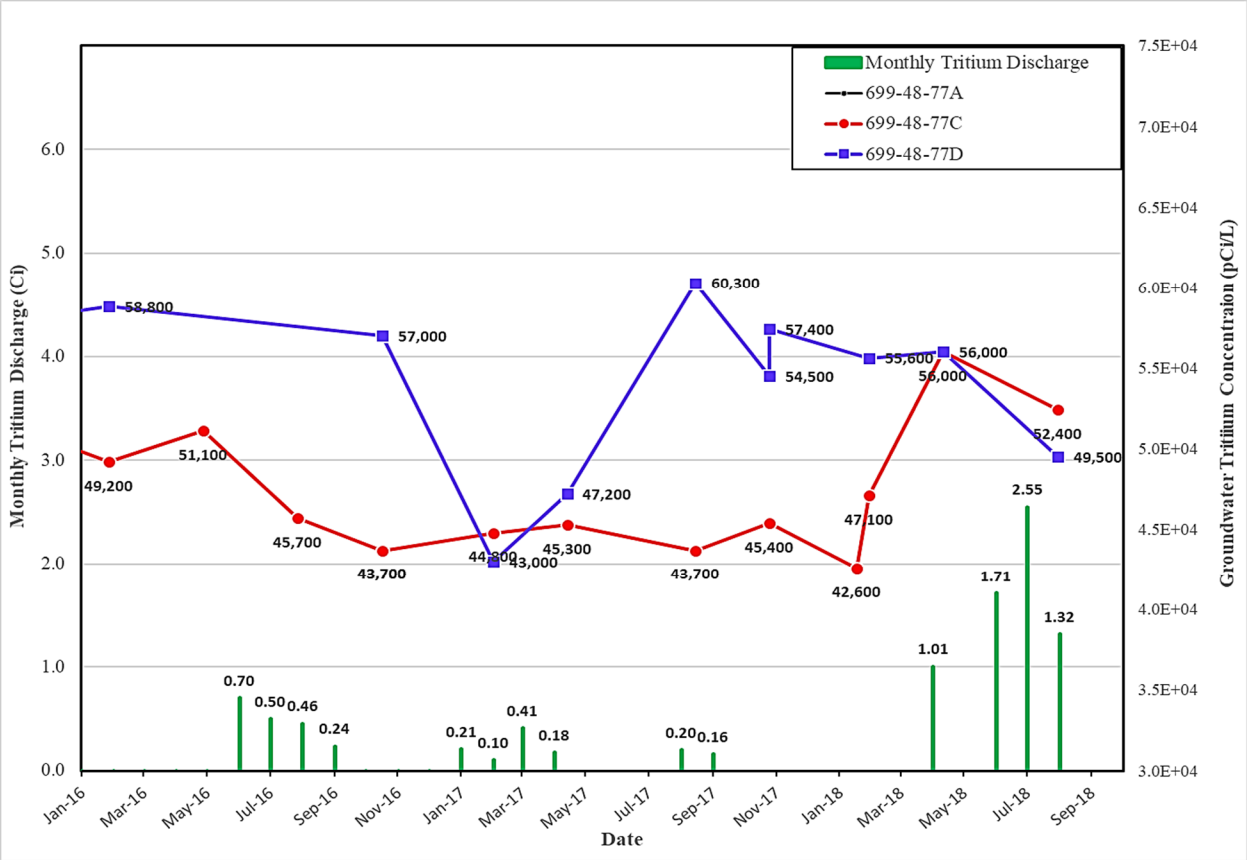

Figure 3-1. Proximal Well Tritium Concentrations and Discharged Tritium Activities

As discussed in Section 2.1, injection well W6-13 of the 200 West P&T system was installed only 9.8 m (32 ft) from well W6-6 (Figure 1-3). This injection well began operating in 2012 and continues to receive water from the 200 West P&T system. Like the ETF, the 200 West P&T system does not remove tritium from the effluent. The average annual tritium concentration of the 200 West P&T effluent was 2,440 pCi/L according to the Hanford Environmental Information System (HEIS). Injection of this effluent is consistent with measured tritium concentrations in tritium tracking wells of SALDS (Figure 3-4). Injections in W6-13 cause tritium to appear in wells W6-6, W6-11, and W6-12. A second injection well, W7-14, is most likely the source of tritium appearing in tracking well W8-1 (Figure 1-3).

Migration of tritium from past wastewater disposal sites (i.e., WMAs) in the 200 West Area has also affected shallow tritium-tracking wells along the northern margin of the 200 West Area. Many of the shallow-screened wells in this area exhibited elevated tritium concentrations prior to the start of SALDS discharges (Figure 3-5), supporting the interpretation that this tritium originated from 200 West WMAs.

The deep tritium-tracking well W6-6, located southeast of SALDS, contained 2,090 pCi/L of tritium in January 2017 and 2,410 pCi/L in 2018 (Figure 3-4). Well W6-6 no longer provides useful information for tracking the tritium from SALDs due to tritium plumes migrating from 200-ZP-1 injection wells and tritium-contaminated groundwater from 200 West WMAs. Another deep tritium-tracking well, W7-3, has not had measureable tritium since January 2008.

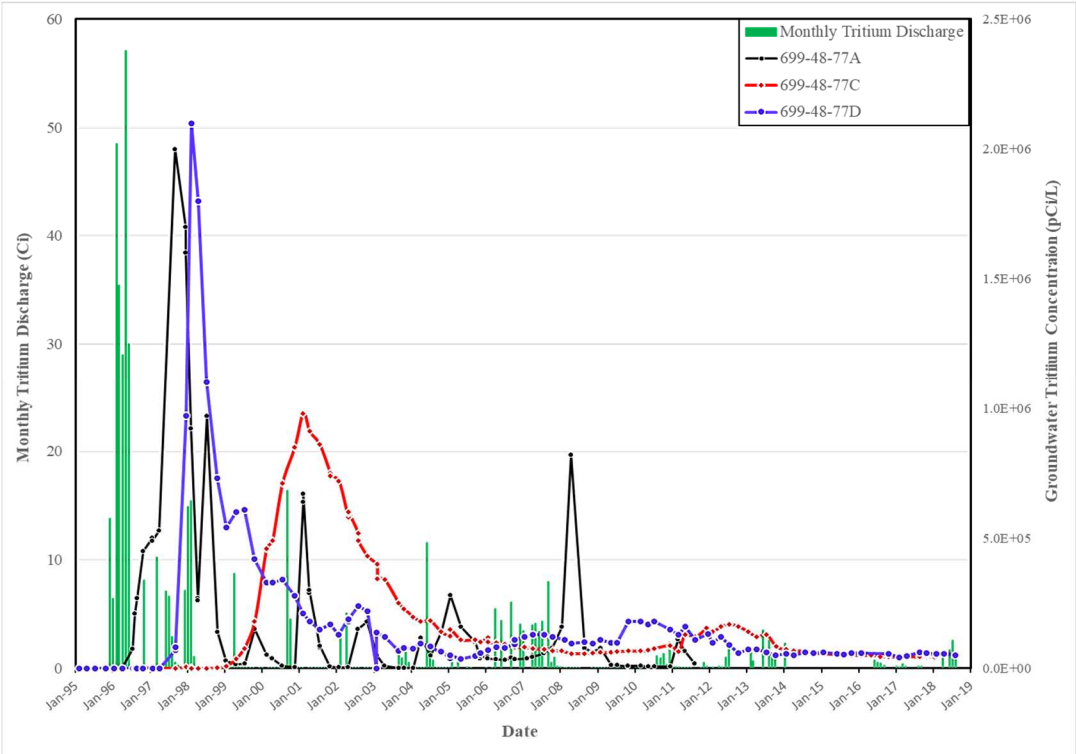

Figure 3-2. Tritium Releases and Concentration Trends in SALDS Proximal Wells from 1995 through September 2018

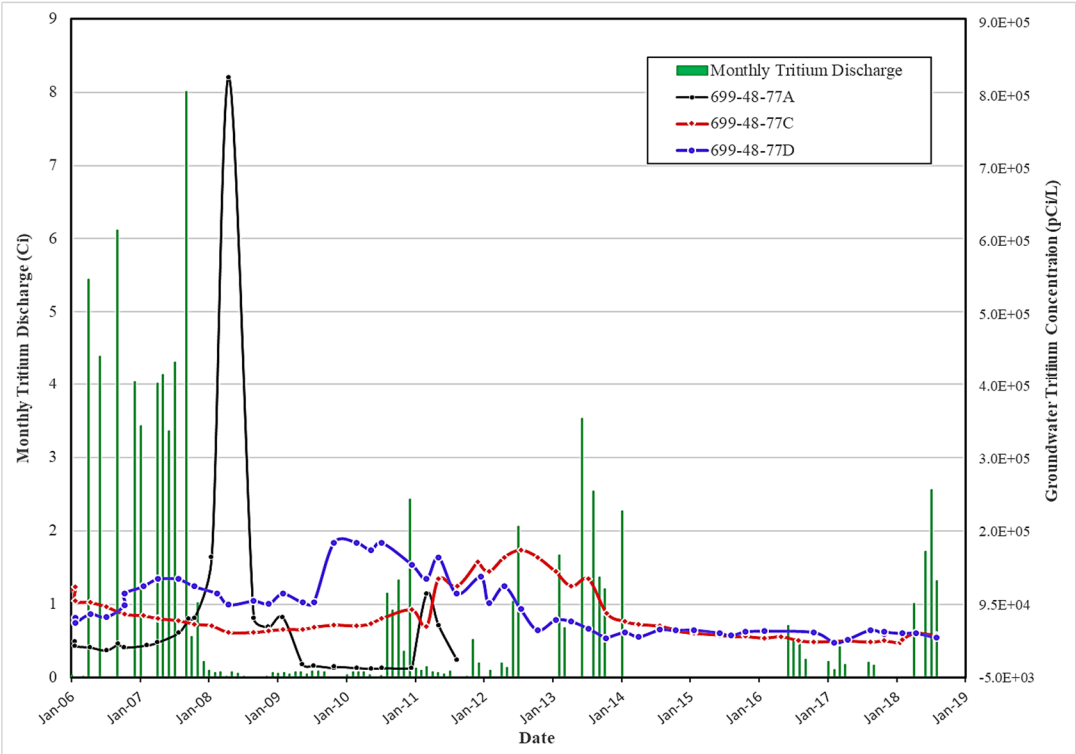

Figure 3-3. Tritium Releases and Concentration Trends in SALDS Proximal Wells from 2006 through September 2018

The tritium concentration in the shallow tracking well W6-11 decreased from 1,400 pCi/L in FY 2017 to 586 pCi/L in FY 2018. However, the long-term tritium concentration in this well had been steadily declining since December 1999 (Figure 3-5). The nearby shallow tracking well W6-12 contained only 101 pCi/L, decreasing slightly from 129 pCi/L in FY 2017. The tritium concentration in tracking well W8-1, which lies southwest of the SALDS, increased from 208 pCi/L in FY 2017 to 640 pCi/L in FY 2018 due to plume migration from either injection well 299-W7-14 or from LLWMA 3 in the 200 Area (Figure 3-4).

Well 48-71, located 1.5 km (0.97 miles) east of SALDS, has exhibited increasing tritium concentrations since 2004 (Figure 3-5). However, the tritium concentration has recently decreased from 3,200 pCi/L in FY 2016 and FY 2017 to 2,910 pCi/L in FY 2018. Although this well is located down gradient of the SALDS crib, the large distance to this well suggests that discharges from SALDS are not the source of tritium in groundwater at this location (Figure 1-3). This is supported by the tritium modeling results (RPP-CALC-61950) which predicts the 500 pCi/L concentration from SALDS plume should not reach well 48-71 prior to the year 2030.

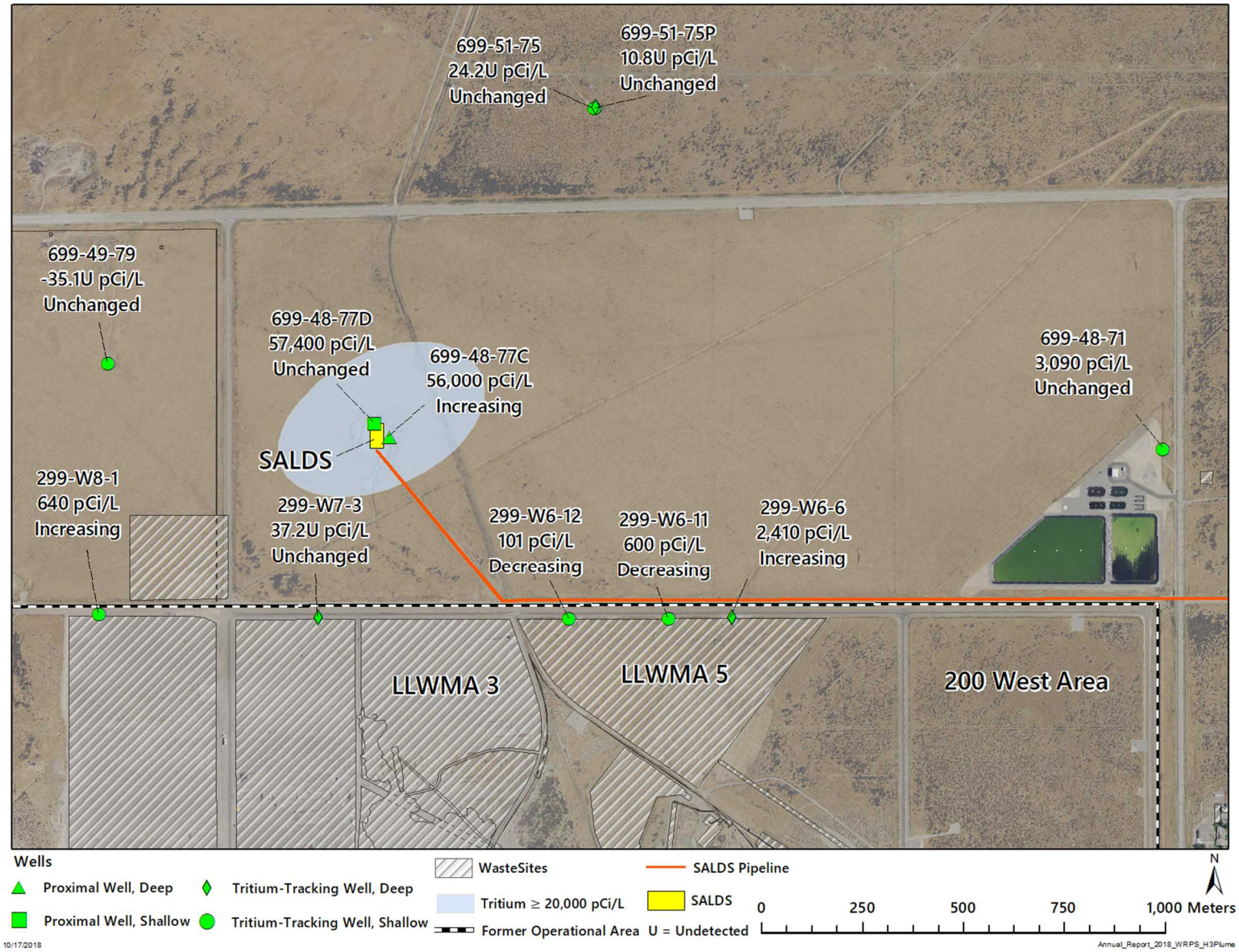

Figure 3-4. Tritium Activities in Groundwater from SALDS Tritium-Tracking Network in Fiscal Year 2018

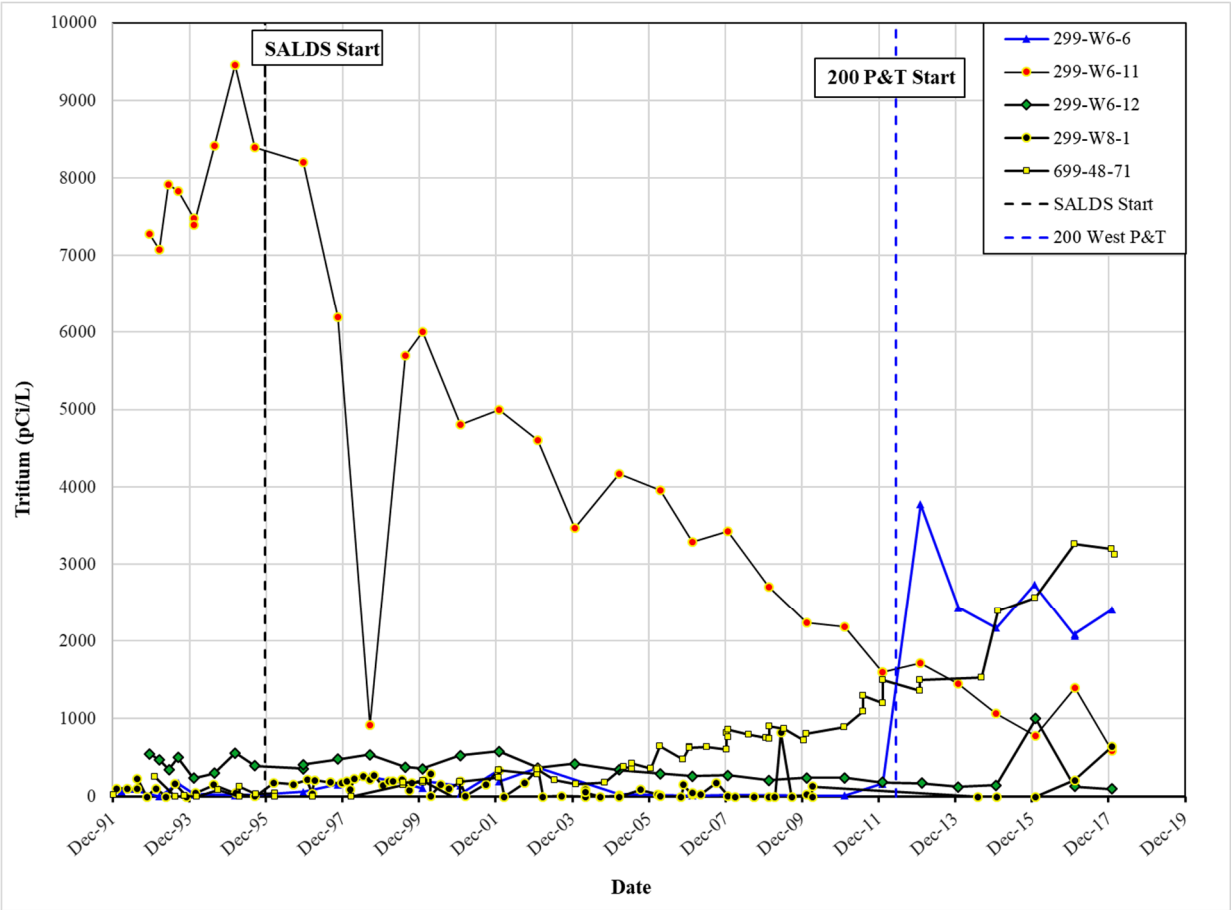

Figure 3-5. Tritium Activity Trends in Wells South and East of SALDS Showing Remnant Effects of the Tritium Plume from the 200 West Area

3.3 Results of Other Constituent Analyses

After discharges began at SALDS, several anions and metals increased in concentration in the proximal wells and then rapidly declined. Specific conductance (a measure of total ions in solution) at well 48-77A shows a well-defined spike in the months after discharges to SALDS began in December 1995 (Figure 3-6), with values peaking at approximately 845 µS/cm in August 1996. This was likely due to transport of soluble mineral species that were dissolved from the vadose zone during initial percolation of effluents discharged to SALDS (PNNL-11633, *Origin of Increased Sulfate in Groundwater at the ETF Disposal Site;* PNNL-11665, *Tritium Monitoring in Groundwater and Evaluation of Model Predictions for the Hanford Site 200 Area Effluent Treatment Facility*). This spike in dissolved constituents was a temporary effect associated with initial effluent wetting and leaching of the emplaced sediments of the vadose zone beneath the SALDS.

Currently, specific conductance in the proximal wells is related to the volume of ETF effluent discharged to SALDS. ETF effluent is low in specific conductance with an average value for FY 2017 of 2.93 µS/cm. The Hanford Site groundwater background for specific conductance has a geometric mean of 348 µS/cm (DOE/RL-96-61). Thus, mixing of ETF effluent with groundwater decreases specific conductance in the monitoring wells by dispersion, and the amount of decrease depends on the volume of effluent released. Conversely, specific conductance in the SALDS wells increases during periods of decreased discharges. For example, between 2005 and 2007 specific conductance in shallow proximal

wells 48-77A and 48-77D increased and peaked in late 2007 and early 2008 (Figure 3-6). A very small peak in specific conductance was observed during early 2011 in deep proximal well 48-77C, which is likely the attenuated, time-lagged response to the 2005 to 2007 period of decreased effluent discharges.

The tritium plume from SALDS is associated with low specific conductance in the groundwater because of the low specific conductance of the ETF effluent. The proximal wells show the lowest specific conductance of all wells, and map isopleths indicate highest specific conductances are measured to the east and southeast of the SALDS (Figure 3-7). Specific conductances in well 48-77C increased marginally in FY18, slowly increasing from 197, to 206, to 214, and 219 µS/cm in November, January, April and July. Similarly, proximal well 48-77D only increased from 245 to 255 µS/cm from November to July in FY18. The highest specific conductance in the eastern part of the mapped area denotes contamination originating from the 200 West Area LLWMAs. Specific conductances in wells W6-6, W6-11, 48-71, W5-1, W5-2 suggest these wells receive the most direct inputs from the LLWMAs (Figure 3-7).

During FY 2018, the maximum concentrations of TDS in the proximal wells were 167 mg/L in 48-77C and 200 mg/L in 48-77D (Figure 3-8). These values are nearly identical to results in FY17 that measured 157 and 200 mg/L, respectively. Specific conductance is an indirect measure of total ions in solution, so it is expected that TDS and specific conductance would trend together. However, recent trends in TDS (i.e., since 2011) do not correlate with trends in specific conductance (compare Figure 3-6 with Figure 3-8). The reason that recent specific conductance and TDS do not trend together is unknown.

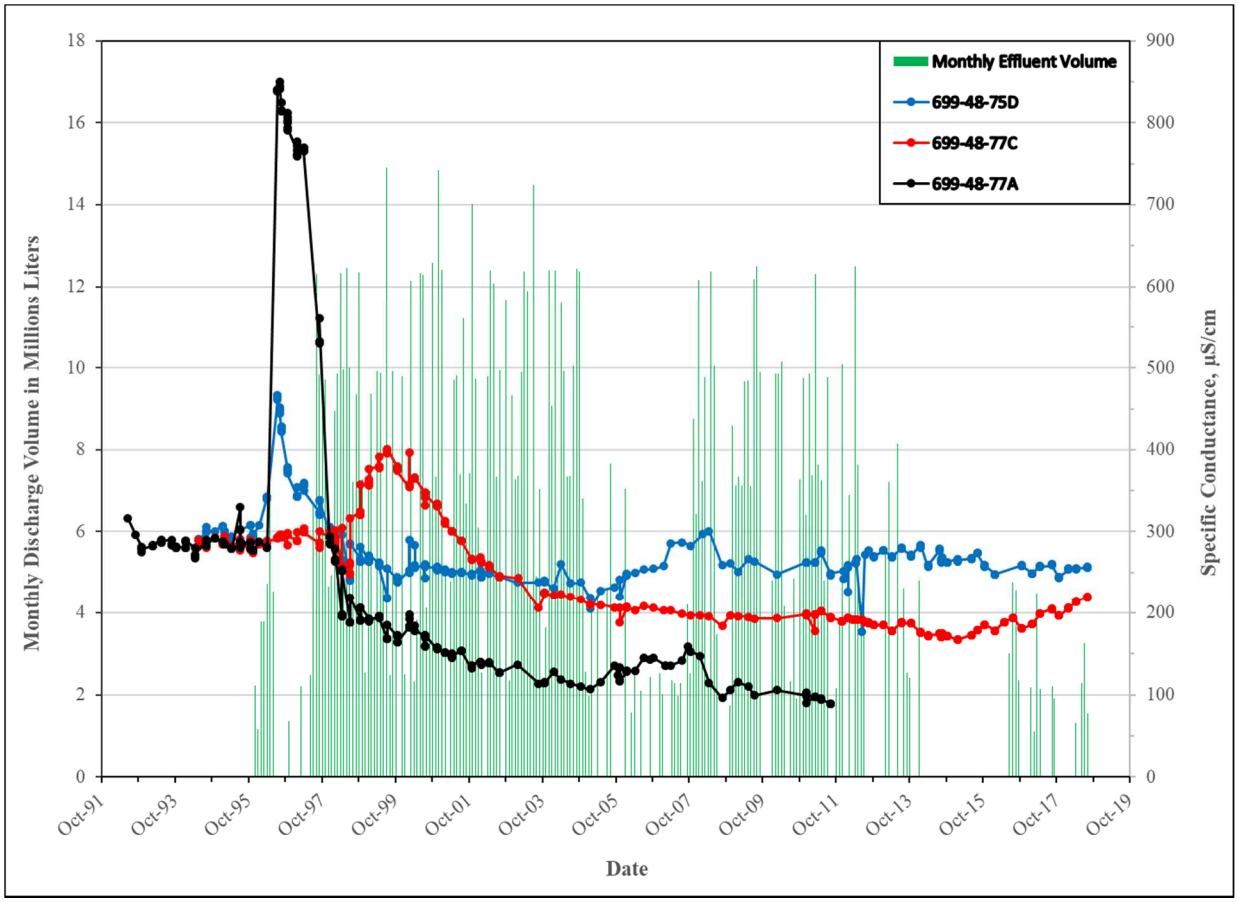

Figure 3-6. Specific Conductance in the SALDS Proximal Wells

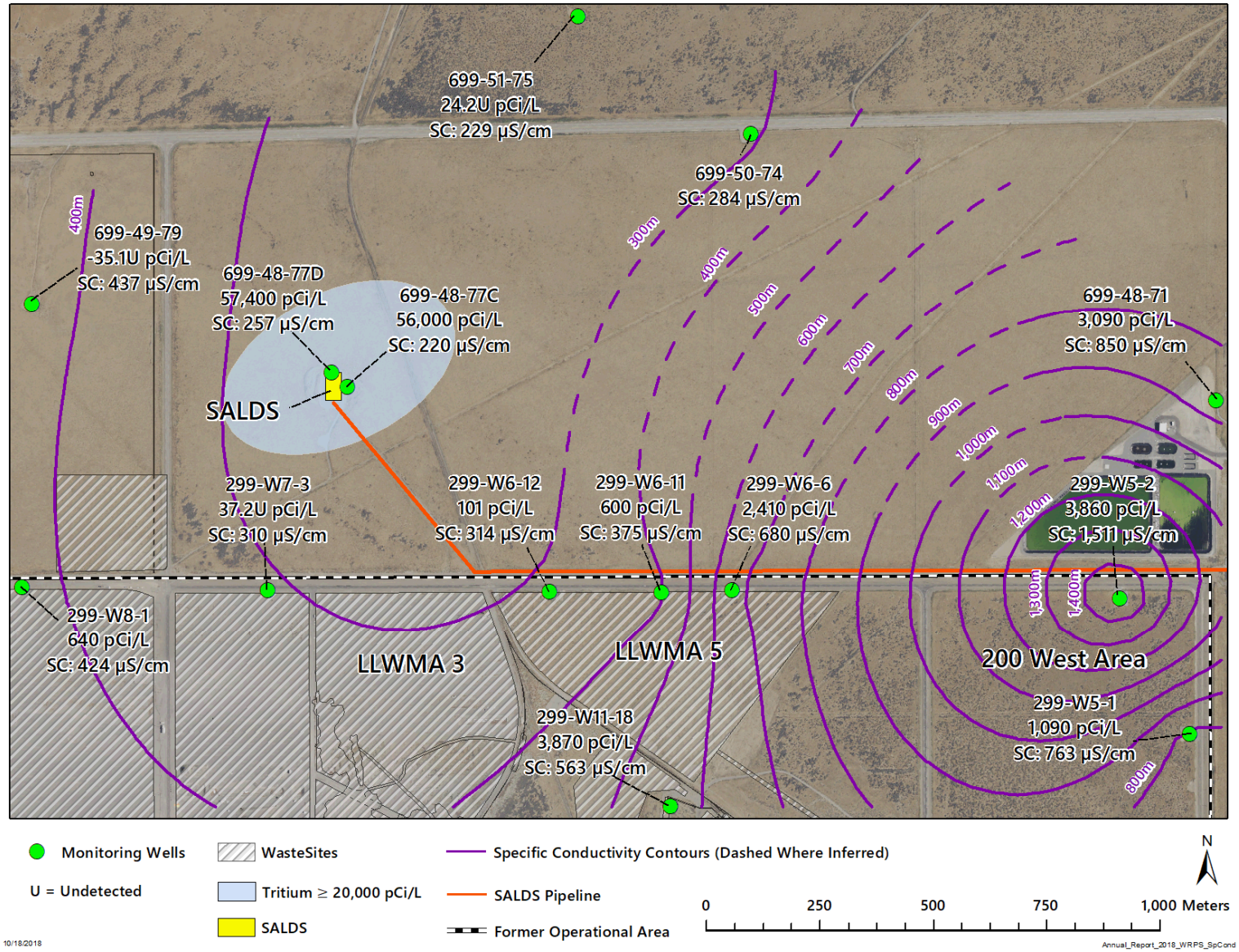

Figure 3-7. Specific Conductance and Tritium Activity in the SALDS Vicinity

Figure 3-9, Figure 3-10, Figure 3-11, and Figure 3-12 are trend plots for chloride, sulfate, calcium, and sodium in the proximal wells, respectively. These constituents are leached from the soil, and they are naturally present in groundwater so the sample results are not representative of ETF effluent. However, these constituents provide useful information regarding the effect of discharges to SALDS on groundwater. Chloride, sulfate, and calcium exhibit the same trends as described previously for specific conductance. Sharp increases were observed in concentrations in the shallow proximal wells (48-77A and 48-77D) shortly after discharges began in 1995 that were due to leaching from the soil column. More recent trends exhibit an inverse relationship with discharge volume, indicating dilution in the aquifer of discharges to SALDS. The trends at deep well 48-77C exhibit the same attenuated, time-lagged response that was observed for specific conductance. The sodium trends also exhibit an increase in concentration shortly after the start of effluent discharges, but the relative increase was lower than for the other constituents (Figure 3-12). More recent sodium concentrations do not appear to trend with the other constituents, and there is no obvious relationship with effluent discharge volumes. This suggests that the effluent is continuing to leach sodium from the soil column, so the concentration in the leachate is similar to the concentration in groundwater.

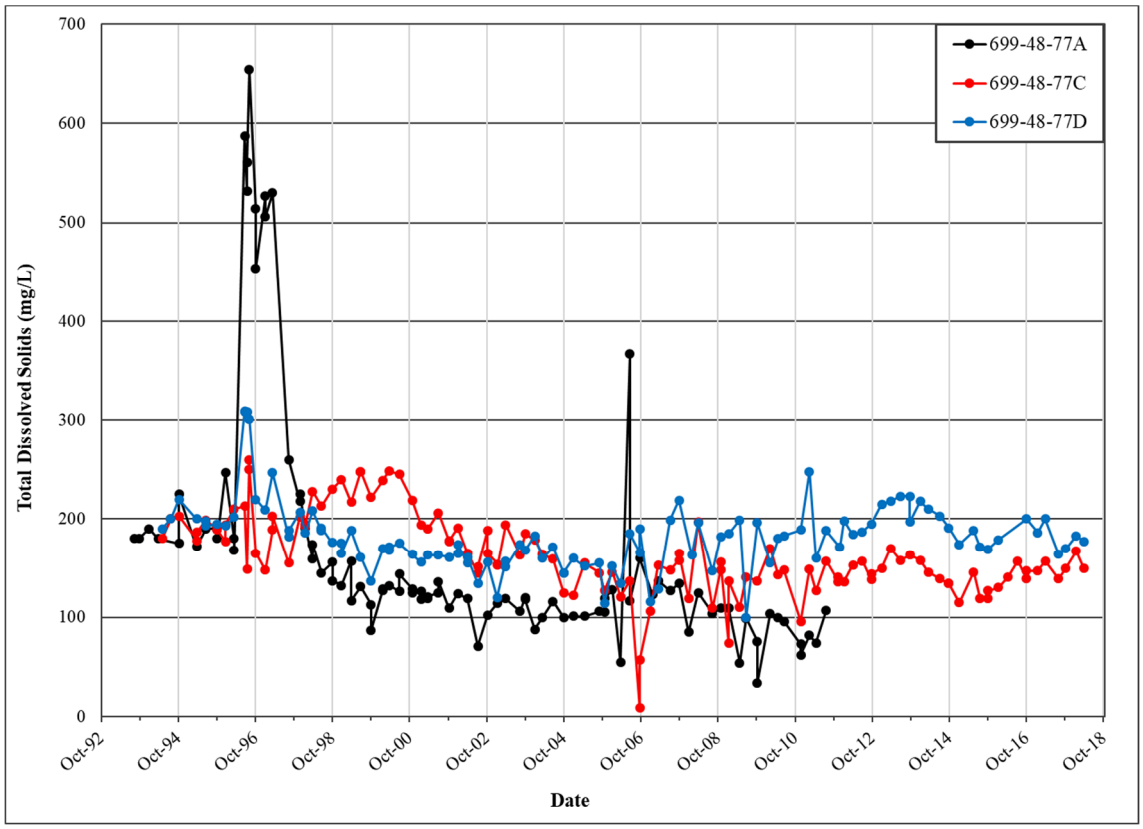

Figure 3-8. Total Dissolved Solids in the SALDS Proximal Wells

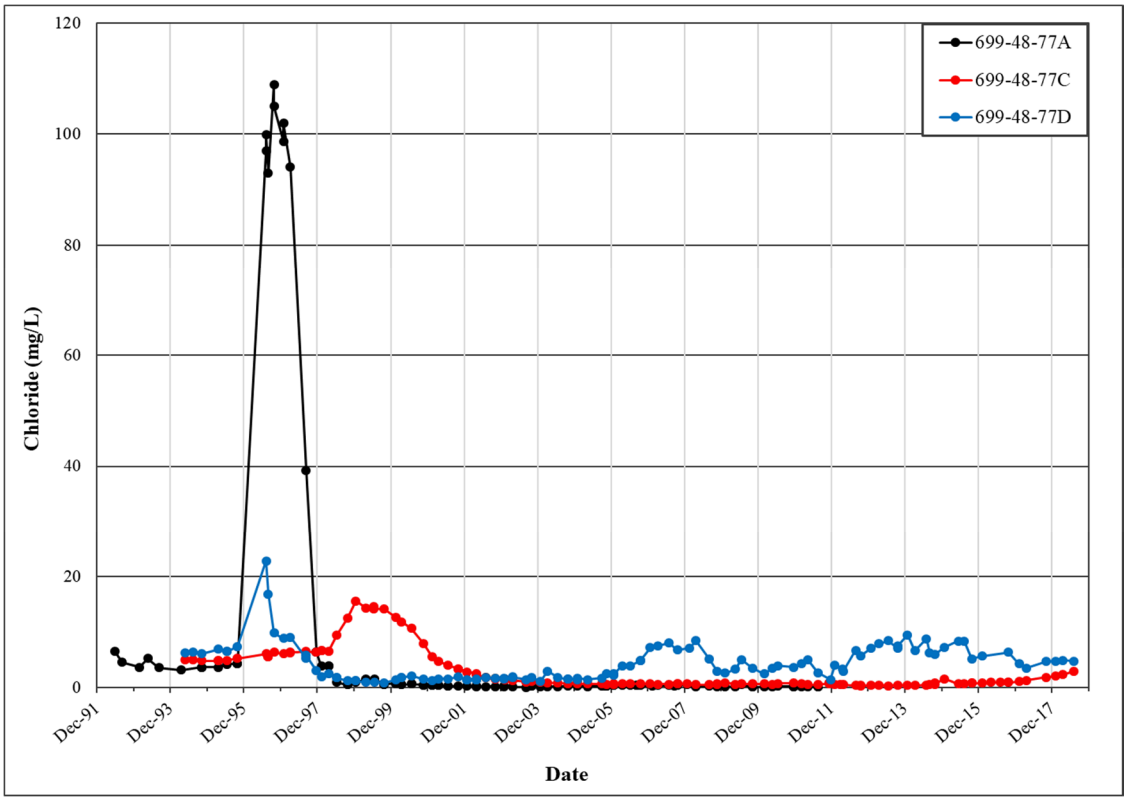

Figure 3-9. Chloride Concentrations in the SALDS Proximal Wells

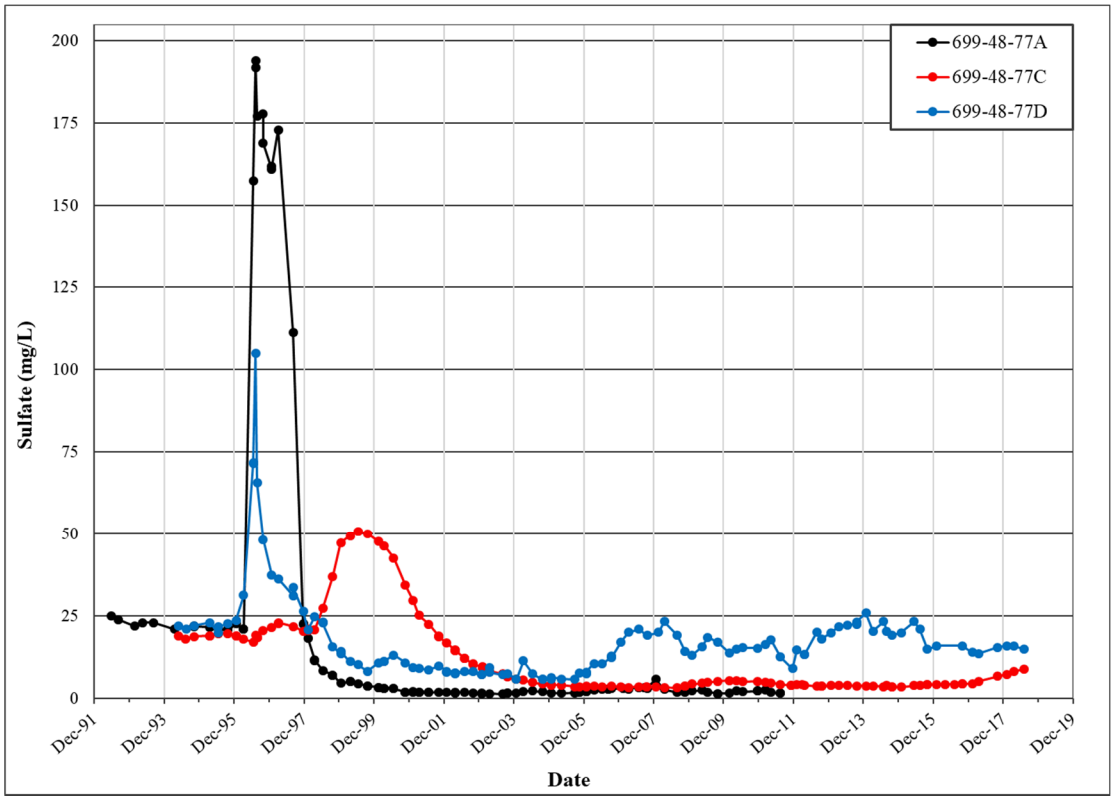

Figure 3-10. Sulfate Concentrations in the SALDS Proximal Wells

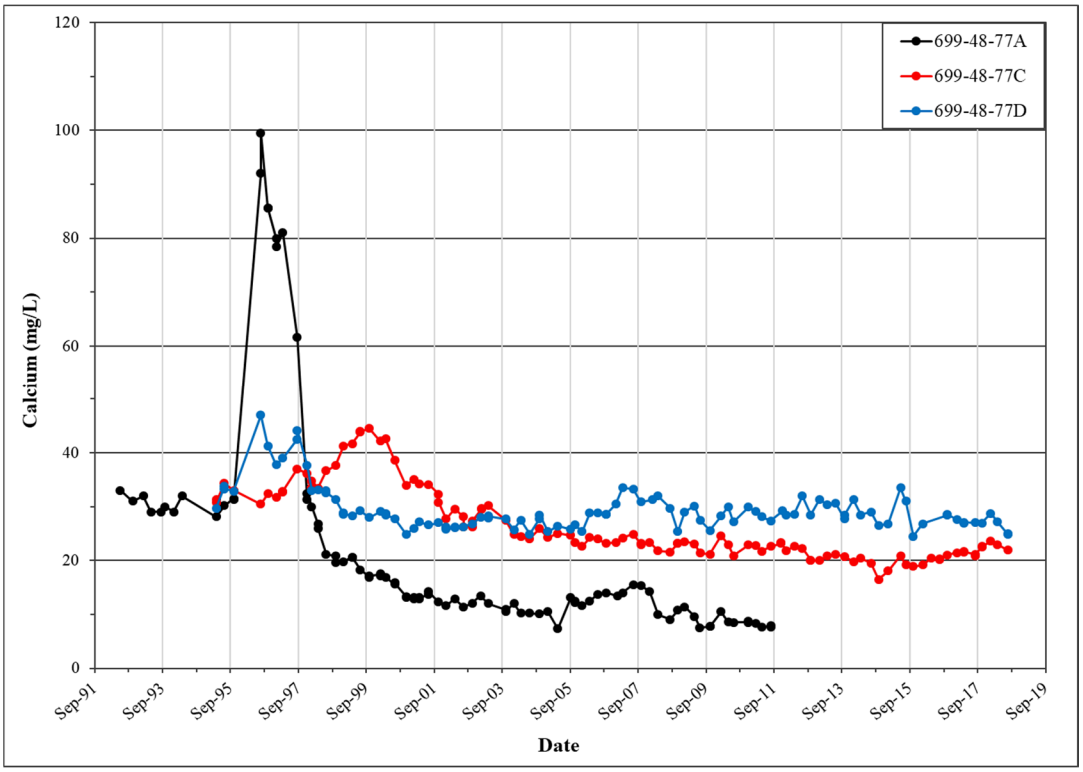

Figure 3-11. Calcium Concentrations in the SALDS Proximal Wells

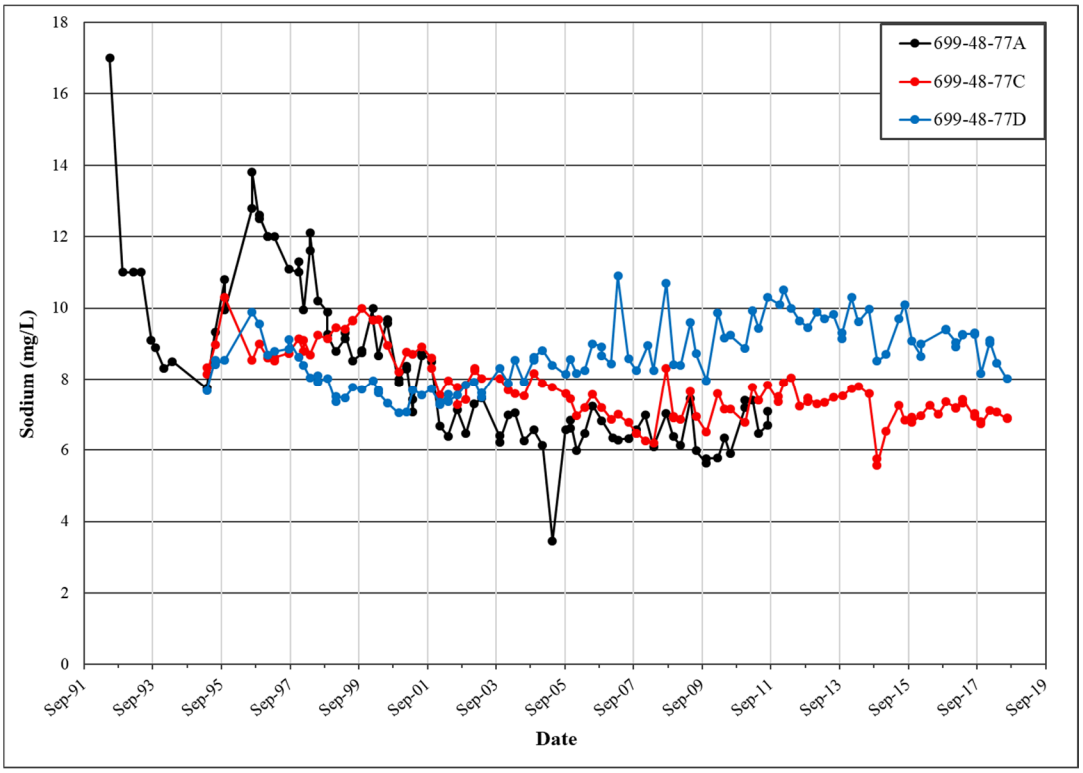

Figure 3-12. Sodium Concentrations in the SALDS Proximal Wells

4 GROUNDWATER MODELING and SITE ANALYSIS

DOE performs numerical modeling of the tritium plume once per 5-year Permit cycle. The current Permit cycle is from January 1, 2015, to December 31, 2019. Modeling was updated in FY 2018 including tritium migration and fate predictions based on the latest calibration of the CP groundwater model, the latest forecast information regarding operation of the 200 West P&T system, and forecast information of effluents from the Waste Treatment Plant. This modeling was reported in RPP-CALC-61950. The previous modeling was performed in FY 2011 and was reported in SGW-51085. The objective of the modeling is to verify that tritium in groundwater, from SALDS, will not intercept the Columbia River or the contiguous aquifer at a concentration above the DWS (20,000 pCi/L). The model verified that tritium concentrations in the aquifer decrease to below the drinking water standard by dispersion and radiological decay before the plume reaches the river.

The reader is directed to the report RPP-CALC-61950 for details of the methodology used, the assumptions made in the model, bounding conditions, the associated software used, tools used for validation, and the predictions produced from modeling. The following summarizes the conclusions excerpted verbatim from report RPP-CALC-61950, section 7.4.

The following conclusions result from the tritium fate and transport simulations:

- *When the 200 West P&T system is operating (projected until year 2037), the east end of the tritium plume from SALDS, at the 500 pCi/L concentration level, migrates south toward the extraction wells. The remainder of the plume is prevented from migrating south by injection wells located along the north boundary of 200 West Area.*

- *The maximum eastward extent of the tritium plume from the SALDS drain field, at the 500 pCi/L concentration level, is 5.5 km (3.4 mi) for 1/1/2078. Previous modeling in 2004 predicted a maximum extent of 2 km (1.2 mi), but that simulation assumed a tritium release duration of 35 years (PNNL-14898[5]). In the current modeling, the tritium release duration is 71 years.*

- *Tritium concentrations above the 20,000 pCi/L DWS remain in the SALDS vicinity (maximum eastward extent of 1.4 km (0.87 mi) east of the drain field). The maximum concentration declines to below the DWS shortly after year 2088.*

- *Effluent discharges to the SALDS cause a mound to form on the water table, which drives some of the tritium to the bottom of the aquifer in Ringold Unit A. Lateral migration of the plume within this unit is limited due to the relatively low hydraulic conductivity compared to the overlying Ringold Unit E. That portion of the plume in unit A remains in the SALDS vicinity until it eventually decays.*

- *Considering historical and projected future effluent releases to the SALDS, the practice of disposing of tritiated water to the SALDS drain field continues to be protective of the Columbia River.*

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[5] PNNL-14898, *Results of Groundwater Modeling for Tritium Tracking at the Hanford Site200 Area State-Approved Land DisposalSite – 2004.*

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Appendix A

Table A 1. State-Approved Land Disposal Site Tritium Results Fiscal Year 2018

Well	Date Sampled	2018 Tritium Concentration (pCi/L)	Lab Qualifier	2017 Tritium Maximum (pCi/L)	2018 Tritium Maximum (pCi/L)	Trend
299-W6-6	1/25/2018	2410		2,090	2,410	Increasing
299-W6-11	1/17/2018	600		1400	600	Decreasing
	1/25/2018	571				
299-W6-12	1/25/2018	101		129	101	Decreasing
299-W7-3	1/17/2018	37.2	U	U	U	NA
	1/25/2018	9.85	U			
	5/8/2018	-154	U			
	6/1/2018	-18	U			
299-W8-1	1/25/2018	640		208	640	Increasing
699-48-71	1/18/2018	2730		3,200	3090	Unchanged
	1/25/2018	3090				
699-48-77C	10/25/2017	45,400		43,700	45,400	Unchanged
	1/17/2018	42,600		43,700	42,600	Unchanged
	1/29/2018	47,100		44,800	47,100	Unchanged
	4/11/2018	56,000		45,300	56,000	Increasing
	7/30/2018	52,400		43,700	52,400	Increasing
699-48-77D	10/25/2017	57,400		57,000	57,400	Unchanged
	1/29/2018	55,600		43,000	55,600	Increasing
	4/11/2018	56,000		47,200	56,000	Increasing
	7/30/2018	49,500		60,300	49,500	Decreasing
699-49-79	1/18/2018	-92.9	U	U	U	NA
	1/25/2018	-35.1	U			
699-51-75	1/25/2018	-10	U	U	U	NA
	6/1/2018	24.2	U			
699-51-75P	1/25/2018	10.8	U	U	U	NA

Notes:
Increasing = 10% higher maximum concentration in FY 2018 than in FY 2017.
Decreasing = 10% lower maximum concentration in FY 2018 than in FY 2017.
Unchanged = FY 2018 maximum concentration within 10% of FY 2017 value.
FY = fiscal year
NA = not applicable
U = less than detection