



**Periodic Report 5  
for the  
Upper Three Runs Integrator Operable Unit (IOU) (U)**

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**U.S. Department of Energy  
and  
Savannah River Nuclear Solutions, LLC  
Aiken, South Carolina**

## **EXECUTIVE SUMMARY**

This periodic report (PR) has been developed in support of the Integrator Operable Unit (IOU) program at the Savannah River Site (SRS). It is the fifth PR for the Upper Three Runs (UTR) IOU and is referred to as UTR Periodic Report 5 (PR5). The UTR IOU is one of six IOUs under investigation at SRS. The IOUs are under investigation because they represent possible pathways for the release of contaminants from SRS activities, within their respective watershed, to on/off-unit receptors and the environment. IOUs are defined as surface water (SW) bodies (e.g., streams and lakes) and associated wetlands, including the SW, sediment, floodplain sediment (sediment/soil), and related biota.

The IOU program is being implemented in three phases that will ultimately culminate in a Record of Decision (ROD) (Figure 1-1). Phase I of the IOU program consisted of an initial assessment of existing data to determine if any early actions were necessary and to determine data needs. Phase I has been completed. Phase II of the IOU program is the ongoing sampling and assessment of the IOU and refinement of the conceptual site model (CSM) for the IOU until the onset of Phase III. Phase II includes a screening level evaluation of risk to evaluate the need for early actions and to identify data needs. The Phase II screening is based on benchmark thresholds appropriate for early action determination. Phase III includes a Remedial Investigation (RI) to address final data needs and completion of the Baseline Risk Assessment and Feasibility Study process through the ROD and remedial action, if applicable.

The purpose of UTR PR5 is to:

- Provide the status of potential contaminant sources;
- Present the refined CSM based on the potential contaminant sources;
- Evaluate UTR PR5 data which includes new analytical data from sampling activities that have occurred within the IOU including new biological data;
- Assess the potential threat to human health and ecological receptors based on review of the new data;

- Evaluate the need for early actions; and
- Develop data needs for the ongoing monitoring and assessment of the IOU based on review of the new data and information presented in this PR.

### **Schedule**

The next Federal Facility Agreement (FFA) milestone is the fifth Phase II Field Start is scheduled for March 31, 2019 (FFA 1993). Long-term projections are listed in Appendix E of the FFA. The projected date for issuance of the ROD is September 2063.

### **UTR IOU Subunits and Contaminant Sources**

UTR originates northeast of the SRS boundary and follows a southwesterly direction for approximately (~) 30 km (19 mi) within the SRS boundary. The entire watershed drains about 645 km<sup>2</sup> (245 mi<sup>2</sup>). The offsite portion (approximately 60%) of the UTR watershed has multiple agricultural, residential, and commercial sources that could potentially impact the UTR IOU. Within the SRS boundary, the UTR watershed drains ~250 km<sup>2</sup> (97 mi<sup>2</sup>). UTR discharges directly into the Savannah River ~1.5-km (0.9-mi) upstream of T Area. The northern portion of the watershed within the site boundary includes portions of A Area, M Area including the Savannah River National Laboratory and Savannah River Ecology Laboratory (SREL). The southern portion of the UTR watershed includes the entirety of the S-Area Vitrification Facility and Z-Area Saltstone Facility, as well as portions of B Area, E Area Waste Management Complex, F and H Separations Areas, and the northeastern portion of R Reactor Area. The main tributaries within the SRS portion of the UTR watershed include Tinker Creek, Tims Branch, and Mill Creek, a tributary of Tinker Creek. Smaller tributaries include Crouch Branch and McQueen Branch. Steed Pond (with historical uranium and nickel discharges) lies within the Tims Branch tributary.

OUs that may potentially impact the UTR IOU due to known or presumed groundwater (GW) and/or SW transport pathways that provide a possible route of exposure to HH and/or ecological receptors are presented in Table 1-1. The CSMs presented in Section 1.2 illustrate the relationship between contaminant sources and their potential to impact various exposure media (SW, sediment,

sediment/soil, fish/other biota) within the IOU and, consequently, human and/or ecological receptors.

### **Presentation of UTR IOU Data and Benchmark Screening**

New data for each PR is compiled and typically includes analytical results from sampling performed in response to IOU-related data needs and results from independent (non-IOU) sampling efforts. Data for UTR PR5 includes analytical results for sediment, sediment/soil, and SW media. The data are used to conduct screening level HH and ecological risk evaluations and evaluate trends for constituents that warrant further evaluation based on the benchmarking process. These data evaluations support identification of data gaps which guide the collection of additional data for the IOU to assess conditions of UTR IOU prior to Phase III final deposition.

Data evaluated in this PR include analytical results collected in association with OUs, site evaluation areas, and other surveys as well as other environmental data that were not included in previous IOU reports. The UTR PR5 dataset used in this evaluation was compiled from supporting databases using data posted since the UTR PR4. The UTR PR5 data set consists of 1,218 analytical records for sediment, 2,355 analytical records for sediment/soil, and 14,541 analytical records for SW records appropriate for screening (Table 2-1).

### **HH and Ecological Benchmark Screening**

The HH and ecological screening is conducted by comparing constituent concentrations to pre-established benchmark values for each medium resulting in a screening level risk evaluation. The sediment, SW, and fish benchmark comparisons are used to support early action evaluations and data needs determinations. The soil benchmark comparisons are used primarily to support the data needs identification.

Benchmark screening is conducted to:

- identify any discernible areas within the IOU warranting early action consideration,
- identify OUs for potential reprioritization, and
- identify areas in need of additional sampling or periodic monitoring

For both the HH and ecological evaluations, a maximum hazard quotient (HQ) (maximum detected value/benchmark) and a mean HQ (mean of detected value/benchmark) are calculated for each constituent per subunit and are used to determine if maximum and/or mean values are greater than (>) the benchmark. The mean HQ is used to represent receptors that average their exposure within the IOU subunit. In general, constituents with a low mean HQ (mean HQ less than [ $<$ ] 1.0) do not warrant further evaluation. Similarly, constituents with a low frequency of exceedance (5% or less), based on data grouped by subunit, do not require additional evaluation by the IOU program.

Background data are also used to determine the importance of benchmark exceedances during Phase II periodic reporting. If levels observed within the IOU are within background levels, this indicates contaminants within the IOU are not necessarily (or “considered”) unit related; and that further investigation by the IOU is not warranted at this time. The background evaluation does not eliminate constituents for future consideration, but is merely used to determine if unit levels are within the range of background during periodic assessment. This comparison is made for Phase II assessment by comparing the detected mean of constituents to the maximum observed background level.”

### **HH Benchmark Screening and Results**

For the UTR IOU, the onsite worker benchmarks are used to evaluate sediment, sediment/soil, and SW media. The subsistence fisherman benchmarks are used to evaluate the fish medium when fish data are available. The HH benchmark values are used to identify constituent concentrations that result in a cancer risk  $>1 \times 10^{-4}$  or an HQ  $>3$ . If a HH benchmark value is exceeded, the following criteria are considered to determine the significance of the exceedance(s): 1) a mean-value consideration, 2) exceedance frequency, 3) background data, and 4) appropriateness of the receptor.

Based on review of the PR5 data, there are HH benchmark exceedances for the sediment and sediment/soil media for cesium-137 based on the onsite worker scenario for the Tinker Creek subunit. The Tinker Creek exceedances are associated with the Z-Area stormwater basin that receives stormwater from Z-Area saltstone processing and disposal facilities, and the Z-01 Z-Area basin outfall. These data were associated with higher than average rainfall events in 2013

that caused the Z-Area stormwater basin to discharge to the Z-01 Outfall location (SRNS 2014a). This basin does not normally discharge. The storm water runoff accumulation in the Z-Area basin included low level radiological contamination from runoff associated with Saltstone Disposal Unit (SDU) 4. Since the release, rainwater intrusion barriers have been implemented and rainwater flow paths engineered to prevent future low level contaminated runoff. In addition, contaminated soils associated with the SDU runoff have been removed. The discharge pipe and Z-01 Outfall were also grouted and closed, and a newly constructed Z-01 Outfall discharge structure is in place. The basin was also expanded to accommodate a 100-year storm event that dramatically reduces the potential for future releases from the basin. Since the Tinker Creek cesium-137 exceedances are associated with an operational basin with an effective monitoring and reporting program, further evaluation by the IOU program is not warranted.

The sediment/soil onsite worker exceedances for cesium-137 are located in the Tinker Creek subunit. As with the sediment medium, the Tinker Creek sediment/soil exceedances, based on sediment benchmarks, are associated with the Z-Area stormwater basin Z-01 Outfall that ultimately leads to McQueen Branch. The sampling locations follow the intended water flow from the basin toward McQueen Branch and show cesium-137 activities above the onsite worker benchmark at locations in proximity to the Z-01 Outfall. The Z-01 Outfall area is part of the radiological administrative control area to protect site workers from inadvertent exposure to contaminated sediments. Since the extent of contamination has been established, and protective controls are already in place for workers, no further evaluation is warranted by the IOU program.

There were no SW benchmark exceedances the UTR PR5, therefore, further evaluation is not warranted by the IOU program at this time.

There were no new fish data for the UTR PR5, therefore, there were no exceedances for the subsistence fisherman for the fish medium.

### **Ecological Benchmark Screening and Results**

The purpose of the ecological evaluation is to provide an overall indicator of ecological health for the UTR IOU. The biological data is supplemented with benchmark comparisons that are used as

a screening step to identify constituents that may pose a threat to ecological receptors. The ecological evaluation provides the basis for determining whether early action may need to be considered and the justification for subsequent investigations that support the ecological risk assessment process for the UTR IOU. The ecological benchmark comparisons are conducted by comparing ecological toxicological screening thresholds for sediment, sediment/soil, and SW media constituent concentrations. Tier I sediment and sediment/soil benchmarks are based on “no effect level” toxicological data, while Tier II sediment/soil benchmarks are based on “low effect level” toxicological data. For surface water screening, the Tier I benchmark is not based on “no effect” level toxicological data at the but rather “low effect” thresholds. The Tier II screening is based on acute-level thresholds. Therefore, the potential for an effect on ecological receptors could be indicated by an exceedance of either the Tier I or Tier II surface water screening benchmarks. Constituents with surface water Tier I and Tier II exceedances, or constituents with sediment and sediment/soil Tier II level exceedances are evaluated further if all criteria below are met:

1. The mean HQ > benchmark
2. The frequency of exceedance is greater than 5%.
3. The mean detected value > maximum background, or if background data are non-determinant.

For the ecological evaluation, the exceedances that fail the criteria, along with biological data, are used to determine if possible early actions may need to be considered. For the ecological evaluation, early actions may include additional ecological data collection during Phase II of the IOU program (long-term monitoring and assessment) to further assess potential threats.

Sediment: Tier I benchmark screening for UTR PR5 resulted in a benchmark exceedance for arsenic (benchmark = 7.24E+00) for the Tinker Creek subunit, with 1 exceedance out of 5 samples, a frequency of exceedance >5% (20%), a mean ratio >1.0 (1.19), and a mean detected value (8.6 mg/kg) greater than background (6.7 mg/kg). The exceedance is located at the perimeter of Z-Area and is associated with the Z-01 Outfall. Review of all arsenic data from the Tinker Creek subunit (including McQueen Branch) shows a total of 25 arsenic records, with four detected results. Two of the detects are from 2015 (UTR PR5 data) with the highest 2015 value (15.3 mg/kg) being located at the Z-01 Outfall. The other result collected downgradient of the

Z-01 Outfall at McQueen Branch was 1.9 mg/kg, well below the arsenic sediment benchmark (7.24 mg/kg). Arsenic has been detected in background locations, upgradient of SRS operational influences, within the Upper and Tinker Creek subunits, and the highest reported value of 22.9 mg/kg is from the SRS Background Soil Study; however, for the Tinker Creek subunit, 15.3 mg/kg was the maximum detected. Based on the available data, the Z-01 Outfall exceedance is elevated but is a single exceedance. Results farther downgradient of the outfall are non-detects or within background. Arsenic did not exceed Tier II benchmarks for the Tinker Creek subunit. Therefore, further evaluation by the IOU program is not warranted. In addition, the Z-01 Outfall is part of the SRS annual environmental report monitoring.

Sediment/Soil (Sediment): For the sediment/soil medium, Tier I exceedance for arsenic required further evaluation with a mean ratio greater than 1.0 (1.09), a frequency of exceedance greater than 5% (3 exceedances out of 20 samples), and a mean detected value (7.87 mg/kg) greater than background (6.7 mg/kg). Tier II exceedances were observed for arsenic, mercury, and zinc based on CCME benchmarks, arsenic based on ORNL Median benchmarks, and arsenic and zinc based on ORNL Effects Level benchmarks. The early action consideration Tier II evaluation did not have any constituents warranting further evaluation since mean ratios were <1.0 and frequencies of exceedances were 5% for all constituents (not >5%). Even through the mean level for arsenic, based on detected results (7.87 mg/kg) was greater than background (6.7 mg/kg), further evaluation was not warranted based on the IOU Phase II screening conducted.

Surface Water: There were Tier II SW exceedances for aluminum, barium, beryllium, cadmium, cobalt, copper, DDD, DDT, endosulfan II, endosulfan sulfate, endrin, iron, lead, manganese, mercury, nickel, silver, and zinc. Constituents with mean ratios >1.0, a frequency of exceedance >5%, and with a mean detected value greater than background levels (or background data are non-determinant) requiring further evaluation included copper in the Tinker Creek subunit and mercury in the Tims Branch subunit.

Constituents based on Tier II AWQC based benchmarks requiring further evaluation include copper (benchmark = 1.80E-03 mg/L) and DDD (benchmark = 6.40E-05 mg/L). Review of copper data shows two detects out of 34 analyses for UTR PR5 for the Tinker Creek subunit. Only one

result is over background (0.07 mg/L). The one result (0.518 mg/L) at the S-04 Outfall representing a sample taken in 2014. This location, the S-04 outfall, is described as Defense Waste Processing Facility non-process wastewater. This outfall is part of the annual environmental monitoring and already under a monitoring and reporting program. As such, further assessment by the IOU program is not warranted. The dichlorodiphenyldichloroethane (DDD) Tier II AWQC exceedance is located in Tinker Creek upgradient of SRS operational sources. There is no known SRS use of DDT (DDD is a breakdown product of DDT) and since this exceedance is located upgradient of operational discharges, no further evaluation is warranted at this time.

The Tier II evaluation also includes exceedances based on ORNL benchmarks. Constituents with mean ratios >1.0, a frequency of exceedance >5%, and with a mean detected value greater than background levels (or if background data are non-determinant) requiring further evaluation based on ORNL benchmarks include mercury and DDD. The DDD exceedance is located in the Tinker Creek upgradient of potential SRS operational discharges. And since there is no known SRS use of DDT or DDD, and this constituent is detected infrequently, no further evaluation by the IOU program is warranted at this time.

The mercury exceedances within the Tims Branch subunit (13 exceedances out of 68 analyses) are all 2014 data associated with National Pollutant Discharge Elimination System (NPDES) industrial outfall A-11 for Area powerhouse operations. The mercury levels are above the IOU Tier II benchmark, but are within NPDES permitted limits. Since the mercury exceedances are data from NPDES permitted monitoring and reporting program, further evaluation by the IOU program is not warranted at this time.

### **Data Needs and Early Actions**

The PR5 HH evaluation lacked recent fish data (Section 2.1.1). A new approach to monitoring contaminant levels and bioaccumulation in fish for the IOU program is planned. Passive diffusive gradients in thin films (DGT) samplers have been used successfully by regulatory agencies and researchers and can be used to collect screening level contaminant data to estimate concentrations in fish tissue without catching or destroying any fish. DGT samplers will be deployed to provide additional data to support future HH subsistence fisherman scenario benchmark screening and

ecological screening. DGT samplers target bioavailable fractions of contaminants to help identify contaminants of interest. The passive sampler deployment will focus on the Middle and Lower UTR subunits where edible sized game fish are more likely and higher fish diversity is supported. These data will be reported in a future PR.

The PR5 ecological assessment showed Tier II sediment/soil and Tier I and II SW exceedances based on review of UTR PR5. Field studies have indicated that mercury in the Lower subunit, and uranium, nickel and mercury in the Tims Branch subunit may pose a threat to ecological receptors within the UTR IOU. As Phase II continues, data will continue to be compiled and assessed for the UTR IOU and reported in upcoming periodic reports (PRs). To support the ongoing Phase II data screening, several biological studies are planned or on-going for the UTR IOU. The passive sampler deployment in Middle and Lower UTR identified as a data need for this PR will assist in identifying bioavailable constituents that may pose a threat to ecological receptors. Other biological sampling efforts include fish and macroinvertebrate assemblages. It is anticipated that macroinvertebrate surveys will be conducted in Crouch Branch in 2018 as part of the NPDES surveillance program. Also, the Savannah River Ecology Laboratory (SREL) has recently conducted macroinvertebrate surveys in McQueen Branch. Additionally, an SRS-wide IOU bioassessment field effort was conducted in 2017 to assess fish communities and macroinvertebrate assemblages within all the IOUs except the Savannah River and Floodplain Swamp (SRFS) IOU. The SRFS IOU was not included since the bioassessment data collection efforts are not tailored to large stream systems such as the Savannah River. The results of these studies, and future data screening, will be reported in upcoming PRs as these efforts are finalized.

No constituents were retained for early action consideration based on the HH evaluation or the ecological assessment presented in Section 2. Therefore, there are no early actions warranted for any portion of the UTR IOU based on evaluation of PR5 data.

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### LIST OF ABBREVIATIONS AND ACRONYMS

~	approximate, approximately
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
AOU	area operable unit
AAOU	A-Area operable unit
ATTA	Advanced Tactical Training Area
AWQC	Ambient Water Quality Criteria
BEIDMS	Bechtel Electronic Information Data Management System
BRA	Baseline Risk Assessment
CCME	Canadian Council of Ministers of the Environment
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Identification System
CSM	conceptual site model
DDD	dichlorodiphenyldichloroethane
DDT	dichlorodiphenyldichloroethane
DWPF	Defense Waste Processing Facility
ECODS	Early Construction and Operations Disposal Sites
EMS	Environmental Monitoring Service
ERA	ecological risk assessment
ERDMS	Environmental Restoration Data Management System
ESV	ecological screening values
FAOU	F-Area Operable Unit
FFA	Federal Facility Agreement
FMB	Fourmile Branch
GIS	Geographic Information System
GW	groundwater
HAOU	H-Area Operable Unit
HQ	hazard quotient
HH	human health
HWCTR	Heavy Water Components Test Reactors
HWMF	Hazardous Waste Management Facility
IAEA	International Atomic Energy Agency
IOU	integrator operable unit
km	kilometer
km <sup>2</sup>	square kilometer
lb	pound
LiDAR	Light Detection and Ranging
LLRWDF	Low-Level Radioactive Waste Disposal Facility
LTR	Lower Three Runs
LUCIP	Land Use Control Implementation Plan

**LIST OF ABBREVIATIONS AND ACRONYMS** *(Continued/End)*

mg/kg	milligram per kilogram
mg/L	milligram per liter
mi	mile
mi <sup>2</sup>	square mile
NBN	No building number
NFA	No Further Action
NPDES	National Pollution Discharge Elimination System
NTCR	non-time critical removal
ORNL	Oak Ridge National Laboratory
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
PR	Periodic Report
PR1	Periodic Report 1
PR2	Periodic Report 2
PR3	Periodic Report 3
PR4	Periodic Report 4
PR5	Periodic Report 5
rad/day	radiation absorbed dose per day
RAIP	Remedial Action Implementation Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SATA	Small Arms Training Area
SCDHEC	South Carolina Department of Health and Environmental Control
SEA	site evaluation area
SGCP	SGCP
SR	Savannah River
SREL	Savannah River Ecology Laboratory
SRFS	Savannah River and Floodplain Swamp
SRL	Savannah River Laboratory
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
SW	surface water
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
UTR	Upper Three Runs
USFS	U.S. Forest Service
WMA	Wildlife Management Area
WSRC	Westinghouse Savannah River Company, LLC

## **1.0 INTRODUCTION**

This periodic report (PR) has been developed to support the Integrator Operable Unit (IOU) program at the Savannah River Site. It is the fifth PR for the Upper Three Runs (UTR) Integrator Operable Unit (IOU). It is referred to as Periodic Report 5 (PR5). IOUs are defined as surface water (SW) bodies (e.g., streams and reservoirs) and associated wetlands, including the SW, sediment, floodplain sediment (sediment/soil), and related biota. The UTR IOU is one of six IOUs under investigation at Savannah River Site (SRS). The IOUs are under investigation because they represent possible pathways for the release of contaminants from SRS activities, within their respective watershed, to on/off-unit receptors and the environment. IOUs represent the integration of potential contaminants discharged to SW or migrating through groundwater (GW) from source operable units (OUs), site evaluation areas (SEAs), operational facilities/National Pollutant Discharge Elimination System (NPDES) outfalls to points of potential receptor exposure. These sources are not formal components of the IOU, but evaluating their potential impact to the IOU SW bodies is part of the IOU assessment.

The IOU program is being implemented in three phases that will ultimately culminate in a Record of Decision (ROD) (Figure 1-1). Phase I of the IOU program consisted of an initial assessment of existing data to determine if any early actions were necessary and to determine data needs. Phase I has been completed for all the UTR IOU and all SRS IOUs. Phase II of the IOU program is the ongoing sampling and assessment of the IOU and refinement of the conceptual site model (CSM) for the IOU until the onset of Phase III. Phase II includes a screening level evaluation of risk to evaluate the need for early action and to identify data needs, both of which are reported in a PR. The Phase II screening is based on benchmarks appropriate for early action determination. The UTR IOU is currently in Phase II. Phase III includes a Remedial Investigation (RI) to address final data needs and completion of the Baseline Risk Assessment (BRA), and Feasibility Study process through the ROD and remedial action, if applicable. If a portion of the IOU has the potential to accelerate into Phase III, the subsequent PR would propose the accelerated strategy. A design team meeting would then be scheduled to obtain agreement between the United States (U.S.) Department of Energy (USDOE), U.S. Environmental Protection Agency (USEPA), and South Carolina Department of Health and Environmental Control (SCDHEC) on the path forward.

PR5 documents the Phase II status of the UTR IOU investigation based on new data and information obtained since the completion of *Periodic Report 4 for the Upper Three Runs Integrator Operable Unit* (SRNS 2014b).

The purpose of UTR PR5 is to:

- Provide the status of potential contaminant sources;
- Present the refined CSM based on the potential contaminant sources;
- Evaluate UTR PR5 data which includes new analytical data from sampling activities that have occurred within the IOU including since compilation of the last PR;
- Assess the potential threat to human health (HH) and ecological receptors based on review of the PR5 data;
- Evaluate the need for early actions; and
- Develop data needs for the ongoing monitoring and assessment of the IOU based on review of the new data and information presented in this PR.

A Sampling and Analysis Plan (SAP) to address IOU generated data collection efforts will be developed as a separate document when warranted by the IOU program for the UTR IOU.

## **1.1 Schedule**

Regulatory approval of this and future PRs are followed by a field start initiating the next round of monitoring, sampling, or data compilation associated with the UTR IOU. The next Federal Facility Agreement (FFA) (1993) milestone for the UTR IOU is the Fifth Phase II Field Start scheduled for March 31, 2019.

Long-term projections listed in the FFA for the UTR IOU include the following:

<b>FFA Milestone</b>	<b>Date</b>
Sixth Phase II Field Start	January 2023
Seventh Phase II Field Start	January 2027
Eighth Phase II Field Start	September 2031
Phase III Field Start	November 2057
ROD Issuance	September 2063

## **1.2 UTR Subunits and Contaminant Sources**

UTR originates northeast of the SRS boundary and follows a southwesterly direction for ~30 km (19 mi) within the SRS boundary (Figure 1-2). The entire watershed drains about 645 km<sup>2</sup> (245 mi<sup>2</sup>). The offsite portion of the UTR watershed (~60%) has multiple agricultural, residential, and commercial sources that could potentially impact the UTR IOU. Within the SRS boundary, the UTR watershed drains ~250 km<sup>2</sup> (97 mi<sup>2</sup>). UTR discharges directly into the Savannah River ~1.5 km (0.9 mi) upstream of T Area. The northern portion of the watershed within the site boundary includes portions of A Area, M Area, Savannah River National Laboratory (SRNL), and Savannah River Ecology Laboratory (SREL). The southern portion of the UTR watershed includes the entirety of the S Area Vitrification Facility and Z-Area Saltstone Facility, as well as portions of B Area, E Area Waste Management Complex, F and H Separations Areas, and a northeastern portion of R Reactor Area. The main tributaries within the SRS portion of the UTR watershed include Tinker Creek, Tims Branch, and Mill Creek, a tributary of Tinker Creek. Smaller tributaries include Crouch Branch and McQueen Branch. Steed Pond (with historical uranium and nickel discharges) lies within the Tims Branch tributary.

UTR has never received thermal discharges from SRS reactors. Above its confluence with Tinker Creek, UTR Creek is relatively unimpacted by SRS activities. Due to the ecological uniqueness of UTR, portions of the stream have been protected from site discharges, and it is currently managed and protected by a USDOE Stream Management Policy. The E. P. Odom Wetland Set-Aside includes the northern section of UTR within the confines of the SRS boundary and its tributaries upstream of the confluence of Tinker Creek, including Tinker Creek, comprising 2,979 hectares (7,362 acres). UTR is known internationally in the scientific community as an outstanding biological resource. This riverine ecosystem has one of the most species-rich

assemblages of aquatic insects in North America, if not the world. More than 575 species of aquatic insects have been documented to inhabit UTR including several rare and unusual species, some of which are found nowhere else in the world (SREL, 1997).

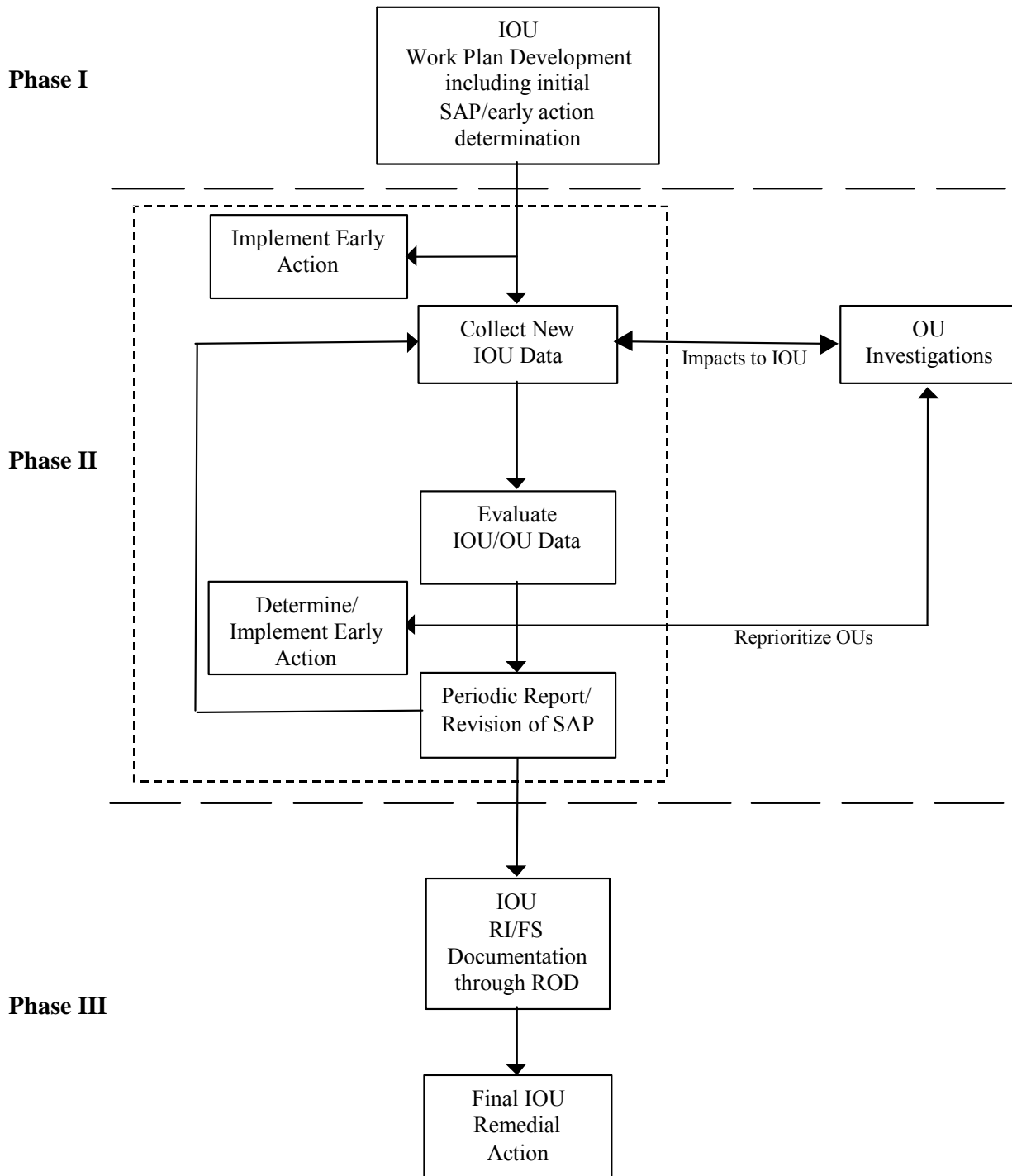
For data evaluation purposes, the UTR IOU is divided into subunits that are based on sub-watersheds. The following subunits make up the UTR IOU: Upper, Middle, Lower, Tinker Creek, and Tims Branch (Figure 1-2).

The potential for contaminant impacts to the IOU are assessed based on knowledge of the OUs or inferred from contaminant migration analysis. The potential SW flow paths for land surfaces are based on Light Detection and Ranging (LiDAR) elevation data from the U.S. Forest Service (USFS 2009). The LiDAR data were acquired for the SRS in 2009 to produce detailed, high resolution bare ground surface models. Data were acquired with an average of 10 pulses/square meter, and the entire point data set includes over 18 billion points. The total area covered by the acquisition is ~119,000 ha (294,054 ac) which is used to approximate SW flow directions from the OUs (listed by unit identification number, "ID", as described in Table 1-1) to receiving water bodies. The LiDAR data-generated surface contours are shown in Figures 1-3a through 1-3f. Figures 1-4a through 1-4f) show the OUs in relation to GW plumes and GW potentiometric contours for the water table surface based on a 2003 regional scale interpretation utilizing 1,324 wells (Westinghouse Savannah River Company [WSRC] 2003a). The potentiometric lines assist in the visualization and interpretation of GW flow directions of OUs that potentially impact the UTR IOU. The SRS watershed boundaries have also been revised based on interpretation of the 2009 LiDAR data. OUs that are included in the UTR PR5 evaluation are presented in Table 1-1. These units are included because potential GW and/or SW transport pathways lead to the UTR IOU providing a possible route of exposure to HH and/or ecological receptors. The Unit Status column on Table 1-1 includes ROD and no further action determinations, and projected FFA scheduled field starts for OUs with future FFA commitments. Table 1-1 also describes OUs with GW components that are currently being addressed by an OU monitoring/assessment program. The Potential GW and SW Transport Pathway column in Table 1-1 describes where GW or SW pathways from a particular OU would ultimately discharge based on potentiometric or LiDAR surface contours. OUs that have not been closed, or units that have a GW component with ongoing

monitoring requirements, have the potential to impact the IOU and are considered a potential contaminant source to the UTR IOU. Whether impact to the IOU may need to be considered during Phase II of the IOU program is summarized in the Potential Impact to GW or SW columns. Units that no longer represent a potential threat to the IOU due to implementation of remedial actions or issuance of regulatory decisions are noted as a “No” and are no longer considered a source to the IOU requiring action during Phase II evaluations. The CSMs have been developed to illustrate the relationship between potential contaminant sources (listed in Table 1-1) and their potential to impact various exposure media (SW, sediment, and/or sediment/soil) within the IOU and, consequently, human and/or ecological receptors.

The UTR CSM is presented in Figure 1-5 and reflects the current understanding of potential contaminant sources and migration pathways for the UTR IOU. Sources listed in Table 1-1 with a potential to impact the IOU are included in the UTR CSM. Primary sources of contamination include the waste materials and the effluents generated from process facilities. Environmental media impacted by the release of primary source contamination become a secondary source. Secondary sources of contamination include sediment, sediment/soils, SW, and GW. Figure 1-6 is a general overview Site-wide CSM model representing all the IOUs that includes historical pathways.

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**Figure 1-1. Flow Chart of the IOU Program**

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**Figure 1-2. Upper Three Runs IOU**

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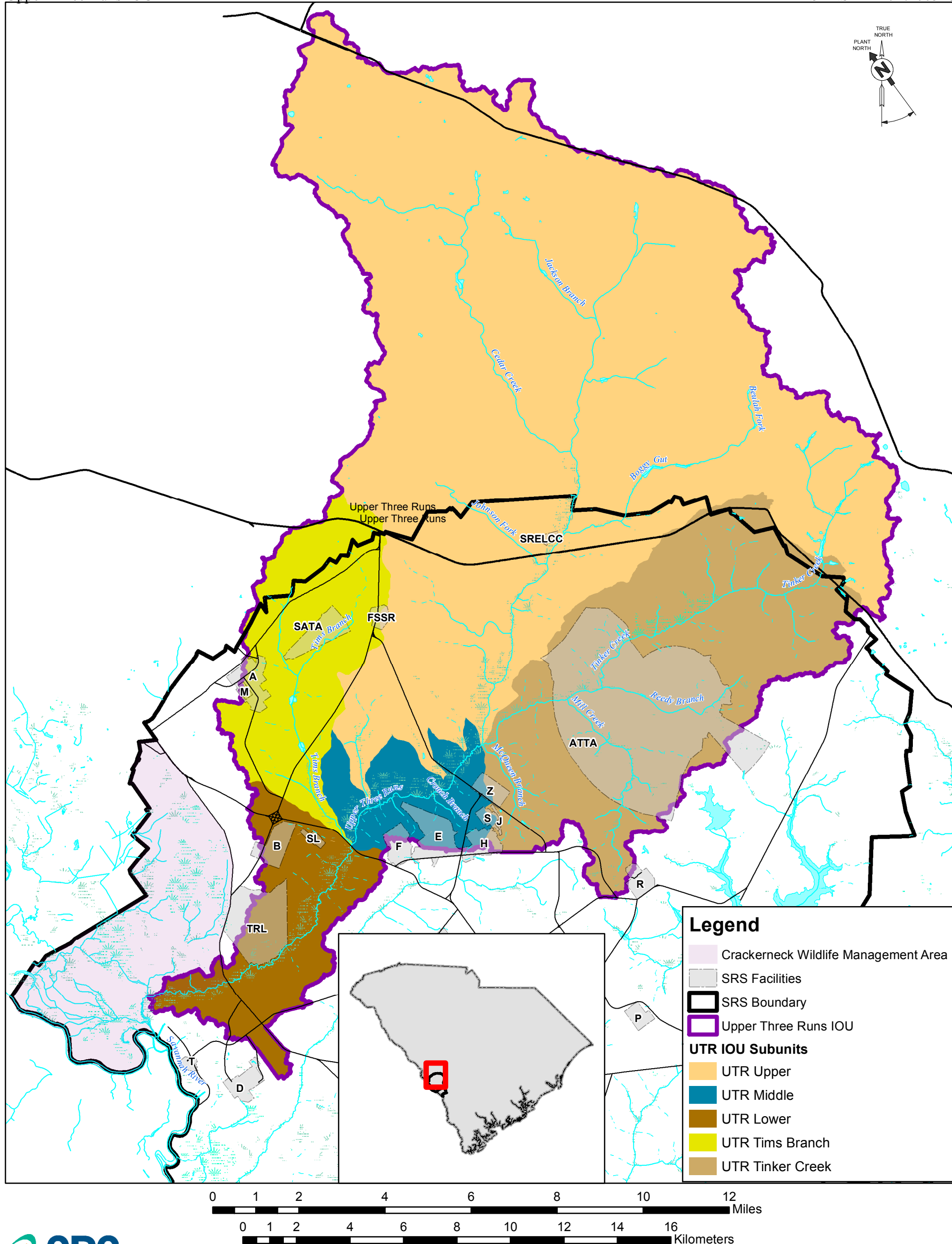


Figure 1-2: Upper Three Runs IOU (subunits)



Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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PROJECT NO: UTRIOUFIG1_2GIS2018	REV. NO: 0	REV. DATE: 01/22/18	AREA: SRS
Upper Three Runs IOU (subunits)			
CREATED BY: Natalie Lopez	DATE: 01/22/18	APPROVED BY: Susan Blas	DATE: 01/22/18

**Figure 1-3a. Operable Units and Topography Associated with the UTR IOU – A/M Area**

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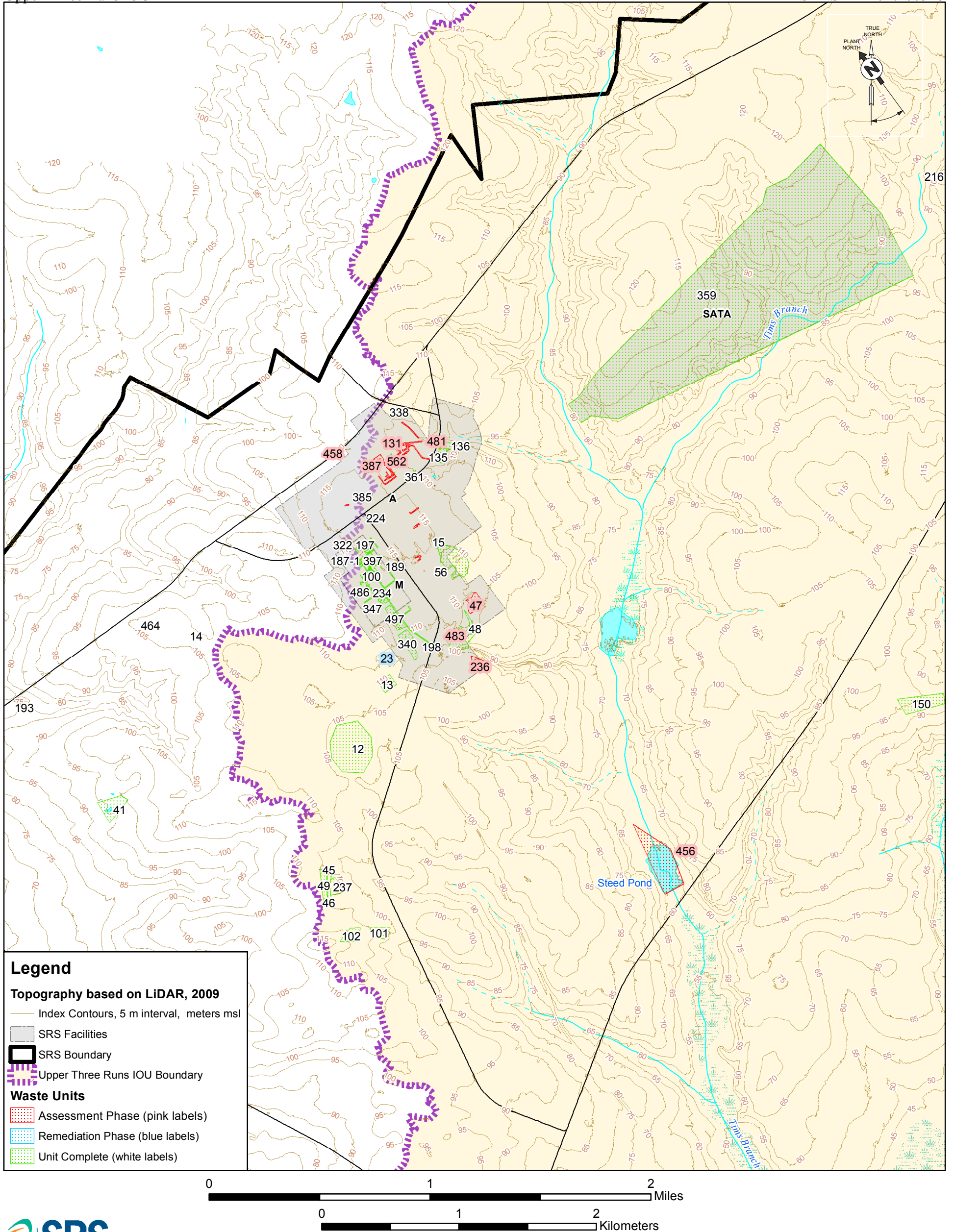


Figure 1-3a: Operable Units and Topography Associated with the UTR IOU - A/M Area



Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

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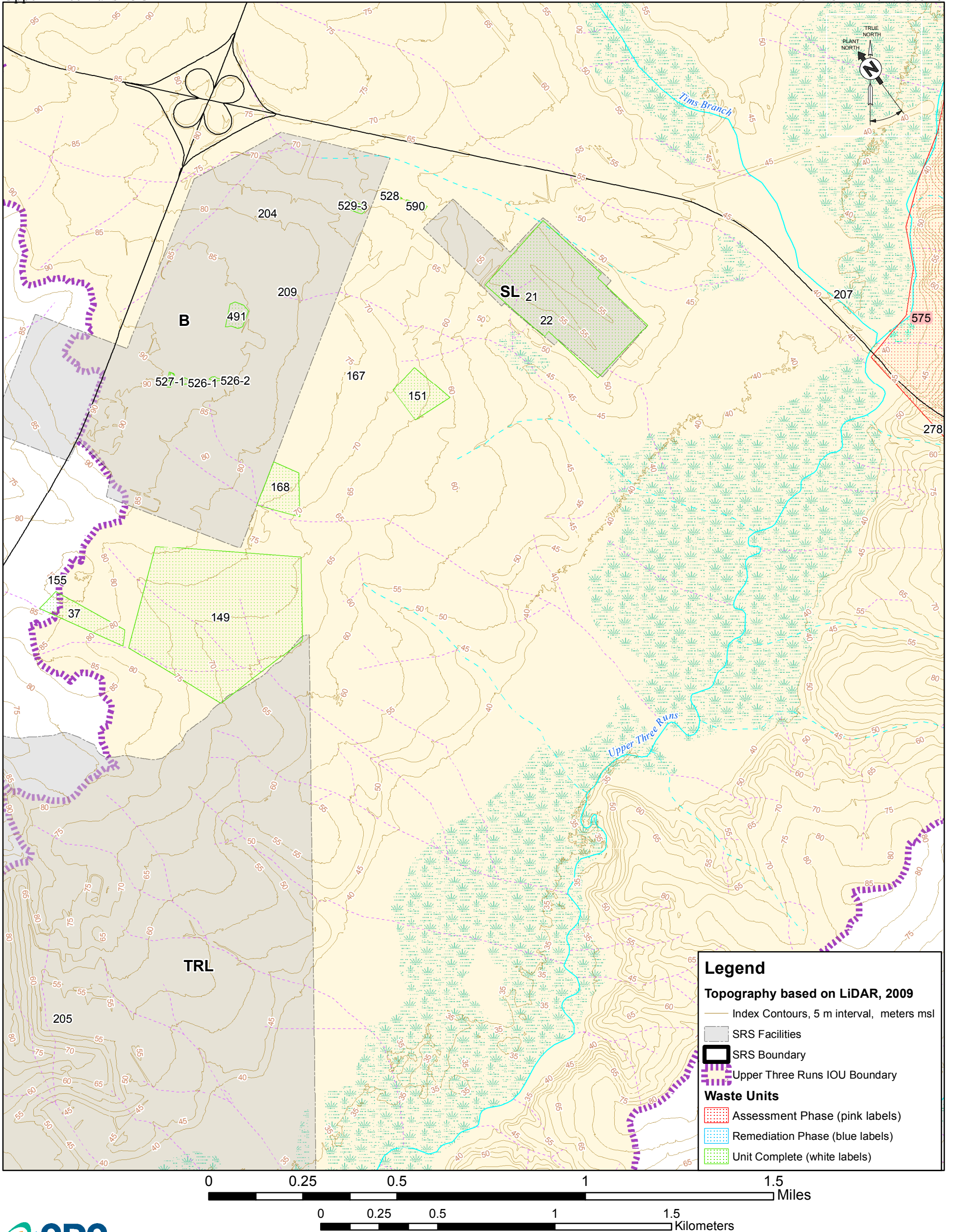
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Operable Units and Topography Associated with the UTR IOU - A/M Area			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-3b. Operable Units and Topography Associated with the UTR IOU – B Area**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

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Figure 1-3b: Operable Units and Topography Associated with the UTR IOU - B Area

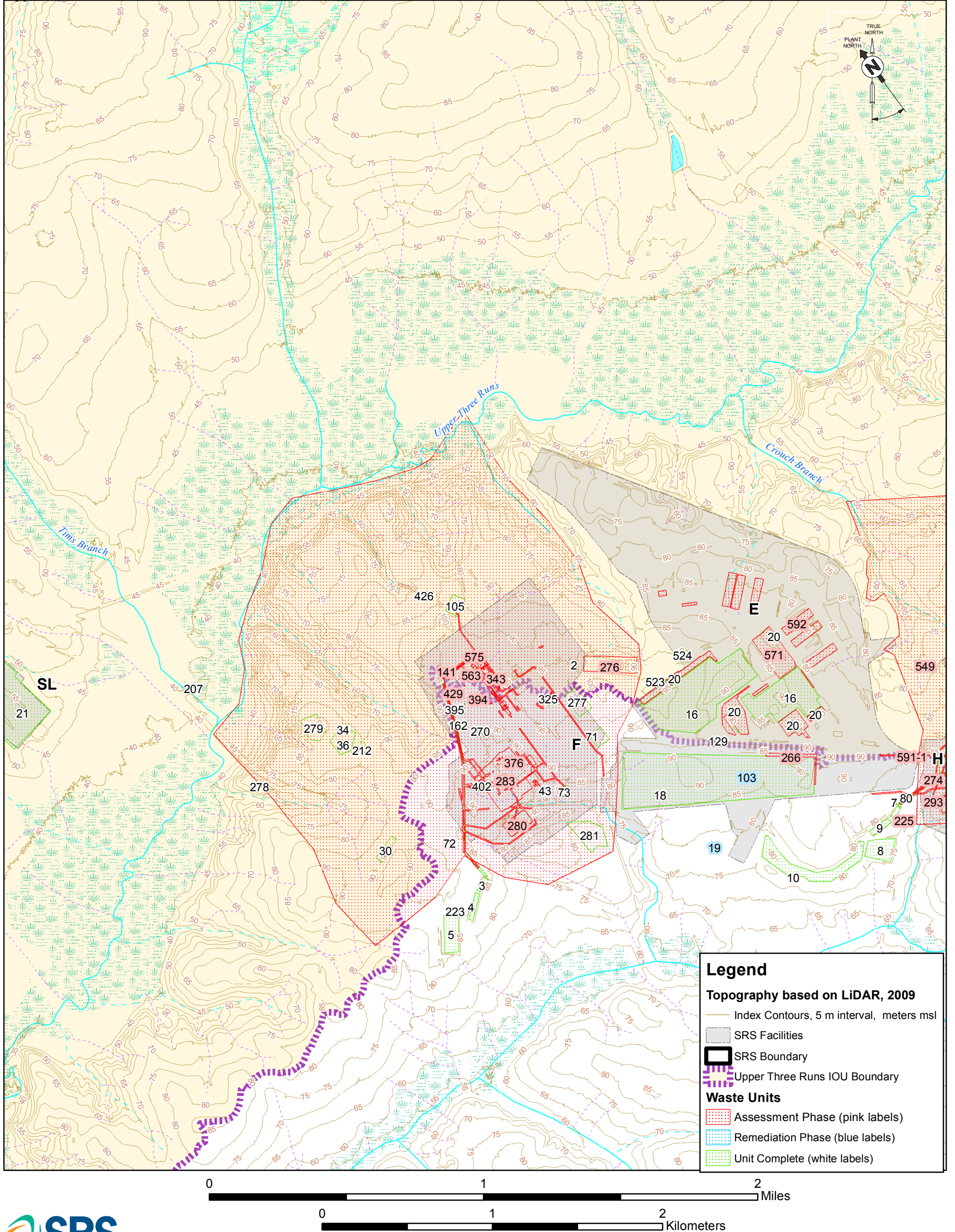
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TITLE: Operable Units and Topography Associated with the UTR IOU - B Area			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-3c. Operable Units and Topography Associated with the UTR IOU – F and E Areas**

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Projection: Universal Transverse Mercator  
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Figure 1-3c: Operable Units and Topography Associated with the UTR IOU - F and E Areas

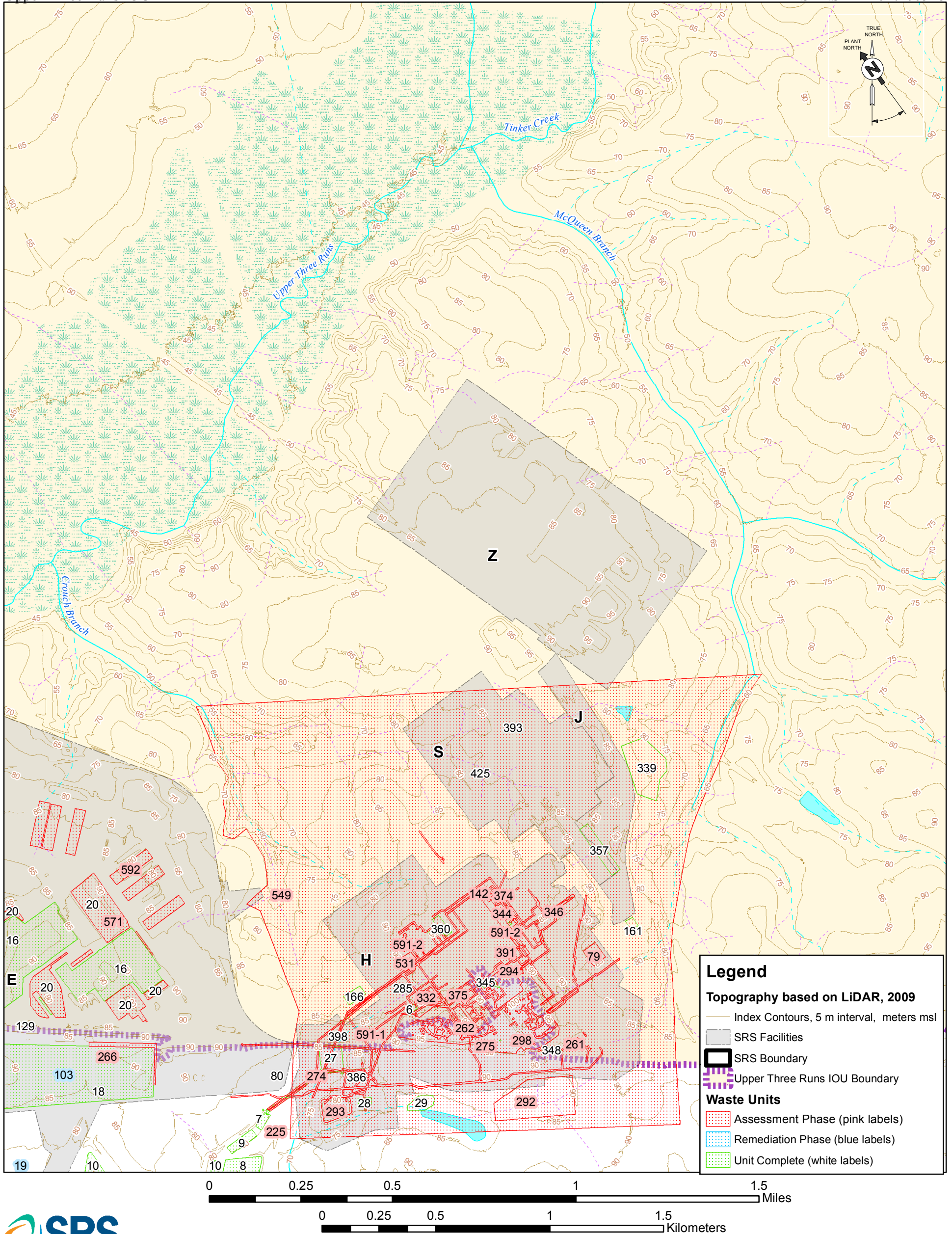
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Operable Units and Topography Associated with the UTR IOU - F and E Areas			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-3d. Operable Units and Topography Associated with the UTR IOU – H, S, and Z Areas**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

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Figure 1-3d: Operable Units and Topography Associated with the UTR IOU - H, S and Z Areas

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Operable Units and Topography Associated with the UTR IOU - H, S and Z Areas			
CREATED BY:	DATE:	APPROVED BY:	DATE:
Natalie Lopez	01/23/18	Susan Blas	01/23/18

**Figure 1-3e. Operable Units and Topography Associated with the UTR IOU – R Area**

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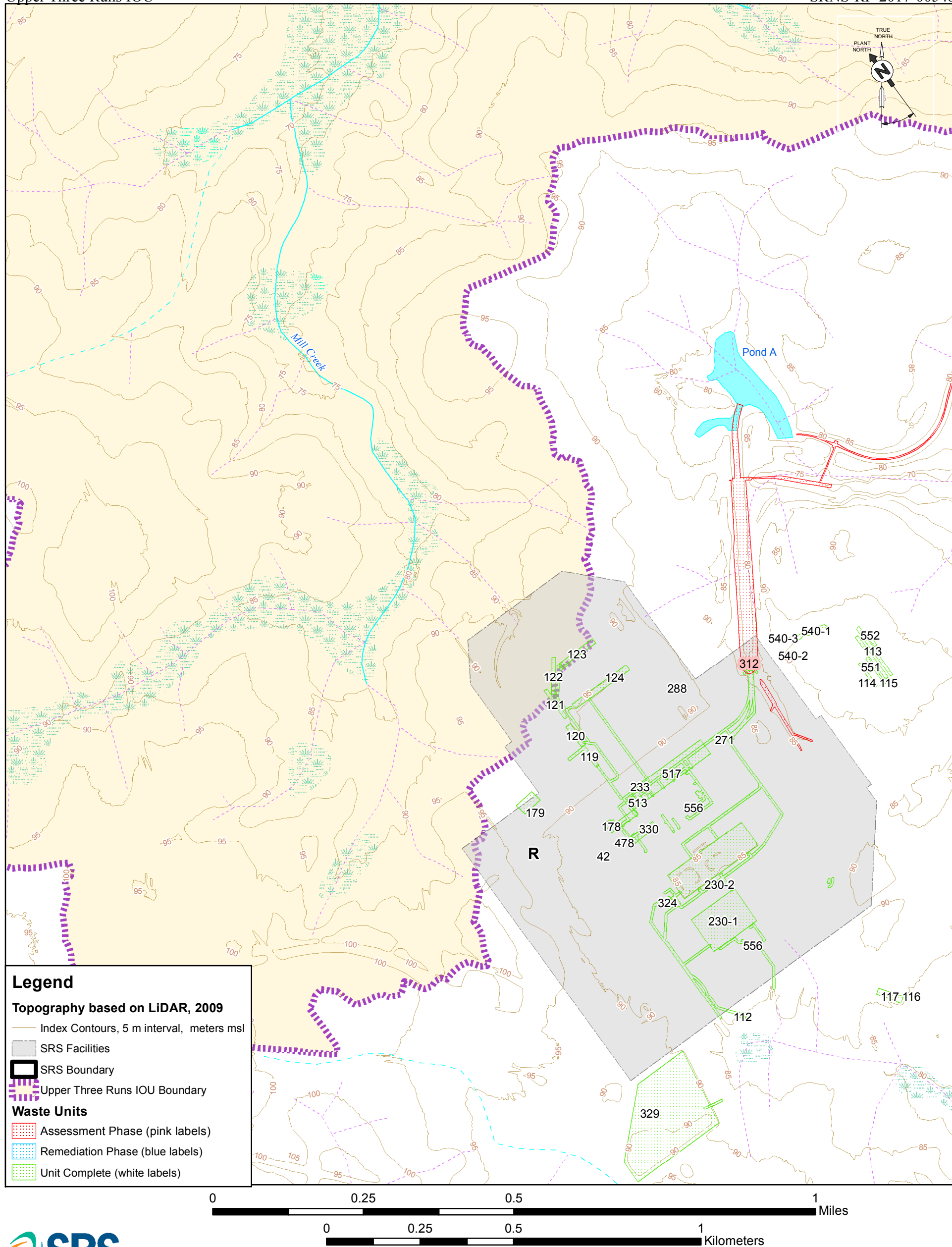


Figure 1-3c: Operable Units and Topography Associated with the UTR IOU - R Area



Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
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<p>Operable Units and Topography Associated with the UTR IOU - R Area</p>			
CREATED BY:	DATE:	APPROVED BY:	DATE:
Natalie Lopez	01/23/18	Susan Blas	01/23/18

**Figure 1-3f. Operable Units and Topography Associated with the UTR IOU – G Area**

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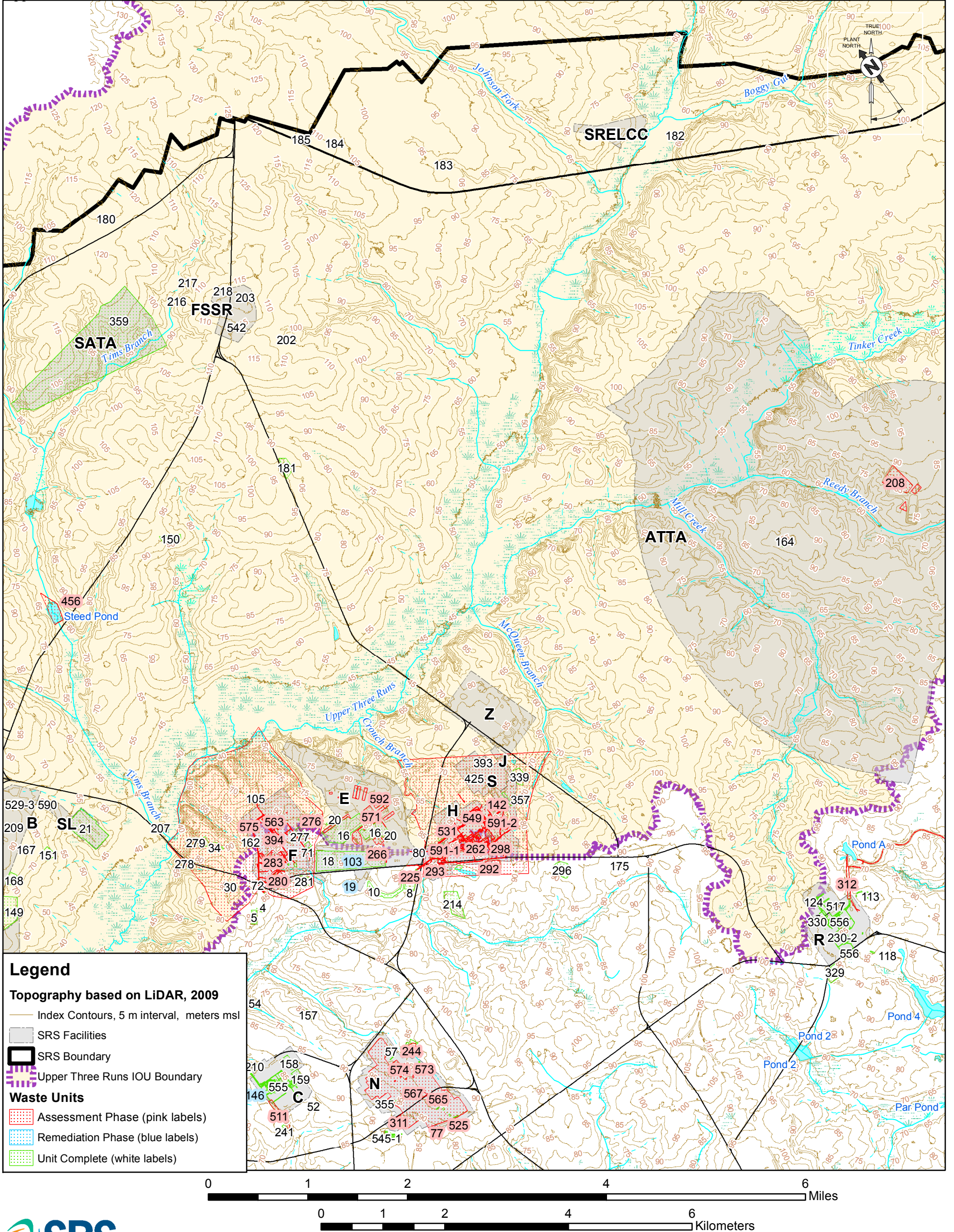


Figure 1-3f: Operable Units and Topography Associated with the UTR IOU - G Area



Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
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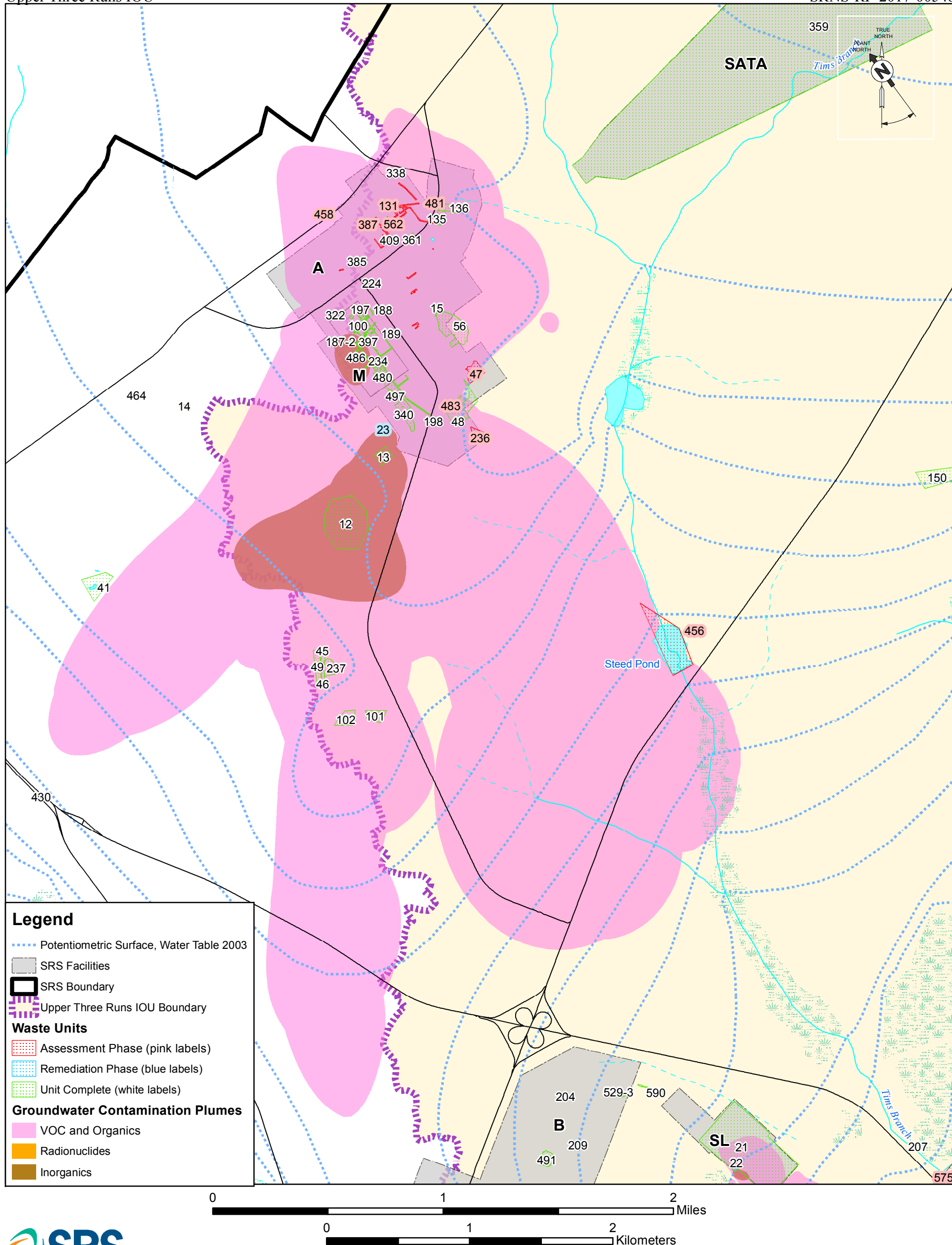
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PROJECT NUMBER UTRIOUFIG1_3FIGIS2018	REV. NUMBER 0	REV. DATE 01/23/18	AREA SRS
Operable Units and Topography Associated with the UTR IOU - G Area			
CREATED BY Natalie Lopez	DATE 01/23/18	APPROVED BY Susan Blas	DATE 01/23/18

**Figure 1-4a. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – A/M Area**

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Projection: Universal Transverse Mercator  
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Figure 1-4a: Operable Units and Topography Associated with the UTR IOU - A/M Area

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<b>Operable Units and Topography Associated with the UTR IOU - A/M Area</b>			
CREATED BY:	DATE:	APPROVED BY:	DATE:
Natalie Lopez	01/23/18	Susan Blas	01/23/18

**Figure 1-4b. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – B Area**

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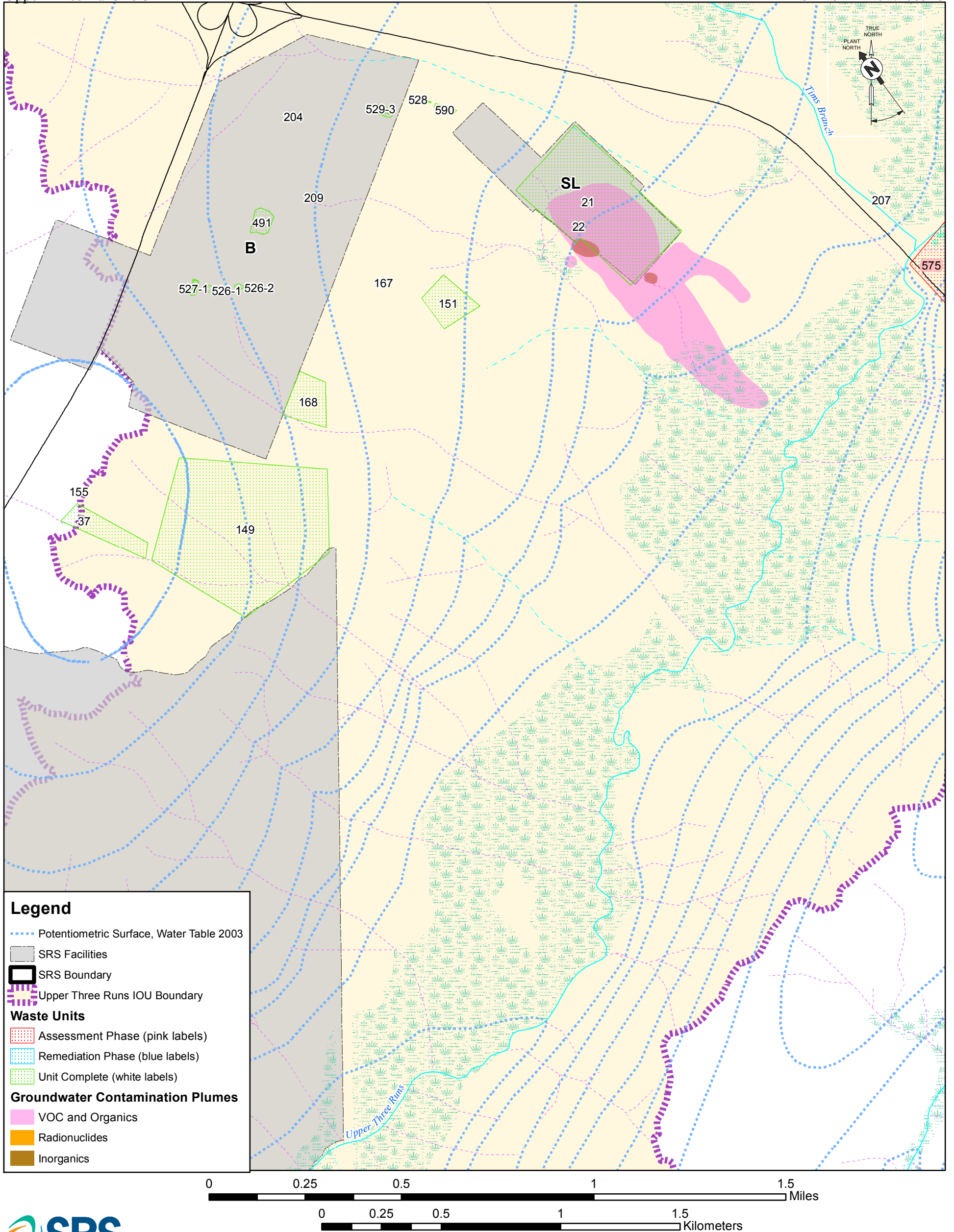


Figure 1-4b: Operable Units and Topography Associated with the UTR IOU - B Area



Projection: Universal Transverse Mercator  
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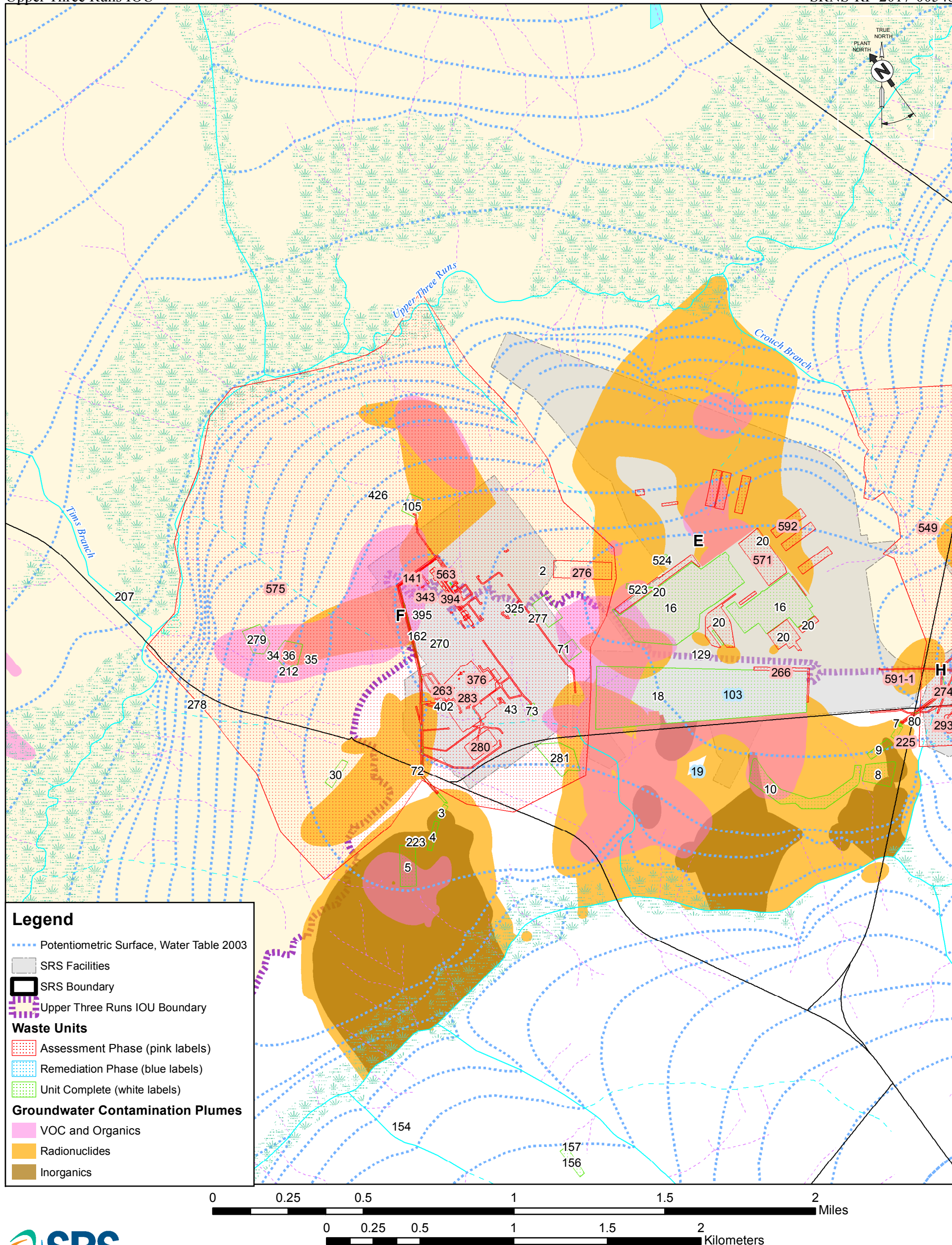
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Operable Units and Topography Associated with the UTR IOU - B Area			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-4c. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – F and E Areas**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
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Figure 1-4c: Operable Units and Topography Associated with the UTR IOU - F and E Areas

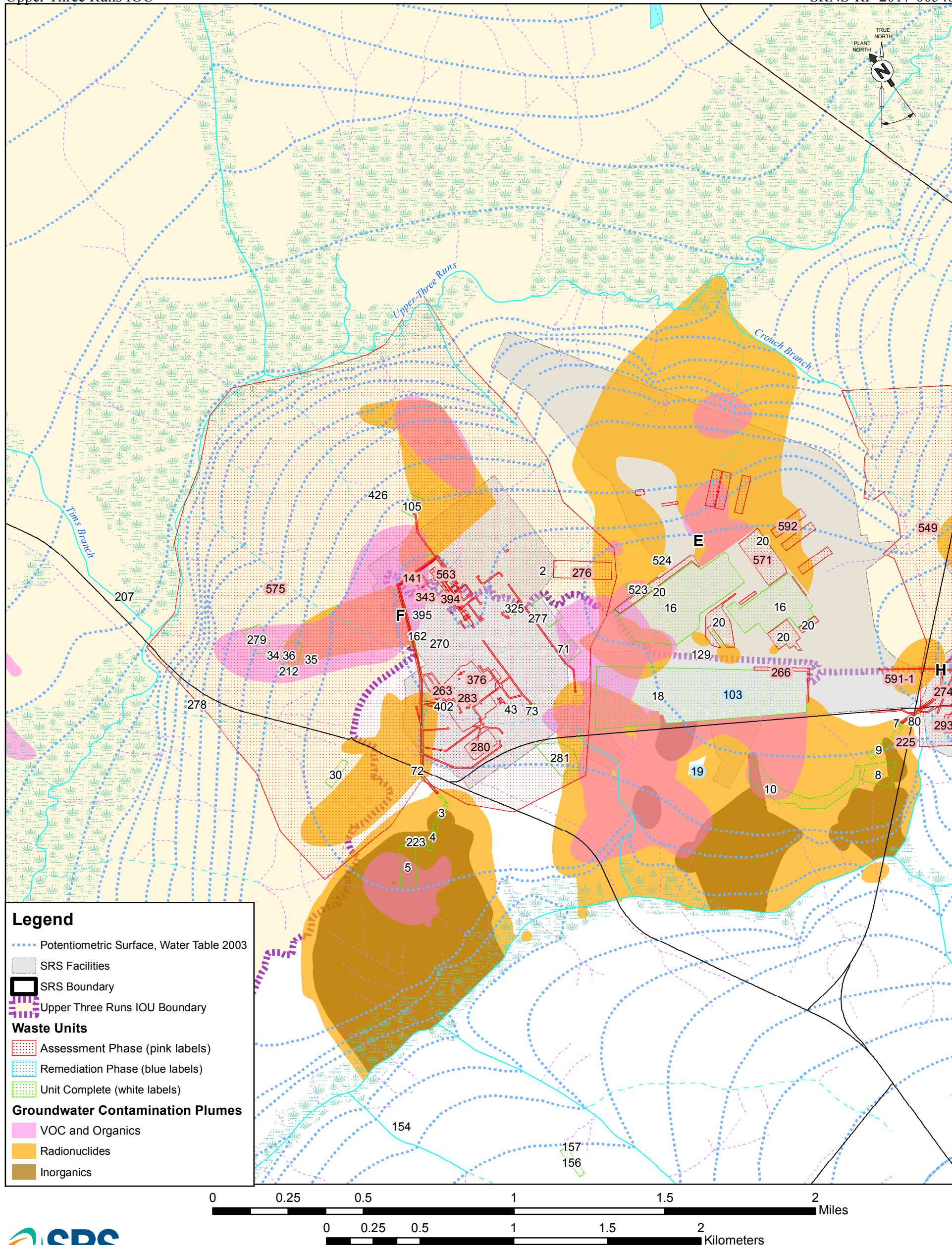
Savannah River Site  
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United States Department of Energy			
ORIGINATOR: JTRIOUFIG1_4cGIS2018	REV. NO.: 0	REV. DATE: 01/23/18	AREA: SRS
Operable Units and Topography Associated with the UTR IOU - F and E Areas			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-4d. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – H, S, and Z Areas**

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Figure 1-4c: Operable Units and Topography Associated with the UTR IOU - F and E Areas

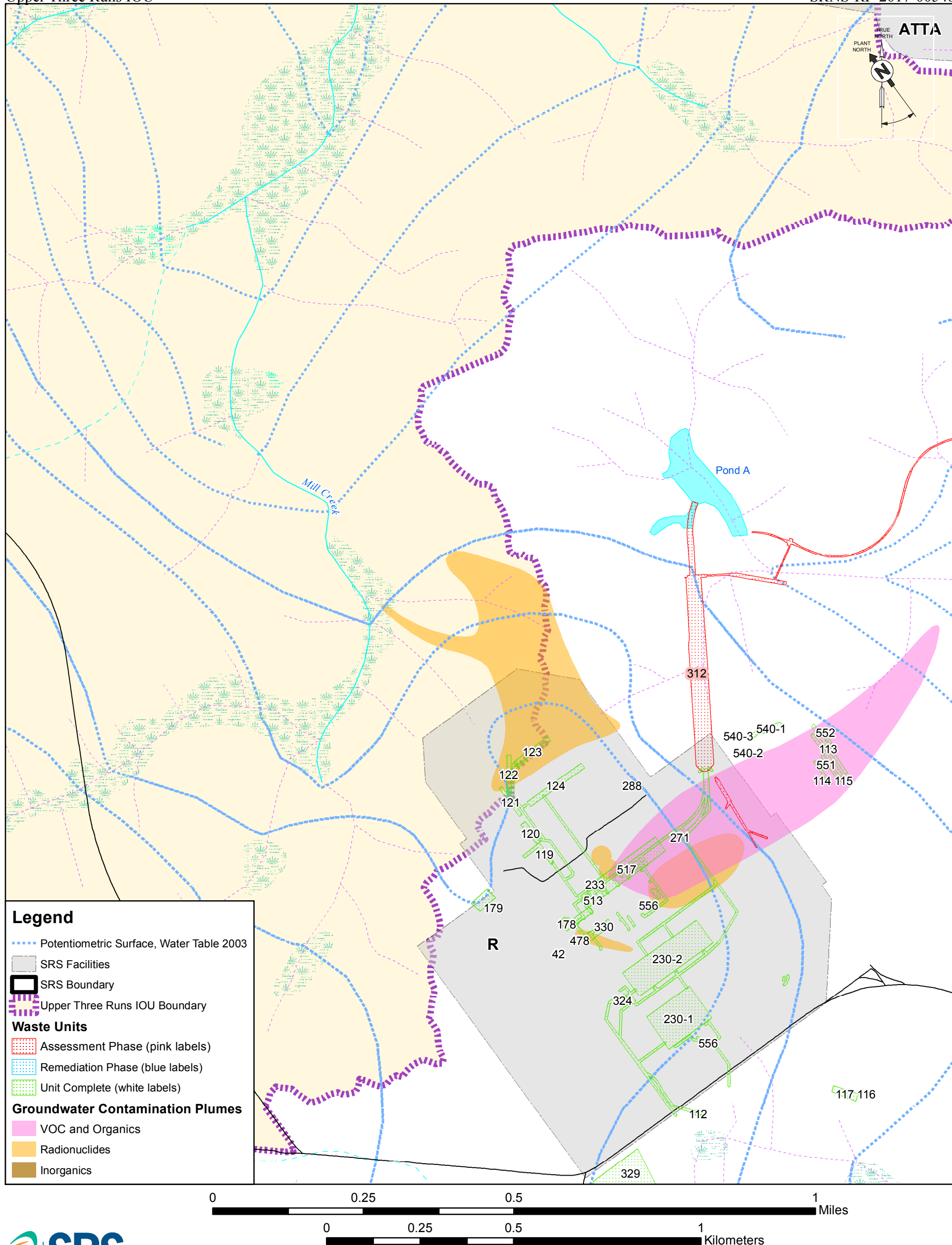
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Operable Units and Topography Associated with the UTR IOU - F and E Areas			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

**Figure 1-4e. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – R Area**

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**Legend**

- Potentiometric Surface, Water Table 2003
- SRS Facilities
- SRS Boundary
- Upper Three Runs IOU Boundary

**Waste Units**

- Assessment Phase (pink labels)
- Remediation Phase (blue labels)
- Unit Complete (white labels)

**Groundwater Contamination Plumes**

- VOC and Organics
- Radionuclides
- Inorganics



Projection: Universal Transverse Mercator  
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Figure 1-4e: Operable Units and Topography Associated with the UTR IOU - R Area

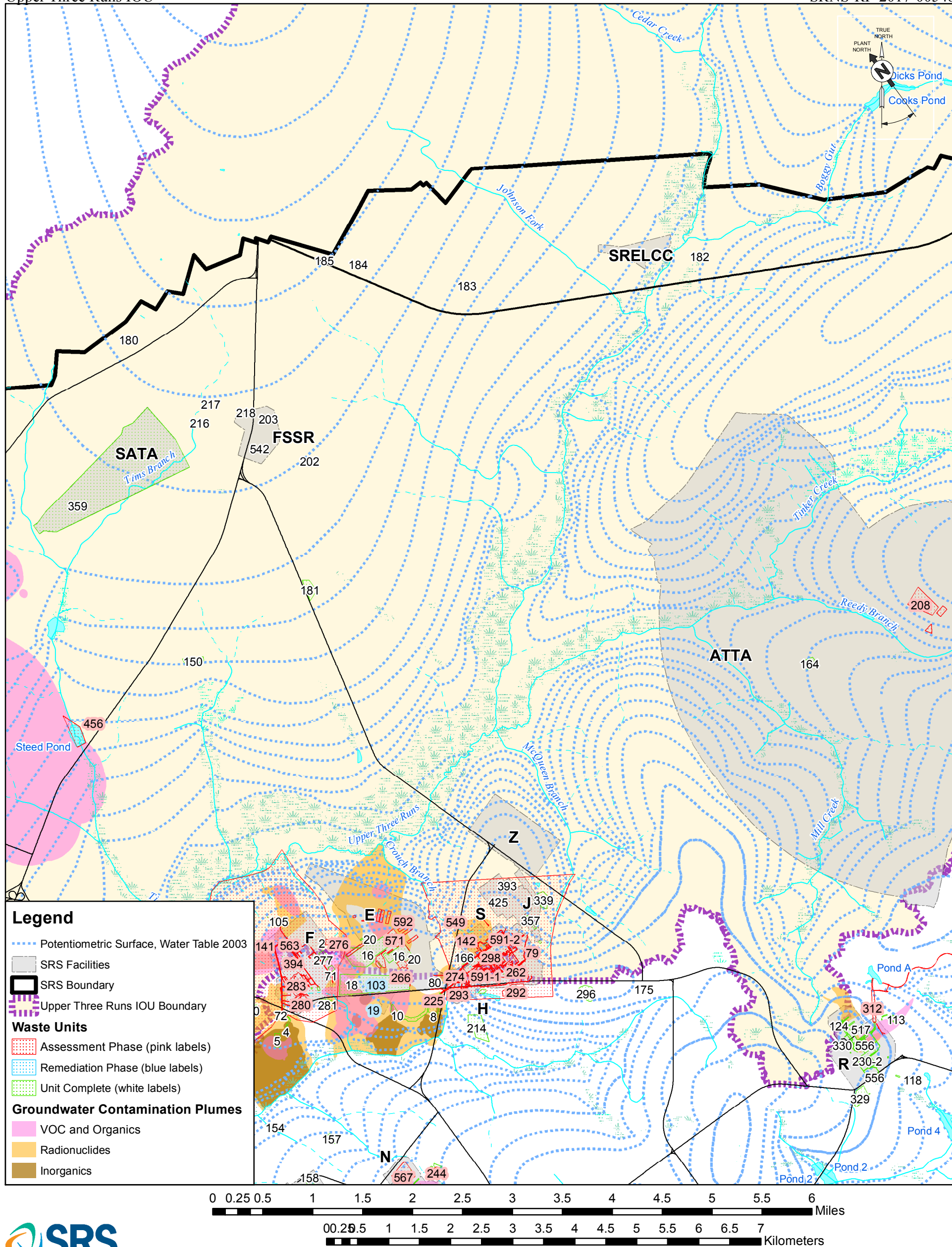
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United States Department of Energy			
ORGANIZATION	REV. NO.	REV. DATE	AREA
UTRIOUFIG1_4eGIS2018	0	01/23/18	SRS
Operable Units and Topography Associated with the UTR IOU - R Area			
CREATED BY	DATE	APPROVED BY	DATE
Natalie Lopez	01/23/18	Susan Blas	01/23/18

**Figure 1-4f. Operable Units, Potentiometric Contours, and Groundwater Plumes  
Associated with the UTR IOU – G Area**

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Figure 1-4f: Operable Units and Topography Associated with the UTR IOU - G Area

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Operable Units and Topography Associated with the UTR IOU - G Area			
CREATED BY: Natalie Lopez	DATE: 01/23/18	APPROVED BY: Susan Blas	DATE: 01/23/18

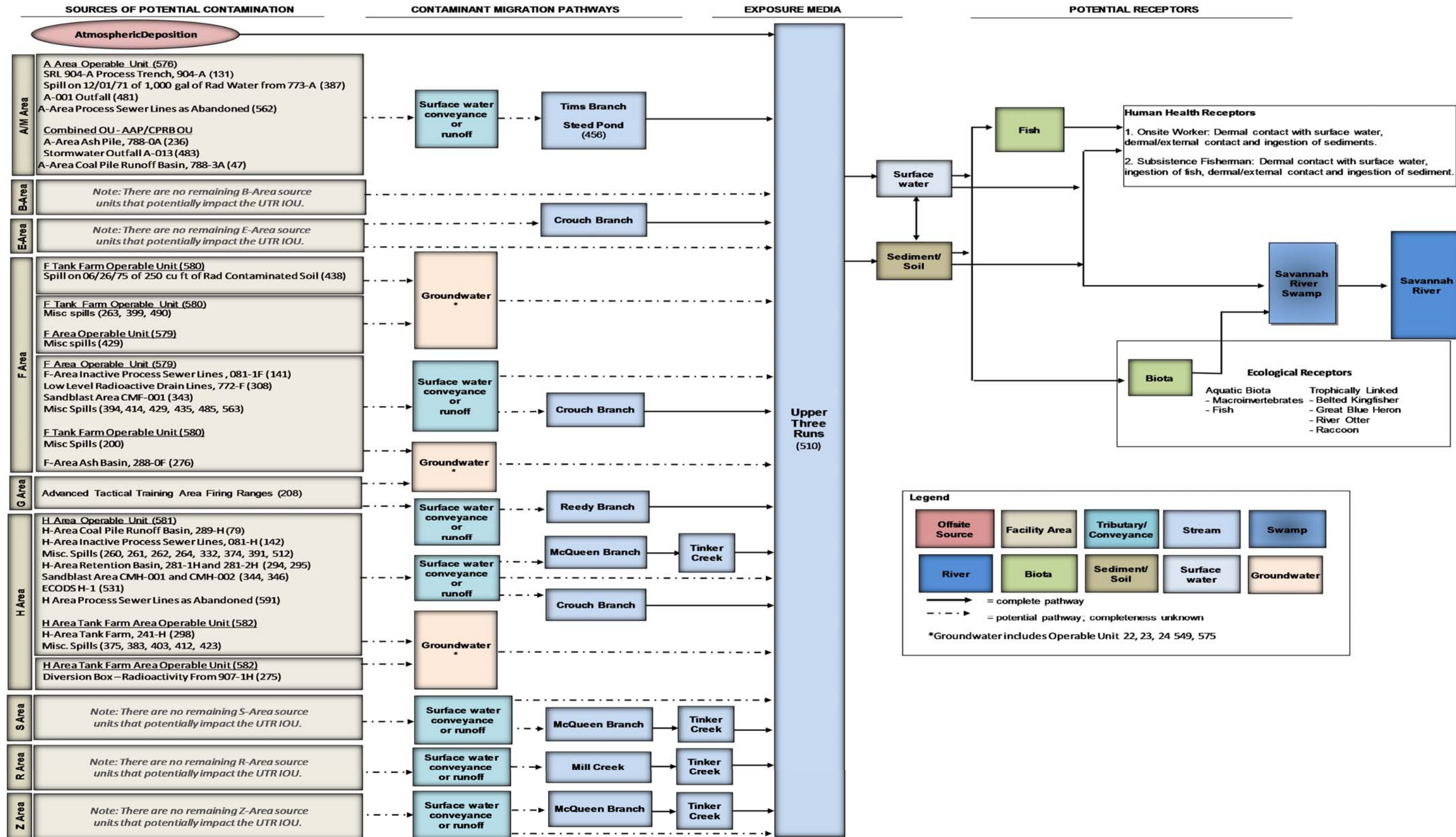


Figure 1-5. Upper Three Runs IOU Conceptual Site Model

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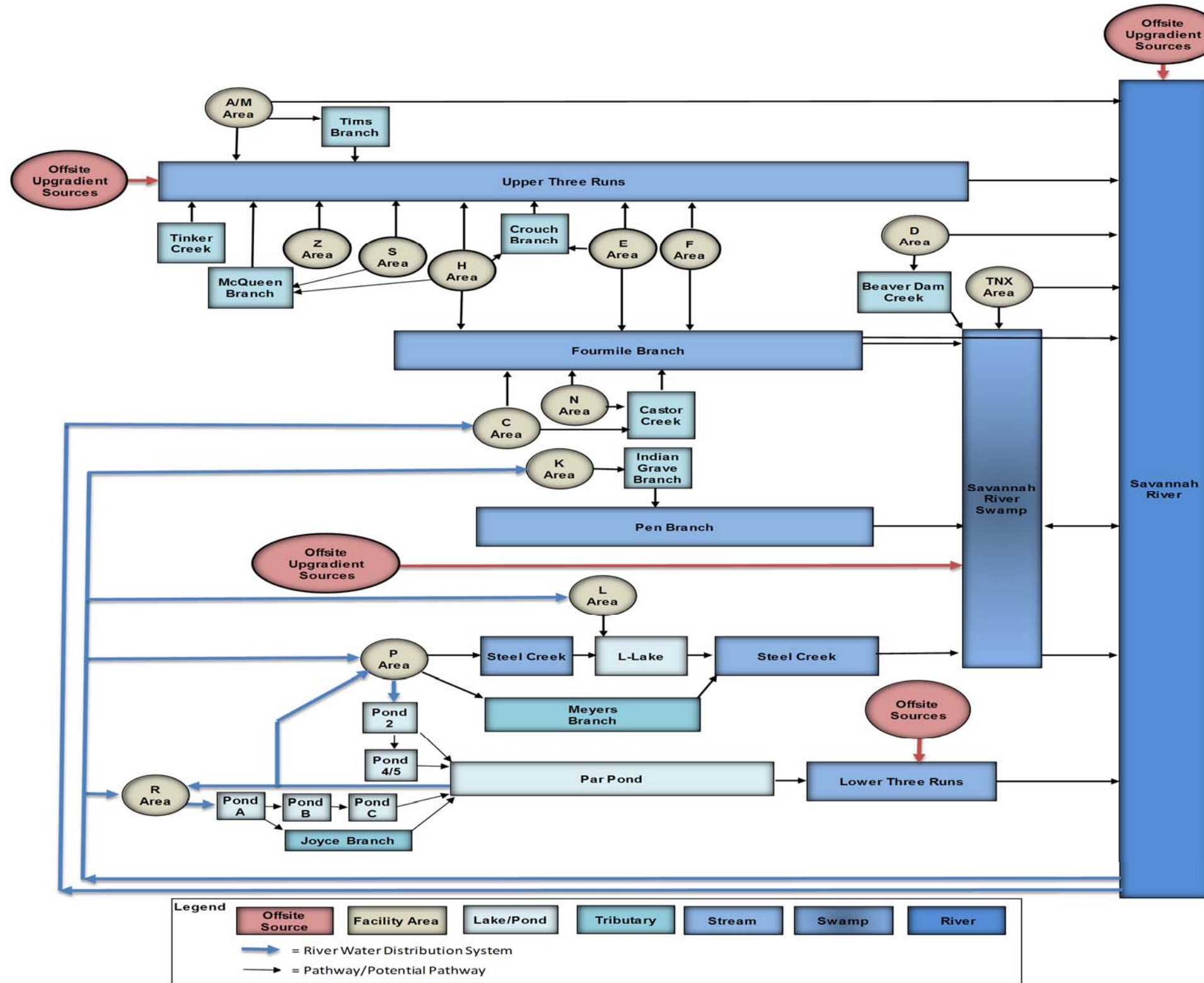


Figure 1-6. SRS-Wide Conceptual Site Model

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
AM	13	GW to SR SW to UTR	M Area Hazardous Waste Management Facility (HWMF) (M-Area Settling Basin, 904-51G)	No	No	Soil	Closed under Resource Conservation and Recovery Act (RCRA). RCRA Regulated Solid Waste Management Unit, continued surveillance and cap maintenance governed under RCRA Part B Permit.
AM	15, 56	GW to SR SW to UTR	Metallurgical Laboratory HWMF/Carolina Bay, 904-110G	No	No	GW/Soil	Interim Action Record of Decision (ROD) June 1992 (WSRC-RP-92-743). RCRA Regulated Solid Waste Management Unit with continued GW monitoring and reporting, surveillance and cap maintenance.
AM	23	GW to SR SW to UTR	M-Area HWMF: A/M Area Groundwater (GW) Portion, 904-110G	Yes	No	GW	RCRA Corrective Action Remediation monitoring and reporting continues. GW addressed under the RCRA Part B Permit.
AM	24	GW to SR SW to UTR	Savannah River Laboratory (SRL) GW	Yes	No	GW	Corrective Action Remediation monitoring and reporting continues. GW addressed under RCRA Part B permit for M-Area and Metallurgical Laboratory Hazardous Waste Management Facility (HWMF)
AM	44	GW to SR SW to UTR	716-A Motor Shop Seepage Basin, 904-101G	No	No	Soil	No Action ROD issued April 1998 (WSRC-RP-97-840).
AM	45	GW to SR SW to UTR	A-Area Burning/Rubble Pits, 731-1A	No	No	GW/Soil	Part of ABRP (Area Burning/Rubble Pits)/MCB (Miscellaneous Chemical Basin)/MBP (Metals Burning Pits) OU. ROD (WSRC-RP-2005-4095) Feb 2007. No remedial action required. Land Use Control Implementation Plan (LUCIP). Annual PER for GW remedial action for the vadose zone.
AM	46	GW to SR SW to UTR	A-Area Burning/Rubble Pits, 731-A	No	No	GW/Soil	Part of ABRP/MCB/MBP OU. ROD (WSRC-RP-2005-4095) Feb 2007. No remedial action required. LUCIP. Annual PER for GW remedial action for the vadose zone.
AM	47	GW to SR SW to UTR	A-Area Coal Pile Runoff Basin, 788-3A	No	Yes	GW/Soil	Combined OU: A-Area Ash Pile, A-Area Coal Pile Runoff Basin, Stormwater Outfall A-013 (ERD-EN-2009-0042) Rev. 1.2, Interim Action SB/PP (SRNS-RP-2012-00307) due June 2020; IROD due Nov 2021. FFA field start date March 2023.
AM	48	GW to SR SW to UTR	A-Area Miscellaneous Rubble Pile, 731-6A	No	No	Soil	Remediation of this unit is complete; CMI/RAIP (WSRC-RP-2002-4067). Submitted 2012 PER submitted annually (WSRC-RP-2004-4088).
AM	49	GW to SR SW to UTR	A-Area Rubble Pit, 731-2A	No	No	GW/Soil	Part of ABRP/MCB/MBP OU. ROD (WSRC-RP-2005-4095) Feb 2007. No remedial action required. LUCIP. Annual PER for GW remedial action for the vadose zone.
AM	101	GW to UTR/SR SW to UTR	Miscellaneous Chemical Basin, 731-4A	No	No	GW/Soil	Part of ABRP/MCB/MBP OU. ROD (WSRC-RP-2005-4095) issued Feb 2007. Final remedial action complete; LUCIP for soil. GW (vadose zone) addressed under RCRA Part B Permit for M-Area and Metallurgical Laboratory HWMF. Annual PER for GW remedial action for the vadose zone submitted annually.
AM	102	GW to UTR/SR SW to UTR	Metals Burning Pits, 731-5A	No	No	Soil	Part of ABRP/MCB/MBP OU. ROD (WSRC-RP-2005-4095) issued Feb 2007. Remedial action complete. LUCIP for soil. GW assessed under RCRA Part B Permit for M-Area and Metallurgical Laboratory HWMF. Annual PER for GW remedial action for the vadose zone
AM	131	GW to SR SW to UTR	SRL 904-A Process Trench, 904-A	No	Yes	Soil	Part of A-Area Operable Unit (AAOU) (576). Sept 2035 start date FFA Append E
AM	133	GW SR SW UTR	SRL Seepage Basins, 904-53G1	No	No	Soil	Corrective Measures Implementation Report (CMIR)/ Post-Construction Report (PCR)/Final Remediation Report (FRR) approved Feb 2002 (WSRC-RP-2001-4123). Continued post-closure maintenance activities with annual inspections.
AM	134	GW to SR SW to UTR	SRL Seepage Basins, 904-53G2	No	No	Soil	CMIR/PCR/FRR approved Feb 2002 (WSRC-RP-2001-4123). Continued post-closure maintenance activities with annual inspections.
AM	135	GW to SR SW to UTR	SRL Seepage Basins, 904-54G	No	No	Soil	CMIR/PCR/FRR approved Feb 2002 (WSRC-RP-2001-4123). Continued post-closure maintenance activities with annual inspections.
AM	136	GW to SR SW to UTR	SRL Seepage Basins, 904-55G	No	No	Soil	CMIR/PCR/FRR approved Feb 2002 (WSRC-RP-2001-4123). Continued post-closure maintenance activities with annual inspections.
AM	195	GW to SR SW UTR	Spill on 03/20/86 of less than (<)1 gal of Water - Rad, No building number (NBN)	No	No	Soil	Unit complete. No Further Action (NFA) approved by USEPA in Aug 1999 and South Carolina Department of Health and Environmental Control (SCDHEC) in July 1999
-	198	GW to SR SW to UTR	Spill on 03/04/86 of 5 gal of 50% NaOH from 341-M, NBN	No	No	Soil	Unit complete. NFA approved by USEPA in Aug 1999 and SCDHEC in July 1999

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
AM	224	GW to SR SW to UTR	Spill on 10/07/85 of 1 gal of Nitric Acid at Barricade 10, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1998 and SCDHEC April 1996
AM	234	GW to SR SW to UTR	313-M And 320-M Inactive Clay Process Sewers to Tims Branch, NBN	No	No	Soil	ROD (WSRC-RP-2006-4001) with LUCIP April 2007. Approved PCR USEPA and SCDHEC, Oct 2008 (WSRC-RP-2008-4029). GW regulated under RCRA Part B Permit HWMF GW Monitoring/Corrective agreements identified in the CMI/RAIP (WSRC-RP-2006-4048). PER submitted annually
AM	236	GW to SR SW to UTR	A-Area Ash Pile, 788-0A	No	Yes	Soil	Combined OU: A-Area Ash Pile, A-Area Coal Pile Runoff Basin, Stormwater Outfall A-013 (ERD-EN-2009-0042) Rev. 1.2 Interim Action SB/PP (SRNS-RP-2012-00307) is due June 2020; IROD due Nov 2021. FFA field start date March 2023.
AM	237	GW to SR SW to UTR	A-Area Ash Pile, 788-2A	No	No	Soil	Part of ABRP/MCB/MBP OU. ROD (WSRC-RP-2005-4095) Feb 2007. Final action complete June 2008; LUCIP.
AM	338	GW to SR SW to UTR	Rubble Pile North of SRL, NBN	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC May 2001
AM	340	GW to SR SW to UTR	Salvage Yard, 741-A	No	No	Soil	Part of MAOU (585). Unit complete. Post Construction Report approved by USEPA Mar 2011 and SCDHEC Feb 2011
AM	347	GW to SR SW to UTR	Sandblast Area, CMM-002, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Mar 2001 and SCDHEC May 2003
AM	359	GW to UTR SW to UTR	Small Arms Training Area (SATA), NBN	No	No	Soil	NTPCR action complete. Removal Action Report approved by SCDHEC and EPA Jan 2012
AM	361	GW to SR SW to UTR	Spill of 218 grams Mercury Adjacent to Bldg. 780-2A, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Aug 1999 and SCDHEC July 1999
AM	384	GW SR SW to UTR	Spill on 11/21/87 of 170 gal of KOH, SMBS, NaPO <sub>4</sub> from 784-A, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Aug 1999 and SCDHEC July 1999
AM	385	GW to SR SW to UTR/SR	Spill on 11/22/85 of Unknown of Chromated Water from Between 702-A and 708-A, NBN	No	No	Soil	Unit complete. NFA approved by USEPA March 2001 and SCDHEC Feb 2001
AM	387	GW SR SW UTR	Spill on 12/01/71 of 1,000 gal of Rad Water from 773-A, NBN	No	Yes	Soil	Part of AAOU (576). Sept 2035 start date FFA Append E
AM	400	GW to SR SW to UTR	Spill on 03/11/87 of 1 gal of Caustic, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
AM	406	GW to SR SW to UTR	Spill on 03/08/86 of ½ Pint of Water – Rad, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Aug 1998
AM	409	GW to SR SW to UTR	Spill on 04/01/85 of 25 mL of Sulfuric Acid, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Aug 1998
AM	410	GW to SR SW to UTR	Spill on 04/01/87 of <5 gal of Cr III Ligno – Sulfonate, NBN	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC April 2001
AM	419	GW to SR SW to UTR	Spill on 05/01/85 of 1 gal of Alcohol from 779-A, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
AM	420	GW to SR SW to UTR	Spill on 05/01/87 of 100 gal of Water from 300-M, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Dec 1999 and SCDHEC Oct 1999
AM	436	GW to SR SW to UTR	Spill on 06/16/87 of ~1 gal of Water – Rad, NBN	No	No	Soil	Unit complete. NFA approved by USEPA May 2004 and SCDHEC Aug 2005
AM	446	GW to SR SW to UTR	Spill on 08/18/86 of 20 gal of Water – Rad, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC Aug 1998
AM	449	GW to SR SW to UTR	Spill on 09/01/85 of <1 pounds (lb) of Mercury from 748-A, NBN	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC July 2003

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
AM	451	GW to SR SW to UTR	Spill on 09/20/87 of Unknown Amount of Water – Rad, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC June 1998
AM	480	GW to SR SW to UTR	Sandblast Area CMM-003, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Mar 2001 and SCDHEC May 2003
AM	481	GW to SR SW to UTR	A-001 Outfall, NBN	No	Yes	Soil	Part of AAOU (576). Sept 2035 start date FFA Append E
AM	483	GW to SR SW to UTR	Stormwater Outfall A-013, NBN	No	Yes	Soil	Combined OU: A-Area Ash Pile, A-Area Coal Pile Runoff Basin, Stormwater Outfall A-013 (ERD-EN-2009-0042) Rev. 1.2 Interim Action SB/PP (SRNS-RP-2012-00307) is due June 2020; IROD due Nov 2021. FFA field start date March 2023.
AM	484	GW to SR SW to UTR	M-Area HWMF: M-Area Vadose Zone, 904-51G	No	No	Soil	Solid Waste Management Unit. Closure plan approved 1987. Continued characterization/ monitoring and reporting.
AM	497	GW to SR SW to UTR	Sandblast Area CMM-001, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC April 2003
AM	521	GW to SR SW to UTR	Early Construction and Operations Disposal Sites (ECODS) A-2 (near Sandblast Area CMM-001, NBN)	No	No	Soil	Unit complete. NFA approved by SCDHEC July 2003
AM	562	GW to SR SW to UTR/SR	A-Area Process Sewer Lines as Abandoned, NBN	No	Yes	Unknown	Part of AAOU (576). Sept 2035 start date FFA Append E
B	21	GW to UTR SW to UTR	Non-Radioactive Waste Disposal Facility (aka Sanitary Landfill RCRA Portion), 740-G	No	No	Soil	RCRA Corrective Action Remediation monitoring continuing and Corrective Action Plan maintenance.
B	22	GW to UTR SW to UTR	Non-Radioactive Waste Disposal Facility (aka Sanitary Landfill) (GW), 740-G	Yes	Yes	GW	RCRA unit addressed under the RCRA Part B Permit. GW monitoring and reporting continues.
B	37	GW to UTR SW to UTR	Grace Road Site, 631-22G	No	No	Soil	RI complete in 1994. No action was warranted; ROD Jan 1997.
B	149	GW to UTR SW to UTR	Lower Kato Road Site, 761-1G	No	No	Soil	Unit complete. NFA approved by USEPA Oct 1997 and SCDHEC Sept 1997
B	151	GW to UTR SW to UTR	Orangeburg Site, 761-2G	No	No	Soil	Unit complete. NFA approved by USEPA April 1998 and SCDHEC Nov 1997
B	155	GW to UTR/SR SW to UTR	B-Area Tower Foundation Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA June 1995 and SCDHEC Dec 1994
B	167	GW to UTR SW to UTR	IMHOFF Tank Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA March 1993 and SCDHEC May 1993
B	168	GW to UTR SW to UTR	Kato Road Site, 761-6G	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC Jan 1994
B	204	GW to UTR SW to UTR	TCU Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC July 1995
B	207	GW to UTR SW to UTR	Zion Fair Church Site, NBN	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC Mar 1994
B	209	GW to UTR SW to UTR	B-Area Sanitary Treatment Plant Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1998 and SCDHEC Mar 1997
B	491	GW to UTR SW to UTR	Sandblast Area CMB-001, NBN	No	No	Soil	Unit complete. site evaluation area (SEA) for NFA approved by USEPA and SCDHEC in May 2009.
B	526	GW to UTR SW to UTR	ECODS B-1A, 1B (South of B Area)	No	No	Soil	Unit complete. NFA approved by USEPA Oct 2004 and SCDHEC Sept 2005

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
B	527	GW to UTR SW to UTR	ECODS B-2 (South of B Area)	No	No	Soil	Unit complete. NFA approved by SCDHEC Oct 2005.
B	528	GW to UTR SW to UTR	ECODS B-3 (East of B Area, South of Road C)	No	No	Soil	Part of BAOU (593). Non-time critical removal (NTPCR) action conducted. Removal Action Report approved by USEPA and SCDHEC June 2011 (SRNS-RP-2011-00210). LUCIP (SRNS-RP-2013-00113) for unrestricted use.
B	529	GW to UTR SW to UTR	ECODS B-4 (East of B Area, South of Road C)	No	No	Soil	Unit complete. NFA approved by USEPA Aug 2005 and SCDHEC Oct 2003
B	530	GW to UTR SW to UTR	ECODS B-5 (Adjacent to ECODS B-3)	No	No	Soil	Part of BAOU (593). NTPCR action conducted. Removal Action Report approved by USEPA and SCDHEC June 2011 (SRNS-RP-2011-00210). LUCIP (SRNS-RP-2013-00113) for unrestricted use.
B	590	GW to UTR SW to UTR	B-Area Disposal Trench, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC Oct 2006.
E	16	GW to UTR/FMB SW to UTR	Mixed Waste Management Facility (including the RCRA Regulated Portions of Low-Level Radioactive Waste Disposal Facility (LLRWF) 643-7E), 643-28E	No	No	Soil	Closed under RCRA. Corrective Action Remediation and monitoring continuing and cap maintenance. GW addressed under RCRA Part B Permit.
E	20	GW to UTR/FMB SW to UTR	LLRWDF (non-hazardous waste disposal portion of 643-7E), 643-7E	No	No	Soil	Closed under RCRA. Corrective Action Remediation and monitoring continuing and cap maintenance. GW addressed under RCRA Part B Permit.
E	523	GW to UTR/FMB SW to UTR	ECODS F-1 (Southeast of F-Area Ash Basin, 276-0F)	No	No	Soil	Unit complete. NFA approved by SCDHEC July 2003.
E	524	GW to UTR SW UTR	ECODS F-3 (East of ECODS F-1)	No	No	Soil	Unit complete. NFA approved by SCDHEC July 2003
E	571	GW to UTR/FMB SW to UTR	LLRWDF (RCRA Regulated Portion) 643-7E (including Combined Spills from 643-G as reported in WSRC-RP-97-419)	No	No	Soil	Closed under RCRA. Corrective Action Remediation and monitoring continuing and cap maintenance. GW addressed under RCRA Part B Permit.
F	2	GW to UTR SW to UTR	F-Area Acid/Caustic Basin, 904-74G	No	No	Soil	Closed under RCRA closure plan for F-, H-, K-, and P-Area Acid/Caustic Basins June 1995. GW is part of the General Separations Area (GSA) Western GW OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016
F	5	GW to FM/UTR SW FMB	F-Area HWMF (F-Area Seepage Basin, 904-43G)	No	No	Soil	Unit complete. ROD for F-Area HWMF Sept 1993. GW is part of the GSA Western Groundwater OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016
F	30	GW to UTR SW to UTR	Burma Road Rubble Pit, 231-4F	No	No	Soil	No remedial action required for this unit (ESD to the Rev 1 ROD, WSRC-RP-98-4170). GW from upgradient sources is part of the GSA Western GW OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016
F	34	GW to UTR SW to UTR	F-Area Burning/Rubble Pits, 231-1F	No	No	Groundwater	Unit complete. ROD for F-Area Burning/Rubble Pits (231-F, -1F, and -2F) April 1997. GW addressed under GSA Western GW OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016
F	35	GW to UTR SW to UTR	F-Area Burning/Rubble Pits, 231-2F	No	No	Soil	Unit complete. ROD for F-Area Burning/Rubble Pits (231-F, -1F, and -2F) April 1997. GW addressed under GSA Western GW OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016
F	36	GW to UTR SW to UTR	F-Area Burning/Rubble Pits, 231-F	No	No	Soil	Unit complete. ROD for F-Area Burning/Rubble Pits (231-F, -1F, and -2F) April 1997. GW addressed under GSA Western GW OU (575). Scoping Summary for the GSA Western GW Operable Unit, ERD-EN-2005-0127, revised Oct 2016

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
F	72	GW to UTR SW UTR/FMB	F-Area HWMF (F-Area Inactive Process Sewer Line 081-F)	No	No	Soil	Unit complete. ROD for F-Area HWMF, Sept 1993. GW addressed under GSA Western GW OU (575). Scoping Summary for the GSA Western GW OU, ERD-EN-2005-0127, revised Oct 2016
F	105	GW to UTR SW to UTR	Old F-Area Seepage Basin, 904-49G	No	No	GW/Soil	ROD April 2004. GW addressed under GSA Western GW OU (575) (575). Annual inspection frequency for maintenance. Scoping Summary for the GSA Western GW OU, ERD-EN-2005-0127, revised Oct 2016
F	141	GW to UTR SW to UTR/FM	F-Area Inactive Process Sewer Lines from Building to the Security Fence, 081-1F	Yes	No	Soil	Part of F-Area Operable Unit (FAOU) (579). ROD Sept 2039; FFA start date Dec 2040. GW addressed under GSA Western GW OU (575). Scoping Summary for the GSA Western GW OU, ERD-EN-2005-0127, revised Oct 2016
F	162	GW to UTR SW FMB	Fire Training Pit At 709-1F, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC and USEPA Jan 1994
F	199	GW to UTR SW UTR	Spill on 04/15/87 of 950 gal of Chromated Water from 772-F, NBN	No	No	Soil	Site complete. NFA approved by USEPA Sept 1996 and SCDHEC Mar 1996
F	200	GW to UTR SW to UTR	Spill on 05/01/57 of 125 ft <sup>2</sup> of Rad Liquid from Solvent Trailer, NBN	Yes	Yes	Soil	Part of F Tank Farm Area Operable Unit (AOU) (580). FFA ROD Jan 2042; RA start date April 2043
F	212	GW to UTR SW to UTR	F-Area Scrap Lumber Pile, 231-3F	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1998 and SCDHEC Feb 1998
F	227	GW to UTR SW FMB	Spill on 05/14/85 of ½ Pint of Mercury Near 284-F, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC Nov 1996
F	263	GW to UTR/FM SW FMB	Combined Spills from 242-F	Yes	No	Soil	Part of F Tank Farm AOU (580). FFA ROD Jan 2042; RA start date April 2043
F	270	GW to UTR SW to FM	Combined Spills from 701-1F Spill, NBN	No	No	Soil	SEA submitted Sept 1, 2016. NFA approved by SCDHEC 12/15/2016 and USEPA 9/1/2016.
F	276	GW to UTR SW to UTR	F-Area Ash Basin, 288-0F	Yes	Yes	Soil	SEA FFA start date Dec 2024
F	277	GW to UTR SW to FMB	F-Area Ash Basin, 288-1F	No	No	Soil	Unit complete. Basin closed under Industrial Wastewater Permit. Closure Plan. NFA approved by USEPA May 2004 and SCDHEC July 2004.
F	278	GW to UTR SW to UTR	F-Area Erosion Control Site, 080-28G	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Nov 1998
F	279	GW to UTR SW to UTR	F-Area Railroad Crosstie Pile, NBN	No	No	Soil	Unit complete. Site closed under Industrial Solid Waste Landfill Permit based on approved site closure plan. NFA approved by SCDHEC July 2003.
F	284	GW to UTR SW to UTR	F-Area Acid/Caustic Basin (GW)	No	No	Soil	Unit complete. Unit closed per Interim Status Closure Plan Feb 1992
F	308	GW to UTR SW to UTR	Low Level Radioactive Drain Lines, 772-F	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	325	GW to UTR SW to FMB	Potential Release of NaOH/H <sup>2</sup> SO <sup>4</sup> from 280-1F, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	343	GW to UTR SW to UTR/FMB	Sandblast Area Cmf-001, NBN	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	368	GW to UTR SW to UTR	Spill on 01/01/85 of 15 gal of 6% Potassium Permanganate, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	372	GW to UTR SW to UTR	Spill on 01/01/87 of Unknown of Potassium Permanganate, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
F	394	GW to UTR SW to UTR/FM	Spill on 02/25/85 of 20,000 CM of Water Vapor – Rad, NBN	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	395	GW to UTR SW to FM	Spill on 02/25/87 of 2 liters of Sulfuric Acid Between 704-8F and 703-F Parking Lots	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	399	GW to UTR SW to FM	Spill on 03/01/66 of 500 ft <sup>2</sup> of Flush Water - Rad, NBN	Yes	No	Soil	Part of F Tank Farm AOU (580). FFA ROD Jan 2042; RA start date April 2043
F	402	GW to UTR SW to FM	Spill on 03/27/80 of 3 gal of Nitric Acid, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	414	GW to UTR SW to UTR	Spill on 04/24/91 of 0.11 curies (Ci) of Pu 239, 772-1F	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	416	GW to UTR SW to UTR	Spill on 04/07/76 of 200 gal of 50% Nitric Acid, NBN	No	No	Soil	Unit complete. NFA approved by USEPA June 1999 and SCDHEC May 1999
F	422	GW to UTR SW to UTR	Spill on 05/19/87 of 1 gal of 50% Sodium Hydroxide, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	424	GW to UTR SW to UTR	Spill on 05/21/84 of 20 gal of Sodium Hydroxide, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	426	GW to UTR SW to UTR	Spill on 05/22/86 of 2 gal of 50% Sodium Hydroxide, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	429	GW to UTR SW FM	Spill on 05/26/88 of 10 gal of Ethylene Glycol-Rad from 772-F, NBN	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	435	GW to UTR SW to UTR	Spill on 06/01/59 of <1 Ci of Segregated Solvent from 211-F, NBN	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	438	GW to UTR SW to FM	Spill on 06/26/75 of 250 cubic feet of Rad Contaminated Soil, NBN	Yes	No	Soil	Part of F Tank Farm AOU (580). FFA ROD Jan 2042; RA start date April 2043
F	445	GW to UTR SW to FM	Spill on 07/05/88 of 2 pints of 64% Nitric Acid in F-Area, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
F	485	GW to UTR SW to UTR	Combined Spills from 221-F, NBN	Yes	Yes	Soil	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
F	490	GW to UTR/FM SW to UTR/FM	Spill on 04/57 of Rad Liquid from Solvent Trailer, NBN	Yes	No	Soil	Part of F Tank Farm AOU (580). FFA ROD Jan 2042; RA start date April 2043
F	563	GW to UTR/FM SW to UTR/FM	Spill on 04/57 of Rad Liquid from Solvent Trailer, NBN	Yes	Yes	Soil/GW	Part of FAOU (579). ROD Sept 2039; FFA start date Dec 2040
G	38	GW to UTR SW to FM	Gunsite 113 Access Road	No	No	Soil	Unit complete. No action ROD Jan 1997
G	40	GW to UTR SW to SR	Gunsite 720 Rubble Pit, 631-16G	No	No	Soil	Unit complete. No action ROD Jan 1997.
G	140	GW to UTR SW to UTR	West of SREL "Georgia Fields" Site, 631-19G	No	No	Soil	Unit complete. No action ROD May 2000.
G	150	GW to UTR SW to UTR	Lucy Site, 761-3G	No	No	Soil	Unit complete. NFA approved by SCDHEC Mar 1997.
G	164	GW to UTR SW to UTR	Gunsite 102 Rubble Pile, 080-30G	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC July 1994
G	165	GW to UTR SW to UTR	Gunsite 113 Rubble Pile, 631-15G	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC June 1996

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
G	174	GW to UTR SW to UTR	Old Ellenton Rubble Pile	No	No	Soil	Unit complete. NFA approved by USEPA Mar 1994 and SCHEC Mar 1994
G	180	GW to UTR SW to UTR	Recreation Area #002 Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC Oct 1995
G	181	GW to UTR SW to UTR	Road F Site, 761-7G	No	No	Soil	Unit complete. NFA approved by USEPA Jun3 1995 and SCDHEC Aug 1994
G	182	GW to UTR SW to UTR	Rubble Pile - Bragg Bay Road, 631-14G	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC April 1995
G	183	GW to UTR SW to UTR	Rubble Pile - Bragg Bay Road and Cemetery Road, 631-12G	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC April 1995
G	184	GW to UTR SW to UTR	Rubble Pile - Cemetery Road, 631-11G	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC April 1995
G	185	GW to UTR SW to UTR	Rubble Pile - Road 781.1, 631-13G	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC April 1995
G	186	GW to UTR SW UTR	Rubble Pile Near Junction US 278 & GE Road 103, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC April 1995
G	202	GW to UTR SW to UTR	SREL Rubble Pile, 761-9G	No	No	Soil	Unit complete. NFA approved by USEPA April 1993 and SCDHEC July 1993
G	203	GW to UTR SW to UTR	SRFS Rubble Pile, 631-9G	No	No	Soil	Unit complete. NFA approved by USEPA April 1993 and SCDHEC July 1993
G	205	GW to UTR SW to UTR	Incident at Three Rivers Sanitary Landfill, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC Jan 1996
G	208	GW to UTR SW to UTR	Advanced Tactical Training Area (ATTA) Firing Ranges, NBN	Yes	Yes	Soil	FFA start date Jan 2025
G	213	GW to UTR SW to UTR	Gunsite 072 Rubble Pile, 080-31G	No	No	Soil	Unit complete. NFA approved by SCDHEC Nov 1996.
G	216	GW to UTR SW to UTR	Risher Road Open Metal Pit, 631-17G	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1998 and SCDHEC Sept 1997
G	217	GW to UTR SW to UTR	Risher Road Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC Oct 1995
G	218	GW to UTR SW to UTR	Risher Road Rubble Pile #2, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1996 and SCDHEC Oct 1995
G	333	GW to UTR SW to UTR	Road 3 Foundation Rubble Pile, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC Oct 1999
G	456	GW to UTR SW to UTR	Steed Pond, NBN	Yes	Yes	Sediment	Part of UTR IOU (456, 510).
G	463	GW to UTR SW to UTR	Substation 51 Erosion Control Site, 080-27G	No	No	Soil	Unit complete. NFA approved by USEPA Sept 1998 and SCDHEC July 1998
G	541	GW to UTR SW to UTR	ECODS G-1 (Adjacent to Gunsite 072 Rubble Pile, 080-31G)	No	No	Soil	Unit complete. NFA approved by USEPA June 2007 and SCDHEC May 2007.
G	542	GW to UTR SW to UTR	ECODS G-2 (Adjacent to Forestry Facilities)	No	No	Soil	Unit complete. NFA approved by SCDHEC July 2002
G	568	GW to UTR SW to UTR	ECODS G-5	No	No	Unknown	Unit complete. NFA approved by USEPA Dec 2005 and SCDHEC July 2006
G	575	GW to UTR/FM SW to UTR/FM	GSA Western GW OU	Yes	No	GW	Under a GW monitoring program. Scoping Summary for the GSA Western GW OU, ERD-EN-2005-0127, revised Oct 2016

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**Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)**

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
H	6	GW to UTR SW to UTR	H-Area Acid/Caustic Basin, 904-75G	No	No	Soil	Unit complete. Closed under RCRA closure plan for F-, H-, K-, and P-Area Acid/Caustic Basins June 1995.
H	79	GW to UTR SW to UTR	H-Area Coal Pile Runoff Basin, 289-H	Yes	Yes	Soil	Part of H-Area Operable Unit (HAOU) (581). FFA start date, Sept 2037
H	142	GW to UTR SW UTR	H-Area Inactive Process Sewer Lines from building to the Security Fence, 081-H	Yes	No	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	166	GW to UTR SW to UTR	H-Area Burning Pit, NBN	No	No	Soil	Unit complete. NFA approved by USEPA June 1995 and SCDHEC May 1994
H	260	GW to UTR SW to UTR	Combined Spills from 211-H, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	261	GW to UTR/FMB SW UTR	Combined Spills from 241-84H, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	262	GW to UTR/FMB SW to UTR/FMB	Combined Spills from 241-H, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, August 2039
H	264	GW to UTR SW to UTR/FMB	Combined Spills from 242-H, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, August 2039
H	275	GW to UTR SW FMB	Diversion Box – Radioactivity From 907-1H, NBN	Yes	No	Soil	Part of H Tank Farm AOU (582). FFA start date, August 20395
H	294	GW to UTR SW to UTR	H-Area Retention Basin, 281-1H	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	295	GW to UTR SW to UTR	H-Area Retention Basin, 281-2H	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	298	GW to UTR/FMB SW to UTR/FMB	H-Area Tank Farm, 241-H	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, August 2039
H	332	GW to UTR SW to UTR	Spill on 10/07/85 of 20,000 gallons of Contaminated Water from 244-H, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	344	GW to UTR SW to UTR	Sandblast Area CMH-001, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	345	GW to UTR SW to FMB	Sandblast Area CMH-003, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Feb 2006 and SCDHEC Dec 2006
H	346	GW to UTR SW to UTR	Sandblast Area CMH-002, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	357	GW to UTR SW to UTR	Sandblast Area CMS-001, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC Jan 2001
H	360	GW to UTR SW to UTR	Spill of <1/2 lb Mercury in Bldg. 232-H, NBN	No	No	Soil	Unit complete. NFA approved by USEPA and SCDHEC April 2001
H	364	GW to UTR SW to UTR	Spill on 01/01/78 of 600 lb of 50% Sodium Hydroxide, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Dec 1999 and SCDHEC Oct 1999
H	374	GW to UTR SW to UTR	Spill on 01/12/87 of <100 gm of Mercury North of 211-H, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	375	GW to UTR SW to UTR	Spill on 01/19/80 of Unknown of Chromated Water from H-Area Pump House, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, Aug 2039
H	383	GW to UTR SW to UTR	Spill on 11/10/81 of 500 gal of Chromated Water from 243-H, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, Aug 2039.
H	391	GW to UTR SW to UTR	Spill on 02/01/83 of 50 gal of Oil - RAD, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037

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Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued)

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
H	403	GW to UTR SW to UTR	Spill on 03/28/87 of <15,000 gal of Chromated Water from 241-24H, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, Aug 2039
H	412	GW to UTR SW to UTR	Spill on 04/18/80 of Unknown of Chromated Water from Valve House 3, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, Aug 2039
H	423	GW to UTR SW to UTR	Spill on 05/02/85 of 10 gal of Cooling Water from Tank Farm, NBN	Yes	Yes	Soil	Part of H Tank Farm AOU (582). FFA start date, Aug 2039
H	433	GW to UTR SW to UTR	Spill on 05/04/87 of 30 gal of Caustic from 295-H, NBN	No	No	Soil	Unit complete. NFA approved by US Jan 1999 and SCDHEC Dec 1998
H	512	GW to UTR SW to UTR	Combined Spills From 221-H, NBN	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	531	GW to UTR SW to UTR	ECODS H-1 (West of main H-Area facilities)	Yes	Yes	Soil	Part of HAOU (581). FFA start date, Sept 2037
H	549	GW to UTR/FMB SW to UTR/FMB	GSA Eastern GW OU (NBN)	Yes	Yes	GW	Under a GW monitoring program. Scoping summary WSRC-RP-2000-4134 revised Sept 2015
H	591	GW to UTR/FMB SW to UTR/FMB	H-Area Process Sewer Lines as Abandoned	Yes	No	Soil	Part of HAOU (581) Waste Units 554 and 564 are retired numbers. These units are now addressed as Waste Unit number 591. FFA start date Sept 2037.
R	119	GW to UTR SW to LTR	R-Area Reactor Seepage Basins, 904-103G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved Remedial Action Implementation Plan (RAIP) (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	120	GW to UTR SW LTR	R-Area Reactor Seepage Basins, 904-104G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved RAIP (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	121	GW UTR SW LTR	R-Area Reactor Seepage Basins, 904-57G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved RAIP (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	122	GW to UTR SW UTR	R-Area Reactor Seepage Basins, 904-58G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved RAIP (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	123	GW to UTR SW UTR/LTR	R-Area Reactor Seepage Basins, 904-59G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved RAIP (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	124	GW to UTR SW LTR	R-Area Reactor Seepage Basins, 904-60G	No	No	Soil	ROD (WSRC-RP-2003-4093, Rev. 1) October 2003. Approved RAIP (WSRC-RP-2004-4006, Rev.1.1) 2004. GW addressed by the R-Area Reactor Seepage Basins/108-4R Overflow Basin OU GW Mixing Zone Application, Nov 2004. Mixing zone sampling summary report for 2015 submitted May 2016.
R	179	GW to UTR SW LTR	R-Area Rubble Pits 131-2R	No	No	Soil	Unit complete. NFA approved by USEPA Jun 1995 and SCDHEC Feb 1995
R	288	GW to UTR/LTR SW LTR	R-Area GW, NBN	Yes	No	GW	Part of RAOU (588), Effectiveness Monitoring report submitted annually; 2016 monitoring report submitted June 2017 (SRNS-RP-2017-00232)
R	556	GW to LTR/UTR SW to LTR/UTR	R-Area Process Sewer Lines As Abandoned, NBN	No	No	Soil	Unit complete. Part of RAOU (588). LUCIP (SRNS-RP-2010-01208) approved by SCDHEC and USEPA March 2011 Post Construction Report for RAOU approved by USEPA Aug 2012 and SCDHEC April 2012.

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**Table 1-1. Operable Units Associated with the Upper Three Runs IOU (Continued/End)**

Area	Unit ID	Potential SW and GW Transport Pathway <sup>1</sup>	Unit Name	Potential Impact to GW <sup>2</sup>	Potential Impact to SW <sup>2</sup>	Contaminated Media	Unit Status <sup>3</sup>
S	161	GW to UTR SW UTR	Defense Waste Processing Facility (DWPF) Concrete Batch Plant, NBN	No	No	Soil	Unit complete. NFA approved by SCDHEC July 1993
S	339	GW to UTR SW UTR	S-Area Erosion Control Site, NBN	No	No	Soil	Unit complete. NFA approved by SCHEC May 2003
S	393	GW to UTR SW UTR	Spill on 02/20/85 of 1-1/2 qt of Acid mixture from S-Area Trailer S-16, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998
S	425	GW to UTR SW UTR	Spill on 05/21/85 of 20 gal of Acid from S-Area, NBN	No	No	Soil	Unit complete. NFA approved by USEPA Jan 1999 and SCDHEC Dec 1998

<sup>1</sup> The potential GW and SW transport pathway determinations are based on the location of the unit within the respective watershed and associated topographic contours for SW (Figures 1-3a through 1.3f) and potentiometric lines for GW (Figures 1-4a through 1-4f).

<sup>2</sup> The term "potential impact" is used to denote whether further evaluation may be required by the IOU program during Phase II monitoring and assessment. All potential sources will be reassessed as the UTR IOU approaches Phase III final action determinations.

<sup>3</sup> NFA approvals by SCDHEC only assumed USEPA approval after 120 days.

CMIR = Corrective Measures Implementation Report  
 CMI/RAIP = Corrective Measures Implementation/Remedial Action Implementation Plan  
 FMB = Fourmile Branch IOU  
 GW = Groundwater  
 GSA = General Separations Area  
 LUCIP = Land Use Controls Implementation Plan  
 LTR = Lower Three Runs IOU  
 NTCR action = Non-Time Critical Removal action  
 N/A = Not Applicable (particle tracks are based on individual units, not Operable Units)  
 SRFS = Savannah River and Floodplain Swamp IOU

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## **2.0 PRESENTATION OF UPPER THREE RUNS IOU DATA AND BENCHMARK SCREENING**

The UTR PR5 data set includes analytical results for constituents in sediment, sediment/soil, and SW that are screened as potential contaminants against HH and ecological benchmarks established for each media. There are no new fish data available for UTR PR5. The benchmarks were developed following USEPA guidance as specified in the UTR Work Plan (WSRC 2002). The HH radionuclide benchmarks for sediment and sediment/soil were revised in 2003 implementing the USEPA's preliminary remediation goal method (WSRC 2003b). The benchmarks used for screening data for this PR are provided in Appendix A.

The sediment medium represents stream sediments that generally remain inundated (covered) with SW. The sediment/soil medium represents wetland/floodplain soils that may periodically dry. The sediment/soil medium is screened against both sediment and soil benchmarks for both HH and ecological receptors. The sediment comparisons are used to support early action determinations, and the soil benchmark comparisons are used to support the data needs identification process. Fish data are also screened against HH benchmarks and serve as biological data for the ecological assessment to assess the health of the stream system and to periodically identify threats to trophically-linked organisms.

New data for each PR is compiled and typically includes analytical results from sampling performed in response to IOU related data needs and from independent (non-IOU) sampling efforts. IOU program personnel coordinate with data stewards and query analytical databases to identify and retrieve new data for each PR update. These data are used to conduct screening level HH and ecological risk evaluations and evaluate trends for constituents that warrant further consideration based on the benchmarking process. These data evaluations support identification of data gaps which guide the collection of additional data as Phase II of the IOU program continues.

The UTR PR5 data are derived from the following primary data stewards:

- SCDHEC;
- USEPA STORET;

- SRS Soil and GW Closure Projects, and
- SRS Environmental Monitoring Section/Sample Data Management

Table 2-1 provides a summary of the UTR PR5 dataset based on environmental medium, data steward, and analyte type. The UTR PR5 data are available in a user friendly ArcReader desktop mapping application accompanying this PR that allows users to view, identify/find, and navigate the various data layers used in the master IOU Geographic Information System (GIS) project. The ArcReader version of the IOU GIS Project is in digital video disk (a.k.a DVD) format accompanying this PR.

Background data for the UTR PR5 evaluation are primarily based on background compiled for the Lower Three Runs (LTR) BRA including the 2009/2010 data collected by implementation of the approved SAP for the LTR IOU (SRNS 2010). The locations include UTR IOU/Tinker Creek, Steel Creek IOU/Meyers Branch, and the SRFS IOU/Crackerneck Wildlife Management Area (WMA).

Tinker Creek is located upgradient of SRS discharges and is part of the E.P. Odum Wetland Set-Aside (SREL 1997). The overall SRS management policy has considered UTR Creek and Tinker Creek as "control" streams which should receive as little impact from SRS operations as possible, due in part to the substantial biodiversity of macroinvertebrates within the system. Meyers Branch, within the Steel Creek IOU, is also part of the USDOE Set-Aside program and is referred to as the Ruth Patrick – Meyers Branch Set-Aside (SREL 1997). Meyers Branch is one of the least disturbed streams on the SRS, and because it originates and terminates entirely on the SRS, this stream is not subjected to any impacts from outside of the SRS. Both the Tinker Creek and Meyers Branch systems are typical low-gradient coastal plain blackwater systems exhibiting a sandy substrate bottom, and are heavily canopied with well-developed riparian vegetation (SREL 1997) and are comparable to other SRS coastal plain streams.

As the UTR IOU and other IOUs continue with Phase II assessment, additional background data will be collected. Over time, the background database will become more robust.

Background data have been collected to compare contaminant levels within the IOU with levels in the environment not impacted by historical operations. The background data include sediment, sediment/soil, and SW data to support the UTR PR5 data assessment. The background data were either collected by the IOU program or compiled from other data stewards from the sources described below.

2009/2010 LTR characterization effort: The 2009/2010 background data were collected by implementation of the approved *Sampling and Analysis Plan for the Lower Three Runs IOU* (SRNS 2009a). The locations include Upper LTR upgradient of the North Arm of PAR Pond, UTR IOU/Tinker Creek, Steel Creek IOU/Meyers Branch, and the SRFS IOU/Crackerneck WMA.

Wetland Study Background Data: The Wetland Study background dataset, described in *Geochemical and Physical Properties of Wetland Soils at the Savannah River Site* (WSRC 1997), involved collecting wetland soil samples from numerous wetlands across SRS and at several offsite locations. Samples were analyzed for selected metals, organics, physical properties, and agricultural parameters following established USEPA protocols and standard methods. The data were collected to characterize wetland soils at SRS and to supplement baseline data. These data are supplemented by additional data collected from the UTR, Tinker Creek, Crackerneck WMA, and Meyers Branch that are also part of the IOU database since these locations have served as background locations for various data stewards, including IOU data collection efforts.

SRS Background Data: These data are presented and described in the Background Soils Study (WSRC 2006), which is a comprehensive background soils dataset based on data compiled from SRS site-wide inorganic and radionuclide data collected from 39 approved OU investigations between 1993 and 1999.

## **2.1 Human Health and Ecological Benchmark Screening**

The analytical data collected and compiled for UTR PR5 are used to screen the IOU from a HH and ecological risk perspective. The screening is conducted by comparing constituent concentrations to pre-established benchmark values for each medium resulting in a screening level risk evaluation. The UTR PR5 data set includes SW, sediment, and sediment/soil data. There are

no new fish data for UTR PR5. The sediment medium represents stream/pond sediments that generally remain inundated (covered) with SW. The sediment/soil medium represents wetland/floodplain sediment that may periodically dry. The sediment/soil medium is screened against both sediment and soil benchmarks for both HH and ecological receptors. The sediment, SW, and fish benchmark comparisons, when fish data are available, are used to support early action determinations and data needs determinations. The soil benchmark comparisons are used primarily to support the data needs identification.

Benchmark screening is conducted to:

- identify any discernable areas within the IOU warranting early action consideration;
- identify OUs for potential reprioritization; and
- identify areas in need of additional sampling or periodic monitoring.

The benchmark evaluations are based on the UTR PR5 dataset compiled by subunit, but are also supplemented by additional data from the IOU database if further scrutiny is required. For both the HH and ecological evaluations, the benchmark exceedance discussions are supplemented with statistical parameters associated with the magnitude and frequency of benchmark exceedances. A maximum hazard quotient (HQ) (maximum detected value/benchmark) and a mean HQ (mean detected value/benchmark) are calculated for each constituent per subunit and are used to determine if maximum and/or mean values are greater than the benchmark (i.e., maximum and/or mean HQ greater than [ $>$ ] 1.0). The mean HQ is used to represent receptors that average their exposure within the IOU subunit. For Phase II IOU evaluations, the mean is calculated using only detected values to provide a more conservative approach to screening. Constituents with a low mean HQ (mean HQ  $<$ 1.0), as grouped by subunit, do not warrant further evaluation. Similarly, constituents with a low frequency of exceedance (5% or less) do not require additional evaluation by the IOU program. The background data are also used to determine the importance of benchmark exceedances. If levels observed within the IOU are within background levels, this indicates contaminants within the IOU are not unit related, and that further investigation by the IOU is not warranted at this time.

The tables presenting the statistical parameters associated with each media-receptor combination are provided in Sections 2.1.2 and 2.1.3 for the HH and ecological screening, respectively. Benchmark exceedances are listed in Table 2-2 through 2-5. The figures showing the sampling locations for constituents with benchmark exceedances are presented in Figures 2-2 through 2-9. Several exceedances may be present at a single sampling location; therefore, the total number of exceedances may not be visible on the figures. The sample locations are color-coded to indicate the UTR subunit associated with each particular sample location.

### ***2.1.1 Human Health and Ecological Benchmark Screening***

For the UTR IOU, benchmarks screening is conducted to evaluate potential contaminants in sediment, sediment/soil, SW, and fish media. The receptor activities and specific pathways selected for quantification are the same as those described in the *Remedial Investigation Work Plan for the UTR IOU* (WSRC 2002). Analytical data for each media (i.e., sediment, sediment/soil, SW, and fish) are combined by subunit, and evaluated based on established criteria as discussed below.

### ***2.1.2 Human Health Benchmark Screening and Results***

For the UTR IOU HH evaluation, benchmark screening is conducted to evaluate potential contaminants in sediment, sediment/soil, SW, and fish media. The on-site worker benchmarks are used to screen sediment, sediment/soil, and SW data. The subsistence fisherman benchmarks are used to evaluate the fish medium when fish data are available. The HH benchmark values are used to identify constituent concentrations that result in a cancer risk  $>1 \times 10^{-4}$  or an HQ greater than three for Phase II evaluations. If a HH benchmark value is exceeded, the following criteria are considered to determine the significance of the exceedance(s):

1. exceedance frequency (number of exceedances/the number of samples x 100);
2. a mean-value consideration (detected mean value/benchmark is greater than 1.0);
3. background data (mean detected value is greater than maximum background levels (or if background is indeterminate); and
4. receptor appropriateness.

If the frequency of exceedance is greater than 5%, the mean HQ >1.0, and the mean detected value is greater than maximum background levels (or if background is indeterminate) for a constituent, further evaluation is required. The benchmarks used for the HH evaluation are provided in Appendix A.

### Sediment

Based on review of UTR PR5 data, there were benchmark exceedances for cesium-137 for the onsite worker for the Tinker Creek subunit (Table 2-2, Figure 2-1). The sediment benchmark for sediment for the onsite worker is 89.2 pCi/g. There were 5 exceedances out of 15 samples for the Tinker Creek subunit representing a frequency of exceedance >5%. The mean of detected values (4.87E+02) was above background (0.623 pCi/g), and the mean ratio (5.45) was >1.0. The exceedances for the Tinker Creek subunit require further evaluation since the mean ratio is >1.0, the frequency of exceedances is >5%, and the mean detected value is greater than background.

The five Tinker Creek exceedances revealed these data were collected in 2014 and 2015 and are associated with the Z-Area stormwater basin that receives stormwater from Z-Area saltstone processing and disposal facilities, and the Z-Area Z-01 Outfall. The basin is part of a monitoring program, and reported through the SRS annual environmental reports (NPDES General Permit for Storm Water Discharges Associated with Industrial Activities stormwater permit, SCR000000). Additionally, the basin and outfall area is posted as a soil contamination area. The cesium-137 data were associated with higher than average rainfall events in 2013 that caused the Z-Area stormwater basin to discharge through the Z-01 Outfall (SRNS 2014a). This basin does not normally discharge. The storm water runoff accumulation in the Z-Area basin included low level radiological contamination from runoff associated with Saltstone Disposal Unit (SDU) 4. Since the releases, rainwater intrusion barriers have been implemented and rainwater flow paths engineered to prevent future low level contaminated runoff. In addition, contaminated soils associated with the SDU runoff have been removed. The discharge pipe and Z-01 Outfall were also grouted and closed, and a newly constructed Z-01 Outfall discharge structure is in place. The basin was also expanded to accommodate a 100-year storm event that eliminates the potential for future releases from the basin.

The exceedances associated with the Z-Area basin and Z-01 Outfall show the sediment sample locations further downgradient of the basin did not exceed the onsite worker benchmark for cesium-137. The 2015 sampling effort followed the extent of contamination (SRNS 2015). The Z-01 Outfall continues to be part of the radiological administrative control buffer area to protect site workers from inadvertent exposure to contaminated sediments. Since these exceedances are associated with an existing monitoring and reporting program, further evaluation by the IOU program is not warranted. Additionally, the Savannah River Ecology laboratory conducted sampling to assess the potential impact of the discharges from the basin and found little evidence of impacts to McQueen Branch attributable to the Z-Area basin discharges in their sediment sample analyses or macroinvertebrate assessment (SREL 2015). The abstract of this investigation is provided in Appendix B (as SREL 2015). Since these exceedances are associated with an existing monitoring and reporting program, further evaluation by the IOU program is not warranted.

#### Sediment/Soil (Sediment)

Review sediment/soil data for UTR PR5 revealed exceedances for the onsite worker for cesium-137 (benchmark = 89.2 pCi/g) for the Tinker Creek subunit (Table 2-2, Figure 2-2). The exceedances have a frequency of exceedance >5% (40.0%) and mean detected level (1.11E+02 pCi/g) greater than background (0.623 pCi/g) for cesium-137. The Tinker Creek subunit also had a mean ratio >1.0 (6.21) thus requiring further evaluation.

As with the sediment cesium-137 exceedances, further evaluation of the Tinker Creek sediment/soil exceedances show these data are associated with the Z-Area stormwater basin, Z-01 Outfall, that ultimately leads to McQueen Branch. These data are from a 2015 sampling effort and represent cesium-137 activities that range from a high of 760 pCi/g to 0.393 pCi/g. The sampling locations follow the intended water flow from the basin toward McQueen Branch and show cesium-137 activities above the onsite worker benchmark at locations in proximity to the Z-01 Outfall. The samples collected at the further extent toward McQueen Branch were less than the onsite worker benchmark (89.2 pCi/g) (Figure 2-2). As the sediment discussion indicated,

since the extent of contamination has been established, and protective controls are already in place, no further evaluation is warranted by the IOU program.

#### Sediment/Soil (Soil)

Sediment/soil exceedances, based on soil benchmarks for the onsite worker, were observed for cesium-137 for the Tinker Creek subunit (Table 2-2, Figure 2-3). The soil benchmark for cesium-137 for the onsite worker is 17.9 pCi/g. The Tinker Creek exceedances were present with a frequency of exceedances >5% (90%), and a mean of detected result (1.11E+02 pCi/g) greater than background (0.623 pCi/g). Additionally, mean ratio was >1.0 (6.21).

The sediment benchmark is the early action screening threshold for the onsite worker, and the soil benchmark is used to assess data needs for the UTR IOU. The Tinker Creek subunit exceedances are associated with the Z-01 Outfall that experienced rain induced discharges in 2013. Sampling has already been conducted to assess the extent of the cesium-137 within the outfall channel as noted in the sediment/soil (sediment) exceedance discussion presented above. Since the extent of contamination has been established, and administrative controls are in place, further investigation by the IOU program is not warranted.

#### Surface Water

There are no SW benchmark exceedances for the onsite worker for UTR PR5. Therefore, further evaluation is not warranted. Existing sampling locations are provided in Figure 2-4.

#### Fish

There were no new fish data for the UTR PR5; therefore, there were no exceedances for the subsistence fisherman for the fish medium. Existing fish sampling locations are shown in Figure 2-5.

### ***2.1.3 Ecological Benchmark Screening and Results***

The purpose of the ecological evaluation is to provide an overall indicator of ecological health for the UTR IOU. The biological data is supplemented with benchmark comparisons that are used as a screening step to identify constituents that may pose a threat to ecological receptors. The ecological benchmark screening process provides the basis for determining whether early action may need to be considered, and provides the justification for subsequent investigations that support the ecological risk assessment (ERA) process for the UTR IOU. The ecological benchmark comparisons are conducted by comparing ecological screening values (ESVs) to sediment, sediment/soil, and SW media constituent concentrations. The benchmarks are toxicological thresholds used for preliminary risk screening. The benchmark evaluation is based on Tier I and Tier II screening benchmarks. The Tier I benchmarks are derived from ecologically relevant criteria and standards such as USEPA Region 4 Screening Values and National Ambient Water Quality Criteria (AWQC) derived from the Ecological Screening Values (ESV) benchmark protocol (SRNS 2012b). Tier I sediment and sediment/soil benchmarks are based on “no effect level” toxicological data, while Tier II sediment/soil benchmarks are based on “low effect” level toxicological data. Therefore, the Tier II sediment and sediment/soil benchmarks could be indicative of potential ecological contaminant threats. For surface water screening, the Tier I benchmark is not based on “no effect” level toxicological data, but rather, from “low effect” thresholds. The Tier II surface water screening benchmarks are based on acute-level thresholds. Therefore, a potential threat to ecological receptors could be indicated by either the Tier I or Tier II surface water screening benchmarks.

The radionuclide benchmark comparison, also part of the Tier I screening, is based on the International Atomic Energy Agency (IAEA) report that states that irradiation at chronic dose rates of 1.0 rad/day or less does not appear likely to cause observable changes in aquatic animal populations (IAEA 1992). The benchmark for aquatic receptor populations exposed to SW or sediment is 0.1 rad/day applying a tenfold safety factor to the IAEA level.

Sediment Tier II early action consideration benchmarks used for screening sediment and sediment/soil data include Canadian Council of Ministers of the Environment (CCME), Oak Ridge National Laboratory (ORNL) Median Level, and ORNL Effects Level low effect thresholds. Tier

I early action consideration benchmarks used for screening SW data are based on chronic level toxicological benchmarks and Tier II on acute-level AWQC and ORNL thresholds. Sediment and sediment/soil Tier II screening, and SW Tier I and Tier II screening is used to focus the evaluation for Phase II early action consideration and to assist in refining the ERA process prior to the BRA and Phase III final deposition. For the ecological evaluation, the exceedances that fail the criteria, along with biological data, are used to determine if possible early actions may need to be considered. For the ecological evaluation, early actions may include additional ecological data collection during Phase II of the IOU program (long-term monitoring and assessment) to further assess potential threats. Phase III will initiate the Remedial Investigation/Baseline Risk Assessment for the UTR IOU. The ecological benchmarks are provided in Appendix A. Constituents that exceed benchmark values are processed further using a lines-of-evidence approach for four criteria: 1) the frequency of benchmark exceedances, 2) mean HQ, 3) a background evaluation, and 4) an evaluation of existing biological data.

### Sediment

A summary of the ecological exceedances for the sediment medium are provided in Table 2-3 and shown in Figure 2-6. Tier I no effect level benchmark screening for UTR PR5 resulted in a benchmark exceedance for arsenic (benchmark = 7.24E+00) in the Tinker Creek subunit with one exceedance out of 5 samples, a frequency of exceedance >5% (20%), a mean ratio >1.0 (1.19), and a mean detected value (8.6 mg/kg) greater than background (6.7 mg/kg). The exceedance is located at the perimeter of Z-Area and is associated with the Z-01 Outfall. Review of all arsenic data from the Tinker Creek subunit (including McQueen Branch) shows a total of 25 arsenic records with four detected results, three estimated “J” value results, and 18 non-detects.

In terms of the UTR watershed, arsenic has been detected in background locations within the UTR IOU in the Upper and Tinker Creek subunits upgradient of SRS operational influences. Two of the detected results from the Tinker Creek subunit are from 2015 with the highest 2015 value (15.3 mg/kg) being located at the Z-01 Outfall. The other result collected downgradient of the Z-01 Outfall at McQueen Branch was 1.9 mg/kg well below the arsenic sediment benchmark (7.24 mg/kg). The highest reported result for arsenic was a result of 22.9 mg/kg from the SRS

Background Soil Study, however, for the Tinker Creek subunit, 15.3 mg/kg was the maximum detected. Based on the available data, the Z-01 Outfall exceedance is elevated, but is a single exceedance. The Z-01 Outfall is part of the SRS annual environmental report monitoring, and results of arsenic downgradient of the outfall are non-detects or within background. Also, the level is less than the SRS Background Soil Study. In addition, the basin has been expanded to accommodate a 100-year storm event and contaminated soils have been removed. Also, since, arsenic did not exceed Tier II benchmarks for the Tinker Creek subunit, further evaluation by the IOU program is not warranted at this time.

There were no Tier II low effect level sediment exceedances for UTR PR5. Therefore, further evaluation is not warranted.

#### Sediment/Soil (Sediment)

Benchmark exceedances for the sediment/soil medium based on sediment benchmarks are presented in Table 2-4 and depicted in Figure 2-7. For Tier I sediment/soil exceedances for UTR PR5, based on effect level sediment benchmarks, there were exceedances for the Tinker Creek subunit for arsenic (benchmark = 7.24 mg/kg), barium (benchmark = 2.00E+02 mg/kg), copper (benchmark = 1.87E+01 mg/kg), mercury (benchmark = 1.30E-01), nickel (benchmark = 1.59E+01 mg/kg), zinc (benchmark = 1.24E+02), and acetone (benchmark = 8.70E-03). Acetone is a common laboratory artifact and does not require further evaluation, Arsenic was present with mean ratio >1.0 (15.1), and the mean based on detected values for arsenic was greater than background with a mean detected value for arsenic of 7.87E+00 with a background level of 6.7 mg/kg. Frequency of exceedances were also >5% for arsenic with a 15% frequency of exceedance based on 3 exceedances out of 20 samples. Therefore, arsenic, with a mean ratio >1.0, a frequency of exceedance >5%, and mean detected value greater than background, further discussion is required.

The Tinker Creek subunit exceedance for arsenic are associated with the Z-01 Outfall that experienced a rain induced discharge in 2013 and 2014. Sampling has already been conducted to assess the extent of contamination along the confluence (approximate 390 meters [m]) from the Z-Area basin toward McQueen Branch. There are three samples for arsenic above background

levels along this transect based on review of UTR PR5 data. The highest detected result (78.8 mg/kg) is from the Z-01 Outfall at the uppermost sampling location adjacent to the Z-Area basin. The second highest result (9.21 mg/kg) is located at the next downgradient sampling location ~15 m from the basin. The third highest result (7.31 mg/kg), approaching the background level (6.7 mg/kg), is located further downgradient (at the eight-sampling location) ~145 m from the basin toward the mid-point of the sampling transect. The remaining arsenic samples dispersed along the transect were either below background or non-detects.

The Savannah River Ecology laboratory has also conducted sampling to assess the impact of discharges from the Z-Area sedimentation basin and found little evidence of impacts to McQueen Branch attributable to the Z-Area basin discharges. The SREL assessment included macroinvertebrate surveys, radiological screening, and sediment sample analyses of metals in depositional areas. The abstract of this investigation is provided in Appendix B (SREL 2015). Since the extent of contamination has been established for this release, the data have already been evaluated by other programs (SRS annual report and SREL investigation) further investigation by the IOU program is not warranted.

Tier II exceedances were observed for arsenic, mercury, and zinc based on CCME (arsenic, mercury, and zinc), ORNL Median (arsenic) and ORNL Effects Level (arsenic and zinc) benchmarks (Table 2-4). However, the early action consideration Tier II evaluation did not have any constituents warranting further evaluation since mean ratios were <1.0 and frequencies of exceedances were 5% for all constituents (not >5%). Therefore, further evaluation is not warranted based on the IOU Phase II screening conducted.

#### Sediment/Soil (Soil)

The soil benchmark comparisons are used solely as a data needs assessment screening tool during IOU Phase II reporting rather than for early action consideration. A summary of the Tier I benchmark exceedances are provided in Table 2-4 and are depicted in Figure 2-8. There are no Tier II screening benchmarks for soil.

The Tier I ecological benchmark screening for the sediment/soil medium, based on soil benchmarks, resulted in exceedances for the Tinker Creek subunit, there were exceedances for aluminum (benchmark =  $5.00E+01$  mg/kg), arsenic (benchmark =  $1.00E+01$  mg/kg), barium (benchmark =  $1.65E+02$  mg/kg), beryllium (benchmark = 1.1 mg/kg), chromium (benchmark =  $3.20E+01$  mg/kg), copper (benchmark =  $4.00E+01$  mg/kg), iron (benchmark =  $2.00E+02$  mg/kg), manganese (benchmark =  $1.00E+02$  mg/kg), mercury (benchmark =  $3.00E-01$  mg/kg), selenium (benchmark =  $8.10E-01$  mg/kg), vanadium (benchmark = 2.00 mg/kg), zinc (benchmark =  $5.00E+01$  mg/kg), and cesium-137 ( $2.39E+02$  pCi/g). These exceedances are 2015 data associated with the Z-01 Outfall that experienced a rain induced discharge in 2013/2014.

Aluminum ( $2.11E-01$ ), iron ( $5.38E+01$ ), manganese ( $1.22E+00$ ), selenium (2.42), vanadium ( $1.49E+01$ ), and zinc (at 1.15) had mean ratios  $>1.0$ . Cesium-137 (7.1%), aluminum (100%), iron (100%), manganese (55%), selenium (65%), vanadium (100%), zinc (30%), and cesium-137 (10%) had frequencies of exceedance  $>5\%$ . Only arsenic and cesium-137 had mean values greater than background. However, no constituent failed all criteria (mean ratio  $>1.0$ , frequency of exceedance  $>5\%$ , and mean detected values greater than background, further evaluation is not warranted. The 2015 sampling effort followed the extent of contamination from the Z-01 Outfall release, and contaminated soil has been removed. In addition, a new outlet structure is in place and the basin associated with the Z-01 Outfall has been expanded to accommodate a 100-year storm event alleviating future releases from the outfall.

### Surface Water

A summary of Tier I (low effect level) benchmark exceedances for the SW medium is provided in Table 2-5 and depicted in Figure 2-9. Tier I (acute level) SW exceedances were observed for aluminum (benchmark =  $8.70E-02$ ), barium (benchmark =  $3.90E-03$ ), beryllium (benchmark =  $5.30E-04$ ), cadmium (benchmark =  $1.67E-04$ ), cobalt (benchmark =  $3.00E-03$ ), copper (benchmark =  $1.48E-03$ ), dichlorodiphenyldichloroethane (DDD) (benchmark =  $6.00E-06$ ), dichlorodiphenyltrichloroethane (DDT) (benchmark =  $1.00E-06$ ), endosulfan II (benchmark =  $5.60E-05$ ), endosulfan sulfate (benchmark =  $5.60E-05$ ), endrin (benchmark =  $2.00E-06$ ), iron (benchmark =  $1.00E+00$ ), lead (benchmark =  $1.44E-04$ ), manganese (benchmark =  $8.00E-02$ ),

mercury (benchmark = 1.20E-05), nickel (benchmark = 2.02E-02), silver (benchmark = 1.20E-05), thallium (benchmark = 4.00E-03), and zinc (benchmark = 1.35E-02).

Of these analytes, copper, manganese, and zinc in the Upper subunit, iron in the Tinker Creek subunit, zinc in Tims Branch, beryllium, cadmium, chromium, cobalt, and manganese in the Middle subunit, and iron in the Lower subunit had mean ratios <1.0 and do not warrant further evaluation at this time. Thallium, copper, and manganese in the Upper subunit, nickel in the Tinker Creek subunit, lead in Tims Branch, chromium, silver, vanadium, and zinc in the Middle subunit, and mercury in the Lower subunit had exceedances with a low frequency of exceedance ( $\leq 5\%$ ) and do not require further evaluation from a data review perspective.

Constituents requiring additional evaluation include copper in the Tinker Creek subunit, and mercury in the Tins Branch subunit. Additionally, the exceedances associated with the Upper and Tinker Creek subunits do not require further evaluation since these subunits are upgradient of SRS operations, and are considered background with the exception any exceedances associated with McQueen Branch. McQueen Branch receives potential discharges from Z Area, S Area, and the western portion of H Area and is not considered a background system.

Copper in the Tinker Creek subunit was present with a mean ratio >1.0 (1.18E+02), a frequency of exceedance >5% (5.9%), and a mean of detected values (1.74E-01 mg/L) greater than background (7.0E-02 mg/L). Mercury in the Tims Branch subunit was present with a mean ratio >1.0 (1.27E+02), a frequency of exceedance >5% (22.1), a mean of detected results (1.52E-03 mg/L) greater than background (0.001 mg/L).

Of the two copper exceedances requiring further evaluation for the Tinker Creek subunit, one of the exceedances (0.004 mg/L) was located near the SRS boundary upgradient of SRS operations and is below background (0.007mg/L). Since this exceedance was location upgradient of potential SRS discharges, in a background area, further evaluation of this exceedance is not warranted. The Tinker Creek subunit, with the exception of McQueen Branch, is considered background. McQueen Branch, although part of the Tinker Creek watershed, receives potential discharges from Z Area, S Area, and the western portion of H Area and, therefore, is not considered a background system. The other copper exceedance (0.518 mg/L) was identified in DWPF non-process water at

the S-04 Outfall and is above background. From a historical perspective, there are a total of 2 copper results above background in the Tinker Creek subunit based on review of all 248 samples. Since the exceedance occurred at an outfall that is part of annual environmental monitoring and already under a monitoring and reporting program (SCR000000), there are infrequent copper exceedances in Tinker Creek, and this is a single exceedance above background, further assessment by the IOU program is not warranted.

The mercury exceedances within the Tims Branch subunit (15 exceedances out of 68 analyses) include 14 sample results associated with NPDES industrial outfall A-11 for Area powerhouse operations near A-Area, and one location further down-gradient toward UTR. The mercury levels are above the IOU Tier II benchmark, but are within NPDES permit limits. Since the mercury exceedances are data from an NPDES-permitted outfall and part of a monitoring and reporting program, further evaluation by the IOU program is not warranted at this time. Additionally, Tims Branch is already undergoing additional study associated with the stannous chloride additions to the system and mercury abatement.

There were Tier II SW exceedances for aluminum, cadmium, copper, DDD, endosulfan II, endosulfan sulfate, endrin, lead, mercury, silver, and zinc (Table 2-5, Figure 2-9). Constituents with mean ratios >1.0, a frequency of exceedance >5%, and with a mean detected value greater than background levels (or background data are non-determinant) requiring further evaluation based on AWQC based benchmarks include copper (benchmark = 1.80E-03 mg/L), and DDD (benchmark = 6.40E-05 mg/L).

Review of copper data shows two detects out of 34 analyses for UTR PR5 for the Tinker Creek subunit. However, only one result is over the benchmark (0.07 mg/L). The one result (0.518 mg/L) at the S-04 Outfall representing a sample taken in 2014. This location, the S-04 Outfall, is described as DWPF non-process wastewater. This outfall is part of the annual environmental monitoring and already under a monitoring and reporting program. Since this is a single result above background, further assessment by the IOU program is not warranted.

The DDD Tier II AWQC exceedance is located in Tinker Creek upgradient of SRS operational sources. This sample was collected in 2012 and is one detect out of 70 samples for DDD in the

Tinker Creek subunit. Prior to the acquisition of SRS in the 1950's, the SRS landscape was comprised primarily rural farming communities where insecticides such as DDT were used. DDD is a result of the breakdown/degradation of DDT. There is no known SRS use of DDT or DDD, and since this exceedance is located upgradient of operational discharges, no further evaluation is warranted at this time.

The Tier II evaluation also includes exceedances based on ORNL benchmarks. Constituents with mean ratios >1.0, a frequency of exceedance >5%, and with a mean detected value greater than background levels (or if background data are non-determinant) requiring further evaluation based on ORNL benchmarks include mercury (benchmark = 9.90E-05 mg/L) and DDD (benchmark = 1.90E-04 mg/L).

As discussed above, the DDD exceedance is located in the Tinker Creek upgradient of potential SRS operational discharges. Also, since there is no known SRS use of DDT or DDD, and this constituent is detected infrequently, no further evaluation by the IOU program is warranted at this time.

The mercury exceedances within the Tims Branch subunit (13 exceedances out of 68 analyses) are all 2014 data associated with NPDES industrial outfall A-11 for Area powerhouse operations. The mercury levels are above the IOU Tier II benchmark, but are within NPDES permitted limits. Since the mercury exceedances are data from NPDES permitted monitoring and reporting program, further evaluation by the IOU program is not warranted at this time. Additionally, Tims Branch is already undergoing additional study associated with the stannous chloride additions to the system.

### Biological Data and Benchmark Screening Results

Benchmark screening is useful in assessing potential contaminant threats to ecological receptors based on toxicity thresholds. However, site-specific biological data are a better indicator of site conditions. Results of these types of studies are beneficial in determining if deleterious effects are occurring or are likely to occur. The annual update of the literature-based wildlife survey and bioassessment data collected for the IOU program are used to assess overall stream system health.

Past assessments of fish and macroinvertebrate assemblage assessments within the UTR IOU reveal fish and macroinvertebrate assemblages, in general, are comparable to background/control sites indicating that aquatic communities are similar to undisturbed reference sites. Locations where past macroinvertebrate surveys indicate impairment, the upper reaches of McQueen Branch and the upper reaches of Crouch Branch, were shown to be scoured by runoff and deeply channelized resulting in poor habitat quality. However, both these systems showed improvement in their lower reaches. Crouch Branch has received elevated copper discharges associated with the H-02 NPDES permitted SW outfall. The constructed wetland system designed to store and treat stormwater runoff and cooling wastewaters from H Area is proving effective in reducing levels of copper, lead, and zinc, and monitoring continues for that system.

IOU collected data including past fish condition factors and health assessment index (necropsy) data show no deleterious effects on the health of individual fish within the UTR system. The fish health assessments were conducted to supplement initial fish assemblage and body burden assessments. These types of data are particularly useful for assessing general fish health when comparing background (control) locations to potentially impacted sites as implemented at the SRS using the IOU bioassessment network locations. The trophic modeling most recently summarized in UTR PR3 (SRNS 2012a) revealed that mercury and aluminum potentially posed a risk to ecological receptors (mammals and birds) in the Lower subunit. However, toxicity benchmarks were also exceeded in reference subunits indicating that this risk may be related to non-SRS sources such as atmospheric deposition (for mercury) or naturally-elevated aluminum levels in SRS soils.

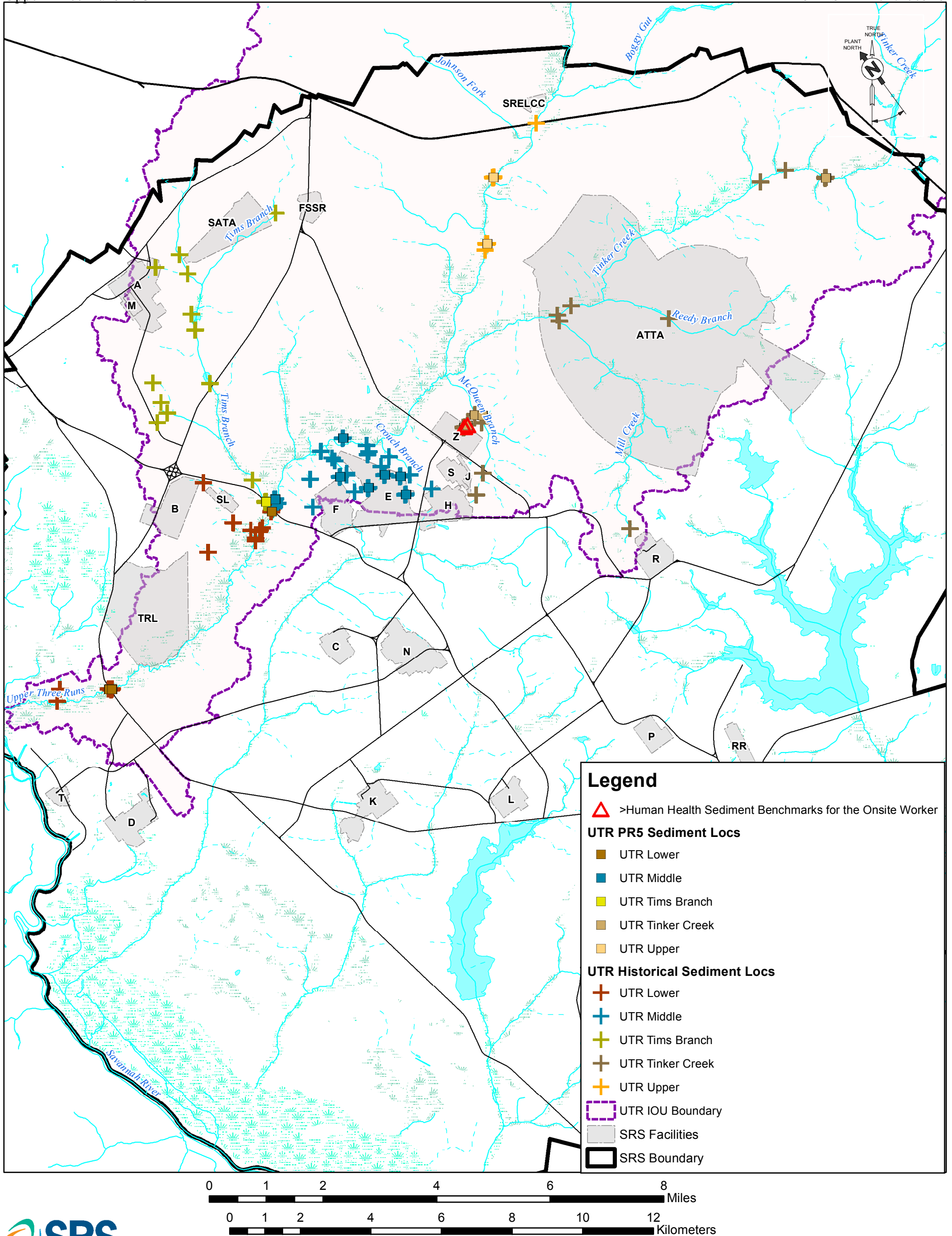
Other biological lines of evidence include a review of publications from 2013 through 2017 update of the literature-based Wildlife Survey that identified pertinent studies relating to the ecological health of SRS stream systems including the UTR IOU. Although appreciable quantities of mercury are not attributable from historic SRS operational discharges in the UTR watershed, several abstracts applicable to aquatic systems within SRS indicate a possible threat of atmospheric deposition of mercury contributing to the conversion of toxic methylmercury in wetland environments. The wildlife survey was also applied to the Tims Branch subunit. Tims Branch has undergone additional study to assess contaminant threats through a field trophic model study. The

Tims Branch study was conducted by the SREL to evaluate levels of contaminants within various biota. Results of the Tims Branch studies are provided in Appendix A. There are two publications by Edwards et al (2014) assessing the trophic dynamics of uranium, nickel, and mercury in the Tims Branch system. Edward et al found the highest level of uranium were found in biofilm samples and highest mercury levels were found in tadpoles, and that a risk to ecosystem integrity may exist. The second publication calculated HQs for primary contaminants and showed levels for mercury were greater than the screening thresholds for upper trophic level organisms indicating the possibility of a high degree of bioavailability and biomagnification.

To summarize, Tier II for sediment/soil and Tier I and Tier II SW exceedances were present based on review of UTR PR5. Field studies have indicated that mercury in the Lower subunit, and uranium, nickel, and mercury in the Tims Branch subunit may pose a threat to ecological receptors within the UTR IOU. As Phase II continues, data will continue to be compiled and assessed for the UTR IOU and reported in upcoming PRs. To support the ongoing Phase II data screening, several biological studies are planned or on-going for the UTR IOU. It is anticipated that macroinvertebrate surveys will be conducted in Crouch Branch in 2018 as part of the NPDES surveillance program. Also, the SREL has recently conducted macroinvertebrate surveys in McQueen Branch. Additionally, an SRS-wide IOU bioassessment field effort was conducted in 2017 to assess fish communities and macroinvertebrate assemblages within all the IOUs except the SRFS IOU. The SRFS IOU was not included since the bioassessment data collection efforts are not tailored to large stream systems such as the Savannah River. The results of these studies, and future data screening, will be reported in upcoming PRs as these efforts are finalized.

**Figure 2-1. Location of Sediment Samples Exceeding Human Health On-Site Worker Benchmarks for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
 Datum: North American Datum 1927  
 Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-1: Location of Sediment Samples Exceeding Human Health On-site Worker Benchmarks for the Upper Three Runs IOU

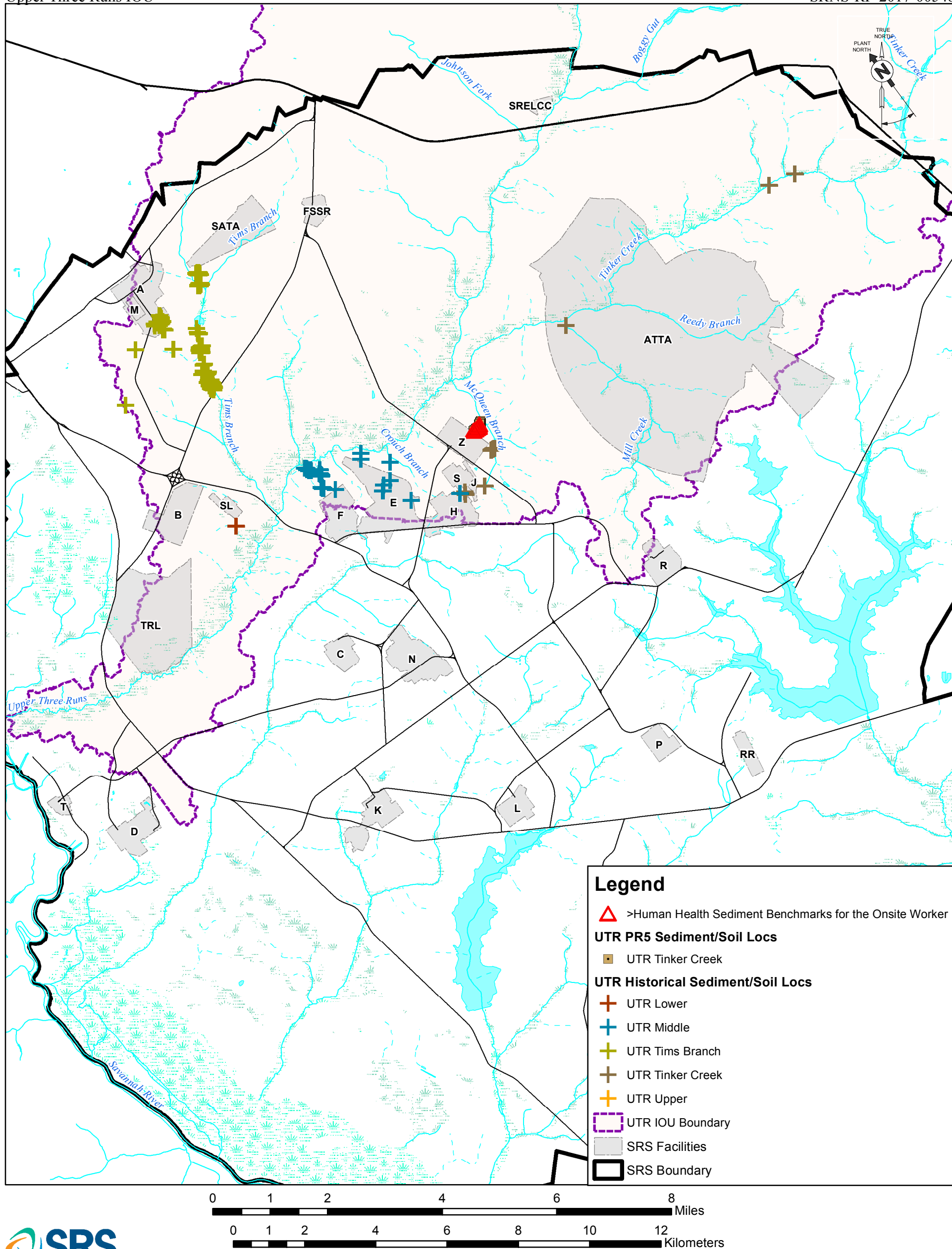
Savannah River Site  
 Aiken, South Carolina



United States Department of Energy			
DRAWING NO: UTRIOUFIG2_1GIS2018	REV. NO: 0	REV. DATE: 01/22/18	AREA: SRS
TITLE Location of Sediment Samples Exceeding Human Health On-site Worker Benchmarks for the Upper Three Runs IOU			
CREATED BY: Natalie Lopez	DATE: 01/22/18	APPROVED BY: Susan Blas	DATE: 01/22/18

**Figure 2-2. Location of Sediment/Soil Samples Exceeding Human Health On-Site Worker Benchmarks for Sediment for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-2: Location of Sediment/Soil Samples Exceeding Human Health On-site Worker Benchmarks for Sediment for the Upper Three Runs IOU

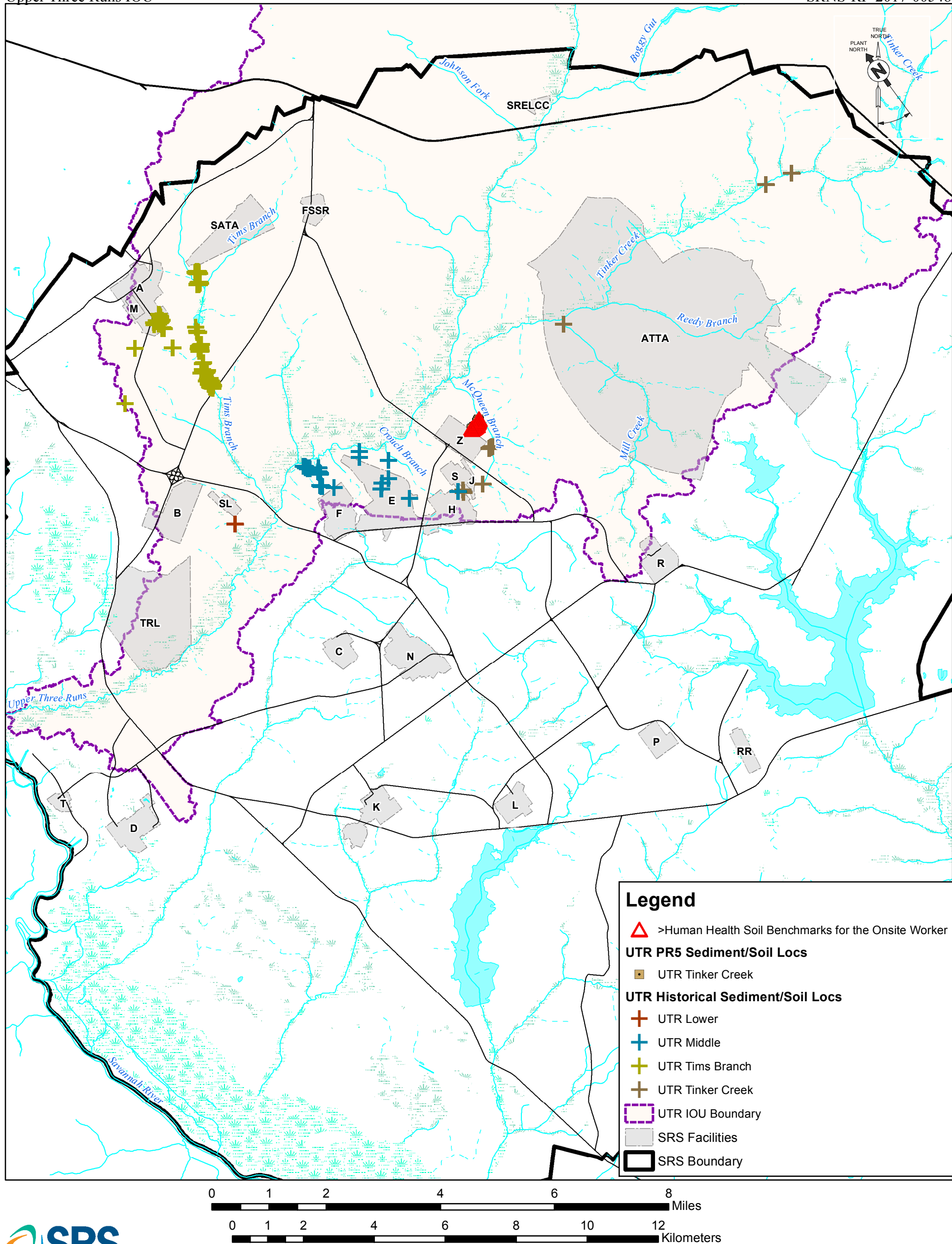
Savannah River Site  
Aiken, South Carolina



United States Department of Energy			
DRAWING NO: UTRIOUFIG2_2GIS2018	REV. NO: 0	REV. DATE: 02/15/18	AREA: SRS
Title Location of Sediment/Soil Samples Exceeding Human Health On-site Worker Benchmarks for Sediment for the Upper Three Runs IOU			
CREATED BY: Natalie Lopez	DATE: 02/15/18	APPROVED BY: Susan Blas	DATE: 02/15/18

**Figure 2-3. Location of Sediment/Soil Samples Exceeding Human Health On-Site Worker Benchmarks for Soil for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-3: Location of Sediment/Soil Samples Exceeding Human Health On-site Worker Benchmarks for Soil for the Upper Three Runs IOU

Savannah River Site  
Aiken, South Carolina



United States Department of Energy			
ORGANIZATION UTRIOUFIG2_3GIS2018	REV. NO. 0	REV. DATE 02/15/18	AREA SRS
Title Location of Sediment/Soil Samples Exceeding Human Health On-site Worker Benchmarks for Soil for the Upper Three Runs IOU			
CREATED BY Natalie Lopez	DATE 02/15/18	APPROVED BY Susan Blas	DATE 02/15/18

**Figure 2-4. Location of Surface Water Samples for the Upper Three Runs IOU**

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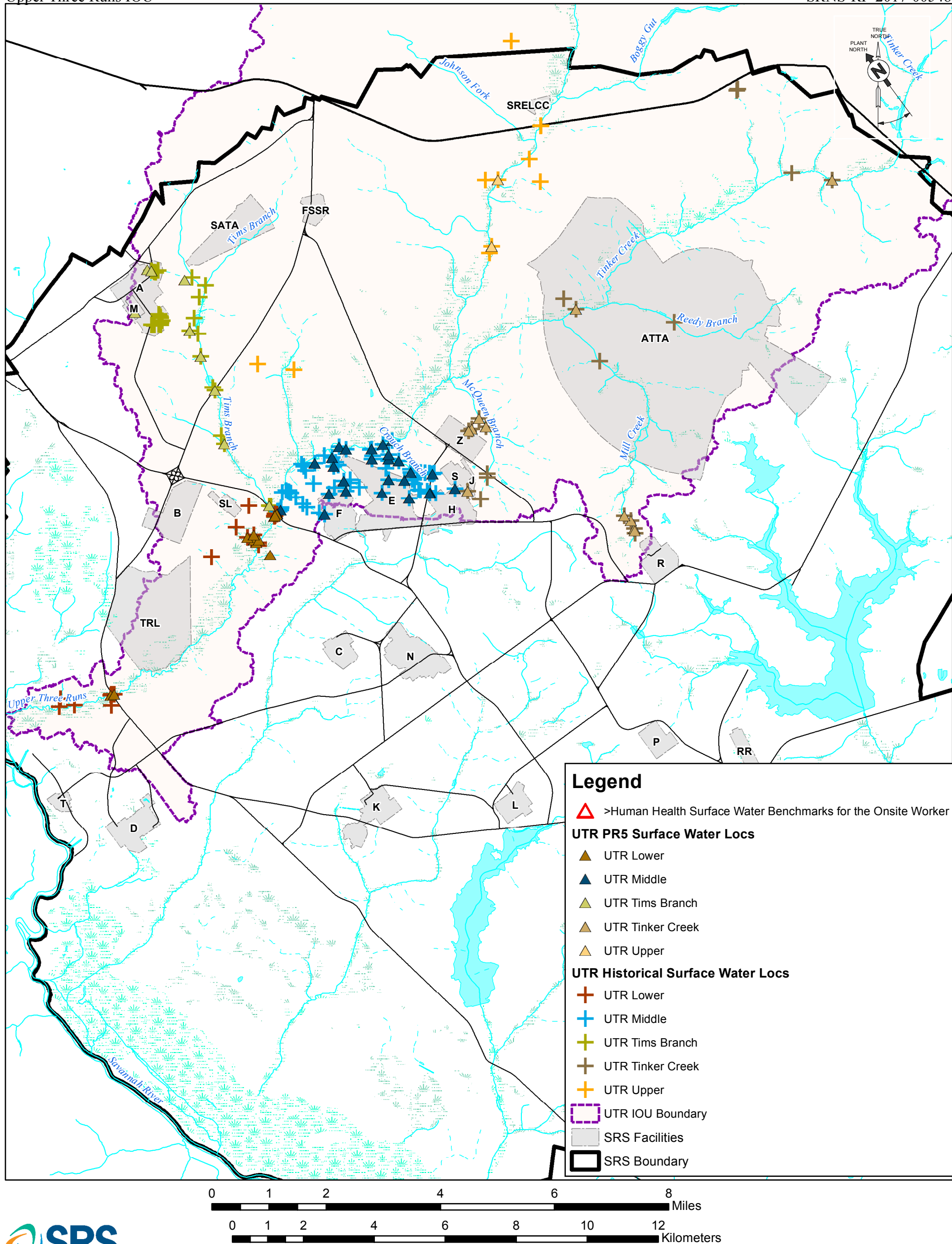


Figure 2-4: Location of Surface Water Samples for the Upper Three Runs IOU

Savannah River Site  
Aiken, South Carolina



Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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United States Department of Energy			
CHARACTERISTICS UTRIOUFIG2_4GIS2018	REV. NO. 0	REV. DATE 01/23/18	AREA SRS
Location of Surface Water Samples for the Upper Three Runs IOU			
CREATED BY Natalie Lopez	DATE 01/23/18	APPROVED BY Susan Blas	DATE 01/23/18

**Figure 2-5. Fish Sampling Locations**

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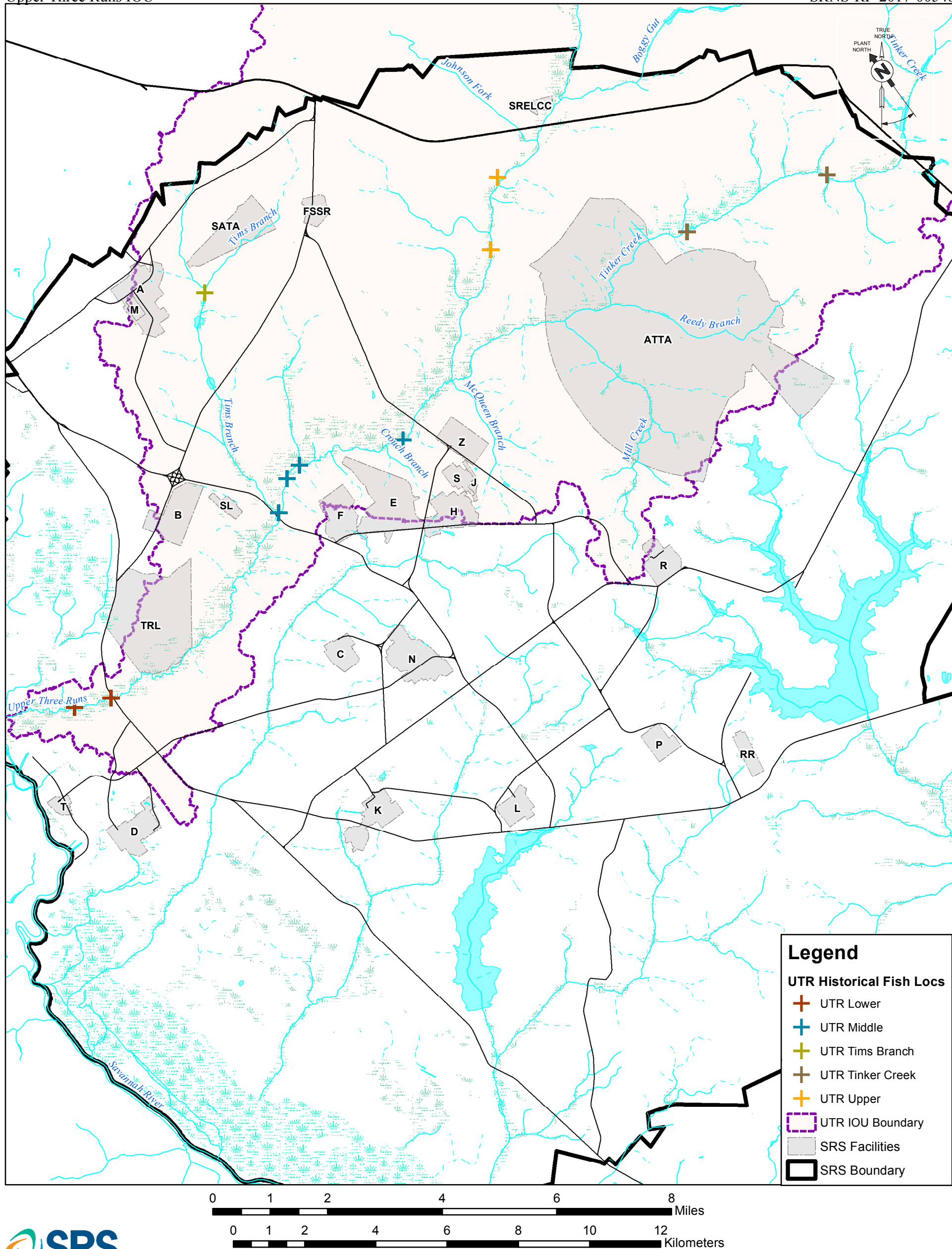


Figure 2-5: Fish Sampling Locations



Projection: Universal Transverse Mercator  
 Datum: North American Datum 1927  
 Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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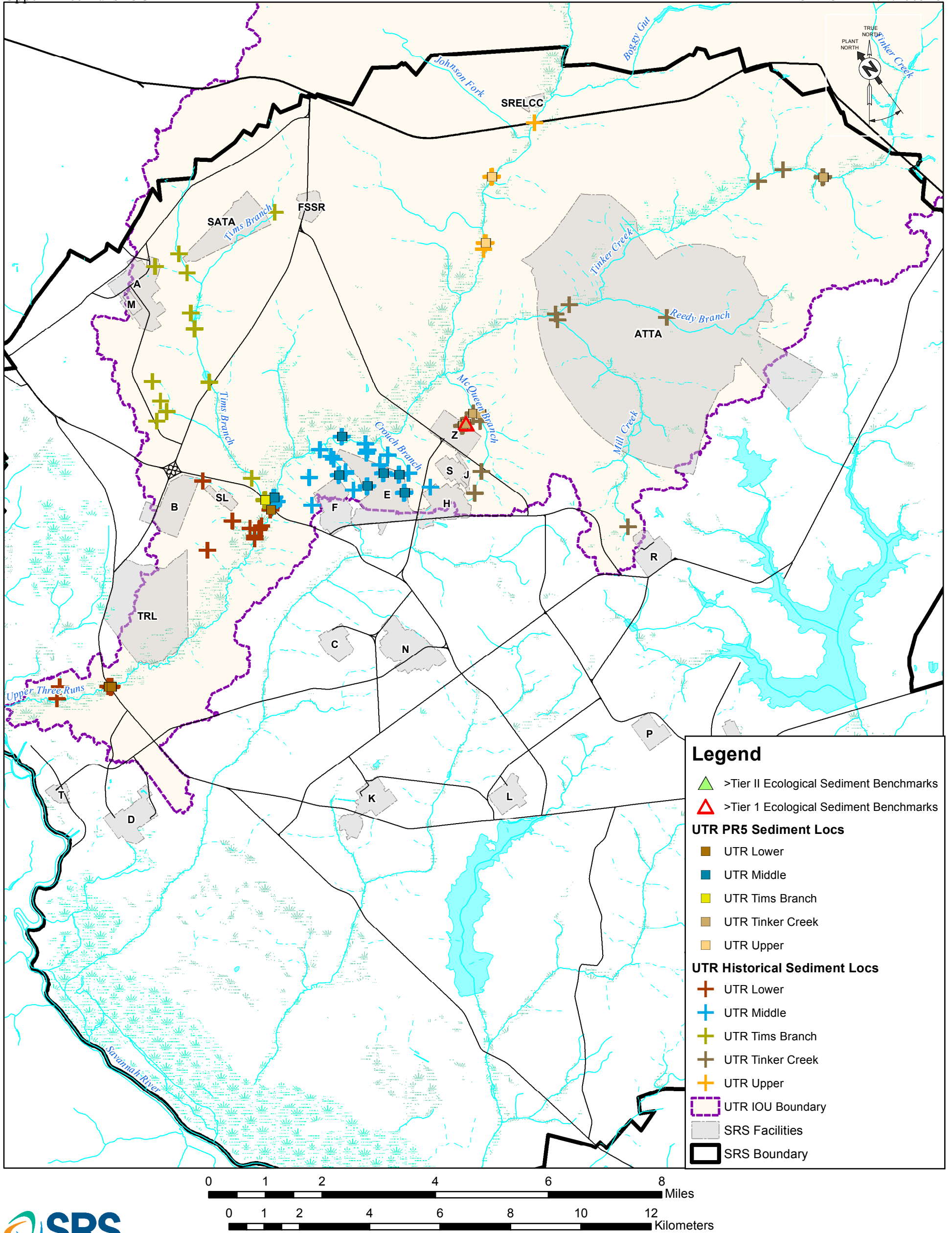
Savannah River Site  
 Aiken, South Carolina



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CREATED BY: UTRIOUFIG2_4GIS2018	REV. NO: 0	REV. DATE: 01/22/18	AREA: SRS
TITLE: Fish Sampling Locations			
CREATED BY: Natalie Lopez	DATE: 01/22/18	APPROVED BY: Susan Blas	DATE: 01/22/18

**Figure 2-6. Location of Sediment Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-6: Location of Sediment Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU

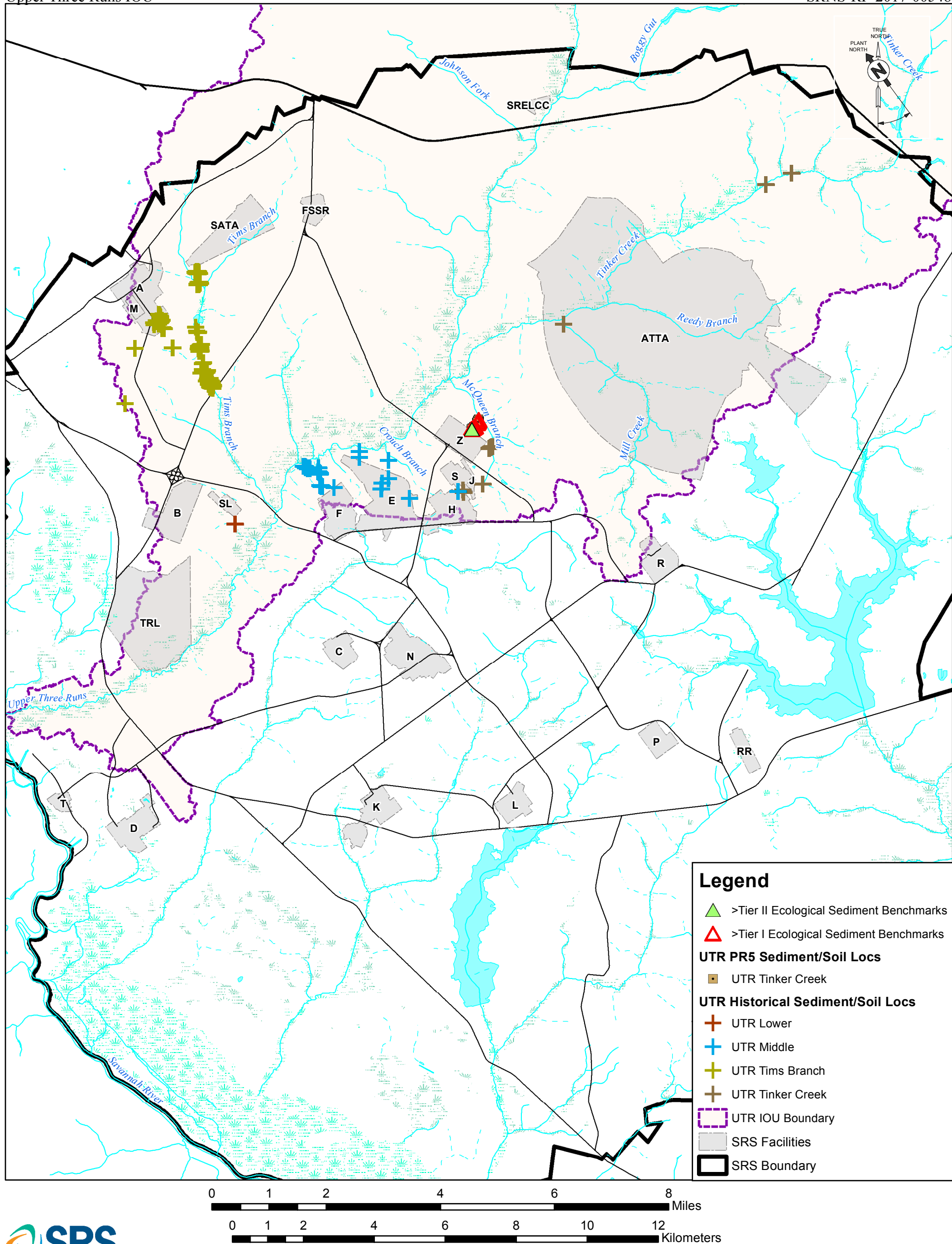
Savannah River Site  
Aiken, South Carolina



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DOCUMENT NO. UTRIOUFIG2_6GIS2018	REV. NO. 0	REV. DATE 01/22/18	AREA SRS
Location of Sediment Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU			
CREATED BY Natalie Lopez	DATE 01/22/18	APPROVED BY Susan Blas	DATE 01/22/18

**Figure 2-7. Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Sediment for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-7: Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Sediment for the Upper Three Runs IOU

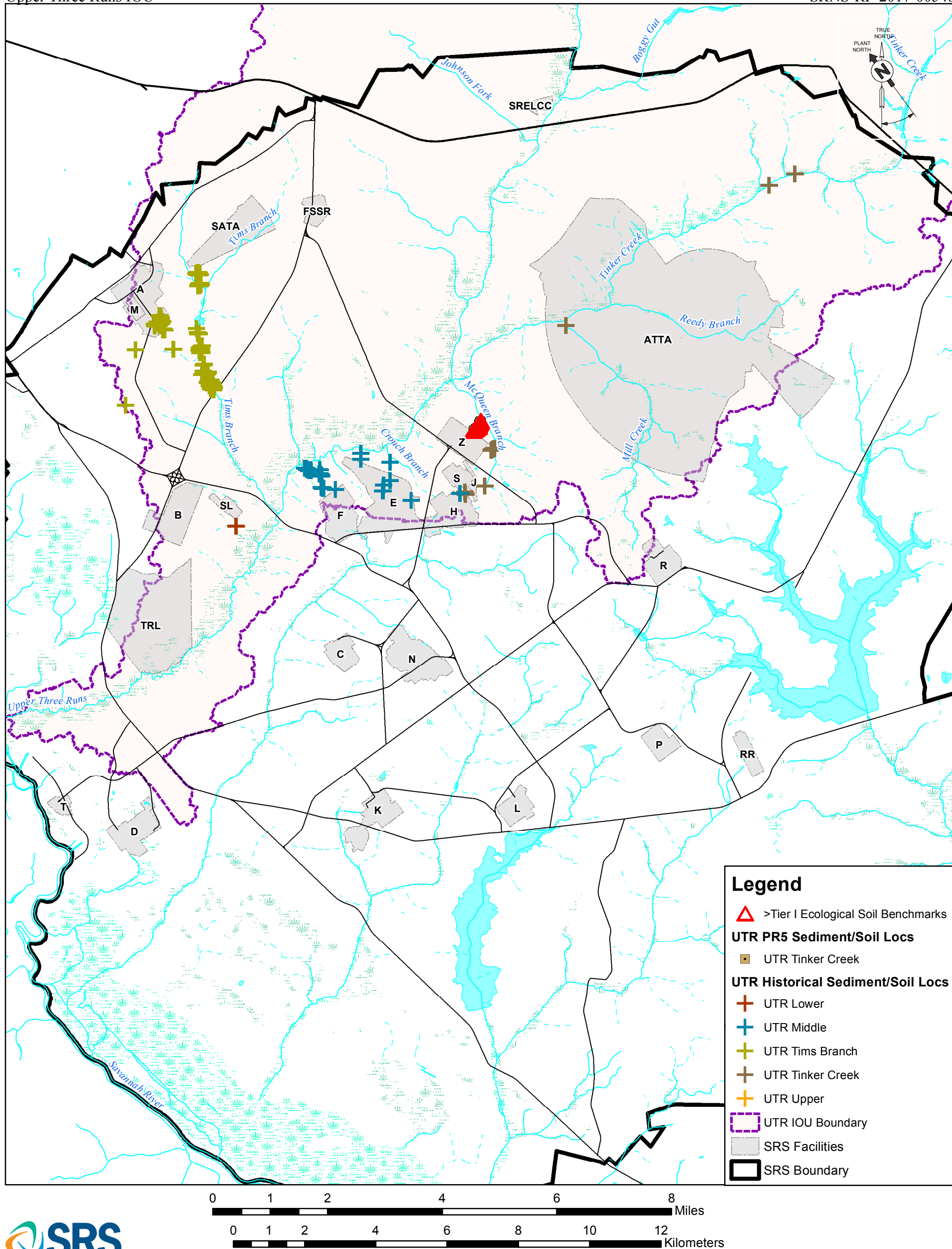
Savannah River Site  
Aiken, South Carolina



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PROJECT NO: UTRIOUFIG2_7GIS2018	REV. NO: 0	REV. DATE: 02/15/18	AREA: SRS
TITLE Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Sediment for the Upper Three Runs IOU			
CREATED BY: Natalie Lopez	DATE: 02/15/18	APPROVED BY: Susan Blas	DATE: 02/15/18

**Figure 2-8. Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Soil for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-8: Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Soil for the Upper Three Runs IOU

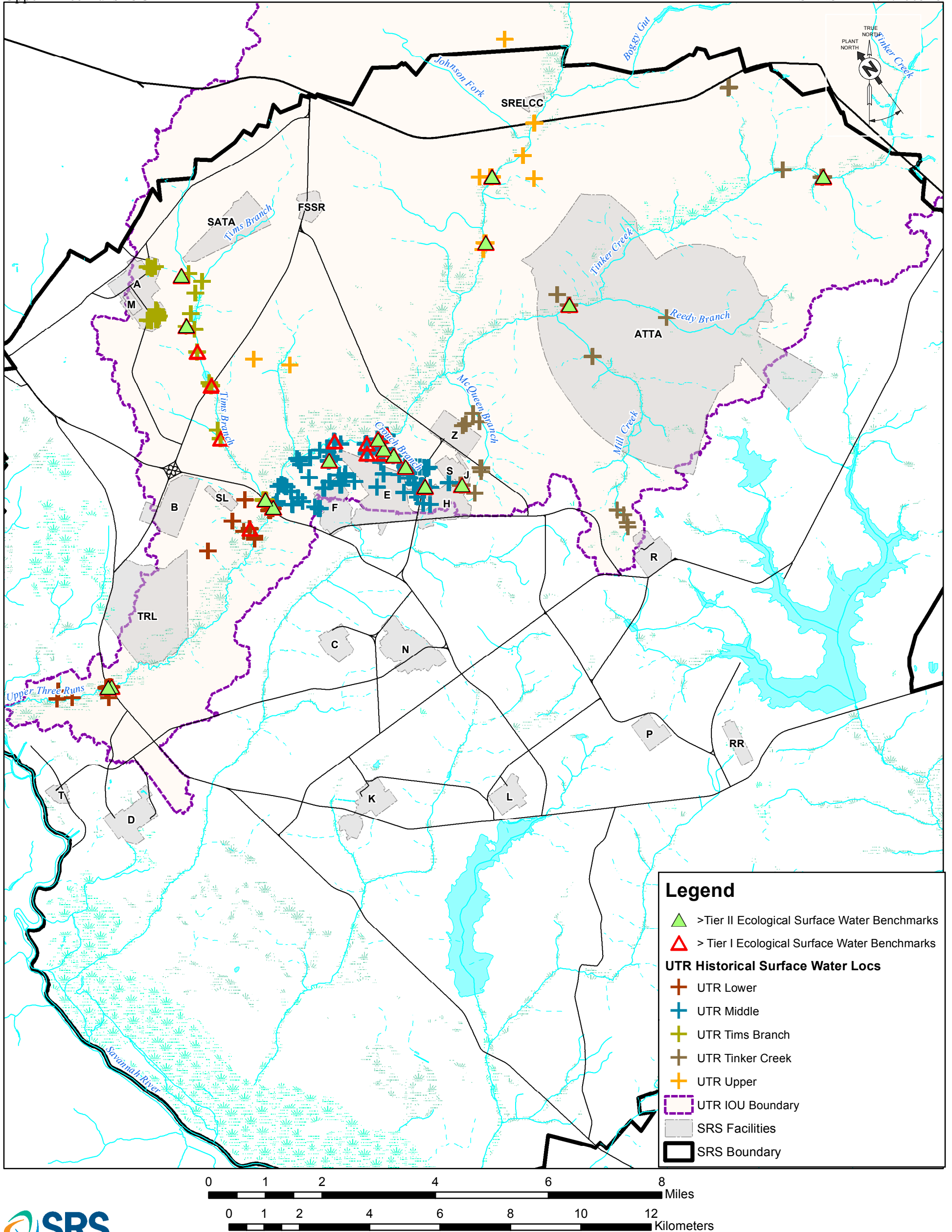
Savannah River Site  
Aiken, South Carolina



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PROJECT NO:	REV. NO.	REV. DATE:	AREA:
UTRIOUFIG2_8GIS2018	0	02/15/18	SRS
Location of Sediment/Soil Samples Exceeding Ecological Benchmarks for Soil for the Upper Three Runs IOU			
CREATED BY:	DATE:	APPROVED BY:	DATE:
Natalie Lopez	02/15/18	Susan Blas	02/15/18

**Figure 2-9. Location of Surface Water Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU**

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Projection: Universal Transverse Mercator  
Datum: North American Datum 1927  
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 2-9: Location of Surface Water Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU

Savannah River Site  
Aiken, South Carolina



United States Department of Energy			
DOCUMENT ID: UTRIOUFIG2_9GIS2018	REV. NO: 0	REV. DATE: 01/22/18	AREA: SRS
Location of Surface Water Samples Exceeding Ecological Benchmarks for the Upper Three Runs IOU			
CREATED BY: Natalie Lopez	DATE: 01/22/18	APPROVED BY: Susan Blas	DATE: 01/22/18

Table 2-1 Data Summary for the UTR PR4

Medium	Data Steward	Dataset Name	Dataset Description	Start Date	End Date	Analyte Type	# Analytical Records
Sediment	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SEDIMENT NONRAD DATA	20140514	20140514	Inorganics	6
Sediment	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SEDIMENT NONRAD DATA	20140514	20140514	Metals	45
Sediment	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental Radiological Monitoring for 2014	UTR EMS SEDIMENT RAD DATA	20140227	20140513	Radionuclides	186
Sediment	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015 ANNUALS	20150311	20150519	Inorganics	19
Sediment	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015 ANNUALS	20150311	20150519	Metals	150
Sediment	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015 ANNUALS	20150311	20150519	Radionuclides	244
Sediment	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event ANNUALRADSEDIMENT-ZBASIN	20140512	20140513	Radionuclides	34
Sediment	South Carolina Department of Health and Environmental Control	UTR SCDHEC Sediment Radiological Data 2013	UTR SCDHEC SEDIMENT NONRAD DATA 2013	20130422	20130424	Radionuclides	156
Sediment	South Carolina Department of Health and Environmental Control	UTR SCDHEC Sediment Radiological Monitoring for 2012	UTR SCDHEC SEDIMENT RAD DATA	20120319	20120320	Radionuclides	189
							<b>1,029</b>
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Inorganics	40
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Metals	440
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Radionuclides	452
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Semivolatiles	100
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Semivolatiles/Volatiles	20
Sediment / Soils	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2015Z01OUTFALL	20150519	20150528	Volatiles	920
							<b>1,972</b>
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Inorganics	240
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Metals	885
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Other	166
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Pesticides/PCBs	416
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Semivolatiles	16
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Unknown	48
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental NonRadiological Monitoring for 2014	UTR EMS SURFACE WATER NONRAD DATA	20140101	20141229	Volatiles	42
Surface Water	EMS now called SDM, Sampling and Data Management of SRNS	SRS Environmental Radiological Monitoring for 2014	UTR EMS SURFACE WATER RAD DATA	20140527	20141215	Radionuclides	2,467
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2012	STORET UPTR	20120214	20121205	Inorganics	26
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2012	STORET UPTR	20120214	20121205	Metals	36
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2012	STORET UPTR	20120214	20121205	Other	48
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2013	STORET UPTR	20130116	20130709	Inorganics	17
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2013	STORET UPTR	20130116	20130709	Metals	18
Surface Water	EPA STORET	EPA STORET Surface Water Non-Rad Data 2013	STORET UPTR	20130116	20130709	Other	28
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 2Q15GSAWOU-FRB	20150512	20150512	Inorganics	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 2Q15GSAWOU-FRB	20150512	20150512	Radionuclides	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 2Q15GSAWOU-FRB	20150512	20150512	Semivolatiles	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 2Q15GSAWOU-FRB	20150512	20150512	Semivolatiles/Volatiles	2
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 2Q15GSAWOU-FRB	20150512	20150512	Volatiles	92
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	FMBR ERDMS: Sampling Event 4Q14MWMFCOMB	20141125	20141125	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14GSAWOU-FRB	20140225	20140225	Inorganics	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14GSAWOU-FRB	20140225	20140225	Radionuclides	13
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14GSAWOU-FRB	20140225	20140225	Semivolatiles	15
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14GSAWOU-FRB	20140225	20140225	Semivolatiles/Volatiles	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14GSAWOU-FRB	20140225	20140225	Volatiles	138
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q14MWMFCOMB	20140306	20140310	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 BASINS	20150102	20150309	Radionuclides	158
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 STREAM WQ	20150113	20150310	Inorganics	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 STREAM WQ	20150113	20150310	Metals	132
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 STREAM WQ	20150113	20150310	Other	24
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 STREAM WQ	20150113	20150310	Pesticides/PCBs	104
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15 STREAM WQ	20150113	20150310	Semivolatiles	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15MWMFCOMB	20150303	20150304	Radionuclides	10

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Table 2-1 Data Summary for the UTR PR4 (Continued)

Medium	Data Steward	Dataset Name	Dataset Description	Start Date	End Date	Analyte Type	# Analytical Records
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15NPDES	20150106	20150323	Metals	134
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15NPDES	20150106	20150323	Other	36
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1Q15NPDES	20150106	20150323	Volatiles	11
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S14MAML	20140324	20140324	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S14MAML	20140324	20140324	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S14MAML	20140324	20140324	Semivolatiles	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S14MAML	20140324	20140324	Unknown	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S14MAML	20140324	20140324	Volatiles	36
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S15MAML	20150325	20150325	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S15MAML	20150325	20150325	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S15MAML	20150325	20150325	Semivolatiles	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S15MAML	20150325	20150325	Unknown	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 1S15MAML	20150325	20150325	Volatiles	39
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q14MWMFCOMB	20140602	20140603	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15MWMFCOMB	20150528	20150601	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15NPDES	20150504	20150622	Metals	123
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15NPDES	20150504	20150622	Other	34
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15NPDES	20150504	20150622	Volatiles	11
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15-STREAMSURV-NORTH	20150407	20150602	Radionuclides	86
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 2Q15-STREAMSURV-SOUTH	20150407	20150505	Radionuclides	17
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB	20140801	20140801	Inorganics	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB	20140801	20140801	Radionuclides	13
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB	20140801	20140801	Semivolatiles	15
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB	20140801	20140801	Volatiles	138
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB NW	20140911	20140911	Inorganics	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14GSAWOU-FRB NW	20140911	20140911	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14LFW	20140808	20140811	Metals	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14LFW	20140808	20140811	Radionuclides	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14LFW	20140808	20140811	Volatiles	12
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Inorganics	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Metals	150
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Radionuclides	120
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Semivolatiles	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Semivolatiles/Volatiles	20
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Unknown	20
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q14MWMFCOMB	20140904	20140908	Volatiles	660
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15 EFFLUENT RUN/E-BASINS	20150713	20150921	Radionuclides	109
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15LFW	20150818	20150819	Metals	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15LFW	20150818	20150819	Radionuclides	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15LFW	20150818	20150819	Volatiles	12
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15LLHG-QUAL	20150901	20151021	Metals	9
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Inorganics	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Metals	150
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Radionuclides	120
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Semivolatiles	80
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Semivolatiles/Volatiles	20
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Unknown	20
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15MWMFCOMB	20150901	20150908	Volatiles	650
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15NPDES	20150706	20150923	Metals	132
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15NPDES	20150706	20150923	Other	36

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Table 2-1 Data Summary for the UTR PR4 (Continued)

Medium	Data Steward	Dataset Name	Dataset Description	Start Date	End Date	Analyte Type	# Analytical Records
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15NPDES	20150706	20150923	Volatiles	11
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15-STREAMSURV-NORTH	20150707	20150909	Radionuclides	70
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3Q15-STREAMSURV-SOUTH	20150707	20150909	Radionuclides	20
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S14MAML	20140923	20140923	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S14MAML	20140923	20140923	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S14MAML	20140923	20140923	Semivolatiles	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S14MAML	20140923	20140923	Unknown	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S14MAML	20140923	20140923	Volatiles	39
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S15MAML	20151029	20151029	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S15MAML	20151029	20151029	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S15MAML	20151029	20151029	Semivolatiles	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S15MAML	20151029	20151029	Unknown	5
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 3S15MAML	20151029	20151029	Volatiles	42
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q14RAG	20141117	20141117	Radionuclides	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15 EFFLUENT RUN/E-BASINS	20151012	20151214	Radionuclides	151
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15GSAWOU-FRB	20151209	20151209	Inorganics	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15GSAWOU-FRB	20151209	20151209	Radionuclides	11
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15MWMFCOMB	20151124	20151124	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15NPDES	20151013	20151222	Metals	92
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15NPDES	20151013	20151222	Other	28
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15NPDES	20151013	20151222	Volatiles	11
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15RAG	20151102	20151102	Radionuclides	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15-STREAMSURV-NORTH	20151006	20151208	Radionuclides	102
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event 4Q15-STREAMSURV-SOUTH	20151006	20151208	Radionuclides	27
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event S04-2014	20141201	20141201	Metals	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-2Q15	20150414	20150609	Inorganics	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-2Q15	20150414	20150609	Metals	132
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-2Q15	20150414	20150609	Other	24
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-2Q15	20150414	20150609	Pesticides/PCBs	104
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-2Q15	20150414	20150609	Semivolatiles	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-3Q15	20150714	20150922	Inorganics	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-3Q15	20150714	20150922	Metals	132
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-3Q15	20150714	20150922	Other	24
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-3Q15	20150714	20150922	Pesticides/PCBs	104
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-3Q15	20150714	20150922	Semivolatiles	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-4Q15	20151013	20121215	Inorganics	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-4Q15	20151013	20121215	Metals	132
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-4Q15	20151013	20121215	Other	24
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-4Q15	20151013	20121215	Pesticides/PCBs	104
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UPTR ERDMS: Sampling Event STREAM-WQ-4Q15	20151013	20121215	Semivolatiles	4
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13GSAWOU-FRB	20130220	20130220	Inorganics	2
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13GSAWOU-FRB	20130220	20130220	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13GSAWOU-FRB	20130220	20130220	Semivolatiles	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13GSAWOU-FRB	20130220	20130220	Semivolatiles/Volatiles	2
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13GSAWOU-FRB	20130220	20130220	Volatiles	92
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1Q13MWMFCOMB	20130304	20130304	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1S13MAML	20130402	20130402	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1S13MAML	20130402	20130402	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1S13MAML	20130402	20130402	Semivolatiles	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS: Sampling Event 1S13MAML	20130402	20130402	Unknown	6

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**Table 2-1 Data Summary for the UTR PR4 (Continued/End)**

Medium	Data Steward	Dataset Name	Dataset Description	Start Date	End Date	Analyte Type	# Analytical Records
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 1S13MAML	20130402	20130402	Volatiles	27
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 2Q13MWMFCOMB	20130530	20130603	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13GSAWOU-FRB	20130814	20130814	Inorganics	2
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13GSAWOU-FRB	20130814	20130814	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13GSAWOU-FRB	20130814	20130814	Semivolatiles	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13GSAWOU-FRB	20130814	20130814	Semivolatiles/Volatiles	2
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13GSAWOU-FRB	20130814	20130814	Volatiles	92
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13LFW	20130807	20130812	Metals	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13LFW	20130807	20130812	Radionuclides	1
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13LFW	20130807	20130812	Semivolatiles	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13LFW	20130807	20130812	Volatiles	52
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Inorganics	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Metals	150
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Radionuclides	120
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Semivolatiles	60
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Semivolatiles/Volatiles	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Unknown	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3Q13MWMFCOMB	20130904	20130909	Volatiles	660
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3S13MAML	20130917	20130917	Inorganics	21
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3S13MAML	20130917	20130917	Other	3
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3S13MAML	20130917	20130917	Semivolatiles	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3S13MAML	20130917	20130917	Unknown	6
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 3S13MAML	20130917	20130917	Volatiles	36
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 4Q13MWMFCOMB	20131202	20131217	Radionuclides	10
Surface Water	Soil and Groundwater Closure Projects	BEIDMS/ERDMS	UTR ERDMS:Sampling Event 4Q13RAG	20131105	20131105	Radionuclides	3
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water NonRadiological Monitoring for 2012	UTR SCDHEC SURFACE WATER NONRAD DATA	20120214	20121205	Inorganics	160
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water NonRadiological Monitoring for 2012	UTR SCDHEC SURFACE WATER NONRAD DATA	20120214	20121205	Metals	354
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water NonRadiological Monitoring for 2012	UTR SCDHEC SURFACE WATER NONRAD DATA	20120214	20121205	Other	196
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water NonRadiological Monitoring for 2012	UTR SCDHEC SURFACE WATER NONRAD DATA	20120214	20121205	Pesticides/PCBs	100
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water NonRadiological Monitoring for 2012	UTR SCDHEC SURFACE WATER NONRAD DATA	20120214	20121205	Volatiles	268
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water Radiological Data 2013	UTR SCDHEC SURFACE WATER RAD DATA 2013	20130102	20131225	Radionuclides	697
Surface Water	South Carolina Department of Health and Environmental Control	UTR SCDHEC Surface Water Radiological Monitoring for 2012	UTR SCDHEC SURFACE WATER RAD DATA	20120103	20121227	Radionuclides	1,459
							<b>14,839</b>

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**Table 2-2. Human Health Benchmark Exceedance Summary for UTR PR5**

**Sediment – Onsite Worker**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Radionuclides	Cesium-137	pCi/g	8.92E+01	1.50E+03	1.68E+01	4.87E+02	5.45E+00	5	15	33.3	9	1	5	6.23E-01	yes	2010, BKGRDSS001

**Sediment/Soil (Sediment) – Onsite Worker**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Radionuclides	Cesium-137	pCi/g	8.92E+01	7.60E+02	8.52E+00	1.11E+02	1.25E+00	8	20	40.0	20	0	0	6.23E-01	yes	2010, BKGRDSS001

**Sediment/Soil (Soil) – Onsite Worker**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Radionuclides	Cesium-137	pCi/g	1.79E+01	7.60E+02	4.25E+01	1.11E+02	6.21E+00	18	20	90.0	20	0	0	6.23E-01	yes	2010, BKGRDSS001

**Surface Water – Onsite Worker**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
<i>No constituents exceeded onsite worker benchmarks for surface water</i>																	

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**Table 2-3. Summary of Ecological Benchmark Exceedances for Sediment for UTR PR5**

**Tier I – Sediment**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detected	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Arsenic	mg/kg	7.24E+00	1.53E+01	2.11E+00	8.60E+00	1.19E+00	1	5	20.0	2	0	3	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road

**Tier II – Sediment Based on CCME Benchmarks**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detect	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
<i>No constituents exceeded Tier II CCME benchmarks for sediment</i>																	
---																	

**Tier II – Sediment Based on ORNL Median Benchmarks**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
<i>No constituents exceeded Tier II ORNL Median benchmarks for sediment</i>																	

**Tier II – Sediment Based on ORNL Effects Level Benchmarks**

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
<i>No constituents exceeded Tier II ORNL Effects Level benchmarks for sediment</i>																	

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Table 2-4. Summary of Ecological Benchmark Exceedances for Sediment/Soil for UTR PR5

## Tier I – Sediment/Soil (Sediment)

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Analyses	Freq Exceed (%)	# Detect	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Arsenic	mg/kg	7.24E+00	7.88E+01	1.09E+01	7.87E+00	1.09E+00	3	20	15.0	9	9	2	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Barium	mg/kg	2.00E+02	3.80E+02	1.90E+00	3.66E+01	1.83E-01	1	20	5.0	20	0	0	3.43E+02	no	1996, L-Lake-55-02, Meyers Branch
UTR Tinker Creek	Metals	Copper	mg/kg	1.87E+01	4.86E+01	2.60E+00	5.71E+00	3.06E-01	1	20	5.0	17	3	0	6.90E+01	no	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Mercury	mg/kg	1.30E-01	4.92E-01	3.78E+00	5.57E-02	4.29E-01	1	20	5.0	20	0	0	2.10E-01	no	1992, Background Upper Three Runs 2
UTR Tinker Creek	Metals	Nickel	mg/kg	1.59E+01	3.00E+01	1.89E+00	3.28E+00	2.06E-01	1	20	5.0	20	0	0	2.38E+01	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Metals	Zinc	mg/kg	1.24E+02	3.46E+02	2.79E+00	5.81E+01	4.68E-01	3	20	15.0	19	1	0	2.04E+02	no	2010, BKGDSS001 Crackerneck WMA
UTR Tinker Creek	Volatiles	Acetone	mg/kg	8.70E-03	3.34E-01	3.84E+01	1.32E-01	1.51E+01	15	20	75.0	11	4	5	NDs	---	---

## Tier II – Sediment/Soil (Sediment) Based on CCME Benchmarks

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Analyses	Freq Exceed (%)	# Detect	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Arsenic	mg/kg	1.70E+01	7.88E+01	4.64E+00	7.87E+00	4.63E-01	1	20	5.0	9	9	2	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Mercury	mg/kg	4.86E-01	4.92E-01	1.01E+00	5.57E-02	1.15E-01	1	20	5.0	20	0	0	2.10E-01	no	1992, Background Upper Three Runs 2
UTR Tinker Creek	Metals	Zinc	mg/kg	3.15E+02	3.46E+02	1.10E+00	5.81E+01	1.84E-01	1	20	5.0	19	1	0	2.04E+02	no	2010, BKGDSS001, Crackerneck WMA

## Tier II – Sediment/Soil (Sediment) Based on ORNL Median Benchmarks

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Arsenic	mg/kg	7.00E+01	7.88E+01	1.13E+00	7.87E+00	1.12E-01	1	20	5.0	9	9	2	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road

## Tier II – Sediment/Soil (Sediment) Based on ORNL Effects Level Benchmarks

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Arsenic	mg/kg	4.16E+01	7.88E+01	1.89E+00	7.87E+00	1.89E-01	1	20	5.0	9	9	2	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Zinc	mg/kg	2.71E+02	3.46E+02	1.28E+00	5.81E+01	2.14E-01	1	20	5.0	19	1	0	2.04E+02	no	2010, BKGDSS001, Crackerneck WMA

## Tier I – Sediment/Soil (Soil)

Subunit	Analyte Type	Analyte	Units	Benchmark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non-Detects	Max Bkgrd Level	Mean > Bkgrd?	Bkgrd Date, Location
UTR Tinker Creek	Metals	Aluminum	mg/kg	5.00E+01	1.47E+04	2.94E+02	5.23E+03	1.05E+02	20	20	100.0	19	1	0	4.41E+04	no	1996, Meyers Branch L-Lake 55-02
UTR Tinker Creek	Metals	Arsenic	mg/kg	1.00E+01	7.88E+01	7.88E+00	7.87E+00	7.87E-01	1	20	5.0	9	9	2	6.70E+00	yes	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Barium	mg/kg	1.65E+02	3.80E+02	2.30E+00	3.66E+01	2.22E-01	1	20	5.0	20	0	0	3.53E+02	no	1996, Meyers Branch, L-Lake-55-02
UTR Tinker Creek	Metals	Beryllium	mg/kg	1.10E+00	4.74E+00	4.31E+00	4.84E-01	4.40E-01	1	20	5.0	1	18	1	4.31E+00	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Metals	Chromium	mg/kg	3.20E+01	4.26E+01	1.33E+00	1.33E+01	4.14E-01	1	20	5.0	20	0	0	4.45E+01	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Metals	Copper	mg/kg	4.00E+01	4.86E+01	1.22E+00	5.71E+00	1.43E-01	1	20	5.0	17	3	0	6.90E+01	no	2007, Tinker Creek at Kennedy's Pond Road
UTR Tinker Creek	Metals	Iron	mg/kg	2.00E+02	2.94E+04	1.47E+02	1.08E+04	5.38E+01	20	20	100.0	19	1	0	3.87E+04	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Metals	Manganese	mg/kg	1.00E+02	3.59E+02	3.59E+00	1.22E+02	1.22E+00	11	20	55.0	19	1	0	3.72E+03	no	1996, Meyers Branch, L-Lake-55-02
UTR Tinker Creek	Metals	Mercury	mg/kg	3.00E-01	4.92E-01	1.64E+00	5.57E-02	1.86E-01	1	20	5.0	20	0	0	2.10E-01	no	1992, Background Upper Three Runs 2
UTR Tinker Creek	Metals	Selenium	mg/kg	8.10E-01	1.04E+01	1.28E+01	1.96E+00	2.42E+00	13	20	65.0	1	15	4	5.65E+00	no	1992, Background Upper Three Runs 15
UTR Tinker Creek	Metals	Vanadium	mg/kg	2.00E+00	9.08E+01	4.54E+01	2.98E+01	1.49E+01	20	20	100.0	20	0	0	1.30E+02	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Metals	Zinc	mg/kg	5.00E+01	3.46E+02	6.92E+00	5.81E+01	1.16E+00	6	20	30.0	19	1	0	2.04E+02	no	2010, BKGDSS001, Crackerneck WMA
UTR Tinker Creek	Radionuclides	Cesium-137	pCi/g	2.39E+02	7.60E+02	3.18E+00	1.11E+02	4.65E-01	2	20	10.0	20	0	0	6.23E-01	yes	2010, BKGDSS001, Crackerneck WMA

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Table 2-5. Summary of Ecological Benchmark Exceedances for Surface Water for UTR PR5

## Tier I – Ecological Benchmark Exceedances for Surface Water

Subunit	Analyte Type	Analyte	Units	Bench- mark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non- Detects	Max Bkgd Level	Mean > Bkgd?	Bkgd Date, Location
UTR Upper	Inorganics	Thallium	mg/L	4.00E-03	1.00E-02	2.50E+00	1.00E-02	2.50E+00	1	24	4.2	1	0	23	1.31E-02	no	2006, Tinker Creek 1
UTR Upper	Metals	Aluminum	mg/L	8.70E-02	2.34E-01	2.69E+00	1.08E-01	1.25E+00	16	24	66.7	13	10	1	6.06E+00	no	1993, Background Wetland 2
UTR Upper	Metals	Cadmium	mg/L	1.67E-04	2.60E-03	1.56E+01	1.04E-03	6.24E+00	4	34	11.8	4	0	30	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Upper	Metals	Copper	mg/L	1.48E-03	1.90E-03	1.28E+00	1.46E-03	9.84E-01	1	34	2.9	2	1	31	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Upper	Metals	Lead	mg/L	1.44E-04	7.60E-03	5.28E+01	7.45E-03	5.17E+01	2	34	5.9	2	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Upper	Metals	Manganese	mg/L	8.00E-02	1.30E-01	1.63E+00	1.70E-02	2.12E-01	1	34	2.9	22	4	8	2.69E+00	no	1999, SR and SC Sediment and Water MBH-01 & MB-03
UTR Upper	Metals	Zinc	mg/L	1.35E-02	2.87E-02	2.12E+00	1.33E-02	9.86E-01	9	34	26.5	14	7	13	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Inorganics	Thallium	mg/L	4.00E-03	1.43E-02	3.58E+00	1.25E-02	3.11E+00	2	24	8.3	1	1	22	1.63E-02	no	2006, Tinker Creek 1
UTR Tinker Creek	Metals	Aluminum	mg/L	8.70E-02	2.70E-01	3.11E+00	1.21E-01	1.39E+00	15	24	62.5	13	9	2	6.06E+00	no	1993, Background Wetland 2
UTR Tinker Creek	Metals	Cadmium	mg/L	1.67E-04	6.00E-04	3.59E+00	5.67E-04	3.40E+00	3	34	8.8	3	0	31	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Tinker Creek	Metals	Copper	mg/L	1.48E-03	5.18E-01	3.49E+02	1.74E-01	1.18E+02	2	34	5.9	3	0	31	7.00E-02	yes	1995, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Metals	Iron	mg/L	1.00E+00	1.47E+00	1.47E+00	5.87E-01	5.87E-01	3	33	9.1	33	0	0	1.24E+01	no	1993, Background Wetland 2
UTR Tinker Creek	Metals	Lead	mg/L	1.44E-04	5.50E-03	3.82E+01	3.99E-03	2.77E+01	3	35	8.6	3	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Metals	Nickel	mg/L	2.02E-02	4.83E-02	2.39E+00	2.97E-02	1.47E+00	1	34	2.9	2	0	32	4.44E-01	no	2010, BKGDSW003 Meyers Branch
UTR Tinker Creek	Metals	Zinc	mg/L	1.35E-02	1.05E-01	7.76E+00	1.51E-02	1.11E+00	8	34	23.5	16	8	10	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Pesticides/PCBs	DDD	mg/L	6.00E-06	3.00E-04	5.00E+01	3.00E-04	5.00E+01	1	9	11.1	1	0	8	3.00E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	DDT	mg/L	1.00E-06	3.10E-04	3.10E+02	3.10E-04	3.10E+02	1	9	11.1	1	0	8	3.10E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	Endosulfan II	mg/L	5.60E-05	3.10E-04	5.54E+00	3.10E-04	5.54E+00	1	9	11.1	1	0	8	3.10E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	Endosulfan sulfate	mg/L	5.60E-05	3.50E-04	6.25E+00	3.50E-04	6.25E+00	1	9	11.1	1	0	8	3.50E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	Endrin	mg/L	2.00E-06	3.20E-04	1.60E+02	3.20E-04	1.60E+02	1	9	11.1	1	0	8	3.20E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tims Branch	Inorganics	Thallium	mg/L	4.00E-03	1.38E-02	3.45E+00	1.21E-02	3.03E+00	2	24	8.3	2	0	22	1.63E-02	no	2006, Tinker Creek 1
UTR Tims Branch	Metals	Aluminum	mg/L	8.70E-02	1.89E-01	2.17E+00	1.02E-01	1.18E+00	14	24	58.3	12	11	1	6.06E+00	no	1993, Background Wetland 2
UTR Tims Branch	Metals	Cadmium	mg/L	1.67E-04	5.12E-04	3.07E+00	5.06E-04	3.03E+00	2	34	5.9	1	1	32	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Tims Branch	Metals	Copper	mg/L	1.48E-03	8.83E-03	5.95E+00	4.86E-03	3.28E+00	10	42	23.8	1	9	32	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Iron	mg/L	1.00E+00	5.76E+00	5.76E+00	1.97E+00	1.97E+00	35	61	57.4	61	0	0	1.24E+01	no	1993, Background Wetland 2
UTR Tims Branch	Metals	Lead	mg/L	1.44E-04	9.20E-03	6.39E+01	9.20E-03	6.39E+01	1	34	2.9	1	0	33	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Manganese	mg/L	8.00E-02	5.23E-01	6.54E+00	1.24E-01	1.55E+00	24	34	70.6	34	0	0	2.69E+00	no	1999, SR and SC Sediment and Water MBH-01 & MB-03
UTR Tims Branch	Metals	Mercury	mg/L	1.20E-05	8.04E-03	6.70E+02	1.52E-03	1.27E+02	15	68	22.1	31	0	37	1.00E-03	yes	1991, Upper Three Runs Near New Ellenton SC
UTR Tims Branch	Metals	Zinc	mg/L	1.35E-02	2.71E-02	2.00E+00	1.19E-02	8.79E-01	9	42	21.4	15	10	17	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Barium	mg/L	3.90E-03	1.01E-01	2.59E+01	1.98E-02	5.09E+00	30	30	100.0	5	25	0	7.24E-02	no	2000, MB-02-02
UTR Middle	Metals	Beryllium	mg/L	5.30E-04	2.25E-03	4.25E+00	3.28E-04	6.19E-01	3	30	10.0	0	8	22	7.00E-04	no	2013, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Cadmium	mg/L	1.67E-04	5.12E-04	3.07E+00	1.41E-04	8.44E-01	5	84	6.0	1	12	71	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Middle	Metals	Cobalt	mg/L	3.00E-03	8.81E-03	2.94E+00	1.04E-03	3.46E-01	2	30	6.7	0	23	7	1.31E-02	no	1999, SR and SC Sediment and Water MBH-01 & MB-03
UTR Middle	Metals	Copper	mg/L	1.48E-03	2.84E-01	1.92E+02	4.26E-03	2.87E+00	29	136	21.3	11	29	96	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Lead	mg/L	1.44E-04	7.92E-02	5.50E+02	6.29E-04	4.37E+00	13	135	9.6	2	20	113	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Mercury	mg/L	1.20E-05	1.60E-04	1.33E+01	6.50E-05	5.42E+00	11	110	10.0	3	8	99	2.42E-04	no	2002, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Silver	mg/L	1.20E-05	1.04E-03	8.67E+01	1.04E-03	8.67E+01	1	117	0.9	0	1	116	NDs	---	---
UTR Middle	Metals	Zinc	mg/L	1.35E-02	4.86E-01	3.59E+01	8.16E-03	6.03E-01	4	136	2.9	11	35	90	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Inorganics	Thallium	mg/L	4.00E-03	1.84E-02	4.60E+00	1.34E-02	3.34E+00	3	24	12.5	2	1	21	1.63E-02	no	2006, Tinker Creek 1
UTR Lower	Metals	Aluminum	mg/L	8.70E-02	7.69E-01	8.84E+00	2.31E-01	2.65E+00	22	24	91.7	18	5	1	6.06E+00	no	1993, Background Wetland 2
UTR Lower	Metals	Cadmium	mg/L	1.67E-04	8.00E-04	4.79E+00	6.30E-04	3.77E+00	4	40	10.0	3	1	36	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Lower	Metals	Copper	mg/L	1.48E-03	2.20E-03	1.48E+00	1.94E-03	1.30E+00	2	40	5.0	1	1	38	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Metals	Iron	mg/L	1.00E+00	1.46E+00	1.46E+00	5.29E-01	5.29E-01	2	40	5.0	40	0	0	1.24E+01	no	1993, Background Wetland 2
UTR Lower	Metals	Lead	mg/L	1.44E-04	6.30E-03	4.38E+01	5.70E-03	3.96E+01	2	34	5.9	2	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Metals	Mercury	mg/L	1.20E-05	9.30E-05	7.75E+00	9.30E-05	7.75E+00	1	43	2.3	0	1	41	2.42E-04	no	2002, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Metals	Zinc	mg/L	1.35E-02	2.64E-02	1.95E+00	1.27E-02	9.37E-01	9	40	22.5	17	7	16	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1

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**Table 2-5. Summary of Ecological Benchmark Exceedances for Surface Water for UTR PR5 (Continued/End)**

**Tier II – Surface Water Based on AWQC Benchmarks**

Subunit	Analyte Type	Analyte	Units	Bench- mark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Analyses	Freq Exceed (%)	# Detects	# Estimated	# Non- Detects	Max Bkgd Level	Mean > Bkgd?	Bkgd Date, Location
UTR Lower	Metals	Aluminum	mg/L	7.50E-01	7.69E-01	1.03E+00	2.31E-01	3.07E-01	1	24	4.2	18	5	1	6.06E+00	no	1993, Background Wetland 2
UTR Lower	Metals	Cadmium	mg/L	2.53E-04	8.00E-04	3.16E+00	6.30E-04	2.49E+00	4	40	10.0	3	1	36	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Lower	Metals	Copper	mg/L	1.80E-03	2.20E-03	1.22E+00	1.94E-03	1.08E+00	1	40	2.5	1	1	38	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Metals	Lead	mg/L	3.71E-03	6.30E-03	1.70E+00	5.70E-03	1.54E+00	2	34	5.9	2	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Lower	Metals	Zinc	mg/L	1.49E-02	2.64E-02	1.77E+00	1.27E-02	8.49E-01	9	40	22.5	17	7	16	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Cadmium	mg/L	2.53E-04	5.12E-04	2.02E+00	1.41E-04	5.57E-01	1	84	1.2	1	12	71	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Middle	Metals	Copper	mg/L	1.80E-03	2.84E-01	1.58E+02	4.26E-03	2.37E+00	27	136	19.9	11	29	96	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Lead	mg/L	3.71E-03	7.92E-02	2.14E+01	6.29E-04	1.70E-01	2	135	1.5	2	20	113	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Middle	Metals	Silver	mg/L	6.20E-05	1.04E-03	1.68E+01	1.04E-03	1.68E+01	1	117	0.9	0	1	116	NDs	---	---
UTR Middle	Metals	Zinc	mg/L	1.49E-02	4.86E-01	3.25E+01	8.16E-03	5.46E-01	3	136	2.2	11	35	90	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Cadmium	mg/L	2.53E-04	5.12E-04	2.02E+00	5.06E-04	2.00E+00	2	34	5.9	1	1	32	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Tims Branch	Metals	Copper	mg/L	1.80E-03	8.83E-03	4.91E+00	4.86E-03	2.70E+00	9	42	21.4	1	9	32	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Lead	mg/L	3.71E-03	9.20E-03	2.48E+00	9.20E-03	2.48E+00	1	34	2.9	1	0	33	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Mercury	mg/L	2.40E-03	8.04E-03	3.35E+00	1.52E-03	6.33E-01	11	68	16.2	31	0	37	2.42E-04	yes	2002, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Zinc	mg/L	1.49E-02	2.71E-02	1.81E+00	1.19E-02	7.97E-01	5	42	11.9	15	10	17	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Metals	Cadmium	mg/L	2.53E-04	6.00E-04	2.37E+00	5.67E-04	2.24E+00	3	34	8.8	3	0	31	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Tinker Creek	Metals	Copper	mg/L	1.80E-03	5.18E-01	2.88E+02	1.74E-01	9.70E+01	2	34	5.9	3	0	31	7.00E-02	yes	1995, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Metals	Lead	mg/L	3.71E-03	5.50E-03	1.48E+00	3.99E-03	1.08E+00	2	35	5.7	3	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Metals	Zinc	mg/L	1.49E-02	1.05E-01	7.03E+00	1.51E-02	1.01E+00	6	34	17.6	16	8	10	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Pesticides/PCBs	DDD	mg/L	6.40E-05	3.00E-04	4.69E+00	3.00E-04	4.69E+00	1	9	11.1	1	0	8	NDs	---	---
UTR Tinker Creek	Pesticides/PCBs	Endosulfan II	mg/L	2.20E-04	3.10E-04	1.41E+00	3.10E-04	1.41E+00	1	9	11.1	1	0	8	3.10E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	Endosulfan sulfate	mg/L	2.20E-04	3.50E-04	1.59E+00	3.50E-04	1.59E+00	1	9	11.1	1	0	8	3.50E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Tinker Creek	Pesticides/PCBs	Endrin	mg/L	1.80E-04	3.20E-04	1.78E+00	3.20E-04	1.78E+00	1	9	11.1	1	0	8	3.20E-04	no	2012, Tinker Creek at SRP Road E-2.1, Tyler Bridge Road
UTR Upper	Metals	Cadmium	mg/L	2.53E-04	2.60E-03	1.03E+01	1.04E-03	4.12E+00	4	34	11.8	4	0	30	4.00E-03	no	2001, Tinker Creek at Kennedy Road
UTR Upper	Metals	Copper	mg/L	1.80E-03	1.90E-03	1.06E+00	1.46E-03	8.12E-01	1	34	2.9	2	1	31	7.00E-02	no	1995, U3R-1A Treadway Bridge RD 8-1
UTR Upper	Metals	Lead	mg/L	3.71E-03	7.60E-03	2.05E+00	7.45E-03	2.01E+00	2	34	5.9	2	0	32	2.00E-02	no	2000, U3R-1A Treadway Bridge RD 8-1
UTR Upper	Metals	Zinc	mg/L	1.49E-02	2.87E-02	1.92E+00	1.33E-02	8.93E-01	8	34	23.5	14	7	13	1.67E-01	no	2007, U3R-1A Treadway Bridge RD 8-1

**Tier II – Surface Water Based on ORNL Benchmarks**

Subunit	Analyte Type	Analyte	Units	Bench- mark	Max Result	Max Ratio	Mean Detect	Mean Ratio	# Exceed	# Samples	Freq Exceed (%)	# Detects	# Estimated	# Non- Detects	Max Bkgd Level	Mean > Bkgd?	Bkgd Date, Location
UTR Middle	Metals	Mercury	mg/L	9.90E-05	1.60E-04	1.62E+00	6.50E-05	6.57E-01	3	110	2.7	3	8	99	2.42E-04	no	2002, U3R-1A Treadway Bridge RD 8-1
UTR Tims Branch	Metals	Mercury	mg/L	9.90E-05	8.04E-03	8.12E+01	1.52E-03	1.53E+01	13	68	19.1	31	0	37	2.42E-04	yes	2002, U3R-1A Treadway Bridge RD 8-1
UTR Tinker Creek	Pesticides/PCBs	DDD	mg/L	1.90E-04	3.00E-04	1.58E+00	3.00E-04	1.58E+00	1	9	11.1	1	0	8	NDs	---	---

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### **3.0 DATA NEEDS AND EARLY ACTIONS**

#### **3.1 Identification of Data Needs**

The results of the benchmark evaluations conducted in Section 2.1 provide the rationale and justification for data needs to support the ongoing assessment of the UTR IOU. Table 3-1 lists IOU identified data needs and sampling conducted to address the data needs for the UTR IOU.

The PR5 HH evaluation lacked recent fish data (Section 2.1.1). Although fishing for consumption is not allowed in UTR IOU, monitoring contaminant levels over time is a useful in assessing potential contaminants threats. A new approach to monitoring contaminant levels and bioaccumulation in fish for the IOU program is planned. Passive diffusive gradients in thin films (DGT) samplers will be deployed in the UTR IOU to provide screening data to estimate concentrations in fish tissue without catching or destroying any fish to support future HH subsistence fisherman scenario benchmark screening and the ecological screening. DGT samplers target bioavailable fractions of contaminants to help identify contaminants of interest. The use of passive samplers was first developed in the 1980s, and samplers started to be deployed in the field for research purposes in the 1990s. Since then, passive samplers have been used for monitoring contaminant concentrations in the water column and sediment by regulatory agencies and researchers, and have been used on the SRS. Passive samplers are useful new tools for assessing contaminant exposures and evaluating the potential for adverse environmental impacts. The data obtained from passive samplers will provide consistent and comparable data allowing for spatial comparison and trending among and within the IOUs since the semipermeable medium is consistently prepared and deployed. The passive sampler collections will focus on the Middle and Lower UTR subunits where edible sized game fish are more likely and high fish diversity of present. These data will be reported in a future PR.

The PR5 ecological assessment showed Tier II sediment/soil and Tier I and II SW exceedances based on review of UTR PR5 data. None of these exceedances warranted further evaluation at this time. Field studies conducted within the UTR IOU have indicated that mercury in the Lower subunit, uranium, nickel, and mercury in the Tims Branch subunit may pose a threat to ecological receptors within the UTR IOU. As Phase II continues, data will continue to be compiled and

assessed for the UTR IOU and reported in upcoming PRs. To support the ongoing Phase II data screening, several biological studies are planned or on-going for the UTR IOU. It is anticipated that macroinvertebrate surveys will be conducted in Crouch Branch in 2018 as part of the NPDES surveillance program. Also, the SREL has recently conducted macroinvertebrate surveys in McQueen Branch. Additionally, an SRS-wide IOU bioassessment field effort was conducted in 2017 to assess fish communities and macroinvertebrate assemblages within all the IOUs except the SRFS IOU. The SRFS IOU was not included since the bioassessment data collection efforts are not tailored to large stream systems such as the Savannah River. The results of these studies, and future data screening, will be reported in upcoming PRs as these efforts are finalized.

### **3.2 Early Actions**

The need for early actions for all or portions of the UTR IOU is assessed as part of this PR. The need to consider an early action is based on results of the HH and ecological benchmarking process (Section 2.1). If results of these evaluations indicate that early action may be warranted, then the area(s) of concern are assessed for the possibility of conducting an early action. The early action strategy follows the decision-making flow diagram titled the “SRS Environmental Restoration RI/FS Early Action Strategy for the Units Listed on FFA Appendix C, RCRA/Comprehensive Environmental Response, Compensation, and Liability Act Units” as presented in the *Remedial Investigation Work Plan for the Upper Three Runs Integrator Operable Unit* (WSRC 2002).

No constituents were retained for early action consideration based on the HH evaluation or the ecological assessment presented in Section 2. Therefore, there are no early actions warranted for any portion of the UTR IOU based on evaluation of PR5 data.

Data will continue to be compiled annually for periodic assessments. These data, typically consisting of IOU sampling efforts, OU investigations, annual environmental monitoring conducted by SRS and SCDHEC, and special studies that may be conducted by various data stewards will be used to continue the assessment of the UTR IOU as Phase II of the IOU program continues.

**Table 3-1. Summary of UTR IOU Sampling and Data Needs**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>WORK PLAN</b>			
<b>Tims Branch</b>			
<i>A/M Area</i>			
Upper reach of the unnamed tributary of Tims Branch originating east of A Area	Sediment	Investigate potential impacts of SW runoff from historical SRTC operations.	Full suite sediment at UTRIOU-03 where particle tracks indicate, and discharge point for several A-Area outfalls.
	Surface Water	Investigate potential impacts of SW runoff from historical SRTC operations.	Full suite sediment at UTRIOU-03 where particle tracks indicate, and discharge point for several A-Area outfalls.
Tims Branch east of A/M Area	Sediment and Sediment/Soil	Investigate potential impacts of SW runoff from Waste Units 47, 236, and 48.	Two full suite sediment samples UTRIOU-31 where surface particle tracks indicate potential impact from the A-Area Coal Pile Runoff Basin and UTRIOU-32 where surface particle tracks indicate potential impact from the A-Area ash pile and miscellaneous rubble pile.
	Surface Water	Investigate potential impacts of SW runoff from Waste Units 47, 236, and 48.	Two full suite sediment samples UTRIOU-31 where surface particle tracks indicate potential impact from the A-Area Coal Pile Runoff Basin and UTRIOU-32 where surface particle tracks indicate potential impact from the A-Area ash pile and miscellaneous rubble pile.
Tims Branch immediately downstream of Steed Pond	Sediment and Sediment/Soil	Investigate potential impacts from Steed Pond.	Full suite sediment sample from UTRIOU-33
	Surface Water	Investigate potential impacts from Steed Pond.	Full suite water sample from UTRIOU-33
At the heads of the lower tributaries of Tims Branch south of A/M Area	Sediment	Investigate potential impacts of SW runoff from A/M-Area waste units.	Two full suite sediment samples: UTRIOU-04 where surface particle tracks from the A-Area Rubble Pit, burning/rubble pits, ash pile, and metals burning pit converge and UTRIOU-05 where SW and GW particle tracks from the Miscellaneous Chemical Basin converge.
	Surface Water	Investigate potential impacts of SW runoff from A/M-Area waste units.	Two full suite sediment samples: UTRIOU-04 where surface particle tracks from the A-Area Rubble Pit, burning/rubble pits, ash pile, and metals burning pit converge and UTRIOU-05 where SW and GW particle tracks from the Miscellaneous Chemical Basin converge.

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**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<i>General Area</i>			
Tims Branch west of United States Forest Service	Sediment	Investigate potential impacts of SW runoff from Waste Unit 542.	One full sediment sample at UTRIOU-34 where potential SW impact from ECODS G-2 is indicated.
	Surface Water	Investigate potential impacts of SW runoff from Waste Unit 542.	One full suite water sample at UTRIOU-34 where potential SW impact from ECODS G-2 is indicated.
Unnamed tributary of Tims Branch above A Area and downstream (west) of Small Arms Training Area (SATA) (Waste Unit 359)	Sediment and Sediment/Soil	Investigate potential impact of SW runoff and GW from the SATA (Waste Unit 359).	One full suite sediment sample at UTRIOU-01 where particle tracks indicate potential impact from SATA.
	Surface Water	Investigate potential impact of SW runoff and GW from the SATA (Waste Unit 359).	One full suite water sample from UTRIOU-01 where particle tracks indicate potential impact from SATA.
<b>Tinker Creek</b>			
<i>R-Area</i>			
Upper reaches of Mill Creek, north of R Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff and GW from R-Area Seepage Basins.	One full suite sediment sample from UTRIOU-07 that may have been impacted from the R-Area Reactor seepage basins.
	Surface Water	Investigate potential impact of SW runoff and GW from R-Area Seepage Basins.	One full suite water sample from UTRIOU-07 that may have been impacted from the R-Area Reactor seepage basins.
<i>General Area</i>			
Reedy Branch immediately downgradient (south) of the Advanced Tactical Training Area range	Sediment and Sediment/Soil	Investigate potential impact of SW runoff and GW from the ATTA range.	One full suite sediment sample from UTRIOU-06 where particle tracks indicate potential impact of surface runoff or GW from ATTA.
	Surface Water	Investigate potential impact of SW runoff and GW from the ATTA range.	One full suite water sample from UTRIOU-06 where particle tracks indicate potential impact of surface runoff or GW from ATTA.

**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>“Middle” Upper Three Runs</b>			
<i>General Separations Area</i>			
Upper reaches of McQueen Branch, east of H and S Areas	Sediment and Sediment/Soil	Investigate potential impact of SW runoff and GW from H-Area waste units.	Two full suites sediment samples: UTRIOU-08 where particle tracks from various waste units converge and discharge point for several H Area, and UTRIOU-09 where GW particle tracks indicate potential impact from the coal pile runoff basin, tank farm, sandblast area, and various spills.
	Surface Water	Investigate potential impact of SW runoff and GW from H-Area waste units.	Two full suite water samples: UTRIOU-08 where particle tracks from various waste units converge and discharge point for several H Area and UTRIOU-09 where GW particle tracks indicate potential impact from the coal pile runoff basin, tank farm, sandblast area, and various spills.
Upper reaches of Crouch Branch, north of H and E Areas	Sediment and Sediment/Soil	Investigate potential impact of SW runoff and GW from H-Area waste units.	Two full suite sediment samples where particle tracks indicate potential impact from several H-Area waste units (UTRIOU-10 and UTRIOU-11). At its headwaters, this tributary also received effluent from the H-02 outfall.
	Surface Water	Investigate potential impact of SW runoff and GW from H-Area waste units.	Two full suite water samples where particle tracks indicate potential impact from several H-Area waste units (UTRIOU-10 and UTRIOU-11). At its headwaters, this tributary also received effluent from the H-02 outfall.
Unnamed tributary of Crouch Branch north of E Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff from the Low-Level Radioactive Waste Disposal Facility (LLRWDF).	One full suite sediment sample from location (UTRIOU-12) where particle tracks indicate that this tributary may have been impacted by runoff from LLRWDF.
	Surface Water	Investigate potential impact of SW runoff from the Low- LLRWDF.	One full suite water sample from location (UTRIOU-12) where particle tracks indicate that this tributary may have been impacted by runoff from LLRWDF.
Upper Three Runs (UTR) north of E Area	Sediment and Sediment/Soil	Investigate potential impact of GW flow from LLRWDF, ECODS F-1, and ECODS F-3.	One full suite sediment sample from location (UTRIOU-13) where GW particle tracks indicate potential impact from several E-Area waste units.
	Surface Water	Investigate potential impact of GW flow from LLRWDF, ECODS F-1, and ECODS F-3.	One full suite water sample from location (UTRIOU-13) where GW particle tracks indicate potential impact from several E Area waste units.

**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>"Middle" Upper Three Runs (Continued)</b>			
<i>General Separations Area</i>			
Unnamed tributary of UTR originating east of F Area	Sediment and Sediment/Soil	Investigate potential impact of GW flow from F-Area waste units.	Three full suite sediment samples where SW and GW particle tracks from F-Area waste units indicate impact (UTRIOU-14, -15, and -16). This tributary also received effluent from several F-Area outfalls.
	Surface Water	Investigate potential impact of GW flow from F-Area waste units.	Three full suite water samples where SW and GW particle tracks from F-Area waste units indicate impact (UTRIOU-14, -15, and -16). This tributary also received effluent from several F-Area outfalls.
UTR north of F Area	Sediment and Sediment/Soil	Investigate potential impact of GW flow from several F-Area waste units.	One full suite sediment sample from area (UTRIOU-17) where SW and GW particle tracks from F-Area coverage
	Surface Water	Investigate potential impact of GW flow from several F-Area waste units.	One full suite water sample from area (UTRIOU-17) where SW and GW particle tracks from F-Area coverage
Unnamed tributary of UTR originating west of F Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff from Waste Unit 270.	One full suite sediment sample in the location (UTRIOU-20) which may have received runoff from waste units in the western portion of F Area and a discharge point for the F-01 outfall
	Surface Water	Investigate potential impact of SW runoff from Waste Unit 270.	One full suite water sample in the location (UTRIOU-20) which may have received runoff from waste units in the western portion of F Area and a discharge point for the F-01 outfall
Unnamed tributary of UTR	Sediment and Sediment/Soil	Investigate potential impact of GW flowing from Old F-Area Seepage Basin.	One full suite sediment sample from location (UTRIOU-19) that potentially received SW runoff from the Old F-Area Seepage Basin.
	Surface Water	Investigate potential impact of GW flowing from Old F-Area Seepage Basin.	One full suite water sample from location (UTRIOU-19) that potentially received SW runoff from the Old F-Area Seepage Basin.
Wetlands area north of E Area (downgradient of the MWMF)	Sediment and Sediment/Soil	Investigate potential impact of GW from MWMF.	Two full suite sediment samples from location where particle tracks indicate that this tributary may have been impacted by GW (UTRIOU-02 and UTRIOU-18).

**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>“Middle” Upper Three Runs (Continued)</b>			
<i>F Area</i>			
UTR west of F Area	Sediment and Sediment/Soil	Investigate potential impact of GW from Waste Units 270, 380, and 438.	Three full suite sediment samples where GW particle tracks indicate potential impact from several F-Area waste units (UTRIOU-21, -22, and -23). This area also received outfall discharges from FS-01, FS-02, and H-016.
	Surface Water	Investigate potential impact of GW from Waste Units 270, 380, and 438.	Three full suite water samples where GW particle tracks indicate potential impact from several F-Area waste units (UTRIOU-21, -22, and -23). This area also received outfall discharges from FS-01, FS-02, and H-016.
<i>B Area</i>			
Unnamed tributary of UTR north of B Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff from Waste Unit 530.	One full suite sediment sample in an area (UTRIOU-24) where particle tracks from several ECODS potentially discharge.
	Surface Water	Investigate potential impact of SW runoff from Waste Unit 530.	One full suite water sample in a location (UTRIOU-24) where particle tracks from several ECODS potentially discharge.
<b>“Lower” Upper Three Runs</b>			
UTR east of B Area	Sediment and Sediment/Soil	Investigate potential impact of GW from Waste Unit 529. Investigate potential impact of GW flow from Waste Units 474, 526, 527, and 491.	Two full suite sediment samples (UTRIOU-25 and UTRIOU-26) where GW particle tracks from several waste units in B Area converge.
	Surface Water	Investigate potential impact of GW from Waste Unit 529. Investigate potential impact of GW flow from Waste Units 474, 526, 527, and 491.	Two full suite water samples (UTRIOU-25 and UTRIOU-26) where GW particle tracks from several waste units in B Area converge.
Unnamed tributary of UTR originating east of B Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff from Waste Unit 491 and GW from Waste Unit 526.	One full suite sediment sample in the location (UTRIOU-27) downstream of area where particle tracks from ECODS B-1A and Sandblast Area CMB-001 potentially discharge. This location will also be used to assess potential impacts from the Sanitary Landfill.
	Surface Water	Investigate potential impact of SW runoff from Waste Unit 491 and GW from Waste Unit 526.	One full suite water sample in the location (UTRIOU-27) downstream of area where particle tracks from ECODS B-1A and Sandblast Area CMB-001 potentially discharge. This location will also be used to assess potential impacts from the Sanitary Landfill.

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**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>“Lower” Upper Three Runs (Continued)</b>			
Unnamed tributary of UTR originating southeast of B Area	Sediment and Sediment/Soil	Investigate potential impact of SW runoff from Waste Units 526 and 527.	One full suite sediment sample in the location where particle tracks indicate potential impact from ECODS B-1A and B-2 (UTRIOU-28).
	Surface Water	Investigate potential impact of SW runoff from Waste Units 526 and 527.	One full suite water sample in the location where particle tracks indicate potential impact from ECODS B-1A and B-2 (UTRIOU-28).
<i>General Area</i>			
UTR downgradient from ECODS G-1	Sediment and Sediment/Soil	Investigate potential impact of GW flow from ECODS G-1.	One full suite sediment sample where GW particle tracks indicate potential discharge to the stream (UTRIOU-30).
	Surface Water	Investigate potential impact of GW flow from ECODS G-1.	One full suite water sample where GW particle tracks indicate potential discharge to the stream (UTRIOU-30).
Unnamed tributary of UTR east of ECODS G-1	Sediment and Sediment/Soil	Investigate potential impact from SW runoff from ECODS G-1.	One full suite sediment sample where SW runoff from ECODS G-1 may potentially impact the tributary (UTRIOU-29).
	Surface Water	Investigate potential impact from SW runoff from ECODS G-1.	One full suite water sample where SW runoff from ECODS G-1 may potentially impact the tributary (UTRIOU-29).
<b>PERIODIC REPORT 1</b>			
<b>Tinker Creek</b>			
	Sediment	UTRIOU-08 exceeded gross alpha trigger	Follow-on alpha spectroscopy
<b>Tims Branch</b>			
	Sediment	UTRIOU-03 and UTRIOU-32 exceeded gross alpha screening trigger	Follow-on alpha spectroscopy
<b>“Middle” Upper Three Runs</b>			
Middle Subunit	Sediment	UTRIOU-02, 13, 15, 17, 29, 21, 22 exceeded gross alpha trigger	Follow-on alpha spectroscopy
<b>“Lower” Upper Three Runs</b>			
	Sediment	UTRIOU-23, 27, 30 exceeded gross alpha trigger	Follow-on alpha spectroscopy
	Surface water	UTRIOU-23 exceeded gross alpha trigger	Follow-on alpha spectroscopy
<b>ALL</b>	Biota	Periodic fish Index of Biotic Integrity and macroinvertebrate monitoring	<i>To be addressed during Phase II</i>
<b>ALL</b>	Biota	Trophic modeling	<i>To be addressed during Phase II</i>
<b>ALL</b>	All Media	Conduct trophic modeling	<i>To be addressed during Phase II</i>

**Table 3-1. Summary of UTR IOU Sampling and Data Needs (Continued/End)**

Location	Media	Data Need Identified	Sampling Conducted to Address Data Needs
<b>PERIODIC REPORT 2</b>			
<b>ALL</b>			
	All Media	Conduct trophic modeling (river otter and belted kingfisher)	Complete. Documented in UTR PR 3
	Biota	Periodic fish Index of Biotic Integrity and macroinvertebrate monitoring	Complete. Documented in UTR PR 3
	Biota	Field based trophic study of Tims Branch	Complete (Savannah River Ecology Laboratory). Documented in UTR PR 4
<b>PERIODIC REPORT 3</b>			
<b>ALL</b>			
	All Media	Continue to compile data for trophic modeling	To be addressed during Phase II
<b>PERIODIC REPORT 4</b>			
<b>ALL</b>			
	All Media	Conduct trophic modeling for additional receptors (raccoon and great blue heron)	To be addressed during Phase II
<b>PERIODIC REPORT 5</b>			
<b>“Middle” and “Lower” Upper Three Runs</b>			
	All Media	DGT samplers will be deployed to target bioavailable fractions of contaminants to help identify contaminants of interest	To be addressed during Phase II

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#### **4.0 REFERENCES**

FFA, 1993. *Federal Facility Agreement for the Savannah River Site*, Administrative Docket No. 89-05-FF (Effective Date: August 16, 1993)

IAEA, 1992. *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, Technical Reports Series, No. 332, (International Atomic Energy Agency) Vienna

SREL, 1997. DOE Research Set-Aside Areas of the Savannah River Site, Publication of the Savannah River Site National Environmental Research Park Program, United States, Department of Energy, Savannah River Ecology Laboratory, Aiken, SC

SRNS, 2009a. *Remedial Investigation/Baseline Risk Assessment for the Lower Three Runs Integrator Operable Unit*, SRNS-RP-2017-00138, Rev. 0, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2010. *Sampling and Analysis Plan for the Lower Three Runs Stream, Floodplain, and Headwaters*, SGCP-SAP-2009-00003, Rev. 1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2012a. *Environmental Compliance and Area Completion Projects Regulatory Document Handbook*, ERD-AG-003, Revision 17, June 2012, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2012b. *Periodic Report 3 for the Upper Three Runs Integrator Operable Unit*, SRNS-RP-2011-01184, Revision 1.1, April 2012, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2014a. *Savannah River Site Environmental Report for 2014*, SRNS-RP-2015-00008, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2014b. *Periodic Report 4 for the Upper Three Runs Integrator Operable Unit*, SRNS-RP-2013-00809, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2015. *Z-01 Outfall Data Report*, SRNS-RP-2015-00784, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

USFS, 2009. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, Savannah River Site 20009 LIDAR Project, FY09 Final Report, Pacific Northwest Research Station, University of Washington, Box 352100, Seattle, WA 98195-2100

WSRC 1997. *Geochemical and Physical Properties of Wetland Soils at the Savannah River Site*, WSRC-TR-96-0115, Final, May 1997, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *Remedial Investigation Work Plan for the Upper Three Runs Integrator Operable Unit*, WSRC-RP-2002-4124, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003a. *An Updated Regional Water Table of the Savannah River Site and Related Coverages*, WSRC-TR-2003-00250, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006. *Background Soils Statistical Summary Report for the Savannah River Site*, ERD-EN-2005-0223, Revision 1, October 2006, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

## APPENDIX A

### Benchmarks for the Upper Three Runs Integrator Operable Unit

Ecological	Tier I	
	Tier II	
Human Health	Fish	– Subsistence Fisherman
	Sediment	– On-Site Worker
	Soil	– On-Site Worker
	Surface Water	– On-Site Worker

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ECOLOGICAL SCREENING BENCHMARK REFERENCES		
Sediment		
	Reference	Citation
	Dutch Ministry Standards (MHSPE 1994)	Ministry of Housing, Spatial Planning, and Environment (MHSPE), 1994. <i>Intervention Values and Target Values - Soil Quality Standards</i> . Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, The Netherlands, May 9.
	Ecotox Thresholds (USEPA 1996)	U.S. Environmental Protection Agency, 1996. "Ecotox Thresholds" Eco Update, Office of Solid Waste and Emergency Response, Intermittent Bulletin Vol. 3, No. 2. USEPA 540/F-95-038 PB95-963324, January. ( <a href="http://www.epa.gov/superfund/oerr/r19/ecotox">http://www.epa.gov/superfund/oerr/r19/ecotox</a> ).
	Environment Canada (CCME 1998)	Canadian Council of Ministers of the Environment (CCME), 1998. <i>Canadian Sediment Quality Guidelines</i> . Winnipeg, Manitoba. ( <a href="http://www.ec.gc.ca/ceqg-rcqe/sediment.htm">http://www.ec.gc.ca/ceqg-rcqe/sediment.htm</a> ).
	USEPA Region IV (USEPA 1995)	U.S. Environmental Protection Agency, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins Ecological Risk Assessment. ( <a href="http://www.epa.gov/region4/wastepegs/oftecser/otsguid.htm">http://www.epa.gov/region4/wastepegs/oftecser/otsguid.htm</a> )
	International Atomic Energy Agency (IAEA 1992)	Calculated ESV documented in IOU workplans based on 1992 <i>Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards</i> . Technical Reports Series, No. 332. Vienna, applying a 10% safety factor to 0.5 rad/day level.
	Jones, Suter, Hull, 1997	Jones, D.S., G.W. Suter, and R.N. Hull, 1997. <i>Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision</i> , ES/ER/RM-95/R4, Environmental Sciences Division of Oak Ridge National Laboratory, Oak Ridge, TN, November.
Soil		
	Reference	Citation
	USEPA Region V Ecological Data Quality Levels, (May 1995)	U.S. Environmental Protection Agency, Region V Ecological Data Quality Levels, Office of RCRA, May 1995.
	Background Concentrations in Soil or Detection Limits	Background concentrations in soil or detection limits
	CCME, 1997. Recommended Canadian Soil Quality Guidelines	CCME, March 1997. <i>Recommended Canadian Soil Quality Guidelines</i> , Winnipeg, Manitoba.
	Crommentuijn et al. (1997)	Crommentuijn, T., D.F. Kalf, M.D. Polder, R. Posthumus, and E.J. van de Plassche, 1997. <i>Maximum Permissible Concentrations for Pesticides</i> . RIVM Report No. 601501002.
	Efroymsen, Will, Suter, Wooten, 1997a. Terrestrial Plants	Efroymsen, R.A., M.E. Will, G.W. Suter, and A.C. Wooten, 1997. <i>Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision</i> . Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-85/R3 ( <a href="http://www.hsrdoornl.gov/ecorisk/reports.html">http://www.hsrdoornl.gov/ecorisk/reports.html</a> ).

ECOLOGICAL SCREENING BENCHMARK REFERENCES		
<b>Soil (cont'd)</b>		
	<b>Reference</b>	<b>Citation</b>
	Efroymsen, Will, Suter, 1997b. Soil and Litter Invertebrates	Efroymsen, R.A., M.E. Will, and G.W. Suter, 1997. <i>Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision</i> . Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2 ( <a href="http://www.hsrdo.ornl.gov/ecorisk/reports.html">http://www.hsrdo.ornl.gov/ecorisk/reports.html</a> ).
	International Atomic Energy Agency (IAEA 1992)	Calculated ESV documented in IOU workplans based on 1992 <i>Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards</i> . Technical Reports Series. No. 332. Vienna, applying a 10% safety factor to 0.5 rad/day level.
	MHSPE (1994)	MHSPE (Ministry of Housing, Spatial Planning, and Environment), 9 May 1994. <i>Intervention Values and Target Values - Soil Quality Standards</i> . Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, The Netherlands.
<b>Surface Water</b>		
	<b>Reference</b>	<b>Citation</b>
	Verschuieren Handbook of Environmental Data of Organic Chemicals, 1983, p.497	2,4-D - LC50, <i>Lepomis macrochirus</i> (bluegill fish) 0.9 ppm/48 hr. Conditions of bioassay not specified; SRP: Unspecified salt or ester of 2,4-D [Verschuieren Handbook of Environmental Data on Organic Chemicals, 1983, p.497]
	Region IV Ambient Water Quality Values (USEPA 1995)	Region IV Ambient Water Quality Values (USEPA 1995) U.S. Environmental Protection Agency, 1995. <i>Supplemental Guidance to RAGS: Region 4 Bulletins Ecological Risk Assessment</i> . ( <a href="http://www.epa.gov/region4/wastepgs/oftecsr/otsguid.htm">http://www.epa.gov/region4/wastepgs/oftecsr/otsguid.htm</a> ).
	CCME 1998 Canadian Water Quality Guidelines	CCME, 1998. <i>Canadian Water Quality Guidelines</i> . Winnipeg, Manitoba. ( <a href="http://www.ec.gc.ca/ceqg-rcqe/water.htm">http://www.ec.gc.ca/ceqg-rcqe/water.htm</a> ).
	Ecotox Thresholds (USEPA 1996)	U.S. Environmental Protection Agency, 1996. "Ecotox Thresholds" Eco Update, Office of Solid Waste and Emergency Response, Intermittent Bulletin Vol. 3, No. 2. USEPA 540/F-95-038 PB95-963324. January. ( <a href="http://www.epa.gov/superfund/oerr/r19/ecotox">http://www.epa.gov/superfund/oerr/r19/ecotox</a> ).
	Handbook Acute Toxicity Fish and Aquatic Invertebrates	Handbook Acute Toxicity Fish and Aquatic Invertebrates, Department of Interior, Fish and Wildlife Service Publication 137, 1980 Page 44. Hexachlorobenzene - LC50 <i>Lepomis macrochirus</i> (bluegill) 12 mg/L/96 hr @ 20 deg C (95% confidence limit); wt 1.0 g; Tested in hard water static bioassay. Technical 80-96% [Hdbk Acut Tox Chem Fish & Aqua Invert 1980, p.44] and LC50 <i>Micropterus salmoides</i> (largemouth bass) 12 mg/L/96hr @ 21 deg C (95% confidence limit); wt.0.5 g; tested in hard water static bioassay; technical 80-96% [Hdbk Acut Tox Chem Rish & Aqua Invert 1980, p.44]

ECOLOGICAL SCREENING BENCHMARK REFERENCES		
Surface Water (cont'd)		
	Reference	Citation
	International Atomic Energy Agency (IAEA 1992)	Calculated ESV documented in IOU workplans based on 1992 Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards. Technical Reports Series. No. 332. Vienna, applying a 10% safety factor to 0.5 rad/day level.
	ORNL Lowest Chronic Value - Suter and Tsao (1996a)	ORNL Lowest Chronic Value - Suter, G.W. and C.L. Tsao, 1996. <i>Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota</i> . Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2. ( <a href="http://www.hsr.ornl.gov/ecorisk/reports/html">http://www.hsr.ornl.gov/ecorisk/reports/html</a> ).
	ORNL Tier II – Suter and Tsao (1996b)	ORNL Tier II - Suter, G.W. and C.L. Tsao, 1996. <i>Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota</i> . Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2. ( <a href="http://www.hsr.ornl.gov/ecorisk/reports/html">http://www.hsr.ornl.gov/ecorisk/reports/html</a> ).
	South Carolina Water Quality Classification Standards (R.61-68)	South Carolina Water Quality Classification Standards (R.61-68)
	USEPA AQUIRE Database Search	USEPA AQUIRE Database Search

Tier II level benchmarks used for screening sediment data include Canadian Council of Ministers of the Environment (CCME), Oak Ridge National Laboratory (ORNL) Median Level, and ORNL Effects Level thresholds.

CCME: Probable Effects Level, Canadian Sediment Quality Guidelines for the Protection of Aquatic Life [https://www.elaw.org/system/files/sediment\\_summary\\_table.pdf](https://www.elaw.org/system/files/sediment_summary_table.pdf)

ORNL Median: Jones, Suter, Hull 1997, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota, ES/ER/TM-95/R4

ORNL Effects Level: Probably Effects Level, Jones, Suter, Hull 1997, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota, ES/ER/TM-95/R4

Tier II benchmarks for SW are based on AWQC and ORNL Tier II thresholds.

ORNL Tier II: Suter and Tsao (1996)

AWQC: USEPA (1996)

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Benchmark	Units	Source	Comments
1,1,1,2-Tetrachloroethane	SE	9.40E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	1,1,2,2-Tetrachloroethane; Sediment quality benchmarks (SWBs)
1,1,1-Trichloroethane	SE	1.70E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
1,1,2,2-Tetrachloroethane	SE	9.40E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
1,1,2-Trichloroethane	SE	1.70E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	1,1,1-Trichloroethane; Sediment quality benchmarks (SWBs)
1,1-Dichloroethane	SE	4.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	1,2-Dichloroethane; intervention value
1,1-Dichloroethene	SE	3.10E-02	mg/kg	Jones, Suter, Hull, 1997	
1,2,4,5-Tetrachlorobenzene	SE	1.00E-02	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Tetrachlorobenzenes
1,2,4-Trichlorobenzene	SE	9.20E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
1,2-Dichlorobenzene	SE	3.40E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
1,2-Dichloroethane	SE	4.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
1,2-Dichloroethene	SE	4.00E-01	mg/kg	Jones, Suter, Hull, 1997	
1,3-Dichlorobenzene	SE	1.70E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
1,3-Dichloropropene	SE	5.10E-05	mg/kg	Jones, Suter, Hull, 1997	
1,4-Dichlorobenzene	SE	3.50E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
2,3,4,6-Tetrachlorophenol	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Tetrachlorophenols
2,4,5-Trichlorophenol	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Trichlorophenols
2,4,6-Trichlorophenol	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Trichlorophenols
2,4-Dichlorophenol	SE	3.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Dichlorophenols
2,4-Dimethylphenol	SE	2.90E-02	mg/kg	Jones, Suter, Hull, 1997	
2,6-Dichlorophenol	SE	3.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Dichlorophenols
2-Chloronaphthalene	SE	1.00E+00	mg/kg	Dutch Ministry Standards (MHSPE 1994)	Chloronaphthalene
2-Chlorophenol	SE	1.00E+00	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Chlorophenols
2-Hexanone	SE	2.20E-02	mg/kg	Jones, Suter, Hull, 1997	
2-Methylnaphthalene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
4-Bromophenyl phenyl ether	SE	1.30E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
4-Chlorophenylphenyl ether	SE	1.00E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	4-Bromophenyl phenyl ether
Acenaphthene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Acenaphthylene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Acetone	SE	8.70E-03	mg/kg	Jones, Suter, Hull, 1997	
Actinium-228	SE	5.37E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Aldrin	SE	2.50E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
alpha-Benzene hexachloride	SE	2.50E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
alpha-Chlordane	SE	1.70E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Aluminum	SE	5.80E+04	mg/kg	Jones, Suter, Hull, 1997	
Americium-241	SE	1.58E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Anthracene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Antimony	SE	1.20E+01	mg/kg	USEPA Region IV (USEPA 1995)	
Antimony-124	SE	2.86E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Antimony-125	SE	1.21E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Arsenic	SE	7.24E+00	mg/kg	USEPA Region IV (USEPA 1995)	
Barium	SE	2.00E+02	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Barium-133	SE	1.30E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Benzene	SE	5.70E-02	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Benzo[a]anthracene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Benzo[a]pyrene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Benzo[b]fluoranthene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	Fluoranthene
Benzo[g,h,i]perylene	SE	1.70E-01	mg/kg	Jones, Suter, Hull, 1997	
Benzo[k]fluoranthene	SE	2.40E-01	mg/kg	Jones, Suter, Hull, 1997	
Benzoic acid	SE	5.70E-02	mg/kg	Ecotox Thresholds (USEPA 1996)	
Beryllium-7	SE	1.06E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
beta-Benzene hexachloride	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Bis[2-ethylhexyl]phthalate	SE	1.82E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Bismuth-212	SE	2.80E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Bismuth-214	SE	3.45E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Bromoform	SE	6.50E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Butylbenzylphthalate	SE	1.10E+01	mg/kg	Ecotox Thresholds (USEPA 1996)	
Cadmium	SE	1.00E+00	mg/kg	USEPA Region IV (USEPA 1995)	
Carbon disulfide	SE	8.50E-04	mg/kg	Jones, Suter, Hull, 1997	
Carbon tetrachloride	SE	1.20E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Tetrachloromethane
Cerium-144	SE	2.48E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cesium-134	SE	3.34E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cesium-137	SE	8.73E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Chlordane	SE	1.70E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Chlorobenzene	SE	8.20E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	
Chloroform	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Chromium	SE	5.23E+01	mg/kg	USEPA Region IV (USEPA 1995)	
Chromium VI	SE	5.23E+01	mg/kg	USEPA Region IV (USEPA 1995)	Chromium III
Chrysene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
cis-1,2-Dichloroethylene	SE	4.00E-01	mg/kg	Jones, Suter, Hull, 1997	1,2-Dichloroethene
Cobalt	SE	2.00E+01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Cobalt-57	SE	4.17E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cobalt-58	SE	5.34E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cobalt-60	SE	2.09E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Copper	SE	1.87E+01	mg/kg	USEPA Region IV (USEPA 1995)	
Curium-242	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-242 and Curium-244	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-243	SE	3.89E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-243 and Curium-244	SE	3.89E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-244	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-245 and Curium-246	SE	5.43E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-246	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cyanide	SE	1.00E+00	mg/kg	Dutch Ministry Standards (MHSPE 1994)	free Cyanide; target value
DDD	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	
DDE	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	
DDT	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Decane	SE	4.10E+01	mg/kg	Jones, Suter, Hull, 1997	
delta-Benzene hexachloride	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
Diazinon	SE	1.90E-03	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Dibenz[a,h]anthracene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Dibenzofuran	SE	2.00E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Dibutylphthalate	SE	1.10E+01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Dieldrin	SE	2.00E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Diethylphthalate	SE	3.60E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Dimethylphthalate	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Phthalates
Diocetylphthalate	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Phthalates
Endosulfan	SE	5.40E-03	mg/kg	Ecotox Thresholds (USEPA 1996)	Endosulfan, mixed isomers; Sediment quality benchmarks (SWBs)
Endosulfan I	SE	2.90E-03	mg/kg	Ecotox Thresholds (USEPA 1996)	Endosulfan, alpha; Sediment quality benchmarks (SWBs)
Endosulfan II	SE	1.40E-02	mg/kg	Ecotox Thresholds (USEPA 1996)	Endosulfan, beta; Sediment quality benchmarks (SWBs)
Endosulfan sulfate	SE	5.40E-03	mg/kg	Ecotox Thresholds (USEPA 1996)	Endosulfan, mixed isomers; Sediment quality benchmarks (SWBs)
Endrin	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Endrin aldehyde	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	Endrin
Endrin ketone	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	Endrin
Ethylbenzene	SE	3.60E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	Sediment quality benchmarks (SWBs)
Europium-152	SE	4.49E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Europium-154	SE	4.20E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Europium-155	SE	8.55E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Fluoranthene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Fluorene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
gamma-BHC	SE	3.30E-03	mg/kg	USEPA Region IV (USEPA 1995)	gamma-BHC (Lindane)
Heptachlor	SE	6.00E-04	mg/kg	Environment Canada (CCME 1998)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
Heptachlor epoxide	SE	6.00E-04	mg/kg	Environment Canada (CCME 1998)	
Hexachlorobenzene	SE	8.20E-01	mg/kg	USEPA Region IV (USEPA 1995)	total Chlorobenzenes
Hexachlorocyclohexane	SE	1.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	beta-BHC
Hexachloroethane	SE	1.00E+00	mg/kg	Jones, Suter, Hull, 1997	
Indeno[1,2,3-cd]pyrene	SE	7.80E-02	mg/kg	Jones, Suter, Hull, 1997	
Iodine-129	SE	2.09E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Lead	SE	3.02E+01	mg/kg	USEPA Region IV (USEPA 1995)	
Lead-212	SE	3.52E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Lead-214	SE	2.09E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
m,p-Cresol	SE	5.00E-01	mg/kg	Environment Canada (CCME 1998)	total Cresols
Malathion	SE	6.70E-04	mg/kg	Ecotox Thresholds (USEPA 1996)	
Manganese	SE	4.60E+02	mg/kg	Jones, Suter, Hull, 1997	
Manganese-54	SE	6.24E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Mercury	SE	1.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Methoxychlor	SE	1.90E-02	mg/kg	Ecotox Thresholds (USEPA 1996)	
Methyl ethyl ketone	SE	2.70E-01	mg/kg	Jones, Suter, Hull, 1997	2-Butanone
Methyl isobutyl ketone	SE	3.30E-02	mg/kg	Jones, Suter, Hull, 1997	(4-Methyl-2-pentanone)
Methylene chloride	SE	2.00E+00	mg/kg	Dutch Ministry Standards (MHSPE 1994)	Dichloromethane
Methylmercury	SE	1.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	Mercury, total
Molybdenum	SE	1.00E+01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Molybdenum	SE	1.00E+01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Naphthalene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Neptunium-237	SE	1.49E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Neptunium-239	SE	3.01E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Nickel	SE	1.59E+01	mg/kg	USEPA Region IV (USEPA 1995)	
o-Cresol	SE	5.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
PAH	SE	1.68E+00	mg/kg	USEPA Region IV (USEPA 1995)	PAHs (total)
PCB-1016	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
PCB-1221	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	
PCB-1232	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
PCB-1242	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
PCB-1248	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
PCB-1254	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221

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Analyte	Matrix	Bench- mark	Units	Source	Comments
PCB-1260	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
PCB-1262	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCB-1221
p-Cresol	SE	5.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Cresols
Pentachlorobenzene	SE	6.90E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	
Pentachlorophenol	SE	2.00E-03	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Phenanthrene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Phenol	SE	5.00E-02	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Phthalate	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	total Phthalates
Plutonium-238	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Plutonium-239 and Plutonium-240	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Plutonium-240	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Polychlorinated biphenyls	SE	6.70E-02	mg/kg	USEPA Region IV (USEPA 1995)	PCBs (total)
Potassium-40	SE	3.34E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Promethium-144	SE	3.34E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Promethium-146	SE	6.92E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Protactinium-234	SE	2.72E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Protactinium-234m	SE	4.34E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Pyrene	SE	3.30E-01	mg/kg	USEPA Region IV (USEPA 1995)	
Pyridine	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
Radium, Total Alpha-Emitting	SE	5.21E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Radium-224	SE	5.21E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Radium-226	SE	7.45E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Silver	SE	2.00E+00	mg/kg	USEPA Region IV (USEPA 1995)	
Sodium-22	SE	2.38E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Styrene	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	
technical-Chlordane	SE	1.70E-03	mg/kg	USEPA Region IV (USEPA 1995)	
Tetrachloroethene	SE	5.30E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	
Tetrahydrofuran	SE	1.00E-01	mg/kg	Dutch Ministry Standards (MHSPE 1994)	Target value
Thallium-208	SE	1.54E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-228	SE	1.74E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-230	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-231	SE	2.01E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-232	SE	5.21E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
Thorium-234	SE	5.79E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Tin-113	SE	2.27E+05	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Toluene	SE	6.70E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	
Toluene-d8	SE	6.70E-01	mg/kg	Ecotox Thresholds (USEPA 1996)	Toluene
Toxaphene	SE	2.80E-02	mg/kg	Ecotox Thresholds (USEPA 1996)	
trans-1,2-Dichloroethylene	SE	4.00E-01	mg/kg	Jones, Suter, Hull, 1997	total 1,2-DCE
Trichloroethene	SE	1.60E+00	mg/kg	Ecotox Thresholds (USEPA 1996)	
Uranium-233 and Uranium-234	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-234	SE	2.61E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-235	SE	3.34E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-238	SE	5.21E+06	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Vinyl Acetate	SE	8.40E-04	mg/kg	Jones, Suter, Hull, 1997	
Vinyl chloride	SE	1.00E-02	mg/kg	Dutch Ministry Standards (MHSPE 1994)	Target value
Xylenes	SE	5.00E-02	mg/kg	Dutch Ministry Standards (MHSPE 1994)	Xylene
Yttrium-88	SE	1.94E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Zinc	SE	1.24E+02	mg/kg	USEPA Region IV (USEPA 1995)	
Zinc-65	SE	8.93E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Zirconium-95	SE	7.05E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
1,1,1,2-Tetrachloroethane	SO	2.25E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,1,1-Trichloroethane	SO	2.98E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,1,2,2-Tetrachloroethane	SO	1.27E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,1,2-Trichloroethane	SO	2.86E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,1-Dichloroethane	SO	2.01E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,1-Dichloroethene	SO	8.28E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated dioxin isomers
1,2,3,4,6,7,8-Heptachlorodibenzofuran	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers
1,2,3,4,7,8-Hexachlorodibenzofuran	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated dioxin isomers
1,2,3,7,8-Pentachlorodibenzene-p-furan	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers

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Analyte	Matrix	Bench- mark	Units	Source	Comments
1,2,3-Trichloropropane	SO	3.36E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2,4,5-Tetrachlorobenzene	SO	2.02E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2,4-Trichlorobenzene	SO	2.00E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
1,2-Dibromo-3-chloropropane	SO	3.52E-02	mg/kg	NA source from UTR table	
1,2-Dibromoethane	SO	1.23E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2-Dichlorobenzene	SO	2.96E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2-Dichloroethane	SO	2.12E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2-Dichloroethene (total)	SO	7.84E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,2-Dichloropropane	SO	7.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
1,3,5-Trinitrobenzene	SO	3.76E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,3-Dichlorobenzene	SO	3.77E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,3-Dichloropropene	SO	3.98E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,3-Dinitrobenzene	SO	6.55E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,4-Dichlorobenzene	SO	2.00E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
1,4-Dioxane	SO	2.05E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1,4-Naphthoquinone	SO	1.67E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
1-Naphthylamine	SO	9.34E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-(2,4,5-Trichlorophenoxy)propionic acid	SO	5.96E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,3,4,6-Tetrachlorophenol	SO	1.99E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,3,7,8-Tetrachlorodibenzodioxin	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,3,7,8-Tetrachlorodibenzofuran	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,4,5-Trichlorophenol	SO	4.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
2,4,6-Trichlorophenol	SO	1.00E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
2,4-Dichlorophenol	SO	8.75E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,4-Dichlorophenoxyacetic acid	SO	2.73E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	2,4-D
2,4-Dimethylphenol	SO	1.00E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,4-Dinitrophenol	SO	2.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
2,4-Dinitrotoluene	SO	1.28E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,6-Dichlorophenol	SO	1.17E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2,6-Dinitrotoluene	SO	3.28E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Chloronaphthalene	SO	1.22E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Chlorophenol	SO	2.43E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Bench- mark	Units	Source	Comments
2-Hexanone	SO	1.26E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Methylnaphthalene	SO	3.24E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Naphthylamine	SO	3.03E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Nitroaniline	SO	7.41E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Nitrophenol	SO	1.60E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-Picoline	SO	9.90E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
2-sec-Butyl-4,6-Dinitrophenol	SO	2.18E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	Dinoseb
3,3-Dichlorobenzidine	SO	6.46E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
3,3-Dimethylbenzidine	SO	1.04E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
3-Methylcholanthrene	SO	7.79E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
3-Nitroaniline	SO	3.16E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Aminobiphenyl	SO	3.05E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Chloraniline	SO	1.10E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Chloro-m-cresol	SO	7.95E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Nitroaniline	SO	2.19E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Nitrophenol	SO	5.12E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
4-Nitroquinoline-1-oxide	SO	1.22E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
5-Nitro-o-toluidine	SO	8.73E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
7,12-Dimethylbenz(a)anthracene	SO	1.63E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
a,a-Dimethylphenethylamine	SO	3.00E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Acenaphthene	SO	2.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Acrylonitrile	SO	1.00E+03	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Actinium-228	SO	1.36E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Aldrin	SO	2.50E-03	mg/kg	MHSPE (1994)	
alpha-Benzene hexachloride	SO	2.50E-03	mg/kg	MHSPE (1994)	
alpha-Chlordane	SO	2.24E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Aluminum	SO	5.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Americium-241	SO	5.19E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Aniline	SO	5.68E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Anthracene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Antimony	SO	3.50E+00	mg/kg	Crommentuijn et al. (1997)	
Antimony-124	SO	8.21E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Antimony-125	SO	3.59E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Aramite	SO	1.66E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Arsenic	SO	1.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Barium	SO	1.65E+02	mg/kg	Crommentuijn et al. (1997)	
Barium-133	SO	1.97E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Benzene	SO	5.00E-02	mg/kg	MHSPE (1994)	
Benzo[a]anthracene	SO	5.21E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Benzo[a]pyrene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Benzo[b]fluoranthene	SO	5.98E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Benzo[g,h,i]perylene	SO	1.19E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Benzo[k]fluoranthene	SO	1.48E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Benzoic acid	SO	5.00E-02	mg/kg	MHSPE (1994)	
Benzyl alcohol	SO	6.58E+01	mg/kg	MHSPE (1994)	
Beryllium	SO	1.10E+00	mg/kg	Crommentuijn et al. (1997)	
Beryllium-7	SO	1.25E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
beta-Benzene hexachloride	SO	1.00E-03	mg/kg	MHSPE (1994)	
Bis(2-chloroisopropyl)ether	SO	2.37E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bis[2-chloroethoxy]methane	SO	3.02E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bis[2-chloroethyl] ether	SO	2.37E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bis[2-chloroisopropyl]ether	SO	2.37E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bis[2-ethylhexyl]phthalate	SO	1.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Bismuth-212	SO	9.73E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Bismuth-214	SO	8.88E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Boron	SO	5.00E-01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Bromodichloromethane	SO	5.94E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bromoform	SO	1.59E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Bromomethane	SO	2.35E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Butylbenzylphthalate	SO	1.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Cadmium	SO	1.60E+00	mg/kg	Crommentuijn et al. (1997)	
Carbon disulfide	SO	9.41E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Carbon tetrachloride	SO	1.00E+03	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Carbon-14	SO	5.88E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cerium-144	SO	2.46E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cesium-134	SO	1.02E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Cesium-137	SO	2.39E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Chlordane	SO	2.24E-01	mg/kg	EPA Region V Ecological Data Quality Levels (May, 1995)	
Chlorobenzene	SO	5.00E-02	mg/kg	Background concentrations in soil or detection limits	
Chlorobenzilate	SO	5.05E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Chloroform	SO	1.19E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Chloromethane	SO	1.04E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Chloroprene	SO	2.90E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Chromium	SO	3.20E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Chromium VI	SO	3.20E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	Chromium III
Chrysene	SO	4.73E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
cis-1,2-Dichloroethylene	SO	7.84E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	trans-isomer
cis-1,3-Dichloropropene	SO	3.98E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Cobalt	SO	2.00E+01	mg/kg	MHSPE (1994)	
Cobalt-57	SO	1.63E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cobalt-58	SO	1.70E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cobalt-60	SO	6.56E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Copper	SO	4.00E+01	mg/kg	Crommentuijn et al. (1997)	
Curium-242	SO	4.71E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-242 and Curium-244	SO	4.71E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-243	SO	4.71E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-243 and Curium-244	SO	4.71E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-244	SO	4.96E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-245 and Curium-246	SO	5.19E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Curium-246	SO	5.34E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Cyanide	SO	9.00E-01	mg/kg	CCME 1997, Recommended Canadian Soil Quality Guidelines	Cyanide, free
DDD	SO	2.50E-03	mg/kg	MHSPE (1994)	total DDD/DDE/DDT
DDE	SO	2.50E-03	mg/kg	MHSPE (1994)	total DDD/DDE/DDT
DDT	SO	2.50E-03	mg/kg	MHSPE (1994)	total DDD/DDE/DDT
delta-Benzene hexachloride	SO	2.50E-03	mg/kg	MHSPE (1994)	
Diallate	SO	4.52E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Dibenz[a,h]anthracene	SO	1.84E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Dibenzofuran	SO	6.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	Furan
Dibromochloromethane	SO	2.05E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Dibutylphthalate	SO	2.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Dichlorodifluoromethane	SO	3.95E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Dieldrin	SO	5.00E-04	mg/kg	MHSPE (1994)	
Diethylphthalate	SO	1.00E+02	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Dimethoate	SO	2.18E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Dimethylphthalate	SO	2.00E+02	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	toxicity reference value earthworms ERD-AG-003
Diocetylphthalate	SO	7.09E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Diphenylamine	SO	1.01E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Disulfoton	SO	1.99E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Endosulfan	SO	1.19E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	Endosulfan I
Endosulfan I	SO	1.19E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Endosulfan II	SO	1.19E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Endosulfan sulfate	SO	3.58E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Endrin	SO	1.00E-03	mg/kg	MHSPE (1994)	
Endrin aldehyde	SO	1.00E-03	mg/kg	MHSPE (1994)	
Endrin ketone	SO	1.00E-03	mg/kg	MHSPE (1994)	
Ethyl methacrylate	SO	3.00E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Ethylbenzene	SO	7.00E-01	mg/kg	CCME 1997, Recommended Canadian Soil Quality Guidelines	
Europium-152	SO	1.40E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Europium-154	SO	1.21E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Europium-155	SO	2.37E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Famphur	SO	4.97E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Fluoranthene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Fluorene	SO	1.22E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Fluoride	SO	3.00E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
gamma-BHC	SO	5.00E-05	mg/kg	MHSPE (1994)	Lindane
Guthion	SO	3.40E-04	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Heptachlor	SO	6.00E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Heptachlor epoxide	SO	1.52E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Heptachlorodibenzo-p-dioxins	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Heptachlorodibenzo-p-furans	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Hexachlorobenzene	SO	2.50E-03	mg/kg	MHSPE (1994)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Hexachlorobutadiene	SO	3.98E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Hexachlorocyclohexane	SO	2.50E-03	mg/kg	MHSPE (1994)	
Hexachlorocyclopentadiene	SO	1.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Hexachlorodibenzo-p-dioxins	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated dioxin isomers
Hexachlorodibenzo-p-furans	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers
Hexachloroethane	SO	5.96E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Hexachlorophene	SO	1.99E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Indeno[1,2,3-cd]pyrene	SO	1.09E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Iodine-129	SO	3.84E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Iodomethane	SO	1.23E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Iron	SO	2.00E+02	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Isobutyl alcohol	SO	2.08E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Isodrin	SO	3.32E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Isophorone	SO	1.39E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Isosafrole	SO	9.94E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Kepone	SO	3.27E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Lead	SO	5.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Lead-212	SO	7.37E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Lead-214	SO	4.17E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Lithium	SO	2.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
m,p-Cresol	SO	1.63E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Manganese	SO	1.00E+02	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Manganese-54	SO	2.02E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Mercury	SO	3.00E-01	mg/kg	MHSPE (1994)	
Methacrylonitrile	SO	5.71E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methapyrilene	SO	2.78E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methoxychlor	SO	2.00E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methyl ethyl ketone	SO	8.96E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	2-Butanone
Methyl isobutyl ketone	SO	4.43E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	4-Methyl-2-pentanone
Methyl methacrylate	SO	9.84E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methyl methanesulfonate	SO	3.15E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methyl parathion	SO	2.92E-04	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Methylene bromide	SO	6.50E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Methylene chloride	SO	2.00E+00	mg/kg	MHSPE (1994)	
Methylmercury	SO	1.58E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Molybdenum	SO	2.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Naphthalene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Neptunium-237	SO	5.92E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Neptunium-239	SO	5.85E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Nickel	SO	3.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Nickel-63	SO	1.69E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Nitrobenzene	SO	4.00E+01	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
N-Nitrosodiethylamine	SO	6.93E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosodimethylamine	SO	3.21E-05	mg/kg	EPA Region V Ecological Data Quality Levels (May, 1995)	
N-Nitrosodi-n-butylamine	SO	2.67E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosodiphenylamine	SO	2.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
N-Nitrosodipropylamine	SO	5.43E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosomethylethylamine	SO	1.66E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosomorpholine	SO	7.06E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosopiperidine	SO	6.65E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
N-Nitrosopyrrolidine	SO	1.26E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
O,O,O-Triethyl phosphorothioate	SO	8.18E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
o-Cresol	SO	4.04E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Octachlorodibenzo-p-dioxin	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated dioxin isomers
Octachlorodibenzo-p-furan	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers
o-Toluidine	SO	2.97E+00	mg/kg	NA source from UTR table	
PAH	SO	1.00E+00	mg/kg	MHSPE (1994)	total PAHs
Parathion	SO	3.40E-04	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
PCB-1016	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1221	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1232	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1242	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1248	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1254	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1260	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
PCB-1262	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Bench- mark	Units	Source	Comments
p-Cresol	SO	1.63E+02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
p-Dimethylaminoazobenzene	SO	3.98E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Pentachlorobenzene	SO	2.50E-03	mg/kg	MHSPE (1994)	
Pentachlorodibenzo-p-dioxins	SO	1.99E-07	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated dioxin isomers
Pentachlorodibenzo-p-furans	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated furan isomers
Pentachloroethane	SO	1.07E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Pentachloronitrobenzene	SO	7.09E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Pentachlorophenol	SO	2.00E-03	mg/kg	MHSPE (1994)	
Phenacetin	SO	1.17E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Phenanthrene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Phenol	SO	2.00E-02	mg/kg	Background concentrations in soil or detection limits	
Phenols	SO	2.00E-02	mg/kg	Background concentrations in soil or detection limits	Phenol
Phorate	SO	4.96E-04	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Phthalate	SO	1.00E+02	mg/kg	Efroymson, Will, Suter, Wooten, 1997. Terrestrial Plants	Diethylphalate
Plutonium-238	SO	5.23E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Plutonium-239	SO	5.59E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Plutonium-239 and Plutonium-240	SO	5.57E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Plutonium-240	SO	5.57E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Polychlorinated biphenyls	SO	2.00E-02	mg/kg	MHSPE (1994)	total PCBs
Potassium-40	SO	3.63E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
p-Phenylenediamine	SO	6.16E+00	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Promethium-144	SO	2.82E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Promethium-146	SO	2.65E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Promethium-147	SO	4.65E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Pronamide	SO	1.36E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Propionic Nitrile	SO	4.98E-02	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Protactinium-234	SO	7.80E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Protactinium-234m	SO	3.47E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Pyrene	SO	1.00E-01	mg/kg	Background concentrations in soil or detection limits	
Pyridine	SO	1.00E-01	mg/kg	MHSPE (1994)	
Radium, Total Alpha-Emitting	SO	5.05E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Radium-224	SO	5.08E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Radium-226	SO	6.01E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
Radium-228	SO	1.69E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Ruthenium-106	SO	2.88E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Safrole	SO	4.04E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Selenium	SO	8.10E-01	mg/kg	Crommentuijn et al. (1997)	
Selenium	SO	8.10E-01	mg/kg	Crommentuijn et al. (1997)	
Selenium, dissolved	SO	8.10E-01	mg/kg	Crommentuijn et al. (1997)	
Silver	SO	2.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Sodium-22	SO	7.31E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Strontium-89	SO	4.92E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Strontium-89 and Strontium-90	SO	4.92E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Strontium-90	SO	1.47E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Styrene	SO	1.00E-01	mg/kg	MHSPE (1994)	
Sulfide	SO	3.58E-03	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Technetium-99	SO	2.85E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
technical-Chlordane	SO	2.24E-01	mg/kg	USEPA Region V Ecological Data Quality Levels, (May 1995)	gamma Chlordane, alpha-Chlordane
Tetrachlorodibenzo-p-furans	SO	3.68E-05	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	polychlorinated Furan isomers
Tetrachloroethene	SO	1.00E-02	mg/kg	MHSPE (1994)	
Tetrahydrofuran	SO	1.00E-01	mg/kg	MHSPE (1994)	
Thallium	SO	1.00E+00	mg/kg	CCME 1997, Recommended Canadian Soil Quality Guidelines	
Thallium	SO	1.00E+00	mg/kg	CCME 1997, Recommended Canadian Soil Quality Guidelines	
Thallium, dissolved	SO	1.00E+00	mg/kg	CCME 1997, Recommended Canadian Soil Quality Guidelines	
Thallium-208	SO	4.55E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-228	SO	5.31E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-230	SO	6.15E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-231	SO	1.57E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-232	SO	7.20E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Thorium-234	SO	3.85E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Tin	SO	5.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Tin-113	SO	5.28E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Titanium	SO	1.00E+00	mg/kg	Efroymsen, Will, Suter 1997, Soil and Litter Invertebrates	
Toluene	SO	5.00E-02	mg/kg	MHSPE (1994)	
Toluene-d8	SO	5.00E-02	mg/kg	MHSPE (1994)	Toluene

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Toxaphene	SO	1.19E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
TPH, Gasoline Range	SO	2.00E+01	mg/kg	Background concentrations in soil or detection limits	
trans-1,2-Dichloroethylene	SO	7.84E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
trans-1,3-Dichloropropene	SO	3.98E-01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Trichloroethene	SO	1.00E-03	mg/kg	MHSPE (1994)	
Trichlorofluoromethane	SO	1.64E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Tritium	SO	4.80E+04	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium	SO	5.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Uranium-233 and Uranium-234	SO	5.96E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-234	SO	6.03E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-235	SO	6.18E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Uranium-238	SO	6.86E+01	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Vanadium	SO	2.00E+00	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Vinyl Acetate	SO	1.27E+01	mg/kg	USEPA Region V Ecological Data Quality Levels (May 1995)	
Vinyl chloride	SO	1.00E-02	mg/kg	MHSPE (1994)	
Xylenes	SO	5.00E-02	mg/kg	Background concentrations in soil or detection limits	Xylenes (total)
Yttrium-88	SO	1.47E+03	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Zinc	SO	5.00E+01	mg/kg	Efroymsen, Will, Suter, Wooten, 1997. Terrestrial Plants	
Zinc-65	SO	2.87E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
Zirconium-95	SO	2.09E+02	pCi/g	International Atomic Energy Agency (IAEA 1992)	
1,1,1,2-Tetrachloroethane	SW	2.40E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	1,1,2,2-Tetrachlorethane
1,1,1-Trichloroethane	SW	5.28E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,1,2,2-Tetrachloroethane	SW	2.40E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,1,2-Trichloroethane	SW	9.40E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,1-Dichloroethane	SW	4.70E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,1-Dichloroethene	SW	3.03E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
1,2,3,4,6,7,8-Heptachlorodibenzofuran	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
1,2,3,4,7,8-Hexachlorodibenzofuran	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD

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Analyte	Matrix	Benchmark	Units	Source	Comments
1,2,3,7,8-Pentachlorodibenzene-p-furan	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (EPA 1995)	2,3,7,8-TCDD
1,2,3-Trichloropropane	SW	5.25E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	1,2-Dichloropropane
1,2,4,5-Tetrachlorobenzene	SW	5.00E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2,4-Trichlorobenzene	SW	4.49E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2-Dibromo-3-chloropropane	SW	5.25E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	1,2-Dichloropropane
1,2-Dichlorobenzene	SW	1.58E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2-Dichloroethane	SW	2.00E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2-Dichloroethene (total)	SW	5.90E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,2-Dichloropropane	SW	5.25E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,3-Dichlorobenzene	SW	5.02E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
1,3-Dichloropropene	SW	5.50E-05	mg/L	ORNL Tier II - Suter and Tsao (1996)	
1,4-Dichlorobenzene	SW	1.12E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,3,4,6-Tetrachlorophenol	SW	1.00E-03	mg/L	CCME 1998 Canadian Water Quality Guidelines	Tetrachlorophenol ESV
2,3,7,8-Tetrachlorodibenzodioxin	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,3,7,8-Tetrachlorodibenzofuran	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
2,4,5-Trichlorophenol	SW	3.20E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,4,6-Trichlorophenol
2,4,6-Trichlorophenol	SW	3.20E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,4-Dichlorophenol	SW	3.65E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,4-Dichlorophenoxyacetic acid	SW	9.00E-01	mg/L	Verschueren.Hdbk Environ Data Org Chem 1983, p.497	2,4-D
2,4-Dimethylphenol	SW	2.12E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,4-Dinitrophenol	SW	6.20E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,4-Dinitrotoluene	SW	3.10E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,6-Dichlorophenol	SW	3.65E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2,6-Dichlorophenoxyacetic acid	SW	9.00E-01	mg/L	Verschueren.Hdbk Environ Data Org Chem 1983, p.497	2,4-D
2,6-Dinitrophenol	SW	6.20E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,4-Dinitrophenol
2,6-Dinitrotoluene	SW	3.10E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,4-Dinitrotoluene
2-Chlorophenol	SW	4.38E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2-Hexanone	SW	9.90E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
2-Methylnaphthalene	SW	2.10E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
2-Nitrophenol	SW	3.50E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
2-sec-Butyl-4,6-Dinitrophenol	SW	9.00E-01	mg/L	Verschueren.Hdbk Environ Data Org Chem 1983, p.497	
4,6-Dinitro-2-Methylphenol	SW	2.30E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	

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Analyte	Matrix	Benchmark	Units	Source	Comments
4-Bromophenyl phenyl ether	SW	1.50E-03	mg/L	Ecotox Thresholds (USEPA 1996)	
4-Nitrophenol	SW	8.28E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Acenaphthene	SW	1.70E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Acenaphthylene	SW	1.70E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Acetone	SW	1.50E+00	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Acrolein	SW	2.10E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Acrylonitrile	SW	7.55E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Actinium-228	SW	1.34E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Aldrin	SW	3.00E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
alpha-Benzene hexachloride	SW	5.00E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
alpha-Chlordane	SW	4.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Aluminum	SW	8.70E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Americium-241	SW	3.51E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Americium-243	SW	3.65E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Ammonia	SW	1.27E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Aniline	SW	2.20E-03	mg/L	CCME 1998 Canadian Water Quality Guidelines	
Anthracene	SW	7.30E-04	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Antimony	SW	1.60E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Antimony-124	SW	8.77E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Antimony-125	SW	3.64E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Arsenic	SW	1.90E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Barium	SW	3.90E-03	mg/L	Ecotox Thresholds (EPA 1996)	
Barium-133	SW	4.23E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Barium-140	SW	3.92E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Benzene	SW	5.30E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Benzidine	SW	2.50E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Benzo[a]anthracene	SW	2.70E-05	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Benzo[a]pyrene	SW	1.40E-05	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Benzoic acid	SW	4.20E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Benzyl alcohol	SW	8.60E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Beryllium	SW	5.30E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Beryllium-7	SW	2.73E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
beta-Benzene hexachloride	SW	5.00E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Bis(2-chloroisopropyl)ether	SW	2.38E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Bis(2-chloroethyl)ether
Bis[2-chloroethyl] ether	SW	2.38E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Bis[2-chloroisopropyl]ether	SW	2.38E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Bis(2-chloroethyl)ether
Bis[2-ethylhexyl]phthalate	SW	3.00E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Bismuth-212	SW	6.91E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Bismuth-214	SW	8.95E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Boron	SW	7.50E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Bromoform	SW	2.93E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Bromomethane	SW	1.10E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Butylbenzylphthalate	SW	2.20E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Cadmium	SW	1.30E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Fourmile Branch (FMB)-Specific SW Hardness 6.38
Cadmium	SW	3.98E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Lower Three Runs (LTR)-Specific SW Hardness 26.64
Cadmium	SW	3.42E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Cadmium	SW	2.27E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Cadmium	SW	1.94E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Cadmium	SW	1.67E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81
Carbon disulfide	SW	9.00E-04	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Carbon tetrachloride	SW	3.52E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Carbon-14	SW	3.99E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cerium-141	SW	7.89E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cerium-144	SW	1.69E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cesium-134	SW	1.12E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cesium-137	SW	2.47E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Chlordane	SW	4.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Chloride	SW	2.30E+02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Chlorobenzene	SW	1.95E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Chloroethane	SW	5.50E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Chloromethane (Methyl chloride)
Chloroform	SW	2.89E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Benchmark	Units	Source	Comments
Chloromethane	SW	5.50E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Chromium	SW	7.01E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	LTR-Specific SW Hardness 26.64
Chromium	SW	5.98E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Chromium	SW	3.90E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Chromium	SW	3.30E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Chromium	SW	2.17E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	FMB-Specific SW Hardness 6.38
Chromium, dissolved	SW	2.83E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81, CR III
Chromium-51	SW	5.10E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
cis-1,2-Dichloroethylene	SW	5.90E-01	mg/L	ORNL Tier II - Suter and Tsao (1996)	total DCE
cis-1,3-Dichloropropene	SW	2.44E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Cobalt	SW	3.00E-03	mg/L	Ecotox Thresholds (USEPA 1996)	
Cobalt	SW	3.00E-03	mg/L	Ecotox Thresholds (USEPA 1996)	
Cobalt, dissolved	SW	3.00E-03	mg/L	Ecotox Thresholds (USEPA 1996)	
Cobalt-57	SW	1.34E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cobalt-58	SW	1.91E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cobalt-60	SW	7.47E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Copper	SW	1.13E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	FMB-Specific SW Hardness 6.38
Copper	SW	3.82E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	LTR-Specific SW Hardness 26.64
Copper	SW	3.24E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Copper	SW	2.07E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Copper	SW	1.74E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Copper	SW	1.48E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81
Creosote	SW	6.40E-01	mg/L	USEPA AQUIRE Database Search	
Curium-242	SW	3.20E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Curium-242 and Curium-244	SW	3.20E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Curium-243	SW	3.22E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Bench- mark	Units	Source	Comments
Curium-243 and Curium-244	SW	3.22E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Curium-244	SW	3.36E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Curium-245 and Curium-246	SW	3.53E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Curium-246	SW	3.63E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Cyanide	SW	5.20E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
DDD	SW	6.40E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
DDE	SW	1.05E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
DDT	SW	1.00E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
delta-Benzene hexachloride	SW	8.00E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	gamma-BHC (Lindane)
Diazinon	SW	4.30E-05	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Dibenzofuran	SW	3.70E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Dibutylphthalate	SW	9.40E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Dieldrin	SW	5.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Diethylphthalate	SW	5.21E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Dimethoate	SW	6.20E-03	mg/L	CCME 1998 Canadian Water Quality Guidelines	
Dimethylphthalate	SW	3.30E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Diocetylphthalate	SW	7.08E-01	mg/L	ORNL Lowest Chronic Value - Suter and Tsao (1996)	
Endosulfan	SW	5.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Endosulfan I
Endosulfan I	SW	5.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Endosulfan II	SW	5.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Endosulfan sulfate	SW	5.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Endosulfan
Endrin	SW	2.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Endrin aldehyde	SW	2.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Endrin
Endrin ketone	SW	2.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Endrin
Ethylbenzene	SW	4.53E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Europium-152	SW	1.49E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Europium-154	SW	1.26E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Europium-155	SW	1.57E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Fluoranthene	SW	3.98E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Fluorene	SW	3.90E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
gamma-BHC	SW	8.00E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Guthion	SW	1.00E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Heptachlor	SW	3.80E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Heptachlor epoxide	SW	3.86E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Heptachlorodibenzo-p-dioxins	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Heptachlorodibenzo-p-furans	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Hexachlorobenzene	SW	1.20E+01	mg/L	Handbook Acute Toxicity Fish and Aquatic Invertebrates	
Hexachlorobutadiene	SW	9.00E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Hexachlorocyclohexane	SW	2.20E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Hexachlorocyclopentadiene	SW	7.00E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Hexachlorodibenzo-p-dioxins	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Hexachlorodibenzo-p-furans	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Hexachloroethane	SW	9.80E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Hydrazobenzene	SW	2.70E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Iodine-129	SW	2.04E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Iodine-131	SW	3.38E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Iron	SW	1.00E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Iron-59	SW	1.48E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Isophorone	SW	1.17E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Lead	SW	9.60E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	FMB-Specific SW Hardness 6.38
Lead	SW	5.91E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	LTR-Specific SW Hardness 26.64
Lead	SW	4.62E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Lead	SW	2.37E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Lead	SW	1.84E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Lead	SW	1.44E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81
Lead-212	SW	6.01E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Lead-214	SW	3.58E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Lithium	SW	1.40E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Magnesium	SW	8.20E+01	mg/L	ORNL Lowest Chronic Value - Suter and Tsao (1996)	
Malathion	SW	1.00E-04	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Manganese	SW	8.00E-02	mg/L	Ecotox Thresholds (USEPA 1996)	
Manganese-54	SW	2.29E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Mercury	SW	1.20E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Methoxychlor	SW	3.00E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Methyl ethyl ketone	SW	1.40E+01	mg/L	ORNL Tier II - Suter and Tsao (1996)	2-Butanone
Methyl isobutyl ketone	SW	1.70E-01	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Methyl parathion	SW	1.30E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Parathion
Methylene bromide	SW	1.10E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Methyl bromide
Methylene chloride	SW	1.93E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Methylmercury	SW	2.80E-06	mg/L	ORNL Tier II Suter and Tsao (1996)	
Mirex	SW	1.00E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Molybdenum	SW	2.40E-01	mg/L	Ecotox Thresholds (USEPA 1996)	
m-Xylene	SW	1.80E-03	mg/L	Ecotox Thresholds (USEPA 1996)	
Naphthalene	SW	6.20E-02	mg/L	Region IV Ambient Water Quality Values (EPA 1995)	
Neptunium-237	SW	4.01E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Neptunium-239	SW	4.49E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Nickel	SW	1.54E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	FMB-Specific SW Hardness 6.38
Nickel	SW	5.15E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	LTR-Specific SW Hardness 26.64
Nickel	SW	4.38E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Nickel	SW	2.81E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Nickel	SW	2.37E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Nickel	SW	2.02E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81
Nickel-63	SW	1.15E+08	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Niobium-95	SW	2.39E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Nitrobenzene	SW	2.70E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
N-Nitrosodiethylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine
N-Nitrosodimethylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine
N-Nitrosodi-n-butylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine
N-Nitrosodiphenylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine
N-Nitrosodipropylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine
N-Nitrosomethylethylamine	SW	5.85E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	N-Nitrosodiphenylamine

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ECOLOGICAL BENCHMARKS — TIER I

Analyte	Matrix	Bench- mark	Units	Source	Comments
o-Cresol	SW	1.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Octachlorodibenzo-p-dioxin	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Octachlorodibenzo-p-furan	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
o-Xylene	SW	1.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Parathion	SW	1.30E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1016	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1221	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1232	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1242	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1248	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1254	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1260	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
PCB-1262	SW	1.40E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
p-Cresol	SW	1.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Pentachlorobenzene	SW	5.00E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Pentachlorodibenzo-p-dioxins	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Pentachlorodibenzo-p-furans	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Pentachloronitrobenzene	SW	5.00E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Pentachlorophenol	SW	1.50E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Phenanthrene	SW	6.30E-03	mg/L	Ecotox Thresholds (EPA 1996)	
Phenol	SW	2.56E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Plutonium-238	SW	3.55E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Plutonium-239	SW	3.79E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Plutonium-239 and Plutonium-240	SW	3.78E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Plutonium-240	SW	3.78E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Plutonium-242	SW	3.99E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Polychlorinated biphenyls	SW	1.40E-04	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Potassium	SW	5.30E+01	mg/L	ORNL Lowest Chronic Value - Suter and Tsao (1996)	
Potassium-40	SW	2.87E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Promethium-144	SW	1.22E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Promethium-146	SW	2.28E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Promethium-147	SW	3.15E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
p-Xylene	SW	1.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	Xylene

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Analyte	Matrix	Benchmark	Units	Source	Comments
Pyrene	SW	2.50E-05	mg/L	CCME 1998 Canadian Water Quality Guidelines	
Radium, Total Alpha-Emitting	SW	3.43E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Radium-226	SW	4.08E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Radium-226 Or Uranium-236	SW	4.08E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Radium-228	SW	1.15E+08	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Ruthenium-103	SW	3.56E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Ruthenium-106	SW	1.96E+08	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Selenium	SW	5.00E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Silica	SW	4.90E+01	mg/L	USEPA AQUIRE Database Search	
Silver	SW	1.20E-05	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Sodium	SW	6.80E+02	mg/L	ORNL Lowest Chronic Value - Suter and Tsao (1996)	
Sodium-22	SW	8.11E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Strontium	SW	1.50E+00	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Strontium-89	SW	3.35E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Strontium-89 and Strontium-90	SW	3.35E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Strontium-90	SW	9.97E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Styrene	SW	7.20E-02	mg/L	CCME 1998 Canadian Water Quality Guidelines	
Sulfide	SW	2.00E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Sulfur-35	SW	3.99E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Technetium-99	SW	1.94E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
technical-Chlordane	SW	4.30E-06	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Chlordane
Tetrachlorodibenzo-p-furans	SW	1.00E-08	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	2,3,7,8-TCDD
Tetrachloroethene	SW	8.40E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Thallium	SW	4.00E-03	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Thallium-208	SW	4.88E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Thorium-228	SW	3.60E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Thorium-230	SW	4.17E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Thorium-232	SW	4.88E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Thorium-234	SW	2.57E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Tin	SW	7.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Tin-113	SW	6.24E+07	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Titanium	SW	6.50E+00	mg/L	US EPA AQUIRE Database Search	Titanium chloride
Toluene	SW	1.75E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	

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Analyte	Matrix	Bench- mark	Units	Source	Comments
Toluene-d8	SW	1.75E-01	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Toxaphene	SW	2.00E-07	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
trans-1,2-Dichloroethylene	SW	1.35E+00	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
trans-1,3-Dichloropropene	SW	2.44E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	
Trichloroethene	SW	4.70E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Trichlorofluoromethane	SW	4.70E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Tritium	SW	3.26E+08	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Uranium	SW	2.60E-03	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Uranium-233 and Uranium-234	SW	4.04E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Uranium-234	SW	4.09E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Uranium-235	SW	4.25E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Uranium-238	SW	4.65E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Vanadium	SW	1.90E-02	mg/L	Ecotox Thresholds (EPA 1996)	
Vinyl Acetate	SW	1.60E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	
Xylenes	SW	1.30E-02	mg/L	ORNL Tier II - Suter and Tsao (1996)	Xylene
Yttrium-88	SW	7.18E+05	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Zinc	SW	1.88E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Savannah River-Specific SW Hardness 13.01
Zinc	SW	1.03E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	FMB-Specific SW Hardness 6.38
Zinc	SW	3.46E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	LTR-Specific SW Hardness 26.64
Zinc	SW	2.94E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Pen Branch-Specific SW Hardness 21.98
Zinc	SW	1.59E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Steel Creek-Specific SW Hardness 10.64
Zinc	SW	1.35E-02	mg/L	Region IV Ambient Water Quality Values (USEPA 1995)	Upper Three Runs-Specific SW Hardness 8.81
Zinc-65	SW	3.26E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	
Zirconium-95	SW	2.26E+06	pCi/L	International Atomic Energy Agency (IAEA 1992)	

Notes: SE = Sediment

SO = Soil

SW = Surface Water

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**ECOLOGICAL BENCHMARKS — TIER II**

Analyte	Matrix	Benchmark	Units	Source
2-Methylnaphthalene	SE	2.01E-01	mg/kg	Effect Level CCME
2-Methylnaphthalene	SE	2.01E-01	mg/kg	Effect Level ORNL
2-Methylnaphthalene	SE	6.70E-01	mg/kg	Effect Median ORNL
Acenaphthene	SE	8.89E-02	mg/kg	Effect Level CCME
Acenaphthene	SE	5.00E-01	mg/kg	Effect Median ORNL
Acenaphthylene	SE	1.28E-01	mg/kg	Effect Level ORNL
Acenaphthylene	SE	6.40E-01	mg/kg	Effect Median ORNL
alpha-Chlordane	SE	8.87E-03	mg/kg	Effect Level CCME
alpha-Chlordane	SE	4.79E-03	mg/kg	Effect Level ORNL
alpha-Chlordane	SE	6.00E-03	mg/kg	Effect Median ORNL
Anthracene	SE	2.45E-01	mg/kg	Effect Level CCME
Anthracene	SE	2.45E-01	mg/kg	Effect Level ORNL
Anthracene	SE	1.10E+00	mg/kg	Effect Median ORNL
Antimony	SE	2.50E+01	mg/kg	Effect Median ORNL
Arsenic	SE	1.70E+01	mg/kg	Effect Level CCME
Arsenic	SE	4.16E+01	mg/kg	Effect Level ORNL
Arsenic	SE	7.00E+01	mg/kg	Effect Median ORNL
Benzo[a]anthracene	SE	3.85E-01	mg/kg	Effect Level CCME
Benzo[a]anthracene	SE	6.93E-01	mg/kg	Effect Level ORNL
Benzo[a]anthracene	SE	1.60E+00	mg/kg	Effect Median ORNL
Benzo[a]pyrene	SE	7.82E-01	mg/kg	Effect Level CCME
Benzo[a]pyrene	SE	7.63E-01	mg/kg	Effect Level ORNL
Benzo[a]pyrene	SE	1.60E+00	mg/kg	Effect Median ORNL
Benzo[b]fluoranthene	SE	2.36E+00	mg/kg	Effect Level CCME
Benzo[b]fluoranthene	SE	1.49E+00	mg/kg	Effect Level ORNL
Benzo[b]fluoranthene	SE	5.10E+00	mg/kg	Effect Median ORNL
Bis[2-ethylhexyl]phthalate	SE	2.65E+00	mg/kg	Effect Level ORNL
Cadmium	SE	3.53E+00	mg/kg	Effect Level CCME
Cadmium	SE	4.21E+00	mg/kg	Effect Level ORNL
Cadmium	SE	9.60E+00	mg/kg	Effect Median ORNL
Chlordane	SE	8.87E-03	mg/kg	Effect Level CCME
Chlordane	SE	4.79E-03	mg/kg	Effect Level ORNL
Chlordane	SE	6.00E-03	mg/kg	Effect Median ORNL
Chromium	SE	9.00E+01	mg/kg	Effect Level CCME

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Analyte	Matrix	Benchmark	Units	Source
Chromium	SE	1.60E+02	mg/kg	Effect Level ORNL
Chromium	SE	3.70E+02	mg/kg	Effect Median ORNL
Chromium VI	SE	9.00E+01	mg/kg	Effect Level CCME
Chromium VI	SE	1.60E+02	mg/kg	Effect Level ORNL
Chromium VI	SE	3.70E+02	mg/kg	Effect Median ORNL
Chrysene	SE	8.62E-01	mg/kg	Effect Level CCME
Chrysene	SE	8.46E-01	mg/kg	Effect Level ORNL
Chrysene	SE	2.80E+00	mg/kg	Effect Median ORNL
Copper	SE	1.97E+02	mg/kg	Effect Level CCME
Copper	SE	1.08E+02	mg/kg	Effect Level ORNL
Copper	SE	2.70E+02	mg/kg	Effect Median ORNL
DDD	SE	8.51E-03	mg/kg	Effect Level CCME
DDD	SE	7.81E-03	mg/kg	Effect Level ORNL
DDD	SE	2.00E-02	mg/kg	Effect Median ORNL
DDE	SE	6.75E-03	mg/kg	Effect Level CCME
DDE	SE	3.74E-01	mg/kg	Effect Level ORNL
DDE	SE	2.70E-02	mg/kg	Effect Median ORNL
DDT	SE	4.77E-03	mg/kg	Effect Level CCME
DDT	SE	4.77E-03	mg/kg	Effect Level ORNL
DDT	SE	7.00E-03	mg/kg	Effect Median ORNL
Dibenz[a,h]anthracene	SE	1.35E-01	mg/kg	Effect Level CCME
Dibenz[a,h]anthracene	SE	1.35E-01	mg/kg	Effect Level ORNL
Dibenz[a,h]anthracene	SE	2.60E-01	mg/kg	Effect Median ORNL
Dieldrin	SE	6.67E-03	mg/kg	Effect Level CCME
Dieldrin	SE	4.30E-03	mg/kg	Effect Level ORNL
Dieldrin	SE	8.00E-03	mg/kg	Effect Median ORNL
Endrin	SE	6.24E-02	mg/kg	Effect Level CCME
Endrin	SE	4.50E-02	mg/kg	Effect Median ORNL
Endrin aldehyde	SE	6.24E-02	mg/kg	Effect Level CCME
Endrin aldehyde	SE	4.50E-02	mg/kg	Effect Median ORNL
Endrin ketone	SE	6.24E-02	mg/kg	Effect Level CCME
Endrin ketone	SE	4.50E-02	mg/kg	Effect Median ORNL
Fluoranthene	SE	2.36E+00	mg/kg	Effect Level CCME
Fluoranthene	SE	1.49E+00	mg/kg	Effect Level ORNL

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Analyte	Matrix	Benchmark	Units	Source
Fluoranthene	SE	5.10E+00	mg/kg	Effect Median ORNL
Fluorene	SE	1.44E-01	mg/kg	Effect Level CCME
Fluorene	SE	1.44E-01	mg/kg	Effect Level ORNL
Fluorene	SE	5.40E-01	mg/kg	Effect Median ORNL
gamma-BHC	SE	1.38E-03	mg/kg	Effect Level CCME
gamma-BHC	SE	9.90E-04	mg/kg	Effect Level ORNL
Heptachlor	SE	2.74E-03	mg/kg	Effect Level CCME
Heptachlor epoxide	SE	2.74E-03	mg/kg	Effect Level CCME
Lead	SE	9.13E+01	mg/kg	Effect Level CCME
Lead	SE	1.12E+02	mg/kg	Effect Level ORNL
Lead	SE	2.18E+02	mg/kg	Effect Median ORNL
Mercury	SE	4.86E-01	mg/kg	Effect Level CCME
Mercury	SE	7.00E-01	mg/kg	Effect Level ORNL
Mercury	SE	7.10E-01	mg/kg	Effect Median ORNL
Naphthalene	SE	3.91E-01	mg/kg	Effect Level CCME
Naphthalene	SE	3.90E-01	mg/kg	Effect Level ORNL
Naphthalene	SE	2.10E+00	mg/kg	Effect Median ORNL
Nickel	SE	4.28E+01	mg/kg	Effect Level ORNL
Nickel	SE	5.16E+01	mg/kg	Effect Median ORNL
PAH	SE	1.68E+01	mg/kg	Effect Level ORNL
PAH	SE	4.48E+01	mg/kg	Effect Median ORNL
PCB-1016	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1016	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1016	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1221	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1221	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1221	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1232	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1232	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1232	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1242	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1242	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1242	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1248	SE	2.77E-01	mg/kg	Effect Level CCME

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Analyte	Matrix	Benchmark	Units	Source
PCB-1248	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1248	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1254	SE	3.40E-01	mg/kg	Effect Level CCME
PCB-1254	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1254	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1260	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1260	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1260	SE	1.80E-01	mg/kg	Effect Median ORNL
PCB-1262	SE	2.77E-01	mg/kg	Effect Level CCME
PCB-1262	SE	1.89E-01	mg/kg	Effect Level ORNL
PCB-1262	SE	1.80E-01	mg/kg	Effect Median ORNL
Phenanthrene	SE	5.15E-01	mg/kg	Effect Level CCME
Phenanthrene	SE	5.44E-01	mg/kg	Effect Level ORNL
Phenanthrene	SE	1.50E+00	mg/kg	Effect Median ORNL
Polychlorinated biphenyls	SE	2.77E-01	mg/kg	Effect Level CCME
Polychlorinated biphenyls	SE	1.89E-01	mg/kg	Effect Level ORNL
Polychlorinated biphenyls	SE	1.80E-01	mg/kg	Effect Median ORNL
Pyrene	SE	8.75E-01	mg/kg	Effect Level CCME
Pyrene	SE	1.40E+00	mg/kg	Effect Level ORNL
Pyrene	SE	2.60E+00	mg/kg	Effect Median ORNL
Silver	SE	1.77E+00	mg/kg	Effect Level ORNL
Silver	SE	3.70E+00	mg/kg	Effect Median ORNL
technical-Chlordane	SE	8.87E-03	mg/kg	Effect Level CCME
technical-Chlordane	SE	4.79E-03	mg/kg	Effect Level ORNL
technical-Chlordane	SE	6.00E-03	mg/kg	Effect Median ORNL
Toxaphene	SE	1.00E-04	mg/kg	Effect Level CCME
Zinc	SE	3.15E+02	mg/kg	Effect Level CCME
Zinc	SE	2.71E+02	mg/kg	Effect Level ORNL
Zinc	SE	4.10E+02	mg/kg	Effect Median ORNL
1,1,1,2-Tetrachloroethane	SW	9.32E-01	mg/L	AWQC
1,1,1,2-Tetrachloroethane	SW	2.10E+00	mg/L	ORNL
1,1,1-Trichloroethane	SW	5.28E+00	mg/L	AWQC
1,1,1-Trichloroethane	SW	2.00E-01	mg/L	ORNL
1,1,2,2-Tetrachloroethane	SW	9.32E-01	mg/L	AWQC

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Analyte	Matrix	Benchmark	Units	Source
1,1,2,2-Tetrachloroethane	SW	2.10E+00	mg/L	ORNL
1,1,2-Trichloroethane	SW	3.60E+00	mg/L	AWQC
1,1,2-Trichloroethane	SW	5.20E+00	mg/L	ORNL
1,1-Dichloroethane	SW	8.30E-01	mg/L	ORNL
1,1-Dichloroethene	SW	3.03E+00	mg/L	AWQC
1,1-Dichloroethene	SW	4.50E-01	mg/L	ORNL
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	SW	1.00E-04	mg/L	AWQC
1,2,3,4,6,7,8-Heptachlorodibenzofuran	SW	1.00E-04	mg/L	AWQC
1,2,3,4,7,8-Hexachlorodibenzofuran	SW	1.00E-04	mg/L	AWQC
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	SW	1.00E-04	mg/L	AWQC
1,2,3,7,8-Pentachlorodibenzene-p-furan	SW	1.00E-04	mg/L	AWQC
1,2,3-Trichloropropane	SW	5.25E+00	mg/L	AWQC
1,2,4,5-Tetrachlorobenzene	SW	2.50E-01	mg/L	AWQC
1,2,4-Trichlorobenzene	SW	1.50E-01	mg/L	AWQC
1,2,4-Trichlorobenzene	SW	7.00E-01	mg/L	ORNL
1,2-Dibromo-3-chloropropane	SW	5.25E+00	mg/L	AWQC
1,2-Dichlorobenzene	SW	1.58E-01	mg/L	AWQC
1,2-Dichlorobenzene	SW	2.60E-01	mg/L	ORNL
1,2-Dichloroethane	SW	1.18E+02	mg/L	AWQC
1,2-Dichloroethane	SW	8.80E+00	mg/L	ORNL
1,2-Dichloroethene (total)	SW	1.35E+01	mg/L	AWQC
1,2-Dichloroethene (total)	SW	1.10E+00	mg/L	ORNL
1,2-Dichloropropane	SW	5.25E+00	mg/L	AWQC
1,3-Dichlorobenzene	SW	5.02E-01	mg/L	AWQC
1,3-Dichlorobenzene	SW	6.30E-01	mg/L	ORNL
1,3-Dichloropropene	SW	9.90E-04	mg/L	ORNL
1,4-Dichlorobenzene	SW	1.12E-01	mg/L	AWQC
1,4-Dichlorobenzene	SW	1.80E-01	mg/L	ORNL
2,3,7,8-Tetrachlorodibenzodioxin	SW	1.00E-04	mg/L	AWQC
2,3,7,8-Tetrachlorodibenzofuran	SW	1.00E-04	mg/L	AWQC
2,4,5-Trichlorophenol	SW	3.20E-02	mg/L	AWQC
2,4,6-Trichlorophenol	SW	3.20E-02	mg/L	AWQC
2,4-Dichlorophenol	SW	2.02E-01	mg/L	AWQC
2,4-Dimethylphenol	SW	2.12E-01	mg/L	AWQC

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**ECOLOGICAL BENCHMARKS — TIER II**

Analyte	Matrix	Benchmark	Units	Source
2,4-Dinitrophenol	SW	6.20E-02	mg/L	AWQC
2,4-Dinitrotoluene	SW	3.10E+00	mg/L	AWQC
2,6-Dichlorophenol	SW	2.02E-01	mg/L	AWQC
2,6-Dinitrophenol	SW	6.20E-02	mg/L	AWQC
2,6-Dinitrotoluene	SW	3.10E+00	mg/L	AWQC
2-Chlorophenol	SW	4.38E-01	mg/L	AWQC
2-Hexanone	SW	1.80E+00	mg/L	ORNL
2-Methylnaphthalene	SW	3.70E-02	mg/L	ORNL
4,6-Dinitro-2-Methylphenol	SW	2.30E-02	mg/L	AWQC
4-Nitrophenol	SW	8.28E-01	mg/L	AWQC
4-Nitrophenol	SW	1.20E+00	mg/L	ORNL
Acenaphthene	SW	1.70E-01	mg/L	AWQC
Acenaphthylene	SW	1.70E-01	mg/L	AWQC
Acetone	SW	2.80E+01	mg/L	ORNL
Acrolein	SW	6.80E-03	mg/L	AWQC
Acrylonitrile	SW	7.55E-01	mg/L	AWQC
Aldrin	SW	3.00E-03	mg/L	AWQC
alpha-Chlordane	SW	2.40E-03	mg/L	AWQC
Aluminum	SW	7.50E-01	mg/L	AWQC
Ammonia	SW	8.40E+00	mg/L	AWQC
Anthracene	SW	1.30E-02	mg/L	ORNL
Antimony	SW	1.30E+00	mg/L	AWQC
Antimony	SW	1.80E-01	mg/L	ORNL
Arsenic	SW	3.60E-01	mg/L	AWQC
Arsenic	SW	6.60E-02	mg/L	ORNL
Barium	SW	1.10E-01	mg/L	ORNL
Benzene	SW	5.30E-01	mg/L	AWQC
Benzene	SW	2.30E+00	mg/L	ORNL
Benzidine	SW	2.50E-01	mg/L	AWQC
Benzidine	SW	7.00E-02	mg/L	ORNL
Benzo[a]anthracene	SW	4.90E-04	mg/L	ORNL
Benzo[a]pyrene	SW	2.40E-04	mg/L	ORNL
Benzoic acid	SW	7.40E-01	mg/L	ORNL
Benzyl alcohol	SW	1.50E-01	mg/L	ORNL

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Analyte	Matrix	Benchmark	Units	Source
Beryllium	SW	1.60E-02	mg/L	AWQC
Beryllium	SW	3.50E-02	mg/L	ORNL
Bis(2-chloroisopropyl)ether	SW	2.38E+01	mg/L	AWQC
Bis[2-chloroethyl] ether	SW	2.38E+01	mg/L	AWQC
Bis[2-chloroisopropyl]ether	SW	2.38E+01	mg/L	AWQC
Bis[2-ethylhexyl]phthalate	SW	1.11E+00	mg/L	AWQC
Bis[2-ethylhexyl]phthalate	SW	2.70E-02	mg/L	ORNL
Boron	SW	3.00E-02	mg/L	ORNL
Bromoform	SW	2.93E+00	mg/L	AWQC
Bromoform	SW	2.30E+00	mg/L	ORNL
Bromomethane	SW	1.10E+00	mg/L	AWQC
Butylbenzylphthalate	SW	3.30E-01	mg/L	AWQC
Cadmium	SW	1.76E-04	mg/L	AWQC Adjusted, FMB Hardness 6.38
Cadmium	SW	8.82E-04	mg/L	AWQC Adjusted, Lower Three Runs (LTR) Hardness 26.64
Cadmium	SW	7.10E-04	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Cadmium	SW	3.93E-04	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Cadmium	SW	3.13E-04	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Cadmium	SW	2.53E-04	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Cadmium	SW	3.13E-04	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Carbon disulfide	SW	1.70E-02	mg/L	ORNL
Carbon tetrachloride	SW	3.52E+00	mg/L	AWQC
Carbon tetrachloride	SW	1.80E-01	mg/L	ORNL
Chlordane	SW	2.40E-03	mg/L	AWQC
Chloride	SW	8.60E+02	mg/L	AWQC
Chlorobenzene	SW	1.95E+00	mg/L	AWQC
Chlorobenzene	SW	1.11E+00	mg/L	ORNL
Chloroethane	SW	5.50E+01	mg/L	AWQC
Chloroform	SW	2.89E+00	mg/L	AWQC
Chloroform	SW	4.90E-01	mg/L	ORNL
Chloromethane	SW	5.50E+01	mg/L	AWQC
Chromium	SW	1.82E-01	mg/L	AWQC Adjusted, FMB Hardness 6.38
Chromium	SW	5.88E-01	mg/L	AWQC Adjusted, LTR Hardness 26.64
Chromium	SW	5.02E-01	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Chromium	SW	3.27E-01	mg/L	AWQC Adjusted, Savannah River Hardness 13.01

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Analyte	Matrix	Benchmark	Units	Source
Chromium	SW	2.77E-01	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Chromium	SW	2.37E-01	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Chromium III	SW	1.82E-01	mg/L	AWQC Adjusted, FMB Hardness 6.38
Chromium III	SW	5.88E-01	mg/L	AWQC Adjusted, LTR Hardness 26.64
Chromium III	SW	5.02E-01	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Chromium III	SW	3.27E-01	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Chromium III	SW	2.77E-01	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Chromium III	SW	2.37E-01	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Chromium VI	SW	1.60E-02	mg/L	AWQC
cis-1,2-Dichloroethylene	SW	1.35E+01	mg/L	AWQC
cis-1,2-Dichloroethylene	SW	1.10E+00	mg/L	ORNL
cis-1,3-Dichloropropene	SW	6.06E-01	mg/L	AWQC
cis-1,3-Dichloropropene	SW	9.90E-02	mg/L	ORNL
Cobalt	SW	1.50E+00	mg/L	ORNL
Copper	SW	1.33E-03	mg/L	AWQC Adjusted, FMB Hardness 6.38
Copper	SW	5.10E-03	mg/L	AWQC Adjusted, LTR Hardness 26.64
Copper	SW	4.25E-03	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Copper	SW	2.60E-03	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Copper	SW	2.15E-03	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Copper	SW	1.80E-03	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Cyanide	SW	2.20E-02	mg/L	AWQC
DDD	SW	6.40E-05	mg/L	AWQC
DDD	SW	1.90E-04	mg/L	ORNL
DDE	SW	1.05E-01	mg/L	AWQC
DDT	SW	1.10E-03	mg/L	AWQC
delta-Benzene hexachloride	SW	3.90E-02	mg/L	ORNL
Diazinon	SW	1.70E-04	mg/L	ORNL
Dibenzofuran	SW	6.60E-02	mg/L	ORNL
Dibutylphthalate	SW	9.40E-02	mg/L	AWQC
Dibutylphthalate	SW	1.90E-01	mg/L	ORNL
Dieldrin	SW	2.40E-04	mg/L	AWQC
Diethylphthalate	SW	5.21E+00	mg/L	AWQC
Diethylphthalate	SW	1.80E+00	mg/L	ORNL
Dimethylphthalate	SW	3.30E+00	mg/L	AWQC

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Analyte	Matrix	Benchmark	Units	Source
Endosulfan	SW	2.20E-04	mg/L	AWQC
Endosulfan I	SW	2.20E-04	mg/L	AWQC
Endosulfan II	SW	2.20E-04	mg/L	AWQC
Endosulfan sulfate	SW	2.20E-04	mg/L	AWQC
Endrin	SW	1.80E-04	mg/L	AWQC
Endrin aldehyde	SW	1.80E-04	mg/L	AWQC
Endrin ketone	SW	1.80E-04	mg/L	AWQC
Ethylbenzene	SW	4.53E+00	mg/L	AWQC
Ethylbenzene	SW	1.30E-01	mg/L	ORNL
Fluoranthene	SW	3.98E-01	mg/L	AWQC
Fluorene	SW	7.00E-02	mg/L	ORNL
gamma-BHC	SW	9.50E-04	mg/L	AWQC
Heptachlor	SW	5.20E-04	mg/L	AWQC
Heptachlor	SW	1.25E-04	mg/L	ORNL
Heptachlor epoxide	SW	5.20E-04	mg/L	AWQC
Heptachlorodibenzo-p-dioxins	SW	1.00E-04	mg/L	AWQC
Heptachlorodibenzo-p-furans	SW	1.00E-04	mg/L	AWQC
Hexachlorobutadiene	SW	9.00E-03	mg/L	AWQC
Hexachlorocyclohexane	SW	3.90E-02	mg/L	ORNL
Hexachlorocyclopentadiene	SW	7.00E-04	mg/L	AWQC
Hexachlorodibenzo-p-dioxins	SW	1.00E-04	mg/L	AWQC
Hexachlorodibenzo-p-furans	SW	1.00E-04	mg/L	AWQC
Hexachloroethane	SW	9.80E-02	mg/L	AWQC
Hexachloroethane	SW	2.10E-01	mg/L	ORNL
Hydrazobenzene	SW	2.70E-02	mg/L	AWQC
Isophorone	SW	1.17E+01	mg/L	AWQC
Lead	SW	2.46E-03	mg/L	AWQC Adjusted, FMB Hardness 6.38
Lead	SW	1.52E-02	mg/L	AWQC Adjusted, LTR Hardness 26.64
Lead	SW	1.19E-02	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Lead	SW	6.09E-03	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Lead	SW	4.71E-03	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Lead	SW	3.71E-03	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Lithium	SW	2.60E-01	mg/L	ORNL
Manganese	SW	2.30E+00	mg/L	ORNL

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**ECOLOGICAL BENCHMARKS — TIER II**

Analyte	Matrix	Benchmark	Units	Source
Mercury	SW	2.40E-03	mg/L	AWQC
Mercury	SW	9.90E-05	mg/L	ORNL
Methyl ethyl ketone	SW	2.40E+02	mg/L	ORNL
Methyl parathion	SW	6.50E-05	mg/L	AWQC
Methylene bromide	SW	1.10E+00	mg/L	AWQC
Methylene chloride	SW	1.93E+02	mg/L	AWQC
Methylene chloride	SW	2.60E+01	mg/L	ORNL
Methylmercury, Total	SW	9.90E-05	mg/L	ORNL
Molybdenum	SW	1.60E+01	mg/L	ORNL
m-Xylene	SW	3.20E-02	mg/L	ORNL
Naphthalene	SW	2.30E-01	mg/L	AWQC
Naphthalene	SW	1.90E-01	mg/L	ORNL
Nickel	SW	1.82E-01	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Nickel	SW	1.38E-01	mg/L	AWQC Adjusted, Fourmile Branch Hardness 6.38
Nickel	SW	4.63E-01	mg/L	AWQC Adjusted, LTR Hardness 26.64
Nickel	SW	3.94E-01	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Nickel	SW	2.53E-01	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Nickel	SW	2.13E-01	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Nitrobenzene	SW	2.70E+00	mg/L	AWQC
N-Nitrosodiethylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosodiethylamine	SW	3.80E+00	mg/L	ORNL
N-Nitrosodimethylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosodimethylamine	SW	3.80E+00	mg/L	ORNL
N-Nitrosodi-n-butylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosodi-n-butylamine	SW	3.80E+00	mg/L	ORNL
N-Nitrosodiphenylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosodiphenylamine	SW	3.80E+00	mg/L	ORNL
N-Nitrosodipropylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosodipropylamine	SW	3.80E+00	mg/L	ORNL
N-Nitrosomethylethylamine	SW	5.85E-01	mg/L	AWQC
N-Nitrosomethylethylamine	SW	3.80E+00	mg/L	ORNL
o-Cresol	SW	2.30E-01	mg/L	ORNL
Octachlorodibenzo-p-dioxin	SW	1.00E-04	mg/L	AWQC
Octachlorodibenzo-p-furan	SW	1.00E-04	mg/L	AWQC

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**ECOLOGICAL BENCHMARKS — TIER II**

Analyte	Matrix	Benchmark	Units	Source
o-Xylene	SW	2.30E-01	mg/L	ORNL
Parathion	SW	6.50E-05	mg/L	AWQC
PCB-1016	SW	2.00E-04	mg/L	AWQC
PCB-1221	SW	2.00E-04	mg/L	AWQC
PCB-1221	SW	5.00E-03	mg/L	ORNL
PCB-1232	SW	2.00E-04	mg/L	AWQC
PCB-1232	SW	1.00E-02	mg/L	ORNL
PCB-1242	SW	2.00E-04	mg/L	AWQC
PCB-1242	SW	1.20E-03	mg/L	ORNL
PCB-1248	SW	2.00E-04	mg/L	AWQC
PCB-1248	SW	1.40E-03	mg/L	ORNL
PCB-1254	SW	2.00E-04	mg/L	AWQC
PCB-1254	SW	6.00E-04	mg/L	ORNL
PCB-1260	SW	2.00E-04	mg/L	AWQC
PCB-1260	SW	1.70E+00	mg/L	ORNL
PCB-1262	SW	2.00E-04	mg/L	AWQC
p-Cresol	SW	2.30E-01	mg/L	ORNL
Pentachlorobenzene	SW	2.50E-01	mg/L	AWQC
Pentachlorobenzene	SW	8.40E-03	mg/L	ORNL
Pentachlorodibenzo-p-dioxins	SW	1.00E-04	mg/L	AWQC
Pentachlorodibenzo-p-furans	SW	1.00E-04	mg/L	AWQC
Pentachloronitrobenzene	SW	2.50E-01	mg/L	AWQC
Pentachloronitrobenzene	SW	8.40E-03	mg/L	ORNL
Pentachlorophenol	SW	1.90E-02	mg/L	AWQC
Phenol	SW	1.02E+00	mg/L	AWQC
p-Xylene	SW	2.30E-01	mg/L	ORNL
Selenium	SW	2.00E-02	mg/L	AWQC
Silver	SW	3.60E-05	mg/L	AWQC Adjusted, FMB Hardness 6.38
Silver	SW	3.00E-04	mg/L	AWQC Adjusted, LTR Hardness 26.64
Silver	SW	3.00E-04	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Silver	SW	1.22E-04	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Silver	SW	8.60E-05	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Silver	SW	6.20E-05	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81
Strontium	SW	1.50E+01	mg/L	ORNL

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**ECOLOGICAL BENCHMARKS — TIER II**

Analyte	Matrix	Benchmark	Units	Source
technical-Chlordane	SW	2.40E-03	mg/L	AWQC
Tetrachlorodibenzo-p-furans	SW	1.00E-04	mg/L	AWQC
Tetrachloroethene	SW	5.28E-01	mg/L	AWQC
Tetrachloroethene	SW	8.30E-01	mg/L	ORNL
Thallium	SW	1.40E-01	mg/L	AWQC
Thallium	SW	1.10E-01	mg/L	ORNL
Tin	SW	2.70E+00	mg/L	ORNL
Toluene	SW	1.75E+00	mg/L	AWQC
Toluene	SW	1.20E-01	mg/L	ORNL
Toluene-d8	SW	1.75E+00	mg/L	AWQC
Toluene-d8	SW	1.20E-01	mg/L	ORNL
Toxaphene	SW	7.30E-04	mg/L	AWQC
trans-1,2-Dichloroethylene	SW	1.35E+01	mg/L	AWQC
trans-1,3-Dichloropropene	SW	6.06E-01	mg/L	AWQC
trans-1,3-Dichloropropene	SW	9.90E-02	mg/L	ORNL
Trichloroethene	SW	4.40E-01	mg/L	ORNL
Trichlorofluoromethane	SW	4.40E-01	mg/L	ORNL
Uranium	SW	4.60E-02	mg/L	ORNL
Vanadium	SW	2.80E-01	mg/L	ORNL
Vinyl Acetate	SW	2.80E-01	mg/L	ORNL
Xylenes	SW	2.30E-01	mg/L	ORNL
Zinc	SW	1.14E-02	mg/L	AWQC Adjusted, FMB Hardness 6.38
Zinc	SW	3.82E-02	mg/L	AWQC Adjusted, LTR Hardness 26.64
Zinc	SW	3.24E-02	mg/L	AWQC Adjusted, Pen Branch Hardness 21.98
Zinc	SW	2.08E-02	mg/L	AWQC Adjusted, Savannah River Hardness 13.01
Zinc	SW	1.75E-02	mg/L	AWQC Adjusted, Steel Creek Hardness 10.64
Zinc	SW	1.49E-02	mg/L	AWQC Adjusted, Upper Three Runs Hardness 8.81

Notes:

SE = Sediment,  
SO = Soil,  
SW = Surface Water

**FISH**  
**Human Health Substance Fisherman**

Analyte	Benchmark	Units
1,1,1-Trichloroethane	3.61E+02	mg/kg
1,1,2,2-Tetrachloroethane	5.00E-01	mg/kg
1,1,2-Trichloroethane	1.75E+00	mg/kg
1,1-Dichloroethane	1.29E+02	mg/kg
1,1-Dichloroethene	1.67E-01	mg/kg
1,2-Dibromo-3-chloropropane	7.14E-02	mg/kg
1,2-Dibromoethane	1.18E-03	mg/kg
1,2-Dichlorobenzene	1.16E+02	mg/kg
1,2-Dichloroethane	1.10E+00	mg/kg
1,2-Dichloroethene (total)	1.29E+01	mg/kg
1,2-Dichloropropane	1.47E+00	mg/kg
1,3-Dichlorobenzene	3.86E+01	mg/kg
1,4-Dichlorobenzene	4.17E+00	mg/kg
2-Hexanone	5.15E+01	mg/kg
2-Methylnaphthalene	5.15E+00	mg/kg
Acetone	1.29E+02	mg/kg
Acrolein	6.44E-01	mg/kg
Actinium-228	1.94E+01	pCi/g
Aldrin	5.88E-03	mg/kg
Aluminum	1.29E+03	mg/kg
Antimony	5.15E-01	mg/kg
Antimony-124	3.03E+00	pCi/g
Antimony-125	7.77E+00	pCi/g
Arsenic	6.67E-02	mg/kg
Barium	9.02E+01	mg/kg
Barium	9.02E+01	mg/kg
Barium, dissolved	9.02E+01	mg/kg
Barium-133	5.93E+00	pCi/g
Benzene	1.82E+00	mg/kg
Beryllium	2.58E+00	mg/kg
beta-Benzene hexachloride	5.56E-02	mg/kg
Bromodichloromethane	1.61E+00	mg/kg
Bromoform	1.27E+01	mg/kg
Bromomethane	1.80E+00	mg/kg
Cadmium	1.29E+00	mg/kg
Carbon disulfide	1.29E+02	mg/kg
Carbon tetrachloride	7.69E-01	mg/kg
Cerium-144	1.08E+00	pCi/g
Cesium-134	1.09E+00	pCi/g
Cesium-137	1.50E+00	pCi/g
Chlordane	2.86E-01	mg/kg
Chlorobenzene	2.58E+01	mg/kg
Chloroethane	3.45E+01	mg/kg
Chloroform	1.29E+01	mg/kg
Chloromethane	7.69E+00	mg/kg
Chromium	1.93E+03	mg/kg
cis-1,2-Dichloroethylene	1.29E+01	mg/kg
cis-1,3-Dichloropropene	1.00E+00	mg/kg
Cobalt	2.58E+01	mg/kg

**FISH**  
**Human Health Substance Fisherman**

Analyte	Benchmark	Units
Cobalt-57	3.76E+01	pCi/g
Cobalt-58	1.34E+01	pCi/g
Cobalt-60	2.51E+00	pCi/g
Copper	5.15E+01	mg/kg
Cyanide	2.58E+01	mg/kg
DDD	4.17E-01	mg/kg
DDE	2.94E-01	mg/kg
DDT	2.94E-01	mg/kg
Diazinon	1.16E+00	mg/kg
Dibromochloromethane	1.19E+00	mg/kg
Dichlorodifluoromethane	2.58E+02	mg/kg
Dieldrin	6.25E-03	mg/kg
Diethylphthalate	5.15E+01	mg/kg
Endosulfan	7.73E+00	mg/kg
Endosulfan sulfate	7.73E+00	mg/kg
Endrin	3.86E-01	mg/kg
Endrin aldehyde	3.86E-01	mg/kg
Ethion	6.44E-01	mg/kg
Ethylbenzene	1.29E+02	mg/kg
Europium-152	6.44E+00	pCi/g
Europium-154	3.76E+00	pCi/g
Europium-155	2.02E+01	pCi/g
gamma-BHC	7.69E-02	mg/kg
Guthion	7.73E+00	mg/kg
Heptachlor	2.22E-02	mg/kg
Heptachlor epoxide	1.10E-02	mg/kg
Hexachlorobenzene	6.25E-02	mg/kg
Hexachlorocyclohexane	7.69E-02	mg/kg
Hexachlorocyclopentadiene	7.73E+00	mg/kg
Iron	3.86E+02	mg/kg
Isopropylbenzene	1.29E+02	mg/kg
Kepone	1.25E-02	mg/kg
Lead-212	1.58E+00	pCi/g
Lead-214	1.16E+02	pCi/g
Malathion	2.58E+01	mg/kg
Manganese	1.80E+02	mg/kg
Manganese-54	1.80E+01	pCi/g
Mercury	3.86E-01	mg/kg
Methoxychlor	6.44E+00	mg/kg
Methyl acetate	1.29E+03	mg/kg
Methyl ethyl ketone	7.73E+02	mg/kg
Methyl isobutyl ketone	1.03E+02	mg/kg
Methyl parathion	3.22E-01	mg/kg
Methylene bromide	1.29E+01	mg/kg
Methylene chloride	1.33E+01	mg/kg
Mirex	2.58E-01	mg/kg
Neptunium-239	7.46E+00	pCi/g
Nickel	2.58E+01	mg/kg
Parathion	7.73E+00	mg/kg

**FISH**  
**Human Health Substance Fisherman**

Analyte	Benchmark	Units
PCB-1016	9.02E-02	mg/kg
PCB-1221	5.00E-02	mg/kg
PCB-1232	5.00E-02	mg/kg
PCB-1242	5.00E-02	mg/kg
PCB-1248	5.00E-02	mg/kg
PCB-1254	2.58E-02	mg/kg
PCB-1260	5.00E-02	mg/kg
PCB-1262	5.00E-02	mg/kg
Plutonium-238	3.31E-01	pCi/g
Plutonium-239	3.22E-01	pCi/g
Plutonium-239 and Plutonium-240	3.22E-01	pCi/g
Plutonium-241	2.46E+01	pCi/g
Plutonium-242	3.40E-01	pCi/g
Potassium-40	1.63E+00	pCi/g
Promethium-144	1.20E+01	pCi/g
Promethium-146	9.35E+00	pCi/g
Ronnel	6.44E+01	mg/kg
Ruthenium-106	9.17E-01	pCi/g
Selenium	6.44E+00	mg/kg
Silver	6.44E+00	mg/kg
Sodium-22	4.45E+00	pCi/g
Strontium-89	3.04E+00	pCi/g
Strontium-89 and Strontium-90	5.88E-01	pCi/g
Strontium-90	5.88E-01	pCi/g
Styrene	2.58E+02	mg/kg
Tetrachloroethene	1.92E+00	mg/kg
Thallium	9.02E-02	mg/kg
Thallium-208	3.20E+03	pCi/g
Thorium-234	1.65E+00	pCi/g
Tin-113	8.85E+00	pCi/g
Toluene	2.58E+02	mg/kg
Toxaphene	9.09E-02	mg/kg
Tralomethrin	9.66E+00	mg/kg
trans-1,3-Dichloropropene	1.00E+00	mg/kg
Trichloroethene	2.50E-01	mg/kg
Trichlorofluoromethane	3.86E+02	mg/kg
Trichlorotrifluoromethane	3.86E+02	mg/kg
Tritium	8.61E+02	pCi/g
Uranium-233	5.78E-01	pCi/g
Uranium-233 and Uranium-234	5.78E-01	pCi/g
Uranium-235	5.74E-01	pCi/g
Uranium-236	6.20E-01	pCi/g
Uranium-238	4.63E-01	pCi/g
Vanadium	9.02E+00	mg/kg
Vinyl Acetate	1.29E+03	mg/kg
Vinyl chloride	6.67E-02	mg/kg
Xylenes	2.58E+02	mg/kg
Yttrium-88	9.58E+00	pCi/g
Zinc	3.86E+02	mg/kg

**FISH****Human Health Subsistence Fisherman**

<b>Analyte</b>	<b>Benchmark</b>	<b>Units</b>
Zinc-65	3.64E+00	pCi/g
Zirconium-95	8.50E+00	pCi/g

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
1,1,1,2-Tetrachloroethane	2.55E+04	mg/kg
1,1,1-Trichloroethane	1.67E+06	mg/kg
1,1,2,2-Tetrachloroethane	3.33E+03	mg/kg
1,1,2-Trichloroethane	1.28E+04	mg/kg
1,1-Dichloroethane	6.23E+05	mg/kg
1,1-Dichloroethene	1.21E+03	mg/kg
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.49E-01	mg/kg
1,2,3,4,6,7,8-Heptachlorodibenzofuran	3.49E-01	mg/kg
1,2,3,4,7,8-Hexachlorodibenzofuran	3.49E-02	mg/kg
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	6.97E-03	mg/kg
1,2,3,7,8-Pentachlorodibenzene-p-furan	6.97E-02	mg/kg
1,2,3-Trichloropropane	3.31E+02	mg/kg
1,2,4,5-Tetrachlorobenzene	1.70E+03	mg/kg
1,2,4-Trichlorobenzene	6.16E+04	mg/kg
1,2-Dibromo-3-chloropropane	4.73E+02	mg/kg
1,2-Dibromoethane	7.79E+00	mg/kg
1,2-Dichlorobenzene	5.11E+05	mg/kg
1,2-Dichloroethane	7.99E+03	mg/kg
1,2-Dichloroethene (total)	5.68E+04	mg/kg
1,2-Dichloropropane	9.40E+03	mg/kg
1,3,5-Trinitrobenzene	1.54E+05	mg/kg
1,3-Dichlorobenzene	1.70E+05	mg/kg
1,3-Dichloropropene	5.51E+03	mg/kg
1,3-Dinitrobenzene	5.15E+02	mg/kg
1,4-Dichlorobenzene	2.90E+04	mg/kg
1,4-Dioxane	6.02E+04	mg/kg
2-(2,4,5-Trichlorophenoxy)propionic acid	3.59E+04	mg/kg
2,3,4,6-Tetrachlorophenol	1.34E+05	mg/kg
2,3,7,8-Tetrachlorodibenzodioxin	3.49E-03	mg/kg
2,3,7,8-Tetrachlorodibenzofuran	3.49E-02	mg/kg
2,4,5-Trichlorophenol	4.48E+05	mg/kg
2,4,6-Trichlorophenol	4.75E+04	mg/kg
2,4-Dichlorophenol	1.72E+04	mg/kg
2,4-Dichlorophenoxyacetic acid	5.68E+04	mg/kg
2,4-Dimethylphenol	8.96E+04	mg/kg
2,4-Dinitrophenol	1.25E+04	mg/kg
2,4-Dinitrotoluene	1.17E+04	mg/kg
2,6-Dichlorophenol	1.72E+04	mg/kg
2,6-Dichlorophenoxyacetic acid	5.68E+04	mg/kg
2,6-Dinitrotoluene	5.83E+03	mg/kg
2-Chloronaphthalene	3.59E+05	mg/kg
2-Chlorophenol	2.24E+04	mg/kg
2-Fluorobiphenyl	2.24E+05	mg/kg
2-Hexanone	2.08E+05	mg/kg
2-Methylnaphthalene	2.27E+04	mg/kg
2-Nitroaniline	2.56E+02	mg/kg
2-Nitrophenol	4.99E+04	mg/kg
2-sec-Butyl-4,6-Dinitrophenol	4.48E+03	mg/kg
3,3-Dichlorobenzidine	1.16E+03	mg/kg

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
3,3-Dimethylbenzidine	5.68E+01	mg/kg
3-Nitroaniline	2.56E+02	mg/kg
4-(2,4-Dichlorophenoxy)butyric acid	3.59E+04	mg/kg
4,6-Dinitro-2-Methylphenol	6.23E+02	mg/kg
4-Chloraniline	1.79E+04	mg/kg
4-Chloro-m-cresol	2.24E+04	mg/kg
4-Nitrophenol	4.99E+04	mg/kg
5-Nitro-o-toluidine	1.58E+04	mg/kg
a,a-Dimethylphenethylamine	4.48E+03	mg/kg
Acenaphthene	2.00E+05	mg/kg
Acenaphthylene	1.00E+05	mg/kg
Acetone	5.77E+05	mg/kg
Acetophenone	5.68E+05	mg/kg
Acrolein	6.54E+01	mg/kg
Acrylonitrile	1.23E+03	mg/kg
Actinium-228	7.99E+05	pCi/g
Aldrin	3.08E+01	mg/kg
Allyl chloride	2.84E+05	mg/kg
alpha-Benzene hexachloride	1.14E+02	mg/kg
alpha-Chlordane	1.49E+03	mg/kg
Aluminum	6.23E+06	mg/kg
Americium-241	3.53E+03	pCi/g
Ammonia	6.41E+03	pCi/g
Aniline	3.14E+04	mg/kg
Anthracene	1.66E+06	mg/kg
Antimony	9.73E+02	mg/kg
Antimony-124	1.73E+03	pCi/g
Antimony-125	5.08E+02	pCi/g
Antimony-125+D	5.08E+02	pCi/g
Aramite	2.09E+04	mg/kg
Arsenic	6.88E+02	mg/kg
Barium	3.74E+05	mg/kg
Barium-133	2.26E+02	pCi/g
Benzene	1.31E+04	mg/kg
Benzidine	2.88E+00	mg/kg
Benzo[a]anthracene	5.33E+02	mg/kg
Benzo[a]pyrene	5.33E+01	mg/kg
Benzo[b]fluoranthene	5.33E+02	mg/kg
Benzo[g,h,i]perylene	1.00E+05	mg/kg
Benzo[k]fluoranthene	5.33E+03	mg/kg
Benzoic acid	2.49E+07	mg/kg
Benzyl alcohol	1.56E+06	mg/kg
Beryllium	2.76E+03	mg/kg
Beryllium-7	8.14E+04	pCi/g
beta-Benzene hexachloride	2.91E+02	mg/kg
Bis(2-chloroisopropyl)ether	7.47E+03	mg/kg
Bis[2-chloroethyl] ether	4.75E+02	mg/kg
Bis[2-chloroisopropyl]ether	7.47E+03	mg/kg
Bis[2-ethylhexyl]phthalate	1.95E+04	mg/kg

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
Bismuth-212	2.48E+07	pCi/g
Bismuth-214	8.94E+06	pCi/g
Boron	8.59E+05	mg/kg
Bromodichloromethane	1.16E+04	mg/kg
Bromoform	7.30E+04	mg/kg
Bromomethane	7.95E+03	mg/kg
Butylbenzylphthalate	9.97E+05	mg/kg
Cadmium	1.38E+03	mg/kg
Cadmium-109	2.06E+05	pCi/g
Carbazole	2.61E+04	mg/kg
Carbon disulfide	5.07E+05	mg/kg
Carbon tetrachloride	3.60E+03	mg/kg
Carbon-14	4.74E+05	pCi/g
Cerium-144	1.33E+04	pCi/g
Cerium-144+D	1.33E+04	pCi/g
Cesium-134	1.73E+02	pCi/g
Cesium-137	8.92E+01	pCi/g
Cesium-137+D	8.92E+01	pCi/g
Chlordane	1.49E+03	mg/kg
Chlorobenzene	6.67E+04	mg/kg
Chlorobenzilate	1.94E+03	mg/kg
Chloroethane	2.28E+05	mg/kg
Chloroform	2.43E+04	mg/kg
Chloromethane	5.10E+04	mg/kg
Chloroprene	1.14E+05	mg/kg
Chromium	1.11E+06	mg/kg
Chromium VI	7.30E+03	mg/kg
Chrysene	5.33E+04	mg/kg
cis-1,2-Dichloroethylene	5.68E+04	mg/kg
cis-1,3-Dichloropropene	6.62E+03	mg/kg
Cobalt	1.89E+05	mg/kg
Cobalt-57	9.60E+03	pCi/g
Cobalt-58	2.91E+03	pCi/g
Cobalt-60	4.17E+01	pCi/g
Copper	3.37E+05	mg/kg
Curium-242	1.09E+06	pCi/g
Curium-242 and Curium-244	1.38E+04	pCi/g
Curium-243	5.24E+02	pCi/g
Curium-243 and Curium-244	5.24E+02	pCi/g
Curium-244	1.38E+04	pCi/g
Curium-245	6.95E+02	pCi/g
Curium-245 and Curium-246	6.95E+02	pCi/g
Curium-246	7.38E+03	pCi/g
Cyanide	1.49E+05	mg/kg
DDD	2.60E+03	mg/kg
DDE	1.83E+03	mg/kg
DDT	1.83E+03	mg/kg
delta-Benzene hexachloride	5.53E+02	mg/kg
Diallate	1.09E+04	mg/kg

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
Diazinon	4.03E+03	mg/kg
Dibenz[a,h]anthracene	5.33E+01	mg/kg
Dibenzofuran	1.79E+04	mg/kg
Dibromochloromethane	6.87E+03	mg/kg
Dibutylphthalate	6.23E+05	mg/kg
Dichlorodifluoromethane	5.40E+05	mg/kg
Dieldrin	3.27E+01	mg/kg
Diethylphthalate	4.78E+06	mg/kg
Dimethoate	8.96E+02	mg/kg
Dimethylphthalate	5.97E+07	mg/kg
Dioctylphthalate	2.39E+05	mg/kg
Diphenylamine	1.12E+05	mg/kg
Disulfoton	1.79E+02	mg/kg
Endosulfan	2.69E+04	mg/kg
Endosulfan I	2.69E+04	mg/kg
Endosulfan II	2.69E+04	mg/kg
Endosulfan sulfate	2.69E+04	mg/kg
Endrin	9.29E+01	mg/kg
Endrin aldehyde	9.29E+01	mg/kg
Endrin ketone	9.29E+01	mg/kg
Ethion	2.24E+03	mg/kg
Ethyl methacrylate	5.11E+05	mg/kg
Ethylbenzene	6.16E+05	mg/kg
Europium-152	5.55E+01	pCi/g
Europium-154	6.22E+01	pCi/g
Europium-155	4.38E+03	pCi/g
Fluoranthene	1.33E+05	mg/kg
Fluorene	1.79E+05	mg/kg
Fluoride	5.75E+05	mg/kg
Francium-221	2.50E+09	pCi/g
gamma-BHC	5.53E+02	mg/kg
Guthion	2.69E+04	mg/kg
Heptachlor	1.40E+02	mg/kg
Heptachlor epoxide	6.94E+01	mg/kg
Heptachlorodibenzo-p-dioxins	3.49E-01	mg/kg
Heptachlorodibenzo-p-furans	3.49E-01	mg/kg
Hexachlorobenzene	3.27E+02	mg/kg
Hexachlorobutadiene	8.96E+02	mg/kg
Hexachlorocyclohexane	4.02E+02	mg/kg
Hexachlorocyclopentadiene	2.69E+04	mg/kg
Hexachlorodibenzo-p-dioxins	8.43E-02	mg/kg
Hexachlorodibenzo-p-furans	3.49E-02	mg/kg
Hexachloroethane	4.48E+03	mg/kg
Hexachlorophene	1.34E+03	mg/kg
Hydrazobenzene	6.54E+02	mg/kg
Indeno[1,2,3-cd]pyrene	5.33E+02	mg/kg
Iodine-129	4.89E+03	pCi/g
Iron	2.15E+06	mg/kg
Isobutyl alcohol	1.70E+06	mg/kg

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
Isophorone	5.50E+05	mg/kg
Kepone	5.66E+02	mg/kg
Lead	4.00E+02	mg/kg
Lead-210	1.48E+03	pCi/g
Lead-210+D	4.36E+02	pCi/g
Lead-212	4.08E+06	pCi/g
Lead-214	5.06E+07	pCi/g
Lithium	1.89E+05	mg/kg
m,p-Cresol	2.24E+05	mg/kg
Malathion	8.96E+04	mg/kg
Manganese	7.86E+04	mg/kg
Manganese-54	7.59E+02	pCi/g
Mercury	1.60E+03	mg/kg
Methacrylonitrile	5.68E+02	mg/kg
Methoxychlor	2.24E+04	mg/kg
Methyl cyclopentane	3.85E+06	mg/kg
Methyl ethyl ketone	3.41E+06	mg/kg
Methyl isobutyl ketone	4.54E+05	mg/kg
Methyl methacrylate	7.95E+06	mg/kg
Methyl parathion	1.12E+03	mg/kg
Methylene bromide	5.68E+04	mg/kg
Methylene chloride	9.50E+04	mg/kg
Methylmercury, Total	5.97E+02	mg/kg
Mirex	8.96E+02	mg/kg
Molybdenum	4.37E+04	mg/kg
Naphthalene	1.14E+05	mg/kg
Neptunium-237	2.25E+02	pCi/g
Neptunium-237+D	2.25E+02	pCi/g
Neptunium-239	7.23E+05	pCi/g
Nickel	1.65E+05	mg/kg
Nickel-59	4.63E+06	pCi/g
Nickel-63	2.05E+06	pCi/g
Nitrate (as Nitrogen)	1.45E+07	mg/kg
Nitrite	9.06E+05	mg/kg
Nitrobenzene	3.08E+03	mg/kg
N-Nitrosodiethylamine	3.49E+00	mg/kg
N-Nitrosodimethylamine	1.03E+01	mg/kg
N-Nitrosodi-n-butylamine	9.68E+01	mg/kg
N-Nitrosodiphenylamine	6.84E+04	mg/kg
N-Nitrosodipropylamine	4.78E+01	mg/kg
N-Nitrosomethylethylamine	2.38E+01	mg/kg
N-Nitrosopyrrolidine	2.49E+02	mg/kg
o-Cresol	2.24E+05	mg/kg
Octachlorodibenzo-p-dioxin	3.49E+00	mg/kg
Octachlorodibenzo-p-furan	3.49E+00	mg/kg
o-Toluidine	2.18E+03	mg/kg
Parathion	2.69E+04	mg/kg
PCB-1016	4.18E+02	mg/kg
PCB-1221	3.48E+02	mg/kg

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
PCB-1232	3.48E+02	mg/kg
PCB-1242	3.48E+02	mg/kg
PCB-1248	3.48E+02	mg/kg
PCB-1254	1.19E+02	mg/kg
PCB-1260	3.48E+02	mg/kg
PCB-1262	3.48E+02	mg/kg
p-Cresol	2.24E+04	mg/kg
p-Dimethylaminoazobenzene	4.75E+03	mg/kg
Pentachlorobenzene	4.54E+03	mg/kg
Pentachlorodibenzo-p-dioxins	6.97E-03	mg/kg
Pentachlorodibenzo-p-furans	6.97E-02	mg/kg
Pentachloroethane	2.55E+04	mg/kg
Pentachloronitrobenzene	2.55E+03	mg/kg
Pentachlorophenol	6.06E+03	mg/kg
Phenanthrene	1.63E+05	mg/kg
Phenol	3.58E+06	mg/kg
Phenols	3.58E+06	mg/kg
Phorate	8.96E+02	mg/kg
Phthalate	3.74E+04	mg/kg
Plutonium-238	6.15E+03	pCi/g
Plutonium-239	5.48E+03	pCi/g
Plutonium-239 and Plutonium-240	5.48E+03	pCi/g
Plutonium-240	5.50E+03	pCi/g
Plutonium-241	5.95E+05	pCi/g
Plutonium-242	5.79E+03	pCi/g
Plutonium-244	5.79E+03	pCi/g
Plutonium-244+D	1.21E+02	pCi/g
Polychlorinated biphenyls	3.48E+02	mg/kg
Potassium-40	2.28E+02	pCi/g
p-Phenylenediamine	8.52E+05	mg/kg
Promethium-144	3.69E+02	pCi/g
Promethium-146	1.51E+02	pCi/g
Promethium-147	4.38E+06	pCi/g
Protactinium-234	3.80E+05	pCi/g
Protactinium-234m	1.66E+10	pCi/g
Pyrene	1.00E+05	mg/kg
Pyridine	4.48E+03	mg/kg
Radium, Total Alpha-Emitting	1.77E+03	pCi/g
Radium-224	4.19E+06	pCi/g
Radium-226	2.14E+01	pCi/g
Radium-226+D	2.14E+01	pCi/g
Radium-228	1.03E+02	pCi/g
Radium-228+D	1.03E+02	pCi/g
Ronnel	2.24E+05	mg/kg
Ruthenium-106	2.60E+03	pCi/g
Ruthenium-106+D	2.60E+03	pCi/g
Selenium	4.46E+04	mg/kg
Silver	3.77E+04	mg/kg
Sodium-22	9.50E+01	pCi/g

**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
Strontium	4.65E+06	mg/kg
Strontium-89	2.04E+06	pCi/g
Strontium-89 and Strontium-90	6.41E+03	pCi/g
Strontium-90	6.41E+03	pCi/g
Strontium-90+D	6.41E+03	pCi/g
Styrene	1.14E+06	mg/kg
Sulfotep	2.24E+03	mg/kg
Technetium-99	4.12E+05	pCi/g
technical-Chlordane	1.49E+03	mg/kg
Tetrachlorodibenzo-p-furans	3.49E-02	mg/kg
Tetrachloroethene	1.40E+04	mg/kg
Tetrahydrofuran	8.72E+04	mg/kg
Tetramethylbenzene	2.84E+05	mg/kg
Thallium	5.01E+02	mg/kg
Thallium-208	2.46E+07	pCi/g
Thorium-228	1.70E+02	pCi/g
Thorium-228+D	1.70E+02	pCi/g
Thorium-230	8.30E+03	pCi/g
Thorium-231	3.51E+07	pCi/g
Thorium-232	7.76E+03	pCi/g
Thorium-234	2.03E+06	pCi/g
Tin	3.74E+06	mg/kg
Tin-113	3.88E+05	pCi/g
Titanium	3.10E+07	mg/kg
Toluene	1.14E+06	mg/kg
Toluene-d8	1.14E+06	mg/kg
Toxaphene	4.75E+02	mg/kg
TPH, Diesel Range	1.70E+05	mg/kg
TPH, Gasoline Range	1.70E+05	mg/kg
trans-1,2-Dichloroethylene	1.25E+05	mg/kg
trans-1,3-Dichloropropene	6.62E+03	mg/kg
Trichloroethene	1.21E+06	mg/kg
Trichlorofluoromethane	8.11E+05	mg/kg
Trimethylbenzene	2.84E+05	mg/kg
Tritium	2.46E+07	pCi/g
Uranium	2.32E+04	mg/kg
Uranium-233 and Uranium-234	1.20E+04	pCi/g
Uranium-234	1.28E+04	pCi/g
Uranium-235	3.28E+02	pCi/g
Uranium-235+D	3.28E+02	pCi/g
Uranium-238	1.41E+03	pCi/g
Uranium-238+D	1.41E+03	pCi/g
Vanadium	9.67E+03	mg/kg
Vinyl Acetate	5.15E+06	mg/kg
Vinyl chloride	4.85E+02	mg/kg
Xylenes	2.84E+03	mg/kg
Yttrium-88	6.30E+02	pCi/g
Zinc	2.32E+06	mg/kg
Zinc-65	1.35E+03	pCi/g

Periodic Report 5 for the Upper Three Runs IOU (U)  
Savannah River Site  
February 2018

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**SEDIMENT**  
**Human Health On-Site Worker**

Analyte	Benchmark	Units
Zirconium-95	4.25E+03	pCi/g

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
1,1,1,2-Tetrachloroethane	2.55E+04	mg/kg
1,1,1-Trichloroethane	1.67E+06	mg/kg
1,1,2,2-Tetrachloroethane	3.33E+03	mg/kg
1,1,2-Trichloroethane	1.28E+04	mg/kg
1,1-Dichloroethane	6.23E+05	mg/kg
1,1-Dichloroethene	1.21E+03	mg/kg
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.49E-01	mg/kg
1,2,3,4,6,7,8-Heptachlorodibenzofuran	3.49E-01	mg/kg
1,2,3,4,7,8-Hexachlorodibenzofuran	3.49E-02	mg/kg
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	6.97E-03	mg/kg
1,2,3,7,8-Pentachlorodibenzene-p-furan	6.97E-02	mg/kg
1,2,3-Trichloropropane	3.31E+02	mg/kg
1,2,4,5-Tetrachlorobenzene	1.70E+03	mg/kg
1,2,4-Trichlorobenzene	6.16E+04	mg/kg
1,2-Dibromo-3-chloropropane	4.73E+02	mg/kg
1,2-Dibromoethane	7.79E+00	mg/kg
1,2-Dichlorobenzene	5.11E+05	mg/kg
1,2-Dichloroethane	7.99E+03	mg/kg
1,2-Dichloroethene (total)	5.68E+04	mg/kg
1,2-Dichloropropane	9.40E+03	mg/kg
1,3,5-Trinitrobenzene	1.54E+05	mg/kg
1,3-Dichlorobenzene	1.70E+05	mg/kg
1,3-Dichloropropene	5.51E+03	mg/kg
1,3-Dinitrobenzene	5.15E+02	mg/kg
1,4-Dichlorobenzene	2.90E+04	mg/kg
1,4-Dioxane	6.02E+04	mg/kg
2-(2,4,5-Trichlorophenoxy)propionic acid	3.59E+04	mg/kg
2,3,4,6-Tetrachlorophenol	1.34E+05	mg/kg
2,3,7,8-Tetrachlorodibenzodioxin	3.49E-03	mg/kg
2,3,7,8-Tetrachlorodibenzofuran	3.49E-02	mg/kg
2,4,5-Trichlorophenol	4.48E+05	mg/kg
2,4,6-Trichlorophenol	4.75E+04	mg/kg
2,4-Dichlorophenol	1.72E+04	mg/kg
2,4-Dichlorophenoxyacetic acid	5.68E+04	mg/kg
2,4-Dimethylphenol	8.96E+04	mg/kg
2,4-Dinitrophenol	1.25E+04	mg/kg
2,4-Dinitrotoluene	1.17E+04	mg/kg
2,6-Dichlorophenol	1.72E+04	mg/kg
2,6-Dichlorophenoxyacetic acid	5.68E+04	mg/kg
2,6-Dinitrotoluene	5.83E+03	mg/kg
2-Chloronaphthalene	3.59E+05	mg/kg
2-Chlorophenol	2.24E+04	mg/kg
2-Fluorobiphenyl	2.24E+05	mg/kg
2-Hexanone	2.08E+05	mg/kg
2-Methylnaphthalene	2.27E+04	mg/kg
2-Nitroaniline	2.56E+02	mg/kg
2-Nitrophenol	4.99E+04	mg/kg
2-sec-Butyl-4,6-Dinitrophenol	4.48E+03	mg/kg
3,3-Dichlorobenzidine	1.16E+03	mg/kg

## SOIL

### Human Health Subsistence Fisherman

Analyte	Benchmark	Units
3,3-Dimethylbenzidine	5.68E+01	mg/kg
3-Nitroaniline	2.56E+02	mg/kg
4-(2,4-Dichlorophenoxy)butyric acid	3.59E+04	mg/kg
4,6-Dinitro-2-Methylphenol	6.23E+02	mg/kg
4-Chloraniline	1.79E+04	mg/kg
4-Chloro-m-cresol	2.24E+04	mg/kg
4-Nitrophenol	4.99E+04	mg/kg
5-Nitro-o-toluidine	1.58E+04	mg/kg
a,a-Dimethylphenethylamine	4.48E+03	mg/kg
Acenaphthene	2.00E+05	mg/kg
Acenaphthylene	1.00E+05	mg/kg
Acetone	5.77E+05	mg/kg
Acetophenone	5.68E+05	mg/kg
Acrolein	6.54E+01	mg/kg
Acrylonitrile	1.23E+03	mg/kg
Actinium-228	1.60E+05	pCi/g
Aldrin	3.08E+01	mg/kg
Allyl chloride	2.84E+05	mg/kg
alpha-Benzene hexachloride	1.14E+02	mg/kg
alpha-Chlordane	1.49E+03	mg/kg
Aluminum	6.23E+06	mg/kg
Americium-241	1.14E+03	pCi/g
Ammonia	1.21E+04	pCi/g
Aniline	3.14E+04	mg/kg
Anthracene	1.66E+06	mg/kg
Antimony	9.73E+02	mg/kg
Antimony-124	3.45E+02	pCi/g
Antimony-125	1.02E+02	pCi/g
Antimony-125+D	1.01E+03	pCi/g
Aramite	2.09E+04	mg/kg
Arsenic	6.88E+02	mg/kg
Barium	3.74E+05	mg/kg
Barium-133	4.53E+01	pCi/g
Benzene	1.31E+04	mg/kg
Benzidine	2.88E+00	mg/kg
Benzo[a]anthracene	5.33E+02	mg/kg
Benzo[a]pyrene	5.33E+01	mg/kg
Benzo[b]fluoranthene	5.33E+02	mg/kg
Benzo[g,h,i]perylene	1.00E+05	mg/kg
Benzo[k]fluoranthene	5.33E+03	mg/kg
Benzoic acid	2.49E+07	mg/kg
Benzyl alcohol	1.56E+06	mg/kg
Beryllium	2.76E+03	mg/kg
Beryllium-7	1.63E+04	pCi/g
beta-Benzene hexachloride	2.91E+02	mg/kg
Bis(2-chloroisopropyl)ether	7.47E+03	mg/kg
Bis[2-chloroethyl] ether	4.75E+02	mg/kg
Bis[2-chloroisopropyl]ether	7.47E+03	mg/kg
Bis[2-ethylhexyl]phthalate	1.95E+04	mg/kg

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
Bismuth-212	4.95E+06	pCi/g
Bismuth-214	1.79E+06	pCi/g
Boron	8.59E+05	mg/kg
Bromodichloromethane	1.16E+04	mg/kg
Bromoform	7.30E+04	mg/kg
Bromomethane	7.95E+03	mg/kg
Butylbenzylphthalate	9.97E+05	mg/kg
Cadmium	1.38E+03	mg/kg
Cadmium-109	4.32E+05	pCi/g
Carbazole	2.61E+04	mg/kg
Carbon disulfide	5.07E+05	mg/kg
Carbon tetrachloride	3.60E+03	mg/kg
Carbon-14	4.38E+05	pCi/g
Cerium-144	2.67E+03	pCi/g
Cerium-144+D	2.66E+04	pCi/g
Cesium-134	3.47E+01	pCi/g
Cesium-137	1.79E+01	pCi/g
Cesium-137+D	1.32E+02	pCi/g
Chlordane	1.49E+03	mg/kg
Chlorobenzene	6.67E+04	mg/kg
Chlorobenzilate	1.94E+03	mg/kg
Chloroethane	2.28E+05	mg/kg
Chloroform	2.43E+04	mg/kg
Chloromethane	5.10E+04	mg/kg
Chloroprene	1.14E+05	mg/kg
Chromium	1.11E+06	mg/kg
Chromium VI	7.30E+03	mg/kg
Chrysene	5.33E+04	mg/kg
cis-1,2-Dichloroethylene	5.68E+04	mg/kg
cis-1,3-Dichloropropene	6.62E+03	mg/kg
Cobalt	1.89E+05	mg/kg
Cobalt	1.89E+05	mg/kg
Cobalt, dissolved	1.89E+05	mg/kg
Cobalt-57	1.92E+03	pCi/g
Cobalt-58	5.83E+02	pCi/g
Cobalt-60	8.35E+00	pCi/g
Copper	3.37E+05	mg/kg
Curium-242	1.03E+06	pCi/g
Curium-242 and Curium-244	1.37E+04	pCi/g
Curium-243	1.09E+02	pCi/g
Curium-243 and Curium-244	1.09E+02	pCi/g
Curium-244	1.37E+04	pCi/g
Curium-245	9.69E+02	pCi/g
Curium-245 and Curium-246	1.50E+02	pCi/g
Curium-246	7.33E+03	pCi/g
Cyanide	1.49E+05	mg/kg
DDD	2.60E+03	mg/kg
DDE	1.83E+03	mg/kg
DDT	1.83E+03	mg/kg

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
delta-Benzene hexachloride	5.53E+02	mg/kg
Diallate	1.09E+04	mg/kg
Diazinon	4.03E+03	mg/kg
Dibenz[a,h]anthracene	5.33E+01	mg/kg
Dibenzofuran	1.79E+04	mg/kg
Dibromochloromethane	6.87E+03	mg/kg
Dibutylphthalate	6.23E+05	mg/kg
Dichlorodifluoromethane	5.40E+05	mg/kg
Dieldrin	3.27E+01	mg/kg
Diethylphthalate	4.78E+06	mg/kg
Dimethoate	8.96E+02	mg/kg
Dimethylphthalate	5.97E+07	mg/kg
Diethylphthalate	2.39E+05	mg/kg
Diphenylamine	1.12E+05	mg/kg
Disulfoton	1.79E+02	mg/kg
Endosulfan	2.69E+04	mg/kg
Endosulfan I	2.69E+04	mg/kg
Endosulfan II	2.69E+04	mg/kg
Endosulfan sulfate	2.69E+04	mg/kg
Endrin	9.29E+01	mg/kg
Endrin aldehyde	9.29E+01	mg/kg
Endrin ketone	9.29E+01	mg/kg
Ethion	2.24E+03	mg/kg
Ethyl methacrylate	5.11E+05	mg/kg
Ethylbenzene	6.16E+05	mg/kg
Europium-152	1.11E+01	pCi/g
Europium-154	1.24E+01	pCi/g
Europium-155	8.77E+02	pCi/g
Fluoranthene	1.33E+05	mg/kg
Fluorene	1.79E+05	mg/kg
Fluoride	5.75E+05	mg/kg
Francium-221	4.99E+09	pCi/g
gamma-BHC	5.53E+02	mg/kg
Guthion	2.69E+04	mg/kg
Heptachlor	1.40E+02	mg/kg
Heptachlor epoxide	6.94E+01	mg/kg
Heptachlorodibenzo-p-dioxins	3.49E-01	mg/kg
Heptachlorodibenzo-p-furans	3.49E-01	mg/kg
Hexachlorobenzene	3.27E+02	mg/kg
Hexachlorobutadiene	8.96E+02	mg/kg
Hexachlorocyclohexane	4.02E+02	mg/kg
Hexachlorocyclopentadiene	2.69E+04	mg/kg
Hexachlorodibenzo-p-dioxins	8.43E-02	mg/kg
Hexachlorodibenzo-p-furans	3.49E-02	mg/kg
Hexachloroethane	4.48E+03	mg/kg
Hexachlorophene	1.34E+03	mg/kg
Hydrazobenzene	6.54E+02	mg/kg
Indeno[1,2,3-cd]pyrene	5.33E+02	mg/kg
Iodine-129	2.96E+03	pCi/g

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
Iron	2.15E+06	mg/kg
Isobutyl alcohol	1.70E+06	mg/kg
Isophorone	5.50E+05	mg/kg
Kepone	5.66E+02	mg/kg
Lead	4.00E+02	mg/kg
Lead-210	4.21E+03	pCi/g
Lead-210+D	1.24E+03	pCi/g
Lead-212	8.21E+05	pCi/g
Lead-214	1.01E+07	pCi/g
Lithium	1.89E+05	mg/kg
m,p-Cresol	2.24E+05	mg/kg
Malathion	8.96E+04	mg/kg
Manganese	7.86E+04	mg/kg
Manganese-54	1.52E+02	pCi/g
Mercury	1.60E+03	mg/kg
Methacrylonitrile	5.68E+02	mg/kg
Methoxychlor	2.24E+04	mg/kg
Methyl cyanide	3.41E+04	mg/kg
Methyl cyclopentane	3.85E+06	mg/kg
Methyl ethyl ketone	3.41E+06	mg/kg
Methyl isobutyl ketone	4.54E+05	mg/kg
Methyl methacrylate	7.95E+06	mg/kg
Methyl parathion	1.12E+03	mg/kg
Methylene bromide	5.68E+04	mg/kg
Methylene chloride	9.50E+04	mg/kg
Methylmercury, Total	5.97E+02	mg/kg
Mirex	8.96E+02	mg/kg
Molybdenum	4.37E+04	mg/kg
Naphthalene	1.14E+05	mg/kg
Neptunium-237	4.57E+01	pCi/g
Neptunium-237+D	3.03E+02	pCi/g
Neptunium-239	1.45E+05	pCi/g
Nickel	1.65E+05	mg/kg
Nickel-59	1.16E+07	pCi/g
Nickel-63	2.05E+06	pCi/g
Nitrobenzene	3.08E+03	mg/kg
N-Nitrosodiethylamine	3.49E+00	mg/kg
N-Nitrosodimethylamine	1.03E+01	mg/kg
N-Nitrosodi-n-butylamine	9.68E+01	mg/kg
N-Nitrosodiphenylamine	6.84E+04	mg/kg
N-Nitrosodipropylamine	4.78E+01	mg/kg
N-Nitrosomethylethylamine	2.38E+01	mg/kg
N-Nitrosopyrrolidine	2.49E+02	mg/kg
o-Cresol	2.24E+05	mg/kg
Octachlorodibenzo-p-dioxin	3.49E+00	mg/kg
Octachlorodibenzo-p-furan	3.49E+00	mg/kg
o-Toluidine	2.18E+03	mg/kg
Parathion	2.69E+04	mg/kg
PCB-1016	4.18E+02	mg/kg

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
PCB-1221	3.48E+02	mg/kg
PCB-1232	3.48E+02	mg/kg
PCB-1242	3.48E+02	mg/kg
PCB-1248	3.48E+02	mg/kg
PCB-1254	1.19E+02	mg/kg
PCB-1260	3.48E+02	mg/kg
PCB-1262	3.48E+02	mg/kg
p-Cresol	2.24E+04	mg/kg
p-Dimethylaminoazobenzene	4.75E+03	mg/kg
Pentachlorobenzene	4.54E+03	mg/kg
Pentachlorodibenzo-p-dioxins	6.97E-03	mg/kg
Pentachlorodibenzo-p-furans	6.97E-02	mg/kg
Pentachloroethane	2.55E+04	mg/kg
Pentachloronitrobenzene	2.55E+03	mg/kg
Pentachlorophenol	6.06E+03	mg/kg
Phenanthrene	1.63E+05	mg/kg
Phenol	3.58E+06	mg/kg
Phenols	3.58E+06	mg/kg
Phorate	8.96E+02	mg/kg
Phthalate	3.74E+04	mg/kg
Plutonium-238	6.09E+03	pCi/g
Plutonium-239	5.35E+03	pCi/g
Plutonium-239 and Plutonium-240	5.35E+03	pCi/g
Plutonium-240	5.46E+03	pCi/g
Plutonium-241	1.79E+06	pCi/g
Plutonium-242	1.44E+04	pCi/g
Plutonium-244	1.45E+04	pCi/g
Plutonium-244	1.61E+02	pCi/g
Plutonium-244+D	1.61E+02	pCi/g
Polychlorinated biphenyls	3.48E+02	mg/kg
Potassium-40	4.48E+01	pCi/g
p-Phenylenediamine	8.52E+05	mg/kg
Promethium-144	7.38E+01	pCi/g
Promethium-146	3.03E+01	pCi/g
Promethium-147	2.77E+06	pCi/g
Protactinium-234	7.60E+04	pCi/g
Protactinium-234m	3.31E+09	pCi/g
Pyrene	1.00E+05	mg/kg
Pyridine	4.48E+03	mg/kg
Radium, Total Alpha-Emitting	4.31E+00	pCi/g
Radium-224	1.21E+06	pCi/g
Radium-226	4.31E+00	pCi/g
Radium-226+D	2.87E+01	pCi/g
Radium-228	2.12E+01	pCi/g
Radium-228+D	1.95E+02	pCi/g
Ronnel	2.24E+05	mg/kg
Ruthenium-106	5.20E+02	pCi/g
Selenium	4.46E+04	mg/kg
Silver	3.77E+04	mg/kg

**SOIL**  
**Human Health Subsistence Fisherman**

Analyte	Benchmark	Units
Sodium-22	1.90E+01	pCi/g
Strontium	4.65E+06	mg/kg
Strontium-89	4.85E+05	pCi/g
Strontium-89 and Strontium-90	2.01E+03	pCi/g
Strontium-90	2.01E+03	pCi/g
Strontium-90+D	1.21E+04	pCi/g
Styrene	1.14E+06	mg/kg
Sulfotep	2.24E+03	mg/kg
Technetium-99	2.38E+05	pCi/g
technical-Chlordane	1.49E+03	mg/kg
Tetrachlorodibenzo-p-furans	3.49E-02	mg/kg
Tetrachloroethene	1.40E+04	mg/kg
Tetrahydrofuran	8.72E+04	mg/kg
Tetramethylbenzene	2.84E+05	mg/kg
Thallium	5.01E+02	mg/kg
Thallium-208	4.93E+06	pCi/g
Thorium-228	3.42E+01	pCi/g
Thorium-228+D	3.40E+02	pCi/g
Thorium-230	7.23E+03	pCi/g
Thorium-231	7.09E+06	pCi/g
Thorium-232	7.33E+03	pCi/g
Thorium-234	4.56E+05	pCi/g
Tin	3.74E+06	mg/kg
Tin-113	7.92E+04	pCi/g
Titanium	3.10E+07	mg/kg
Titanium, dissolved	3.10E+07	mg/kg
Titanium, total recoverable	3.10E+07	mg/kg
Toluene	1.14E+06	mg/kg
Toluene-d8	1.14E+06	mg/kg
Toxaphene	4.75E+02	mg/kg
TPH, Diesel Range	1.70E+05	mg/kg
TPH, Gasoline Range	1.70E+05	mg/kg
trans-1,2-Dichloroethylene	1.25E+05	mg/kg
trans-1,3-Dichloropropene	6.62E+03	mg/kg
Trichloroethene	1.21E+06	mg/kg
Trichlorofluoromethane	8.11E+05	mg/kg
Trimethylbenzene	2.84E+05	mg/kg
Tritium	2.46E+07	pCi/g
Uranium	2.32E+04	mg/kg
Uranium-233 and Uranium-234	9.51E+03	pCi/g
Uranium-234	1.20E+04	pCi/g
Uranium-235	6.69E+01	pCi/g
Uranium-235+D	4.42E+02	pCi/g
Uranium-238	3.12E+02	pCi/g
Uranium-238+D	1.99E+03	pCi/g
Vanadium	9.67E+03	mg/kg
Vinyl Acetate	5.15E+06	mg/kg
Vinyl chloride	4.85E+02	mg/kg
Xylenes	2.84E+03	mg/kg

## SOIL

### Human Health Subsistence Fisherman

Analyte	Benchmark	Units
Yttrium-88	1.26E+02	pCi/g
Zinc	2.32E+06	mg/kg
Zinc-65	2.70E+02	pCi/g
Zirconium-95	8.49E+02	pCi/g
Tetrachlorodibenzo-p-furans	3.49E-02	mg/kg
Tetrachloroethene	1.40E+04	mg/kg
Tetrahydrofuran	8.72E+04	mg/kg
Tetramethylbenzene	2.84E+05	mg/kg
Thallium	5.01E+02	mg/kg
Thallium-208	4.93E+06	pCi/g
Thorium-228	3.42E+01	pCi/g
Thorium-228+D	3.40E+02	pCi/g
Thorium-230	7.23E+03	pCi/g
Thorium-231	7.09E+06	pCi/g
Thorium-232	7.33E+03	pCi/g
Thorium-234	4.56E+05	pCi/g
Tin	3.74E+06	mg/kg
Tin-113	7.92E+04	pCi/g
Titanium	3.10E+07	mg/kg
Toluene	1.14E+06	mg/kg
Toluene-d8	1.14E+06	mg/kg
Toxaphene	4.75E+02	mg/kg
TPH, Diesel Range	1.70E+05	mg/kg
TPH, Gasoline Range	1.70E+05	mg/kg
trans-1,2-Dichloroethylene	1.25E+05	mg/kg
trans-1,3-Dichloropropene	6.62E+03	mg/kg
Trichloroethene	1.21E+06	mg/kg
Trichlorofluoromethane	8.11E+05	mg/kg
Trimethylbenzene	2.84E+05	mg/kg
Tritium	2.46E+07	pCi/g
Uranium	2.32E+04	mg/kg
Uranium-233 and Uranium-234	9.51E+03	pCi/g
Uranium-234	1.20E+04	pCi/g
Uranium-235	6.69E+01	pCi/g
Uranium-235+D	4.42E+02	pCi/g
Uranium-238	3.12E+02	pCi/g
Uranium-238+D	1.99E+03	pCi/g
Vanadium	9.67E+03	mg/kg
Vinyl Acetate	5.15E+06	mg/kg
Vinyl chloride	4.85E+02	mg/kg
Xylenes	2.84E+03	mg/kg
Yttrium-88	1.26E+02	pCi/g
Zinc	2.32E+06	mg/kg
Zinc-65	2.70E+02	pCi/g
Zirconium-95	8.49E+02	pCi/g

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
1,1,1,2-Tetrachloroethane	9.55E+00	mg/L
1,1,1-Trichloroethane	9.47E+02	mg/L
1,1,2,2-Tetrachloroethane	3.35E+00	mg/L
1,1,2-Trichloroethane	1.56E+01	mg/L
1,1-Dichloroethane	7.18E+02	mg/L
1,1-Dichloroethene	1.40E+00	mg/L
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1.55E-06	mg/L
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.55E-06	mg/L
1,2,3,4,7,8-Hexachlorodibenzofuran	1.77E-07	mg/L
1,2,3,7,8-Pentachlorodibenzene-p-dioxin	4.52E-08	mg/L
1,2,3,7,8-Pentachlorodibenzene-p-furan	4.52E-07	mg/L
1,2,3-Trichloropropane	6.77E-03	mg/L
1,2,4,5-Tetrachlorobenzene	9.02E-02	mg/L
1,2,4-Trichlorobenzene	6.20E+00	mg/L
1,2-Dibromo-3-chloropropane	8.87E-01	mg/L
1,2-Dibromoethane	2.13E-02	mg/L
1,2-Dichlorobenzene	7.54E+01	mg/L
1,2-Dichloroethane	1.55E+01	mg/L
1,2-Dichloroethene (total)	4.65E+02	mg/L
1,2-Dichloropropane	8.11E+00	mg/L
1,3,5-Trinitrobenzene	1.83E+03	mg/L
1,3-Dichlorobenzene	1.76E+01	mg/L
1,3-Dichloropropene	7.45E+00	mg/L
1,3-Dinitrobenzene	1.73E+00	mg/L
1,4-Dichlorobenzene	4.51E+00	mg/L
1,4-Dioxane	1.35E+03	mg/L
2-(2,4,5-Trichlorophenoxy)propionic acid	1.02E+01	mg/L
2,3,4,6-Tetrachlorophenol	1.60E+01	mg/L
2,3,7,8-Tetrachlorodibenzodioxin	1.77E-08	mg/L
2,3,7,8-Tetrachlorodibenzofuran	7.10E-07	mg/L
2,4,5-Trichlorophenol	5.41E+01	mg/L
2,4,6-Trichlorophenol	5.74E+00	mg/L
2,4-Dichlorophenol	2.62E+00	mg/L
2,4-Dichlorophenoxyacetic acid	1.00E+02	mg/L
2,4-Dimethylphenol	5.81E+00	mg/L
2,4-Dinitrophenol	3.99E+01	mg/L
2,4-Dinitrotoluene	2.86E+01	mg/L
2,6-Dichlorophenol	2.62E+00	mg/L
2,6-Dichlorophenoxyacetic acid	1.00E+02	mg/L
2,6-Dinitrophenol	3.99E+01	mg/L
2,6-Dinitrotoluene	2.17E+01	mg/L
2-Chloronaphthalene	1.60E+01	mg/L
2-Chlorophenol	4.84E+00	mg/L
2-Hexanone	3.67E+02	mg/L
2-Methylnaphthalene	1.36E+00	mg/L
2-Nitroaniline	3.50E-01	mg/L
2-Nitrophenol	8.52E+01	mg/L
2-sec-Butyl-4,6-Dinitrophenol	1.14E+00	mg/L
3,3-Dichlorobenzidine	4.87E-01	mg/L

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
3-Nitroaniline	3.50E-01	mg/L
4,6-Dinitro-2-Methylphenol	6.52E-01	mg/L
4,6-Dinitro-o-cyclohexyl phenol	1.16E+05	mg/L
4-Chloraniline	4.12E+00	mg/L
4-Chloro-m-cresol	1.06E+01	mg/L
4-Nitrophenol	8.52E+01	mg/L
5-Nitro-o-toluidine	1.91E+01	mg/L
a,a-Dimethylphenethylamine	5.91E-01	mg/L
Acenaphthene	4.75E+00	mg/L
Acenaphthylene	6.25E+00	mg/L
Acetone	9.30E+03	mg/L
Acetophenone	8.96E+02	mg/L
Acrolein	3.45E+01	mg/L
Acrylonitrile	7.89E+00	mg/L
Aldrin	1.37E-01	mg/L
Allyl chloride	3.65E+02	mg/L
alpha-Benzene hexachloride	6.04E-02	mg/L
alpha-Chlordane	2.05E-01	mg/L
Aluminum	6.39E+03	mg/L
Aniline	5.45E+00	mg/L
Anthracene	6.62E+01	mg/L
Antimony	5.11E-01	mg/L
Aramite	3.24E+00	mg/L
Arsenic	2.04E+00	mg/L
Azobenzene	4.58E-01	mg/L
Barium	3.13E+02	mg/L
Benzene	6.26E+00	mg/L
Benzidine	1.99E-02	mg/L
Benzo[a]anthracene	3.91E-03	mg/L
Benzo[a]pyrene	2.64E-04	mg/L
Benzo[b]fluoranthene	2.64E-03	mg/L
Benzo[g,h,i]perylene	3.30E-01	mg/L
Benzo[k]fluoranthene	5.27E-02	mg/L
Benzoic acid	3.50E+04	mg/L
Benzyl alcohol	2.11E+03	mg/L
Beryllium	1.28E+00	mg/L
Beryllium	1.28E+00	mg/L
Beryllium, dissolved	1.28E+00	mg/L
beta-Benzene hexachloride	9.41E-02	mg/L
Bis(2-chloroisopropyl)ether	1.00E+01	mg/L
Bis[2-chloroethyl] ether	1.61E+00	mg/L
Bis[2-chloroisopropyl]ether	4.44E+00	mg/L
Bis[2-ethylhexyl]phthalate	4.40E+00	mg/L
Bis[2-methoxyethyl]ether	1.61E+00	mg/L
Boron	5.17E+03	mg/L
Bromodichloromethane	2.03E+01	mg/L
Bromoform	2.18E+02	mg/L
Bromomethane	2.04E+01	mg/L
Butylbenzylphthalate	1.10E+02	mg/L

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
Cadmium	3.19E-01	mg/L
Carbazole	2.05E+00	mg/L
Carbon disulfide	1.68E+02	mg/L
Carbon tetrachloride	1.32E+00	mg/L
Chlordane	2.05E-01	mg/L
Chlorobenzene	9.66E+00	mg/L
Chlorobenzilate	4.45E-01	mg/L
Chloroethane	2.57E+02	mg/L
Chloroform	1.44E+01	mg/L
Chloromethane	1.09E+02	mg/L
Chloroprene	1.02E+02	mg/L
Chromium	4.79E+02	mg/L
Chromium VI	3.83E+00	mg/L
Chrysene	3.91E-01	mg/L
cis-1,2-Dichloroethylene	4.65E+02	mg/L
cis-1,3-Dichloropropene	1.08E+01	mg/L
Cobalt	2.56E+03	mg/L
Copper	7.67E+02	mg/L
Cyanide	2.90E+01	mg/L
DDD	7.76E-02	mg/L
DDE	6.39E-02	mg/L
DDT	3.57E-02	mg/L
delta-Benzene hexachloride	2.53E-01	mg/L
Diallate	6.98E+02	mg/L
Diazinon	2.21E+00	mg/L
Dibenz[a,h]anthracene	1.17E-04	mg/L
Dibenzofuran	8.52E-01	mg/L
Dibromochloromethane	1.36E+01	mg/L
Dibutylphthalate	5.32E+01	mg/L
Dichlorodifluoromethane	2.45E+02	mg/L
Dieldrin	1.46E-02	mg/L
Diethylphthalate	9.58E+03	mg/L
Dimethoate	1.01E+00	mg/L
Dimethylphthalate	3.59E+05	mg/L
Diethylphthalate	8.52E-02	mg/L
Diphenylamine	1.48E+01	mg/L
Disulfoton	4.56E-02	mg/L
Endosulfan	9.13E+01	mg/L
Endosulfan I	9.13E+01	mg/L
Endosulfan II	9.13E+01	mg/L
Endosulfan sulfate	9.13E+01	mg/L
Endrin	2.40E-02	mg/L
Endrin aldehyde	2.40E-02	mg/L
Endrin ketone	2.40E-02	mg/L
Ethion	4.70E-01	mg/L
Ethyl acetate	2.19E+04	mg/L
Ethyl methacrylate	5.35E+02	mg/L
Ethylbenzene	8.37E+01	mg/L
Fluoranthene	2.20E+00	mg/L

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
Fluorene	5.11E+00	mg/L
Fluoride	3.72E+03	mg/L
gamma-BHC	3.97E-01	mg/L
Guthion	1.13E+01	mg/L
Heptachlor	1.08E-01	mg/L
Heptachlor epoxide	1.07E-02	mg/L
Heptachlorodibenzo-p-dioxins	1.55E-06	mg/L
Heptachlorodibenzo-p-furans	1.55E-06	mg/L
Hexachlorobenzene	1.11E-02	mg/L
Hexachlorobutadiene	5.32E-02	mg/L
Hexachlorocyclohexane	2.05E-01	mg/L
Hexachlorocyclopentadiene	6.61E+00	mg/L
Hexachlorodibenzo-p-dioxins	3.76E-07	mg/L
Hexachlorodibenzo-p-furans	1.55E-07	mg/L
Hexachloroethane	7.60E-01	mg/L
Hexachlorophene	7.37E-03	mg/L
Hydrazobenzene	2.59E-01	mg/L
Indeno[1,2,3-cd]pyrene	1.67E-03	mg/L
Iron	2.87E+03	mg/L
Isobutyl alcohol	5.90E+03	mg/L
Isophorone	8.91E+02	mg/L
Kepone	9.32E-02	mg/L
Lead	1.50E-02	mg/L
Lithium	1.02E+03	mg/L
m,p-Cresol	8.87E+01	mg/L
Malathion	3.04E+02	mg/L
Manganese	5.11E+01	mg/L
Mercury	1.34E+00	mg/L
Methacrylonitrile	2.84E+00	mg/L
Methidathion	2.28E+01	mg/L
Methoxychlor	7.98E+00	mg/L
Methyl cyanide	5.03E+02	mg/L
Methyl ethyl ketone	2.79E+04	mg/L
Methyl isobutyl ketone	1.24E+03	mg/L
Methyl methacrylate	1.83E+04	mg/L
Methyl parathion	7.26E+00	mg/L
Methylene bromide	4.26E+02	mg/L
Methylene chloride	2.10E+02	mg/L
Methylmercury, Total	5.75E+00	mg/L
Mirex	1.28E+00	mg/L
Molybdenum	1.21E+02	mg/L
m-Xylene	1.28E+03	mg/L
Naphthalene	1.48E+01	mg/L
Nickel	3.45E+03	mg/L
Nitrobenzene	4.49E+00	mg/L
N-Nitrosodiethylamine	2.07E-02	mg/L
N-Nitrosodimethylamine	2.71E-01	mg/L
N-Nitrosodi-n-butylamine	1.44E-01	mg/L
N-Nitrosodiphenylamine	1.90E+01	mg/L

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
N-Nitrosodipropylamine	9.51E-02	mg/L
N-Nitrosomethylethylamine	2.87E-01	mg/L
N-Nitrosopyrrolidine	2.30E+01	mg/L
o-Cresol	9.98E+01	mg/L
Octachlorodibenzo-p-dioxin	4.87E-06	mg/L
Octachlorodibenzo-p-furan	5.18E-06	mg/L
o-Toluidine	4.20E+00	mg/L
o-Xylene	1.28E+03	mg/L
Parathion	1.13E+01	mg/L
PCB-1016	5.09E-03	mg/L
PCB-1221	3.65E-02	mg/L
PCB-1232	2.40E-01	mg/L
PCB-1242	9.06E-02	mg/L
PCB-1248	9.06E-03	mg/L
PCB-1254	2.09E-03	mg/L
PCB-1260	3.05E-03	mg/L
PCB-1262	9.06E-03	mg/L
p-Cresol	8.87E+00	mg/L
p-Dimethylaminoazobenzene	4.58E-01	mg/L
Pentachlorobenzene	1.46E-01	mg/L
Pentachlorodibenzo-p-dioxins	4.52E-08	mg/L
Pentachlorodibenzo-p-furans	4.52E-07	mg/L
Pentachloroethane	2.55E+01	mg/L
Pentachloronitrobenzene	3.89E-01	mg/L
Pentachlorophenol	9.55E-02	mg/L
Phenanthrene	5.18E+00	mg/L
Phenol	6.27E+03	mg/L
Phorate	8.09E+00	mg/L
Polychlorinated biphenyls	9.58E-03	mg/L
p-Phenylenediamine	1.03E+05	mg/L
p-Xylene	1.28E+03	mg/L
Pyrene	1.86E+00	mg/L
Pyridine	6.03E+00	mg/L
Ronnel	1.84E+01	mg/L
Selenium	1.41E+02	mg/L
Silver	9.58E+01	mg/L
Strontium	7.67E+03	mg/L
Styrene	1.53E+01	mg/L
Sulfotep	5.70E+00	mg/L
technical-Chlordane	2.05E-01	mg/L
Tetrachlorodibenzo-p-furans	7.10E-07	mg/L
Tetrachloroethene	3.87E-01	mg/L
Thallium	6.71E-01	mg/L
Tin	3.83E+03	mg/L
Titanium	5.11E+04	mg/L
Toluene	2.27E+02	mg/L
Toluene-d8	2.27E+02	mg/L
Toxaphene	2.26E-01	mg/L
TPH, Diesel Range	1.02E+01	mg/L

**SURFACE WATER**  
**Human Health Onsite Worker**

Analyte	Benchmark	Units
TPH, Gasoline Range	7.30E+01	mg/L
trans-1,2-Dichloroethylene	1.16E+03	mg/L
trans-1,3-Dichloropropene	1.08E+01	mg/L
Trichloroethene	1.75E-01	mg/L
Trichlorofluoromethane	2.59E+02	mg/L
Tritium	9.78E+07	pCi/L
Uranium	3.83E+01	mg/L
Vanadium	4.47E+00	mg/L
Vinyl Acetate	3.46E+03	mg/L
Vinyl chloride	6.81E-01	mg/L
Xylenes	1.24E+02	mg/L
Zinc	6.39E+03	mg/L

**APPENDIX B**

**2014 – 2017  
Update of the Literature-Based Wildlife Survey**

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1. Bryan Jr., A. L., J. W. Snodgrass, H. A. Brant, C. S. Romanek, C. H. Jagoe, G. L. Mills and I. L. Brisbin Jr., 2014. *Precipitation Influences on Uptake of a Global Pollutant By a Coastal Avian Species*. Environmental Toxicology and Chemistry 33(12): 2711-2715.

Climatic variation, including precipitation amounts and timing, has been linked to abundance and breeding success of many avian species. Less studied, but also of significance, is the consequence of climatic variability on the exposure and uptake of nutrients and contaminants by wildlife. The authors examined mercury (Hg) concentrations in nestling wood stork feathers in a coastal setting over a 16-yr period to understand the influence of rainfall amounts on Hg transfer by parental provisioning relative to habitat use, assuming differential bioavailability of Hg within freshwater and saltwater habitat types. Coastal Hg uptake by stork nestlings was linked to freshwater habitat use, as indicated by stable carbon isotope ( $\delta^{13}\text{C}$ ) analyses. Cumulative rainfall amounts exceeding 220 cm in the 23 months preceding the breeding seasons resulted in greater use of freshwater wetlands as foraging habitat and greater Hg accumulation by nestling storks.

2. Bryan Jr., A. L., C. N. Love, G. L. Mills, R. R. Borkhataria, and S. L. Lance, 2015. *Testing For Associations Between Hematozoa Infection and Mercury In Wading Bird Nestlings*. Journal of Wildlife Diseases 51(1): 222-226.

Several wading bird species in the southeastern US have a history of infection by hematozoa/avian malaria as well as mercury accumulation through their diet, and thus may be exposed to two, generally sublethal, yet chronic, stressors. We analyzed nestling wading birds ( $n=171$ ) of varying size and trophic position from the southeastern US, and a smaller sample ( $n=23$ ) of older, free-ranging birds, to look for potential interrelationships between infection by hematozoa and mercury (Hg) uptake. Only one nestling was PCR positive for hematozoa (*Plasmodium/Haemoproteus*) whereas nine (39%) of the older wading birds were positive. Sequencing indicated that both nestling and adult positives were infected with *Plasmodium*. Given the low infection rate of the nestlings, there was no association between Hg and malaria. The older birds exhibited a possible malaria/Hg association, but it may be confounded by their greater potential exposure period and large-scale movements.

3. Cooper, Z., R. Bringolf, R. Cooper, K. Loftis, A. L. Bryan Jr., and J. A. Martin, 2017. Heavy metal bioaccumulation in two passerines with differing migration strategies. Science of the Total Environment 592(2017): 25-32.

Various anthropogenic activities have resulted in concentration of heavy metals and contamination of surrounding environments. Historically, heavy metal contamination at the Savannah River Site (SRS) in South Carolina has resulted from accidental releases of stored waste generated from nuclear weapon production in the early 1950s. Songbirds inhabiting and using resources from these areas have the potential to bioaccumulate metals but there is limited information on metal concentration levels in areas suspected of contamination as well as uncontaminated sites. Nonlethal tissues samples from avian blood and feathers provide a reliable approach for determining the bioavailability of these pollutants (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, and Zn). The objectives of this study were to survey terrestrial heavy metal contamination at the SRS on potentially bioavailable contaminated (PBC) sites through blood and feather samples from resident Northern Cardinals (*Cardinalis cardinalis*) and migratory Great Crested Flycatchers (*Myiarchus*

*crinitus*) and quantify sex-specific concentrations within species. Samples were collected in April to June of 2016. Cardinals had lower blood concentrations of Hg ( $\beta = -0.17$ , 85% CL = -0.26, -0.09) and Se ( $\beta = -0.33$ , 85% CL = -0.50, -0.16) than flycatchers. Cr feather concentrations were less in cardinals ( $\beta = -1.46$ , 85% CL = -2.44, -0.49) and all feathers of both species from reference locations had significantly less Zn ( $\beta = -67.92$ , 85% CL = -128.71, -7.14). Results indicate flycatchers were exposed to differing heavy metal levels during feather formation on their wintering grounds as compared to their recent exposure (through bloods samples) on their breeding grounds. Sex of individuals did not have a significant impact on bioaccumulation in either species. Overall, metal concentration levels in both species indicate minimal risk for acute toxicity; however, there is limited research on wild passerine populations with similar concentration levels. Therefore, further research on reproductive success of these birds should be explored.

4. Deryabina, T. G., S. V. Kuchmel, L. L. Nagorskaya, T. G. Hinton, J. C. Beasley, A. Lerebours, and J. T. Smith, 2015. Long-term census data reveal abundant wildlife populations at Chernobyl. *Current Biology* 25: R824-R826.

Following the 1986 Chernobyl accident, 116,000 people were permanently evacuated from the 4,200 km<sup>2</sup> Chernobyl exclusion zone. There is continuing scientific and public debate surrounding the fate of wildlife that remained in the abandoned area. Several previous studies of the Chernobyl exclusion zone indicated major radiation effects and pronounced reductions in wildlife populations at dose rates well below those thought to cause significant impacts. In contrast, our long-term empirical data showed no evidence of a negative influence of radiation on mammal abundance. Relative abundances of elk, roe deer, red deer and wild boar within the Chernobyl exclusion zone are similar to those in four (uncontaminated) nature reserves in the region and wolf abundance is more than 7 times higher. Additionally, our earlier helicopter survey data show rising trends in elk, roe deer and wild boar abundances from one to ten years post-accident. These results demonstrate for the first time that, regardless of potential radiation effects on individual animals, the Chernobyl exclusion zone supports an abundant mammal community after nearly three decades of chronic radiation exposures.

5. Edwards, P. G., K. F. Gaines, A. L. Bryan Jr., J. M. Novak, and S. A. Blas, 2014. Trophic dynamics of U, Ni, Hg and other contaminants of potential concern on the Department of Energy's Savannah River Site. *Environmental Monitoring and Assessment* 2014(186): 481-500.

The Department of Energy's Savannah River Site is a former nuclear weapon material production and current research facility located in South Carolina, USA. Wastewater discharges from a fuel and nuclear reactor target manufacturing facility released depleted and natural U, as well as other metals into the Tims Branch-Steed Pond water system. We investigated the current dynamics of this system for the purposes of environmental monitoring and assessment by examining metal concentrations, bioavailability, and trophic transfer of contaminants in seven ponds. Biofilm, detritus, and Anuran and Anisopteran larvae were collected and analyzed for stable isotopes ( $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}$ ) and contaminants of potential concern (COPC) with a focus on Ni, U, and Hg, to examine metal mobility. Highest levels of Ni and U were found in biofilms U (147 and 332 mg kg<sup>-1</sup> DW, respectively), while highest Hg levels were found in tadpoles (1.1 mg kg<sup>-1</sup> DW). We found intraspecific biomagnification of COPCs as expressed through stable isotope analysis. Biofilms were the best indicators for contamination and Anuran larvae with the digestive tract

removed were the best indicators of the specific bioavailability of the focal metals. Monitoring data showed that baseline  $\delta^{15}\text{N}$  values differed between ponds, but within a pond, values were stable throughout tadpole Gosner stage, strengthening the case to use this species for monitoring purposes. It is likely that there still is risk to ecosystem integrity as COPC metals are being assimilated into lower trophic organisms and even low levels of this mixture has shown to produce deleterious effects to some wildlife species.

6. Edwards, P. G., K. F. Gaines, A. L. Bryan, Jr., J. M. Novak, and S. A. Blas, 2014. Are U, Ni, and Hg an Environmental Risk within a RCRA/Comprehensive Environmental Response, Compensation, and Liability Act Unit on the U.S. Department of Energy's Savannah River Site? Human and Ecological Risk Assessment 20(2014): 1565-1589.

The U.S. Department of Energy's Savannah River Site (SRS) is a former nuclear weapon production facility. From 1954–1985, releases of Al, Cu, Cr, Hg, Ni, Pb, U, and Zn were discharged into the Tims Branch-Steed Pond water system. This study investigates whether metal concentrations in Tims Branch's sediment, biofilm, and other biota exceed screening level risk calculations to determine if remedial actions should be pursued for the Contaminants of Potential Concern (U, Ni, Hg). Transfer factors (TFs) were calculated to determine metal concentration changes throughout lower trophic levels and results were compared with sediment benchmarks to create hazard quotients (HQs) to assess risk and a scientific-management decision point. Most TFs for Ni and U from lower to higher trophic level biota were  $<1$ , suggesting no biomagnifications; however, HQs  $>1$  and cumulative distributions showed the majority of the samples exceeded action levels. Elevated TFs and HQs  $>1$  in the upper trophic levels for Hg indicated a high degree of bioavailability and biomagnification. Monte Carlo resampling analyses supported these empirical results. This system should continue to be closely monitored to ensure that contamination does not move off the SRS.

7. Finger Jr., J. W., M. T. Hamilton, T. C. Glenn, and T. D. Tuberville, 2017. Dietary selenomethionine administration in the American Alligator (*Alligator mississippiensis*): hepatic and renal Se accumulation and its effects on growth and body condition. Archives of Environmental Contamination and Toxicology 72(3): 439-448.

Selenium (Se) is an essential trace nutrient, but in excess, it can induce toxicity. Incomplete combustion of coal produces coal combustion wastes, which are enriched in Se and often disposed of in aquatic basins. While a multitude of studies have investigated Se accumulation in vertebrates, few studies have examined its effects on longer-lived top trophic carnivores, such as the American alligator (*Alligator mississippiensis*). In this study, alligators were fed one of three Dietary Treatments: mice injected with water (controls) or water supplemented with 1,000 or 2,000 ppm selenomethionine (SeMet). Dietary Treatment significantly affected Se levels in both the liver ( $p < 0.0001$ ; raw mean  $\pm$  SE: 1,000 ppm group,  $35.20 \pm 6.32$  ppm; 2,000 ppm group,  $49.97 \pm 4.00$  ppm) and kidney ( $p < 0.0001$ ; raw mean  $\pm$  SE: 1,000 ppm group,  $101.60 \pm 8.64$  ppm; 2,000 ppm,  $96.38 \pm 5.81$  ppm), which were significantly higher in alligators fed SeMet than in controls. Post-treatment head length, used to control for size variation, was negatively related to both kidney ( $p = 0.0142$ ) and liver ( $p = 0.0010$ ) Se concentrations. Dietary treatment with SeMet significantly reduced body condition (1,000 ppm,  $p < 0.0029$ ; 2,000 ppm,  $p = 0.0075$ ), but it significantly increased growth (1,000 ppm,  $p < 0.0001$ ; 2,000 ppm,  $p = 0.0316$ ). Body condition

and growth remained unchanged in control alligators ( $p > 0.05$ ). Our results demonstrate alligators are capable of accumulating high levels of Se through trophic transfer. The positive effects of accumulation on growth may demonstrate Se essentiality, whereas the negative effects on condition may demonstrate toxicity. Accumulation also was associated with mortality, further demonstrating toxicity. Future studies should further investigate the physiological effects of Se accumulation in long-lived, top-trophic carnivores.

8. Finger Jr., J. W., M. T. Hamilton, B. S. Metts, T. C. Glenn, and T. D. Tuberville, 2016. Chronic ingestion of coal fly-ash contaminated prey and its effects on health and immune parameters in juvenile American alligators (*Alligator mississippiensis*). Archives of Environmental Contamination and Toxicology 71(3): 347-358.

Coal-burning power plants supply approximately 37% of the electricity in the United States. However, incomplete combustion produces ash wastes enriched with toxic trace elements that have historically been disposed of in aquatic basins. Organisms inhabiting such habitats may accumulate these trace elements; however, studies investigating the effects on biota have been primarily restricted to shorter-lived, lower-trophic organisms. The American alligator (*Alligator mississippiensis*), a long-lived, top-trophic carnivore, has been observed inhabiting these basins, yet the health or immune effects of chronic exposure and possible accumulation remains unknown. In this study, we investigated how chronic dietary ingestion of prey contaminated with coal combustion wastes (CCWs) for 25 months, and subsequent accumulation of trace elements present in CCWs, affected juvenile alligator immune function and health. Alligators were assigned to one of four dietary-treatment groups including controls and those fed prey contaminated with CCWs for one, two, or three times a week. However, no effect of Dietary Treatment ( $p > 0.05$ ) was observed on any immune parameter or hematological or plasma analyte we tested. Our results suggest that neither exposure to nor accumulation of low doses of CCWs had a negative effect on certain aspects of the immune and hematological system. However, future studies are required to elucidate this further.

9. Fletcher, D. E., A. H. Lindell, G. K. Stillings, G. L. Mills, S. A. Blas, and J. V. McArthur, 2014. Variation in trace-element accumulation in predatory fishes from a stream contaminated by coal combustion waste. Archives of Environmental Contamination and Toxicology 66(3): 341-360.

Extensive and critical evaluation can be required to assess contaminant bioaccumulation in large predatory fishes. Species differences in habitat use, resource use, and trophic level, often influenced by body form, can result in diverging contaminant bioaccumulation patterns. Moreover, the broad size ranges inherent with large-bodied fish provide opportunity for trophic and habitat shifts within species that can further influence contaminant exposure. We compared contaminant bioaccumulation in four fish species, as well as two herbivorous invertebrates, from a coal combustion waste contaminated stream. Muscle, liver, and gonad tissue were analyzed from fish stratified across the broadest size ranges available. Effects of trophic position ( $\delta^{15}\text{N}$ ), carbon sources ( $\delta^{13}\text{C}$ ), and body size varied among and within species. Mercury and cesium concentrations were lowest in the invertebrates and increased with trophic level both among and within fish species. Other elements, such as vanadium, cadmium, barium, nickel, and lead, had greater levels in herbivorous invertebrates than in fish muscle. Sequestration by the fish livers averted accumulation in muscle. Consequently, fish liver tissue appeared to be a more sensitive

indicator of bioavailability, but exceptions existed. Despite liver sequestration, within fishes, muscle concentrations of many elements still tended to increase by trophic level. Notable variation within some species was observed. These results illustrate the utility of stable isotope data in exploring differences of bioaccumulation within taxa. Our analyses suggest a need for further evaluation of the underlying sources of this variability to better understand contaminant bioaccumulation in large predatory fishes.

10. Fletcher, D. E., A. H. Lindell, G. K. Stillings, S. A. Blas, and J. V. McArthur, 2017. Trace element accumulation in lotic dragonfly nymphs: Genus matters. *PLoS ONE* 12(2): 1-27.

Constituents of coal combustion waste (CCW) expose aquatic organisms to complex mixtures of potentially toxic metals and metalloids. Multi-element trace element analyses were used to distinguish patterns of accumulation among 8 genera of dragonfly nymphs collected from two sites on a CCW contaminated coastal plain stream. Dragonfly nymphs are exceptional for comparing trace element accumulation in syntopic macroinvertebrates that are all predators within the same order (Odonata) and suborder (Anisoptera), but differ vastly in habitat use and body form. Sixteen trace element (Be, V, Cr, Ni, Cu, Zn, As, Se, Sr, Cd, Sb, Cs, Ba, Hg, Tl, and Pb) were analyzed and trophic position and basal carbon sources assessed with stable isotope analyses (C and N). Trophic positions varied within relatively narrow ranges. Size did not appear to influence trophic position. Trophic position rarely influenced trace element accumulation within genera and did not consistently correlate with accumulation among genera. Patterns between  $\delta^{13}\text{C}$  and trace element accumulation were generally driven by differences between sites. An increase in trace element accumulation was associated with a divergence of carbon sources between sites in two genera. Higher trace element concentrations tended to accumulate in nymphs from the upstream site, closer to contaminant sources. Influences of factors such as body form and habitat use appeared more influential on trace element accumulation than phylogeny for several elements (Ni, Ba, Sr, V, Be, Cd, and Cr) as higher concentrations accumulated in sprawler and the climber-sprawler genera, irrespective of family. In contrast, As and Se accumulated variably higher in burrowers, but accumulation in sprawlers differed between sites. Greater variation between genera than within genera suggests genus as an acceptable unit of comparison in dragonfly nymphs. Overall, taxonomic differences in trace element accumulation can be substantial, often exceeding variation between sites. Our results underscore the element and taxa specific nature of trace element accumulation, but we provide evidence of accumulation of some trace elements differing among dragonflies that differ in body form and utilize different sub-habitats within a stream reach.

11. Fletcher, D. E., A. H. Lindell, G. K. Stillings, G. L. Mills, S. A. Blas, and J. V. McArthur, 2014. Spatial and taxonomic variation in trace element bioaccumulation in two herbivores from a coal combustion waste contaminated stream. *Ecotoxicology and Environmental Safety* 101(2014): 196-204.

Dissimilarities in habitat use, feeding habits, life histories, and physiology can result in syntopic aquatic taxa of similar trophic position bioaccumulating trace elements in vastly different patterns. We compared bioaccumulation in a clam, *Corbicula fluminea* and mayfly nymph *Maccaffertium modestum* from a coal combustion waste contaminated stream. Collection sites differed in distance to contaminant sources, incision, floodplain activity, and sources of flood event water and organic matter. Contaminants variably accumulated in both sediment and biofilm. Bioaccumulation

differed between species and sites with *C. fluminea* accumulating higher concentrations of Hg, Cs, SR, Se, As, Be, and Cu, but *M. modestum* higher Pb and V. Stable isotope analyses suggested both spatial and taxonomic differences in resource use with greater variability and overlap between species in the more physically disturbed site. The complex but essential interactions between organismal biology, divergence in resource use, and bioaccumulation as related to stream habitat requires further studies essential to understand impacts of metal pollution on stream systems.

12. Haskins, D. L., M. T. Hamilton, A. L. Jones, J. W. Finger Jr., R. B. Bringolf, and T. D. Tuberville, 2017. Accumulation of coal combustion residues and their immunological effects in the yellow-bellied slider (*Trachemys scripta scripta*). *Environmental Pollution* 224(2017): 810-819.

Anthropogenic activities such as industrial processes often produce copious amounts of contaminants that have the potential to negatively impact growth, survival, and reproduction of exposed wildlife. Coal combustion residues (CCRs) represent a major source of pollutants globally, resulting in the release of potentially harmful trace elements such as arsenic (As), cadmium (Cd), and selenium (Se) into the environment. In the United States, CCRs are typically stored in aquatic settling basins that may become attractive nuisances to wildlife. Trace element contaminants, such as CCRs, may pose a threat to biota yet little is known about their sublethal effects on reptiles. To assess the effects of CCR exposure in turtles, we sampled 81 yellow-bellied sliders (*Trachemys scripta scripta*) in 2014e2015 from CCR-contaminated and uncontaminated reference wetlands located on the Savannah River Site (Aiken, SC, USA). Specific aims were to 1) compare the accumulation of trace elements in *T. s. scripta* claw and blood samples between reference and CCR-contaminated site types; 2) evaluate potential immunological effects of CCRs via bacterial killing assays and phytohaemagglutinin (PHA) assays; and 3) quantify differences in hemogregarine parasite loads between site types. Claw As, Cd, copper (Cu), and Se (all  $p \leq 0.001$ ) and blood As, Cu, Se, and strontium (Sr;  $p \leq 0.015$ ) were significantly elevated in turtles from CCR-contaminated wetlands compared to turtles from reference wetlands. Turtles from reference wetlands exhibited lower bacterial killing ( $p = 0.015$ ) abilities than individuals from contaminated sites but neither PHA responses ( $p = 0.566$ ) nor parasite loads ( $p = 0.980$ ) differed by site type. Despite relatively high CCR body burdens, sliders did not exhibit apparent impairment of immunological response or parasite load. In addition, the high correlation between claw and blood concentrations within individuals suggests that nonlethal tissue sampling may be useful for monitoring CCR exposure in turtles.

13. Haskins, D. L., M. T. Hamilton, N. I. Stacy, J. W. Finger Jr., and T. D. Tuberville, 2017. Effects of selenium exposure on the hematology, innate immunity, and metabolic rate of yellow-bellied sliders (*Trachemys scripta scripta*). *Ecotoxicology* 26(8): 1134-1146.

Selenium (Se) is a naturally occurring essential element that can be toxic to vertebrates at high concentrations. Despite studies that have documented that wild reptile species can accumulate copious amounts of Se, little is known regarding specific toxicologic effects of Se. In this study, 70 juvenile yellow-bellied sliders (*Trachemys scripta scripta*) were exposed to one of three seleno-L-methionine (SetMet) treatments (control,  $n = 24$ ; 15 mg/kg,  $n = 23$ ; and 30 mg/kg,  $n = 23$ ) via weekly oral gavage for 5 weeks. At the conclusion of the experiment, kidney, liver, muscle, and blood samples were collected for quantitative Se analysis. Turtles in the SeMet treatment groups accumulated significantly higher amounts of Se in all tissue types relative to controls

(all  $p < 0.001$ ). Turtles in the 30 mg/kg SeMet group also accumulated significantly higher amounts of Se compared to the 15 mg/kg group (all  $p < 0.001$ ). Although toxicity thresholds for reptiles have not been established, Se concentrations in liver tissue from both SeMet treatment groups exceeded reported avian toxicity thresholds for liver tissue. Neither oxygen consumption nor innate bactericidal capacity were impacted by SeMet exposure. However, turtles in the 30 mg/kg SeMet group exhibited anemia, which has been reported in other vertebrates exposed to Se. Furthermore, juvenile *T. s. scripta* in the 30 mg/kg SeMet group experienced 17% mortality compared to 0% in the 15 mg/kg treatment and control groups. To our knowledge, this study is the first to report dose-dependent Se-associated anemia and mortality in a chelonian species.

14. Hernandez, F., R. E. Oldenkamp, S. Webster, J. C. Beasley, L. L. Farina, and S. M. Wisely, 2017. Raccoons (*Procyon lotor*) as sentinels of trace element contamination and physiological effects of exposure to coal fly ash. Archives of Environmental Contamination and Toxicology 72(2): 235-246.

Anthropogenic pollutants disrupt global biodiversity, and terrestrial sentinels of pollution can provide a warning system for ecosystem-wide contamination. This study sought to assess whether raccoons (*Procyon lotor*) are sentinels of local exposure to trace element contaminants at a coal fly ash site and whether exposure resulted in health impairment or changes in the intestinal helminth communities. We compared trace element accumulation and the impact on health responses and intestinal helminth communities of raccoons inhabiting contaminated and reference sites of the U.S. Department of Energy's Savannah River Site (South Carolina, USA). Data on morphometry, hematology, histopathology, helminth community and abundance, and liver trace element burdens were collected from 15 raccoons captured adjacent to a coal fly ash basin and 11 raccoons from a comparable uncontaminated site nearby. Of eight trace elements analyzed, Cu, As, Se, and Pb were elevated in raccoons from the contaminated site. Raccoons from the contaminated site harbored higher helminth abundance than animals from the reference site and that abundance was positively associated with increased Cu concentrations. While we found changes in hematology associated with increased Se exposure, we did not find physiological or histological changes associated with higher levels of contaminants. Our results suggest that raccoons and their intestinal helminths act as sentinels of trace elements in the environment associated with coal fly ash contamination.

15. Hinton, T. G., M. E. Byrne, S. C. Webster, and J. C. Beasley, 2015. Quantifying the spatial and temporal variation in dose from external exposure to radiation: a new tool for use on free-ranging wildlife. Journal of Environmental Radioactivity 145(2015): 58-65.

Inadequate dosimetry is often the fundamental problem in much of the controversial research dealing with radiation effects on free-ranging wildlife. Such research is difficult because of the need to measure dose from several potential pathways of exposure (i.e., internal contamination, external irradiation, and inhalation). Difficulties in quantifying external exposures can contribute significantly to the uncertainties of dose-effect relationships. Quantifying an animal's external exposure due to spatial—temporal use of habitats that can vary by orders of magnitude in radiation levels is particularly challenging. Historically, wildlife dosimetry studies have largely ignored or been unable to accurately quantify variability in external dose because of technological limitations. The difficulties of quantifying the temporal—spatial aspects of external irradiation prompted us to

develop a new dosimetry instrument for field research. We merged two existing technologies [Global Positioning Systems (GPS) and electronic dosimeters] to accommodate the restrictive conditions of having a combined unit small enough to be unobtrusively worn on the neck of a free-ranging animal, and sufficiently robust to withstand harsh environmental conditions. The GPS—dosimeter quantifies the spatial and temporal variation in external dose as wildlife traverse radioactively contaminated habitats and sends, via satellites, an animal's location and short term integrated dose to the researcher at a user-defined interval. Herein we describe: 1) the GPS—dosimeters; 2) tests to compare their uniformity of response to external irradiation under laboratory conditions; 3) field tests of their durability when worn on wildlife under natural conditions; and 4) a field application of the new technology at a radioactively contaminated site. Use of coupled GPS—dosimetry will allow, for the first time, researchers to better understand the relationship of animals to their contaminated habitats and better assess animal responses to the stress of radiological exposures.

16. Kenamer, R. A., R. E. Oldenkamp, J. C. Leaphart, J. D. King, A. L. Bryan Jr., and J. C. Beasley, 2017. Radiocesium in migratory aquatic game birds using contaminated U.S. Department of Energy reactor-cooling reservoirs: A long-term perspective. *Journal of Environmental Radioactivity* 171(2017): 189-199.

Low-level releases of radiocesium into former nuclear reactor cooling-reservoirs on the U.S. Department of Energy's Savannah River Site (SRS) in South Carolina, USA, dating primarily to the late 1950s and early 1960s, have allowed examination of long-term contaminant attenuation in biota occupying these habitats. Periodic collections of migratory game birds since the 1970s have documented  $^{137}\text{Cs}$  (radiocesium) activity concentrations in birds of SRS reservoirs, including mainly PAR Pond and Pond B. In this study, during 2014 and 2015 we released wild-caught American coots (*Fulica americana*) and ring-necked ducks (*Aythya collaris*) onto Pond B. We made lethal collections of these same birds with residence times ranging from 32 to 173 days to examine radiocesium uptake and estimate the rate of natural attenuation. The two species achieved asymptotic whole-body activity concentrations of radiocesium at different times, with ring-necked ducks requiring almost three times longer than the 30–35 days needed by coots. We estimated ecological half-life ( $T_e$ ) for Pond B coots over a 28-yr period as 16.8 yr (95% CI = 12.9–24.2 yr). Pond B coot  $T_e$  was nearly four times longer than  $T_e$  for coots at nearby PAR Pond where radiocesium bioavailability had been constrained for decades by pumping of potassium-enriched river water into that reservoir.  $T_e$  could not be estimated from long-term data for radiocesium in Pond B diving ducks, including ring-necked ducks, likely because of high variability in residence times of ducks on Pond B. Our results highlight the importance: 1) for risk managers to understand site-specific biogeochemistry of radiocesium for successful implementation of countermeasures at contaminated sites and 2) of residence time as a critical determinant of observed radiocesium activity concentrations in highly mobile wildlife inhabiting contaminated habitats.

17. Kosnicki, E., S. A. Sefick, M. H. Paller, M. S. Jerrell, B. A. Prusha, S. C. Sterrett, T. D. Tuberville, and J. W. Feminella, 2016. A stream multimetric macroinvertebrate index (MMI) for the Sand Hills ecoregion of the Southeastern Plains, USA. *Environmental Management* 58(4): 741-751.

A macroinvertebrate multimetric index is an effective tool for assessing the biological integrity of streams. However, data collected under a single protocol may not be available for an entire region.

We sampled macroinvertebrates from the full extent of the Sand Hills ecoregion Level IV of the Southeastern Plains with a standard protocol during the summers of 2010–2012. We evaluated the performance of 94 metrics through a series of screening criteria and built 48 macroinvertebrate multimetric indexes with combinations of the best performing metrics, representing richness, habit, functional feeding guild, sensitivity, and community composition. A series of narrative-response tests for each macroinvertebrate multimetric index was used to find the best performing macroinvertebrate multimetric index which we called the Sand Hills macroinvertebrate multimetric index. The Sand Hills macroinvertebrate multimetric index consisted of the measures Biotic Index, % Shredder taxa, Clinger taxa<sup>2</sup>/total taxa, Plecoptera and Trichoptera richness, and Tanytarsini taxa<sup>2</sup>/Chironomidae taxa. Comparison of the Sand Hills macroinvertebrate multimetric index with existing assessment tools calculated with our data indicated that the Sand Hills macroinvertebrate multimetric index performs at a high level with regards to identifying degraded sites and in its response to stress gradients.

18. Koster van Groos, P., D. I. Kaplan, H. Chang, J. C. Seaman, D. Li, A. D. Peacock, K. G. Scheckel, and P. R. Jaffé, 2016. Uranium fate in wetland mesocosms: Effects of plants at two iron loadings with different pH values. *Chemosphere* 163(2016): 116-124.

Small-scale continuous flow wetland mesocosms (~0.8 L) were used to evaluate how plant roots under different iron loadings affect uranium (U) mobility. When significant concentrations of ferrous iron (Fe) were present at circumneutral pH values, U concentrations in root exposed sediments were an order of magnitude greater than concentrations in root excluded sediments. Micro X-ray absorption near-edge structure ( $\mu$ -XANES) spectroscopy indicated that U was associated with the plant roots primarily as U(VI) or U(V), with limited evidence of U(IV). Micro X-ray fluorescence ( $\mu$ -XRF) of plant roots suggested that for high iron loading at circumneutral pH, U was co-located with Fe, perhaps co-precipitated with root Fe plaques, while for low iron loading at a pH of ~4 the correlation between U and Fe was not significant, consistent with previous observations of U associated with organic matter. Quantitative PCR analyses indicated that the root exposed sediments also contained elevated numbers of *Geobacter* spp., which are likely associated with enhanced iron cycling, but may also reduce mobile U(VI) to less mobile U(IV) species.

19. Li, D., J. C. Seaman, H. Chang, P. R. Jaffe, P. Koster van Groos, D. Jiang, N. Chen, J. Lin, Z. Arthur, Y. Pan, K. G. Scheckel, M. Newville, A. Lanzirotti, and D. I. Kaplan, 2014. Retention and chemical speciation of uranium in an oxidized wetland sediment from the Savannah River Site. *Journal of Environmental Radioactivity* 131(2014): 40-46.

Uranium speciation and retention mechanisms onto Savannah River Site (SRS) wetland sediments was studied using batch (ad)sorption experiments, sequential extraction, U L<sub>3</sub>-edge X-ray absorption near-edge structure (XANES) spectroscopy, fluorescence mapping and  $\mu$ -XANES. Under oxidized conditions, U was highly retained by the SRS wetland sediments. In contrast to other similar but much lower natural organic matter (NOM) sediments, significant sorption of U onto the SRS sediments was observed at pH <4 and pH >8. Sequential extraction indicated that the U species were primarily associated with the acid soluble fraction (weak acetic acid extractable) and organic fraction (Na-pyrophosphate extractable). Uranium L<sub>3</sub>-edge XANES spectra of the U-bound sediments were nearly identical to that of uranyl acetate. Based on fluorescence mapping,

U and Fe distributions in the sediment were poorly correlated, U was distributed throughout the sample and did not appear as isolated U mineral phases. The primary oxidation state of U in these oxidized sediments was U(VI), and there was little evidence that the high sorptive capacity of the sediments could be ascribed to abiotic or biotic reduction to the less soluble U(IV) species or to secondary mineral formation. Collectively, this study suggests that U may be strongly bound to wetland sediments, not only under reducing conditions by reductive precipitation, but also under oxidizing conditions through NOM-uranium bonding.

20. Lindell, A. H., R. C. Tuckfield, and J. V. McArthur, 2016. Differences in the effect of coal pile runoff (low pH, high metal concentration) versus natural Carolina Bay water (low pH, low metal concentration) on plant condition and associated bacterial epiphytes of *Salvinia minima*. *Bulletin of Environmental Contamination and Toxicology* 96(5): 602-607.

Numerous wetlands and streams have been impacted by acid mine drainage (AMD) resulting in lowered pH and increased levels of toxic heavy metals. Remediation of these contaminated sites requires knowledge on the response of microbial communities (especially epiphytic) and aquatic plants to these altered environmental conditions. We examined the effect of coal pile runoff waters as an example of AMD in contrast to natural water from Carolina Bays with low pH and levels of metals on *Salvinia minima*, a non-native, metal accumulating plant and associated epiphytic bacteria. Treatments included water from two Carolina Bays, one AMD basin and Hoagland's Solution at two pH levels (natural and adjusted to 5.0 – 5.5). Using controlled replicated microcosms (N = 64) we determined that the combination of low pH and high metal concentrations has a significant negative impact ( $p < 0.05$ ) on plant condition and epiphytes. Solution metal concentrations dropped indicating removal from solution by *S. minima* in all microcosms.

21. Mathews, T.J., B.B. Looney, A.L. Bryan, J.G. Smith, C.L. Miller, G.R. Southworth, M.J. Peterson, 2015. The effects of a stannous chloride-based water treatment systems in a mercury contaminated stream. *Chemosphere* 138(2015)190-196.

We assessed the impacts of an innovative Hg water treatment system on a small, industrially-contaminated stream in the southeastern United States. The treatment system, installed in 2007, removes Hg from wastewater using tin (Sn) (II) chloride followed by air stripping. Mercury concentrations in the receiving stream, Tims Branch, decreased from >100 to ~10 ng/L in the four years following treatment, and Hg body burdens in redbfin pickerel (*Esox americanus*) decreased by 70% at the most contaminated site. Tin concentrations in water and fish increased significantly in the tributary leading to Tims Branch, but concentrations remain below levels of concern for human health or ecological risks. While other studies have shown that Sn may be environmentally methylated and methyltin can transfer its methyl group to Hg, results from our field studies and sediment incubation experiments suggest that the added Sn to the Tims Branch watershed is not contributing to methylmercury (MeHg) production or bioaccumulation in this system. The stannous chloride treatment system installed at Tims Branch was effective at removing Hg inputs and reducing Hg bioaccumulation in the stream, but future studies are needed to assess longer term impacts of Sn on the environment.

22. McArthur, J. V., C. A. Dicks, A. L. Bryan Jr., and R. C. Tuckfield, 2017. The effects of low-level ionizing radiation and copper exposure on the incidence of antibiotic resistance in lentic biofilm bacteria. *Environmental Pollution* 228(2017): 390-397.

Environmental reservoirs of antibiotic resistant bacteria are poorly understood. Understanding how the environment selects for resistance traits in the absence of antibiotics is critical in developing strategies to mitigate this growing menace. Indirect or co-selection of resistance by environmental pollution has been shown to increase antibiotic resistance. However, no attention has been given to the effects of low-level ionizing radiation or the interactions between radiation and heavy metals on the maintenance or selection for antibiotic resistance (AR) traits. Here we explore the effect of radiation and copper on antibiotic resistance. Bacteria were collected from biofilms in two ponds — one impacted by low-level radiocesium and the other an abandoned farm pond. Through laboratory controlled experiments we examined the effects of increasing concentrations of copper on the incidence of antibiotic resistance. Differences were detected in the resistance profiles of the controls from each pond. Low levels (0.01 mM) of copper sulfate increased resistance but 0.5 mM concentrations of copper sulfate depressed the AR response in both ponds. A similar pattern was observed for levels of multiple antibiotic resistance per isolate. The first principal component response of isolate exposure to multiple antibiotics showed significant differences among the six isolate treatment combinations. These differences were clearly visualized through a discriminant function analysis, which showed distinct antibiotic resistance response patterns based on the six treatment groups.

23. McArthur, J. V., R. C. Tuckfield, D. E. Fletcher, and A. H. Lindell, 2017. Effect of heavy metal pollution on the incidence of antibiotic resistance in *Aeromonas hydrophila* isolates obtained from the surface of fish. *Aquatic Microbial Ecology* 79(3): 197-207.

A large collection of aquatic *Aeromonas* obtained from the surfaces of 5 species of fish in 2 streams with different contamination histories were examined to test hypotheses on the effects of contaminant history, stream habitat and longitudinal location on the incidence of antibiotic resistance (AR) towards 6 antibiotics and levels of multiple antibiotic resistance (MAR). Fish species included an open-water species (*Micropterus salmoides*), 2 mid-water species of centrarchids (*Lepomis auritus* and *L. punctatus*) and 2 species of bottom-dwelling fish (*Ameiurus natalis* and *A. platycephalus*). Metal analysis of the sediments indicated that there was a strong downstream contamination gradient in one stream but not in the other. However, we found that the average MAR level was similar between the 2 streams. Comparisons among fish species found the highest levels of resistance in bacteria isolated from bottom-dwelling fish in the least contaminated stream. However, there were clear differences in levels of resistance between bacteria isolated from the 2 bottom-dwelling fish, with those isolated from *A. natalis* having significantly higher levels than those isolated from *A. platycephalus*. We suggest that these differences relate to higher concentrations of metals and other contaminants in habitats where *A. natalis* is normally found. For some antibiotics, there was a clear pattern of decreasing resistance among bacteria isolated from bottom-dwelling, mid-water and open-water fish. Unlike culturable sediment bacteria from the same streams in previous studies, these commensal aeromonads did not show the same expected patterns of increasing antibiotic resistance in metal-contaminated vs. uncontaminated streams.

24. Oldenkamp, R. E., A. L. Bryan Jr., R. A. Kennamer, J. C. Leaphart, S. C. Webster, and J. C. Beasley, 2017. Trace elements and radiocesium in game species near contaminated sites. *Journal of Wildlife Management* 81(8): 1338-1350.

Mercury (Hg), Selenium (Se), and Arsenic (As) found in coal combustion wastes (CCW) and radionuclides released from anthropogenic activities present potential environmental and human health concerns. Despite the widespread harvest and consumption of wildlife by recreational hunters, game species are not subject to the same safety testing as commercially marketed livestock; thus, there are few data available regarding contaminant concentrations in many commonly harvested wildlife. We sampled feral pigs (*Sus scrofa*; invasive wild pigs), gray squirrels (*Sciurus carolinensis*), and waterfowl from relatively uncontaminated habitats and areas of contamination to quantify levels of trace elements and radiocesium ( $^{137}\text{Cs}$ ) in muscle and liver tissues for assessment of potential human health risks from the consumption of game. Species collected at a CCW ash basin consistently had levels of selected trace elements, particularly Se, above concentrations considered toxic to waterfowl, suggesting CCW may be an important pathway for wildlife, and subsequently human exposure to this element. Similarly, we observed elevated concentrations of  $^{137}\text{Cs}$  in wildlife collected in or near aquatic ecosystems with histories of operational releases of radionuclides. The majority of tissue samples analyzed were below elemental levels known to adversely affect wildlife health and  $^{137}\text{Cs}$  levels were below European Economic Community limits for human consumption established following the 1986 Chernobyl accident. Waterfowl, however, had levels of several elements of interest (Se and Hg) that could be of health concern to the birds, especially individuals collected from areas with known contamination, or human consumers of the birds. Given the high levels of trace element burdens we observed in waterfowl collected from ash basins, and the common occurrence of similar surface impoundments throughout much of the globe, wide-scale sampling for contaminants in waterfowl within or across migratory flyways appear to be greatly needed to better understand routes of contaminant movement and potential areas (or species) with elevated contamination risk to waterfowl and hunters

25. Rumrill, C. T., D. E. Scott, and S. L. Lance, 2016. Effects of metal and predator stressors in larval southern toads (*Anaxyrus terrestris*). *Ecotoxicology* 25(2016): 1278-1286.

Natural and anthropogenic stressors typically do not occur in isolation; therefore, understanding ecological risk of contaminant exposure should account for potential interactions of multiple stressors. Realistically, common contaminants can also occur chronically in the environment. Because parental exposure to stressors may cause transgenerational effects on offspring, affecting their ability to cope with the same or novel environmental stressors, the exposure histories of generations preceding that being tested should be considered. To examine multiple stressor and parental exposure effects we employed a 2 x 2 x 2 factorial design in outdoor 1,000-L mesocosms ( $n = 24$ ). Larval southern toads (*Anaxyrus terrestris*), bred from parents collected from reference and metal-contaminated sites, were exposed to two levels of both an anthropogenic (copper — 0, 30  $\mu\text{g/L}$  Cu) and natural (predator cue - present/absent) stressor and reared to metamorphosis. Toads from the metal-contaminated parental source population were smaller at metamorphosis and had delayed development; i.e., a prolonged larval period. Similarly, larval Cu exposure also reduced size at metamorphosis and prolonged the larval period. We, additionally, observed a significant interaction between larval Cu and predator-cue exposure on larval period, wherein

delayed emergence was only present in the 30- $\mu\text{g/L}$  Cu treatments in the absence of predator cues. The presence of parental effects as well as an interaction between aquatic stressors on commonly measured endpoints highlight the importance of conducting multistressor studies across generations to obtain data that are more relevant to field conditions in order to determine population-level effects of contaminant exposure.

26. Soteropoulos, D. L., S. L. Lance, R. W. Flynn, and D. E. Scott, 2014. Effects of copper exposure on hatchling success and early larval survival in marbled salamanders, *Ambystoma opacum*. *Environmental Toxicology and Chemistry* 33(7): 1631-1637.

The creation of wetlands, such as urban and industrial ponds, has increased in recent decades, and these wetlands often become enriched in pollutants over time. One metal contaminant trapped in created wetlands is copper ( $\text{Cu}^{2+}$ ). Copper concentrations in sediments and overlying water may affect amphibian species that breed in created wetlands. The authors analyzed the Cu concentration in dried sediments from a contaminated wetland and the levels of aqueous Cu released after flooding the sediments with different volumes of water, mimicking low, medium, and high pond-filling events. Eggs and larvae of *Ambystoma opacum* Gravenhorst, a salamander that lays eggs on the sediments in dry pond beds that hatch on pond-filling, were exposed to a range of Cu concentrations that bracketed potential aqueous Cu levels in created wetlands. Embryo survival varied among clutches, but increased Cu levels did not affect embryo survival. At Cu concentrations of 500  $\mu\text{g/L}$  or greater; however, embryos hatched earlier, and the aquatic larvae died shortly after hatching. Because Cu concentrations in sediments increase over time in created wetlands, even relatively tolerant species such as *A. opacum* may be affected by Cu levels in the posthatching environment.

27. SREL, 2015. Chemical and Radiological Analysis of Sediment and Biological Samples Collected from McQueens Branch, Final Report, R-15-003, Ver. 1.0, June 22, 2015, Savannah River Ecology Laboratory, Aiken, SC

The objective of the current study was to evaluate contaminant levels present in sediment and biota samples collected from a section of McQueens Branch downstream from the Saltstone Facility before and after the 2013 spillway discharge from Z-Area Sedimentation Basin No. 4 to Storm Water Outfall Z-01. Sediments within the basin have elevated levels of  $^{137}\text{Cs}$  and other radionuclides originating from the Saltstone Disposal Facility. Sediment and macroinvertebrate samples were fortuitously collected from the McQueens Branch stream just prior to the 2013 discharge event as part of a larger effort to evaluate the impact of SRS operations on streams and watersheds. A second set of McQueens Branch samples were collected in 2014 for comparison. In addition, another set of sediment samples was collected in 2014 from a beaver pond located upstream on McQueens Branch from the Saltstone Facility.

The radionuclide levels observed for the 2013 and 2014 McQueens Branch sediment samples suggest that very little if any additional radioactivity can be attributed to the Z-Area Sedimentation Basin No. 4 discharge event that occurred in 2013. The  $^{137}\text{Cs}$  levels for all sediment samples collected in 2013 and 2014 from the McQueens Branch study site were  $< 1$  pCi g<sup>-1</sup>. Although  $^{137}\text{Cs}$  makes up a large portion of the radioactivity associated with the saltwaste materials and present in the Z-Area Sedimentation Basin No. 4, there was no increase

in  $^{137}\text{Cs}$  levels measured in sediments from the McQueens Branch study site following the 2013 discharge event. Gross alpha/beta levels were a bit higher for the McQueens Branch sediment samples in 2014, but not high enough to differentiate from background variability. Similar trends were observed with respect to radionuclides in the biological samples. In general, the levels of  $^{137}\text{Cs}$  and gross alpha/non-volatile beta were quite low for all biological tissues (in most cases below the minimum detectable activity (MDA) for  $^{137}\text{Cs}$ ), with somewhat higher levels observed in the 2014 samples. However, the high level of variability observed for biological samples collected within a given year suggests that such differences are not significant.

Analyzing contaminant accumulation in macroinvertebrates enhances the assessment of contamination in McQueens Branch by verifying which contaminants detected in the sediments are bioavailable and actually entering the stream community. Macroinvertebrates are known to accumulate a variety of contaminants and represent trophic links between primary production and higher trophic level vertebrates. We selected three groups of aquatic macroinvertebrates as biomonitors for the current study: dragonfly nymphs, crane fly larvae and crayfish. Dragonfly nymphs are predators that utilize a wide range of stream habitats. Crane fly larvae feed on decaying leaves and consequently biofilm that is known to accumulate high concentrations of contaminants. Crayfish inhabit depositional zones where highest contaminant concentrations were found. Additionally, as omnivores, crayfish can be exposed trophically via many potentials comprised by the genus) of some sensitive dragonfly genera decreased moderately while the particularly tolerant genus *Progomphus* increased in relative abundance between 2013 and 2014. Macroinvertebrate Tolerance Values (TVs) are indices ranging from 0-10 indicating how tolerant taxa are to poor water quality. The average over all TVs for dragonflies collected in 2013 vs. 2014 only increased 0.4 points from 7.4 to 7.8. Consequently, based on the dragonfly community composition, there was no evidence of an extreme community shift indicating a severe stream degradation following discharge from the Z-Area Sedimentation Basin No. 4.

The concentration of several metals was found to be higher in the 2014 McQueens Branch stream sediments, particularly for depositional samples, compared to the 2013 McQueens Branch sediments and other comparable SRS data sets. However, the 2014 metal levels are similar to those found in sediments collected in 2014 from a beaver pond up-stream from the Saltstone Facility. This increase in metals coincides with a significant increase in organic matter, from  $\approx 1\%$  in 2013 to  $\approx 28\%$  in 2014, observed for the depositional 2014 McQueens Branch samples. These results suggest that the buildup in metals for the 2014 samples is associated with the increase in allochthonous organic matter in depositional regions of the stream, and not related to storm water discharge from the Saltstone Facility.

Although considerable variation was evident among taxa, trace element concentrations also were found to be higher in 2014 McQueens Branch biota. Despite the increased concentrations in biota between years, the Biota-Sediment Accumulation Factor of most elements decreased between years across all taxa. This pattern results from concentrations increasing in the biota at a lower rate than measured in the sediment.

Identification of recently collected caddisfly adults is still in progress. Comparison of recently collected adults to those collected over 25 years ago is finding both: species collected recently but not in the early collection, and species absent in current collections that were previously recorded. The SCDHEC macroinvertebrate procedure indicated a site on Mill Creek and the lower reaches of McQueens Branch to be of similar condition when the 2014 collections were made. This is an encouraging indicator that the lower reaches of McQueens Branch have not been severely degraded.

28. SREL, 2016. Annual Technical Progress Report of Ecological Research for FY 16, Final Report, December, 2016, for the Period of October 1 2015 – September 30, 2016, *H-02 Constructed Wetland Studies: Amphibian Ecotoxicity*, Savannah River Ecology Laboratory, Aiken, SC

### Objectives

Our research at the H-02 constructed wetland complex focuses on several questions related to these treatment wetlands: 1) Over time, what amphibians have become established in the wetlands? 2) Do the elevated trace metal (e.g., copper [Cu] and zinc [Zn]) levels in the wetlands affect amphibian reproductive success, disease ecology, and population dynamics? 3) How do the amphibian diversity and numbers compare to more natural, wetlands? and 4) As the constructed wetlands age, how will the amphibian community respond?

Summary of Research Activities: This report summarizes our amphibian studies related to the H-02 treatment wetlands from October 2015 to September 2016. We used aquatic trapping to characterize biota of the treatment wetlands. We completed a third field season examining the influence of wetland hydroperiod on the prevalence of two amphibian diseases, chytridiomycosis and ranavirus. We also expanded that study to include community structure and water quality surveys of 20 wetlands. To more directly examine the effect of copper on disease susceptibility we conducted an experimental challenge. To do this we reared southern toad and eastern narrowmouth toad larvae under conditions of no and low levels of copper. After 7 days, we exposed them to known concentrations of ranavirus and then reared them for an additional 10 days. We completed studies examining the interactive effects of exposure to both Cu and Zn in three species of amphibians and lab studies examining the effects of Cu on three larval ambystomatid salamander species. We initiated studies examining effects of contamination on methylation patterns in southern toads and southern leopard frogs and to investigate how distance from a contaminated wetland influences tolerance to copper. We combined natural history data with copper toxicity results from prior experiments to model the potential combined effects of copper contamination and climate change on reproductive success in toads and leopard frogs. We also analyzed long-term data from Rainbow Bay (RB) in the context of nutrient flux between aquatic and terrestrial habitats. Rainbow Bay and other isolated wetlands serve as comparison sites for the H-02 amphibian studies. We completed the 38th year of monitoring at RB, and have begun analyzing the data in the context of community shifts in response to environmental change and altered hydrology.

## Conclusions

- 1) Southern toad juveniles exposed to ranavirus had reduced growth rates, but Cu did not affect viral loads.
- 2) Over time there has been a shift in nutrient flux from a net flow to the terrestrial environment to a flow into the aquatic environment that is likely tied to climate change.
- 3) Exposure to ranavirus causes a decline in growth rate.
- 4) Larval ambystomatids were highly sensitive to Cu with 50% mortality at 18.7, 35.3, and 47.9 ppb for three species. Cu also caused reduced growth rates in *A. talpoideium*.
- 5) Amphibians inhabiting reference wetlands are less tolerant to a novel metal stressor than those from metal impacted wetlands.
- 6) The amphibian community at Rainbow Bay has shifted from long- to short-hydroperiod species over three decades in response to drought and associated shortened wetland hydroperiods. The RB data are useful to build a conceptual model of the impact of climate change on southeastern isolated wetlands. Initial models showed that Cu toxicity alone did not result in significant extinction risk for two species unless toxicity was >50% for survival parameters, whereas shortened hydroperiods could greatly increase the chance of local extinction.

## Major Impact(s) of Research

- 1) Our continued time series of metal concentrations in the H-02 system (in sediments, water, and biota) will enable informed assessment of how this type of constructed treatment wetland functions, and whether it provides suitable wildlife habitat in addition to enhancing water quality. We have found that the levels of Zn in the wetlands do not pose a threat to amphibians.
- 2) Our lab and mesocosm studies demonstrate the importance of looking a) at multiple stressors, b) beyond the larval period, and c) at multiple source populations.
- 3) Our disease studies are ongoing, but are demonstrating the complexity of variables involved with disease incidence and prevalence in amphibians. The nature of the wetland—metal-contaminated vs. clean, permanent vs. ephemeral, and constructed treatment wetland vs. natural—impacts disease prevalence and variables are confounded with each other.
- 4) Ranavirus exposure can cause serious sub-lethal effects such as growth rate, and more studies are required to determine if these effects can influence population dynamics.
- 5) Our understanding of the factors that drive the population dynamics of amphibians in natural systems, based on the long-term RB study, will allow predictions of the effects of climate change on isolated wetlands and provide insights to land managers who may need to design protective measures for rare species.

29. SRNL, 2015. *2015 Assessment of Mercury in the Savannah River Site Environment and Responses to the Agency for Toxic Substances and Disease Registry 2012 Report of Assessment of Biota Exposure to Mercury Originating from the Savannah River Site*, SRNL-STI-2015-00393, Rev. 0, August 2015, Savannah River National Laboratory, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

The purpose of the report is to 1) update previous SRNL assessment reports on the fate of mercury in SRS environment and 2) address comments and recommendations from the review of SRS by the Agency for Toxic Substances and Disease Registry (ATSDR) concerning the evaluation of exposures to contaminants in biota originating from the SRS. The ATSDR reviewed and evaluated data from SRS, SCDHEC and the Georgia Department of Natural Resources concerning the non-radioactive contaminant mercury. This report will provide a response and update to conclusions and recommendations made by the ATSDR.

In an effort to address the implications of the ATSDR report, the mercury in biota of the SR originated from SRS activities, a review of existing literature, monitoring data, and a comprehensive accounting of the mass balance of mercury usage and deposition from offsite sources to the SRS was conducted. A recent review by the U.S. Geological Survey (USGS) in 2014 was included in this report on mercury status and implications in our nation's streams. The USGS report highlights the unique environmental factors of forested wetlands, that are prominent features of the southeast, and the higher rainfall totals as primary keys to understanding the higher methylmercury tissue concentrations in higher trophic level fish as compared to the rest of the nation. Nearly 22% of the total land area of the SRS consists of forested wetlands which drain into five primary streams and ultimately to the SR.

Little information was provided in the ATSDR report on the long historical inputs of mercury to the SR from industries located upstream of SRS (i.e. Olin Corporation Chlor-Alkali Plant). It is documented that the Olin Corporation discharged 12 lb per day into the SR from August 1965 to August 1970. During this time period, the SRS was pumping water directly from the SR onto the site to cool reactors. The cooling water was pumped through the reactor cooling systems and then to holding ponds and subsequently to the site streams or directly to site streams. Reviews conducted by the Risk Assessment Corporation on behalf of the Centers for Disease Control and Prevention investigated mercury usage at SRS from 1954 to 1992 and concluded the mercury levels in sediment of creeks known to have mercury inputs from SRS activities have not resulted in appreciable mercury releases to the SR. Additionally, high mercury concentrations were measured in fish caught onsite in SRS streams and ponds that directly received reactor cooling effluent. Mercury would not have been used in or produced as a byproduct of reactor operations; therefore, the input of mercury originating from the Olin Corporation releases into the SRS is the likely source.

A comprehensive review of the mass balance of mercury inputs and deposition to the SRS and the SR indicates that ~1.1 kg/yr of mercury enters the SR from SRS stream outfalls. This value is small compared to the upstream sources of mercury that input ~12.0 kg/yr from known sources, and ~3.8 kg/yr from unknown sources, resulting in 16.9 kg/yr in the river effluent below the SRS.

Comparison of largemouth bass tissue concentrations for the SRS streams, the SR and other streams in South Carolina showed that average concentrations were similar among all sites. Largemouth bass are known to bioaccumulate methylmercury and are a popular choice among sport fisherman so continued monitoring of this species is required.

A list of several projects describing efforts to mitigate impacts from residual mercury captured in bottom and bank sediments by employing a strategy to minimize mercury methylation through the use of stannous chloride, and projects initiated by SRS through the University of Georgia's, SREL to address concerns of mercury uptake in biota are presented.

Section 4.7.2 of the SRNL report is specific to mercury in fish, *Concentrations of Mercury in Fish Caught On-Site at SRS Versus Off-Site in the Savannah River*. Fish data reported in the 1971 to 1991 annual environmental monitoring reports were evaluated and compared with fish collected from a control location upriver from the SRS (Thurmond Lake). Average mercury concentrations measured in fish from Thurmond Lake and the SR at locations above, adjacent to, and below the SRS showed no statistically significant differences. This was not consistent with the fact that Olin Corporation discharges to the SR are well downriver from the Thurmond Reservoir, and concentrations of mercury in the fish from Thurmond Lake would not be expected to be the same as fish from the SR. Fish evaluated in the study (Bream, Bass, Catfish and other) were of similar size and length.

Conclusions made from the review of available data indicated:

- Evaluations of average mercury concentrations in fish for on-site and SR locations from 1971 to 1991 showed that concentrations appear to be a factor of 2 greater in onsite fish;
- There is little evidence to suggest that mercury from F-Area and H-Area Seepage Basins has resulted in elevated fish concentration in Four Mile Creek or any other onsite stream.
- The highest concentrations appear to be in SRS streams and reservoirs that have received reactor cooling effluent. It is unlikely that cooling effluent would contain mercury resulting from reactor operations, and it appears that the primary source of mercury at the SRS has been the continuous pumping of SR water for use as a reactor coolant.
- Several studies have reported elevated mercury concentrations in fish (approaching and exceeding concentrations measured in onsite fish) collected from South Carolina and Georgia reservoirs lacking a known mercury point source of contamination.”

30. Tuberville, T. D., D. E. Scott, B. S. Metts, J. W. Finger Jr., and M. T. Hamilton, 2016. Hepatic and renal trace element concentrations in American alligators (*Alligator mississippiensis*) following chronic dietary exposure to coal fly ash contaminated prey. *Environmental Pollution* 214(2016): 680-689.

Little is known about the propensity of crocodylians to bioaccumulate trace elements as a result of chronic dietary exposure. We exposed 36 juvenile alligators (*Alligator mississippiensis*) to one of four dietary treatments that varied in the relative frequency of meals containing prey from coal combustion waste (CCW)-contaminated habitats vs. prey from uncontaminated sites, and evaluated tissue residues and growth rates after 12 mo and 25 mo of exposure. Hepatic and renal

concentrations of arsenic (As), cadmium (Cd) and selenium (Se) varied significantly among dietary treatment groups in a dosedependent manner and were higher in kidneys than in livers. Exposure period did not affect Se or As levels but Cd levels were significantly higher after 25 mo than 12 mo of exposure. Kidney As and Se levels were negatively correlated with body size but neither growth rates nor body condition varied significantly among dietary treatment groups. Our study is among the first to experimentally examine bioaccumulation of trace element contaminants in crocodylians as a result of chronic dietary exposure. A combination of field surveys and laboratory experiments will be required to understand the effects of different exposure scenarios on tissue residues, and ultimately link these concentrations with effects on individual health.

31. Weir, S. M., R. W. Flynn, D. E. Scott, S. Yu, and S. L. Lance, 2016. Environmental levels of Zn do not protect embryos from Cu toxicity in three species of amphibians. *Environmental Pollution* 214(2016): 161-168

Contaminants often occur as mixtures in the environment, but investigations into toxicity usually employ a single chemical. Metal contaminant mixtures from anthropogenic activities such as mining and coal combustion energy are widespread, yet relatively little research has been performed on effects of these mixtures on amphibians. Considering that amphibians tend to be highly sensitive to copper (Cu) and that metal contaminants often occur as mixtures in the environment, it is important to understand the interactive effects that may result from multiple metals. Interactive effects of Cu and zinc (Zn) on amphibians have been reported as antagonistic and, conversely, synergistic. The goal of our study was to investigate the role of Zn in Cu toxicity to amphibians throughout the embryonic developmental period. We also considered maternal effects and population differences by collecting multiple egg masses from contaminated and reference areas for use in four experiments across three species. We performed acute toxicity experiments with Cu concentrations that cause toxicity (10–200 µg/L) in the absence of other contaminants combined with sublethal concentrations of Zn (100 and 1,000 µg/L). Our results suggest very few effects of Zn on Cu toxicity at these concentrations of Zn. As has been previously reported, we found that maternal effects and population history had significant influence on Cu toxicity. The explanation for a lack of interaction between Cu and Zn in this experiment is unknown but may be due to the use of sublethal Zn concentrations when previous experiments have used Zn concentrations associated with acute toxicity. Understanding the inconsistency of amphibian Cu/Zn mixture toxicity studies is an important research direction in order to create generalities that can be used to understand risk of contaminant mixtures in the environment.

32. Xu, C., M. Athon, Y. F. Ho, H. S. Chang, S. Zhang, D. I. Kaplan, K. A. Schwehr, N. DiDonato, P. G. Hatcher, and P. H. Santschi, 2014. Plutonium Immobilization and Remobilization by Soil Mineral and Organic Matter in the Far-Field of the Savannah River Site, U.S. *Environmental Science and Technology* 48(6): 3186-3195.

To study the effects of natural organic matter (NOM) on Pu sorption, Pu(IV) and (V) were amended at environmentally relevant concentrations ( $10^{-14}$  M) to two soils of contrasting particulate NOM concentrations collected from the F-Area of the Savannah River Site. More Pu(IV) than (V) was bound to soil colloidal organic matter (COM). A de-ashed humic acid (i.e., metals being removed) scavenged more Pu(IV,V) into its colloidal fraction than the original HA incorporated into its colloidal fraction, and an inverse trend was thus observed for the particulate-fraction-bound Pu for

these two types of HAs. However, the overall Pu binding capacity of HA (particulate + colloidal-Pu) decreased after de-ashing. The presence of NOM in the F-Area soil did not enhance Pu fixation to the organic-rich soil when compared to the organic-poor soil or the mineral phase from the same soil source, due to the formation of COM-bound Pu. Most importantly, Pu uptake by organic-rich soil decreased with increasing pH because more NOM in the colloidal size desorbed from the particulate fraction in the elevated pH systems, resulting in greater amounts of Pu associated with the COM fraction. This is in contrast to previous observations with low-NOM sediments or minerals, which showed increased Pu uptake with increasing pH levels. This demonstrates that despite Pu immobilization by NOM, COM can convert Pu into a more mobile form.