ADDITIONAL SOIL VAPOR & VAPOR INTRUSION SAMPLING WORK PLAN

BNSF Livingston Shop Complex Facility, Livingston, Montana

Prepared for:

Livingston Restoration Group

Livingston, MT

Prepared by:

Water & Environmental TECHNOLOGIES

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February 2015

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List of Acronyms

BGS	below ground surface
BNSF	BNSF Railway Company
MDEQ	Montana Department of Environmental Quality
EPA	United States Environmental Protection Agency
ERCL	Environmental Requirements, Criteria, and Limitations
HASP	Health and Safety Plan
IDW	investigation-derived waste
LRG	Livingston Restoration Group
NAVD	North American Vertical Datum
CVOC	Chlorinated Volatile Organic Compound
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RA	remedial action
RD	remedial design
SI	Site Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analytical Plan
SOG	Standard Operating Guideline
SVE	soil vapor extraction
VOC	volatile organic compound
WET	Water and Environmental Technologies, PC

1.0 Introduction

At the request of the LRG Board and at the suggestion of the Montana Department of Environmental Quality (MDEQ), Water & Environmental Technologies (WET) has prepared this work plan for a PCE soil vapor and indoor air study to provide additional information about the characteristics and distribution of chlorinated volatile organic compounds (CVOCs) in soil vapor and indoor air within or in the vicinity of the tetrachloroethene (PCE) dissolved-phase groundwater plume (Facility). The study includes two parts: 1) Study soil vapor and subsurface pressure to verify there are no negative effects of the biovent system extraction and injection wells on subsurface vapor concentrations (Figure 1); 2) Long term monitoring of indoor air of residential properties using passive samplers. The locations chosen include properties periodically exhibiting higher concentrations of VOCs in indoor air relative to other properties sampled. The soil vapor investigation will utilize existing probes and incorporate direct-push drilling methods to allow discrete placement of new soil vapor probes. In the event that direct-push drilling methods are unable to penetrate the subsurface to adequate depth(s) for installation of discrete soil vapor points at multiple completion depths, alternative drilling technology (e.g., rotosonic, or similar) will be employed.

All field procedures will be conducted in accordance with the *Facility-Wide Sampling and Analysis Plan* (Facility-Wide SAP) (Kennedy/Jenks Consultants 2006) and Quality Assurance Project Plan (QAPP), consistent with current Kennedy/Jenks Consultants – Montana Department of Environmental Quality (MDEQ) policy. Facility-Wide documents were originally formed to avoid redundancy and have been amended with new investigations and remedial designs. Task-specific components to the SAP are submitted to MDEQ as new attachments to the comprehensive SAP when Site Investigation (SI) work plans are prepared. To simplify the review process and operational control of the site by MDEQ, all work plans prepared by WET will be submitted following this protocol and will adhere to the methods provided in the documents. Field activities will adhere to methodologies described in Standard Operating Guidelines (SOGs) identified in the Facility-Wide SAP. Field procedures in the Facility-Wide SAP will not be included in work plans provided modifications/additions to a protocol or procedure are not proposed.

Investigation-derived waste (IDW) generated during implementation of this work plan will include soil cuttings, decontamination water, and all disposable personal protective equipment (PPE) or sampling equipment. The IDW will be managed as described in the Facility-Wide SAP unless otherwise directed by the MDEQ.

1.1 Background

Multiple investigations of soil vapor and indoor air have been conducted on and near the railyard in accordance with the remedy for indoor air selected in MDEQ's 2001 *Record of Decision (ROD), Burlington Northern Livingston Shop Complex* and the August 2005 Spring Statement of Work (SOW) Task I (MDEQ, 2001 and 2005).

The procedures for ambient (outdoor) air sampling, indoor air sampling, and soil vapor sampling at the Facility are described in the MDEQ-approved *Final Task I Supplemental Investigation Work Plan for Indoor Air* (Kennedy/Jenks Consultants, 2005) and addendums (MDEQ, 2006a, 2007a).

The original list of chemicals of concern (COCs) identified in the ROD has been reduced to include tetrachloroethene (PCE), trichloroethene (TCE), benzene, and ethylbenzene. The cleanup levels identified

in the ROD for PCE and TCE were subsequently revised based on new EPA toxicity data and are presented in MDEQs Final Task I Risk Assessment Amendment Number 2 (MDEQ, 2012). As specified above, PCE is the only chemical being studied here, which has established cleanup levels of 42 $\mu g/m^3$ and 105 $\mu g/m^3$ for all non-railyard structures and railyard structures respectively.

1.2 Dissolved Phase PCE Groundwater Plume

The current placement of the biovent systems focus primarily on or near the free-product zones within the railyard and south of Park Street. However, the dissolved phase PCE groundwater plume extends north to East Gallatin Street and south to Lewis Street (Kennedy/Jenks, 2014). The dissolved phase groundwater plume is the primary potential source of VOCs in soil vapor in these areas (Figure 2).

1.3 PCE Soil Vapor Distribution

Soil vapor sampling has been conducted at multiple locations across the Facility including beneath homes in open crawl spaces or earth floor basements. Soil vapor concentrations vary significantly due to a many variables including source concentrations, lithology, barometric pressure, wind direction, cover materials, time of year, etc. Although this variability creates difficulty with mapping soil vapor distribution near the periphery, the base distribution of vapor is controlled by the source area.

1.4 Indoor Air Vapor

Due to the variable nature of vapor concentrations, discussions with MDEQ regarding VOCs in indoor air due to vapor intrusion have involved the possibility that daily short term monitoring (24-hour) may not accurately portray the actual flux of vapors into structures. Actual or average VOC concentrations may be erroneously represented (either high or low) by short-term sampling fluctuations. The purpose of this study is to provide 1) averaged concentrations over longer durations to determine actual flux through a structure, and 2) Map periods of elevated vapor flux to better understand environmental effects on the physical process moving vapors through structures.

1.5 Biovent System

Remedial Tasks D and E for the Facility include Phase I and II installations of a diesel product recovery system (Task D) and subsurface soil treatment systems (Task E). The implementation of the two phases directly affects the public and private properties along and south of East Park Street and between the Facility and E Gallatin Street. Phase I installation which included 40 multi-use wells (MUWs) and 7 biovent wells (BVWs) took place over a period of two years. The Phase I system was fully operational by January 2009 and has operated on a continuous basis since then. Full operation of the Phase I system includes 16 MUWs used for dual-level pumping and 12 MUWs used for bioventing (CDM; 2012). The Phase II Remedial Action Work Plan for Task D and Task E was finalized on February 24, 2012 and included the installation of seven biovent wells in the alley-way south of East Park Street between the South L Street and South N Street (CDM; 2012). MDEQ provides operational directives (ODs) to BNSF for operation of the bioventing systems.

The biovent systems are designed to have a net negative pressure or downward movement of air in the subsurface. Currently, the biovent system is operated under balanced extraction/injection flow rate. In general, soil vapor is extracted at up to 100 cfm and injected no greater than 50 cfm per extraction/injection

well. Depending on the current MDEQ-issued ODs, the system may have limited capture of vapors influenced by biovent injection zones along the 3/5 track corridor that may affect properties on Park Street between North E and North K Streets (Figure 2). Vapor Monitoring Points (VMP) located in areas of concern include VMP-2, VMP-3, VMP-4, VMP-15, VMP-16, and VMP-17. Although respirometry testing is conducted at one of these points (VMP-17), the remainder of VMPs are not tested and vapor samples are not collected for VOC analyses.

In addition, the bioventing system represented by BVW located adjacent to the groundwater treatment plant (particularly BVW-74 through BVW-77) may not have full capture to the north and injection may be generating vapors that could potentially migrate to the north towards the 300 block of North L through M Streets. Respirometry testing is conducted on wells VMP-10 through VMP-15. Respirometry data for these wells including oxygen and carbon dioxide indicate influence to as much as 200 feet (VMP-14), potentially causing vapor migration to structures north in the area.

1.6 Health and Safety Plan

A task-specific Health and Safety Plan (HASP) for this work is presented in Appendix A. The HASP has been prepared to be used in conjunction with the Facility-Wide Health and Safety Plan (HASP) (Kennedy/Jenks Consultants, 2008) and will be incorporated as an addendum to the Facility-Wide HASP.

1.7 Access

All soil vapor and subsurface pressure monitoring wells will be installed in City of Livingston right-of-way and access will be coordinated with the City of Livingston. For indoor air and sub-structure soil vapor sampling, access will be coordinated through LRG Board direction and contact with concerned property owners.

1.8 ERCLs

Environmental requirements, criteria, and limitations (ERCLs) have been developed by DEQ for the Facility and are included in Attachment A of the ROD. WET completed an analysis of the implementation of the activities included in this work plan for compliance with the ERCLs for the site (Appendix B). The activities included in this work plan comply with ERCLs for the Facility.

2.0 Soil Vapor Monitoring

2.1 OBJECTIVES

The objectives of this work plan are as follows:

- Determine if the current bioventing system is affecting PCE vapor gradients and concentrations within the unsaturated zone;
- Determine if there is any substantive PCE flux into structures when measured over a longer period of time
- Monitor the area north and east of the BN Livingston Railyard to establish subsurface PCE soil vapor concentrations;

SCOPE

The proposed scope of work will be broken into two Tasks:

- Task 1 – Soil Vapor Monitoring;
- Task 2 – Indoor Air Monitoring..

2.2 Soil Vapor Well Installation

WET will install nested soil vapor monitoring wells that are screened on five feet vertical intervals from depths of 15 feet to approximately 5 feet below ground surface. The total depth of 15 feet below ground surface has been selected to assure wells are screened above historical depth to groundwater in the area. Each soil vapor well will be installed using a Geoprobe Direct-push drill rig (or contingent drilling technology) and completed using a 3/8-inch diameter, six-inch long stainless steel mesh with ¼-inch Teflon tubing. The tubing will be brought to the surface and equipped with a ball valve sampling port. Each screen will be centered in approximately one foot of 10-20 grade silica sand. The annular space above the sand will be filled with approximately one foot of dry granular bentonite covered with hydrated bentonite to form a seal from overlying probes and from the surface. Each nested set of soil vapor wells will be completed with an appropriate locking well-head protector set in a concrete monument stamped with identifier. A typical multi-depth vapor well completion detail is presented on Figure 3.

All soil vapor probe installations will remain above the seasonal high groundwater elevations. However, due to the potential for impacted subsurface soils, drill rods will be decontaminated between borings by first cleaning with phosphate-free detergent using a brush and tap water, then rinsing with tap water, and finally rinsing with distilled water.

2.3 Soil Vapor Well Locations

Two primary zones of concern exist for the LRG. These include commercial, private, and public properties over the dissolved VOC groundwater plume south of the railyard (south of Park Street) and an area north of the railyard and south of East Gallatin Street.

Existing SGP and VMP will be utilized to collect soil vapor samples from the area north of the main track line (SGP-7 through SGP-11, SGP-CW) and south of the rail yard (VMP-2, VMP-15, VMP-16; and SGP-43, and soil vapor wells at 103 North M) will be sampled (Figure 2). The purpose of these soil vapor samples is to determine the overall effect of the biovent extraction wells in these areas and to correlate soil gas data to sub-slab and indoor air samples collected as part of the vapor intrusion sampling.

Two soil vapor wells will be installed in the area north of the railyard, one on the 300 block of North L and one on the 300 block of North M Streets (Figure 2). These locations will include nested sets of soil vapor wells as described in Section 2.2.

2.4 Soil Vapor Sample Collection and Analysis

All air sampling activities will be conducted in accordance with MDEQ guidelines (MDEQ, 2011) and the Facility-Wide SAP, and SOG-10. In order to detect surface breakthrough of ambient air during soil vapor

sample collection, a tracer vapor will be introduced around the borehole at the ground surface during the collection of the shallowest soil vapor sample from each completed soil vapor probe.

Tracer vapor procedures will follow MDEQ Vapor Intrusion Guidance (MDEQ, 2011) and will include the introduction of high purity helium vapor beneath a shroud that encapsulates the surface completion. Helium concentration will be measured using a helium vapor meter until the measured concentration beneath the shroud is at least 20 percent (%) (200,000 parts per million (ppm)). The helium meter will then be connected to the soil vapor probe sample tubing to measure helium concentrations during purging. If helium is detected during purging at a concentration less than or equal to 10% of the helium concentration measured under the shroud, the well seal will be considered adequate and the well installation complete. A helium detection of greater than 10% of the shroud concentration will be considered a surface breakthrough. The failed vapor probe will not be sampled. The remaining vapor probes in the associated well will be sampled and the data analyzed. Based on the analytical results a determination will be made to reinstall any failed vapor probes.

Prior to sampling, all soil vapor wells will be allowed to rest a minimum of one week following installation to allow formation stabilization. Soil vapor samples will be collected at two intervals consistent with change-out of passive indoor air samples described in Section 3.0. All soil vapor samples will be collected using 6-liter summa canisters supplied by the laboratory, certified clean, and equipped with 200 mL/min flow regulators. Samples will be submitted for analysis using EPA Method TO-15 SIM analysis for PCE. Samples will be shipped to Eurofins (Air Toxics) laboratory in Folsom, California.

2.5 Sample Shipping and Handling

Shipping and handling, and chain-of-custody procedures that will be followed are provided in Section B2.3 of the Facility-Wide QAPP, SOG-3, and SOG-10 (Appendix A of the Facility-Wide SAP).

Samples will be labeled in accordance with the guidelines specified in the Facility-Wide SAP (section B2.2.3). Field notes will be collected for each sample collected and will include the following information: Sample identification; probe location; date and time of sampling; sample probe depth; identity of sampler; sampling train; purge volumes; volume of sample; and weather conditions.

3.0 Indoor Air/Vapor Intrusion Monitoring

3.1 Indoor Air Sampling

At the request of MDEQ passive sampling will be conducted in select structures to determine the overall average exposure using long-term passive samplers. Advances in passive samplers design have allowed for higher uptake relative to historic passive samplers. Radiello created a new cylindrical design which provides a more sensitive, accurate, reproducible, and consequently dependable result. Additionally, the passive long-term sampling process allows for removal of short-term variability that in turn causes problems reproducing results. The Radiello sampler was verified with Eurofins to be ideal for the purposes of this study due to the affinity of the PCE to the sorbent used in the sampler. Historical data from previous sampling events at the structures included in this work plan was forwarded to Eurofins to verify any potential interference of PCE adsorption by other VOCs present over the three week sample period. Eurofins confirmed that PCE detections would be unaffected by other VOCs based on concentrations present and that detection limits would be low for PCE over the three week period.

3.2 Properties to Be Sampled

Five locations were selected by MDEQ to be sampled using passive samplers. These include sampling locations 28 (328 N. M), 23B (326 N. L), 75B (1500 E. Park), 91 (1305 E. Park), and NE-4 (416 N. K). In addition, LRG selected two locations for this study (NE-14 and NE-17) located at 403 N. L and 1123 E. Gallatin, respectively, to conduct passive sampling (Figure 4). These locations were chosen based on historically elevated subslab PCE concentrations. Properties requested for sampling will be screened for inclusion based on location relative to the dissolved VOC groundwater plume.

3.3 Occupied Dwelling Questionnaires

Occupied dwelling questionnaires will be completed for each building included in the indoor air sampling. Pre-sample screening will include the use of a mobile Hapsite field portable Gas Chromotrograph/Mass Spectrometer (GC/MS) for screening and removal of any potential indoor contaminant sources with sufficient stabilization time prior to sampling. The Hapsite screening will occur in conjunction with dwelling questionnaires prior to initial sampling and during each sampler change-out. The Hapsite will be carried throughout the structure and held within cabinets used to store chemicals or held over individual containers to determine the presence of PCE. All containers determined to contain a measurable amount of PCE or suspected of containing PCE will be removed from the structure for the period of testing. Materials removed from individual structures will be placed in a plastic tote with lid, labeled for the property of origin, and stored above freezing. Occupants in all structures will be informed about the nature of the survey and the importance of avoiding activities potentially affecting the results including introduction of any additional chemicals during the test period. A review of the initial questionnaire will take place prior to each change-out of passive samplers. Any changes to materials stored or activities conducted at individual structures will be documented and carried forward during the duration of sampling.

3.4 Indoor Air, Ambient, and Soil Vapor Sampling and Analysis

Passive samples will be collected simultaneously from the main floor and basement (if applicable), and from outdoor ambient air at each property selected. Passive samples will be collected over a twelve week period with each passive sampler being exposed for a period of three weeks. This results in four indoor passive samplers collected at each sample site over the duration of testing (one sampler every three weeks over a twelve week period) and four simultaneous ambient air samples. In the case of structures with main floor and basement areas, an additional passive sampler will be simultaneously deployed in the basement. In this scenario, four passive samplers would be collected from the main floor, four passive samplers from the basement, and four ambient samples resulting in a total of twelve passive samplers over the full twelve week period. In accordance with the Radiello guidance, temperature will be logged during the sampling period using a Solinst barometric logger in each structure. All sampling will be conducted in accordance with the Facility-Wide SAP, SOG-10, and in accordance with guidelines specified in the Radiello guidelines brochure and the Standard Operating Procedures presented in Appendix C.

In addition to the passive sampling, WET will conduct standard vapor intrusion sampling in each structure. This will include installing up to three permanent sub-slab soil vapor probes in each structure. These points will consist of a 3/8-inch diameter stainless steel screen set attached to ¼-inch diameter stainless steel tubing extending through the slab and equipped with a ball valve. The tubing will be sealed in the floor with a bentonite cement to assure adequate seal. The actual number of sub-slab sample probes per structure will be dependent on surface area. Finally, deep soil vapor wells will be installed adjacent to structures that

currently do not have nearby soil vapor probes. This will include NE-17, and 75B. It is important to note that groundwater is very shallow in the vicinity of location 75B. A soil vapor probe at location 75B will only be installed if an installation depth of 5 feet below ground surface or greater can be achieved. Sub-slab, soil vapor, and indoor air samples will be collected with 6-liter summa canisters in conjunction with the initial placement of passive samplers and with each change-out of passive samplers.

All passive vapor samplers will be submitted for analysis using Passive S.E. RAD130, VOCs by Passive Sampler – GC/MS and analyzed for PCE. Summa canister samples will be analyzed using method TO-15 SIM for PCE. All samples will be shipped to Eurofins (Air Toxics) laboratory in Folsom, California.

3.5 Air Sample Labeling

Samples will be labeled in accordance with the guidelines specified in the Facility-Wide SAP (section B2.2.3) and in accordance with guidelines specified in the Radiello guidelines brochure in Appendix C. Field notes will be collected for each sample collected and will include the following information: Sample identification; probe location; date and time of both start and stop of sampling period; sample probe depth if applicable; identity of sampler; sampling train; purge volumes; volume of sample; and atmospheric conditions.

3.6 Sample Shipping and Handling

Shipping and handling, and chain-of-custody procedures that will be followed are provided in Section B2.3 of the Facility-Wide QAPP and in SOG-10 (Appendix A of the Facility-Wide SAP). Radiello samplers will follow shipping and handling instruction in the Radiello guideline.

4.0 Quality Assurance/Quality Control (QA/QC)

Eurofin Labs was consulted regarding the presence of cigarette smoke and its effect on adsorption of PCE. Due to the affinity of PCE to the charcoal cigarette smoke and background VOCs are not considered to have adverse effect on the analysis.

QA/QC for the Radiello samples will be consistent with those for summa canisters. A minimum of one duplicate/split sample will be collected for every ten samples collected. Radiello duplicates will consist of deployment of two passive samplers. Summa canister sample duplicates will be collected using a barbed T fitting to split the flow into two streams for sampling. Sample identifications, collection methods, chain of custody procedures will be conducted in accordance with the Radiello guidelines and summa canisters will follow that described in the Facility-Wide SAP.

Any Summa canisters used for this sampling investigation will be cleaned and certified by the laboratory to the minimum reporting limits for COCs using EPA Method TO-15 analyses. TO-15 SIM may be used if necessary to meet required reporting limits. All sampling equipment supplied by the laboratory for use during soil vapor sampling will be prepared by the laboratory before use. The equipment will be leak tested, flow rates set, and sampling equipment certified clean by the laboratory. All equipment preparation and verification documents will be included in the appendices of the laboratory supplied laboratory report.

5.0 Schedule

WET will begin soil vapor and vapor intrusion sampling activities following final approval by MDEQ. The soil vapor well and sub-slab sample point installation activities are projected to take two days to complete with regular monitoring events and cartridge exchange taking place over a three month period.

6.0 Deliverables

Each Task identified above will be incorporated into a report outlining findings, conclusions, and recommendations based on the interpretation of the data collected.

7.0 References

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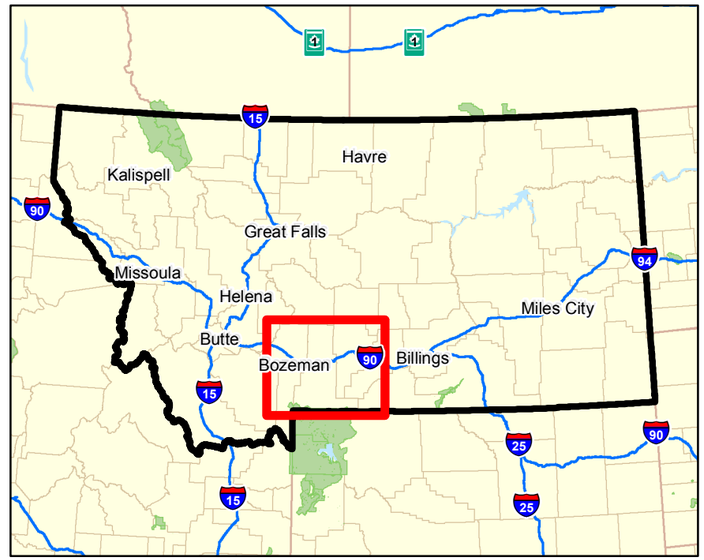
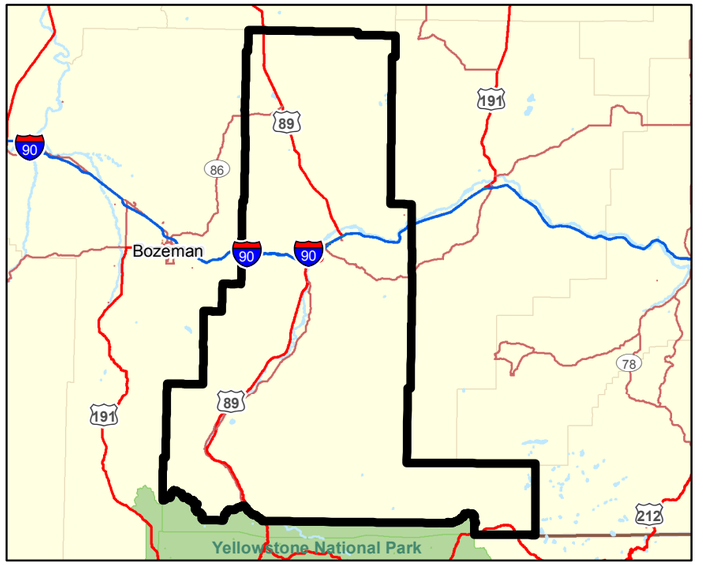
FIGURES





WATER & ENVIRONMENTAL TECHNOLOGIES, PC

SITE LOCATION

Burlington Northern Livingston Shop Complex

Job#: LRGM01 Task 2

Date: 9/24/2013

FIGURE 1

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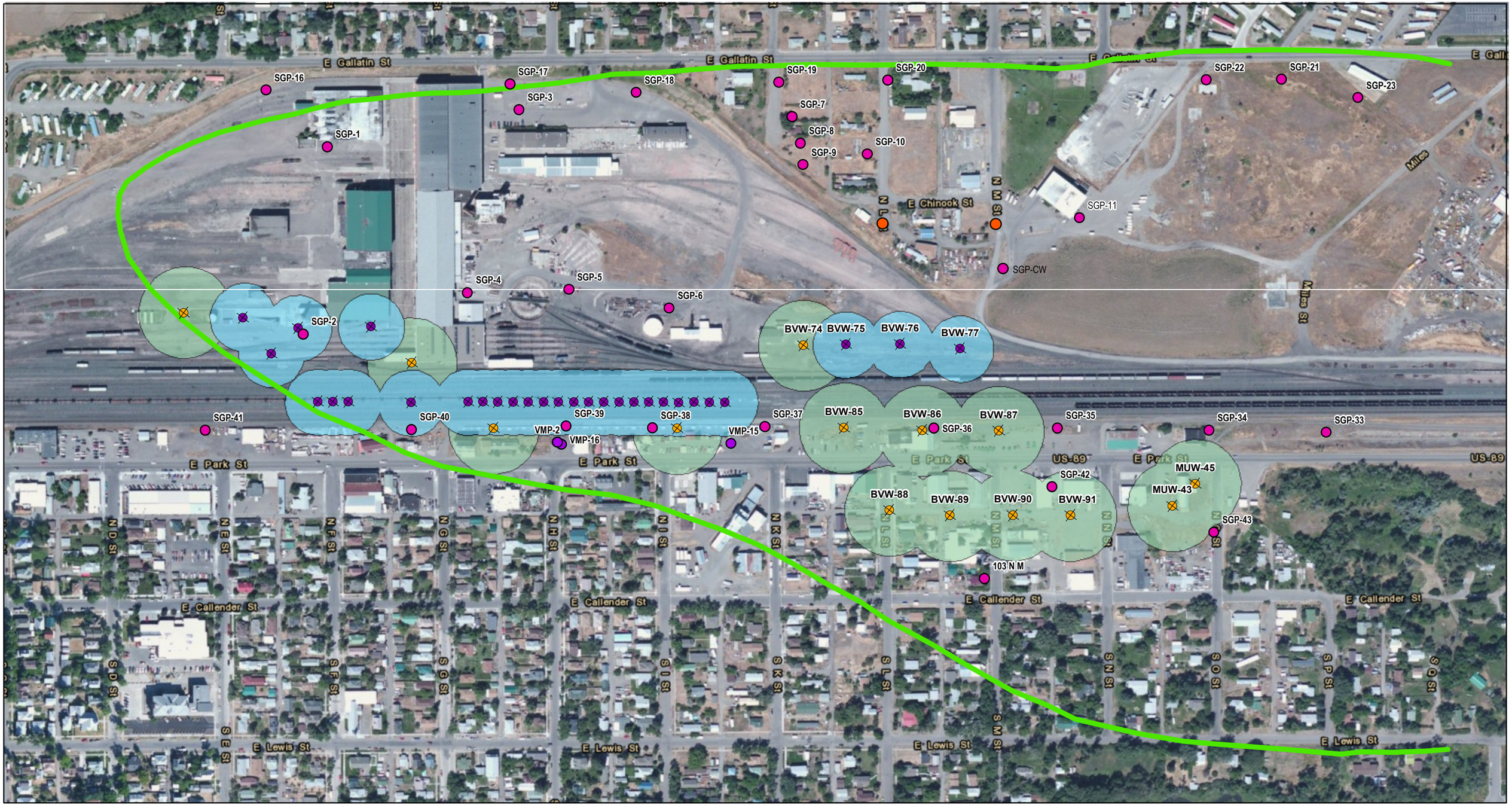

Legend

- Soil Gas Probe
- Vapor Monitoring Probe
- Task D/E Bioventing Injection Well Location
- Task D/E Biventing Extraction Well Location
- Proposed Soil Gas Well
- Extent of Dissolved VOC Plume
- Bioventing Injection Well Area of Influence (110-foot Radius)
- Bioventing Extraction Well Area of Influence (150-foot Radius)

Feet

0 150 300

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PROPOSED SOIL GAS NETWORK

BNSF Livingston Shop Complex

Job#: LRGM01 Task 2

Date: 1/15/2015

FIGURE 2

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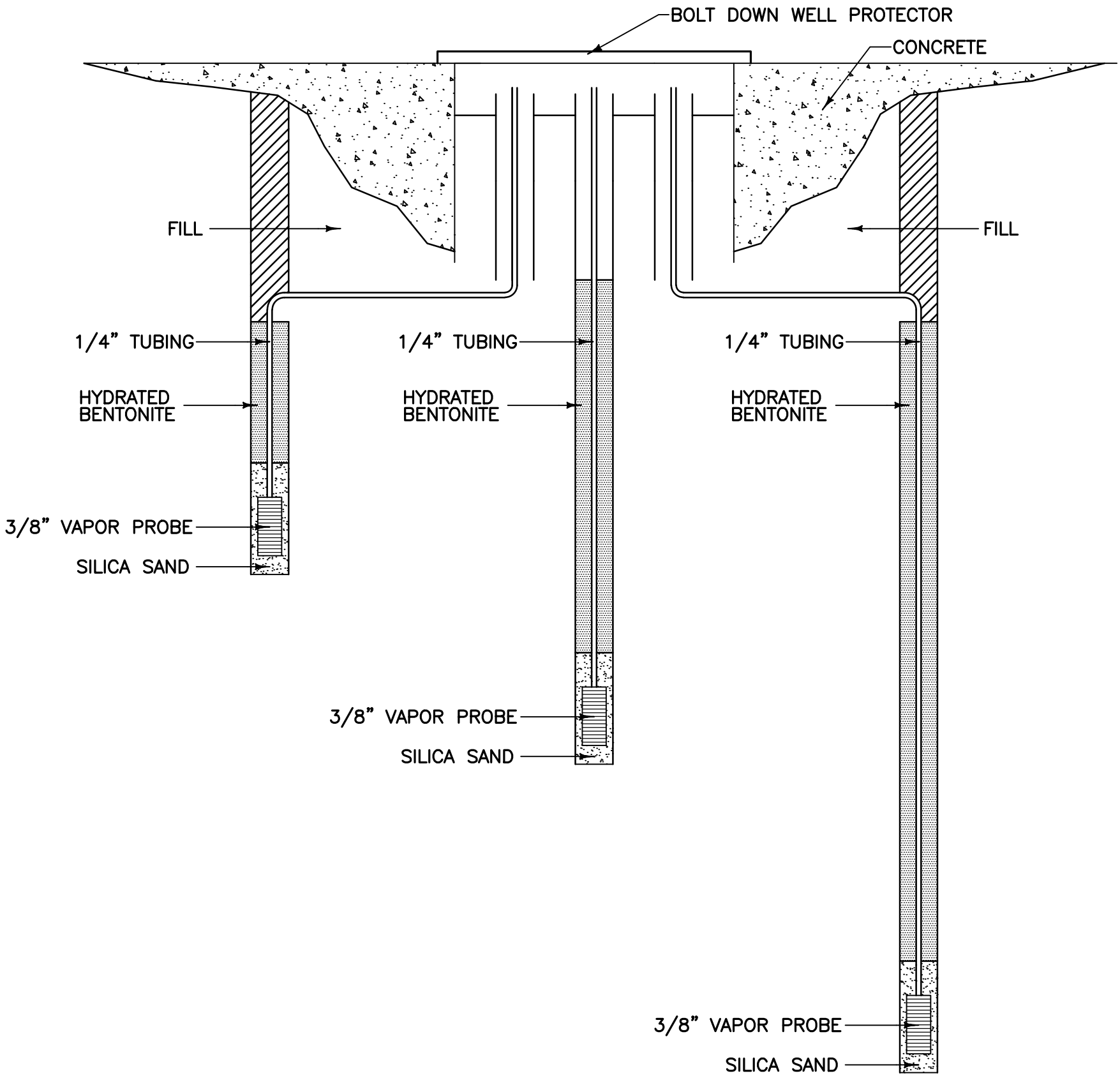

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BNSF LIVINGSTON SHOP COMPLEX

SOIL VAPOR WELL
TYPICAL CONSTRUCTION
DETAIL

LRGM01 T2

DATE: 1/14/15

FIGURE 3

Match_addr	LBL
328 N M St, Livingston, MT, 59047	28
1500 E Park St, Livingston, MT, 59047	75B
1305 E Park St, Livingston, MT, 59047	91
1123 E Gallatin St, Livingston, MT, 59047	NE-17
416 N K, Livingston, MT, 59047	NE-4
406 N St, Livingston, MT, 59047	NE-14
326 N L St, Livingston, MT, 59047	23B

Legend

- Address Locations
- Owner Parcel

N
W E
S

Feet
0 150 300

WATER & ENVIRONMENTAL TECHNOLOGIES, PC

Long-Term Vapor Sample Locations

BNSF Livingston Shop Complex

Job#: LRGM01 Task 2

Date: 10/29/2014

FIGURE 4

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TABLES

Air/Vapor PCE Sample Matrix

		Method Sample Count per Event		Sample Count - Four 3-Week Periods[1]		PCE Screening level
Location ID	**Sample Location**	**TO-15**	**Radiello 130**	**TO-15**	**Radiello 130**	
Vapor Intrusion Monitoring						
23B	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	1	-	2	-	
	soil gas	2	-	4	-	
28	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	3	-	6	-	
	soil gas	2	-	4	-	
75B	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	2	-	4	-	
	soil gas	-	-	-	-	
91	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	2	-	6	-	
	soil gas	1	-	2	-	
NE-4	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	2	-	4	-	
	soil gas	2	-	4	-	
NE14	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	-	-	-	-	
	soil gas	2	-	4	-	
NE-17	Indoor	1	1	2	4	
	Ambient	1	1	2	4	
	Sub-slab	2	-	4	-	
	soil gas	1	-	2	-	
Soil Vapor Monitoring[2]						
SGP-7	soil gas - 5'	1	-	1	-	
	soil gas - 11'	1	-	1	-	
	soil gas - 17'	1	-	1	-	
SGP-8	soil gas - 5'	1	-	1	-	
	soil gas - 10.5'	1	-	1	-	
	soil gas - 16'	1	-	1	-	
SGP-9	soil gas - 5'	1	-	1	-	
	soil gas - 11'	1	-	1	-	
	soil gas - 17'	1	-	1	-	
SGP-10	soil gas - 5.5'	1	-	1	-	
	soil gas - 12'	1	-	1	-	
	soil gas - 18.5'	1	-	1	-	
SGP-11	soil gas - 5'	1	-	1	-	
	soil gas - 12'	1	-	1	-	
	soil gas - 19'	1	-	1	-	
SGP-CW	soil gas - 5'	1	-	1	-	
SGP-43	soil gas - 5'	1	-	1	-	
	soil gas - 10.5'	1	-	1	-	
	soil gas - 16'	1	-	1	-	
VMP-2	soil gas	1	-	1	-	
VMP-15	soil gas	1	-	1	-	
VMP-16	soil gas	1	-	1	-	
103 N. M St.	soil gas	2	-	2	-	
LRG SGPs 300 block of N. L St.	soil gas - 5'	1	-	1	-	-
	soil gas - 10'	1		1		
	soil gas - 15'	1		1		
LRG SGPs 300 block of N. L St.	soil gas - 5'	1	-	1	-	-
	soil gas - 10'	1		1		
	soil gas - 15'	1		1		
Total Count		66	14	74	56	
Field QA/QC @ 10%		**6**	**1**	**7**	**5**	
Lab QA/QC						
CCV	Start of Job			2	4	
LCS	Daily after CCV			2	4	
Blank	After CCV			2	4	
Duplicate	10%	6	1	7	5	
Method Reporting Limit (µg/m^3)				0.14	0.056	42
Method Detection Limit (µg/m^3)				0.043		

1. TO-15 Sampling to be conducted at two Radiello Change out intervals
2. Soil vapor sampling will be conducted in a single event

APPENDIX A

Task-Specific Health and Safety Plan

Task Site Safety Officer: Patrick Thomson **Phone: 406-782-5220**

Task Field Site Safety Officer: Patrick Thomson **Phone: 406-490-0329 (cell)**

Task Description:

This work plan involves advancing borings and constructing vapor wells using direct-push drilling techniques, collecting soil vapor samples from wells, collecting passive long-term air samples from residences, and conducting vapor intrusion sampling. Detailed scope of work and procedures are described in the following documents:

- *Final Facility-Wide Sampling and Analysis Plan* (SAP) dated March 2006
- *Soil Vapor and Vapor Intrusion Sampling, Water & Environmental Technologies, January 2015.*

Additional health and safety procedures are explained herein. Field work performed during This work plan will adhere to safety protocols specified in the Facility-Wide Health and Safety Plan (Revision No. 3) (HASP) dated May 2008.

Task-specific health and safety protocols, and additional health and safety protocols and/or deviations from the *Facility-Wide Health and Safety Plan (Revision No. 3)* , if applicable, are outlined in this task-specific HASP.

Summary Information

Activity	Approx. Start Date	Approx. Duration (Days)	Field Personnel
Construction of soil vapor monitoring wells.	TBD	2 days	Ty Deboo John Babcock
Overseeing advancement of soil borings and collection of soil vapor and indoor air samples.	TBD	4 weeks	Patrick Thomson Ty Deboo

HAZWOPER and BNSF Safety Training:

___No _x_Yes Field personnel 40-hour and 8-hour HAZWOPER trained.

Field personnel to wear a photographic identification badge and carry proof of current BNSF training when working at the Livingston railyard.

Applicable Sampling and Analysis Plan (SAP) and Standard Operating Guidelines (SOGs):

1. *Final Facility-Wide Sampling and Analysis Plan*

2. SOG-2, SOG-3, and SOG-10 (Appendix A of *Final Facility-Wide Sampling and Analysis Plan*)

- Soil Vapor and Vapor Intrusion Sampling, Water & Environmental Technologies, January 2015.

Study Area:

The study area includes the areas in the vicinity of the BN Livingston Rail Yard as identified in the Soil Vapor and Vapor Intrusion Sampling Work Plan.

Task involves work within 25 feet of track:

_**x**__No __Yes If yes, describe means of work clearance and track control:

If work is to be performed within 25 feet of track, Montana Rail Link (MRL) will be notified that a flagger will need to be present at the work area. The flagger will oversee worker safety at the work area.

Physical Hazards:

Hazards associated with operating a drilling rig (noise, dust, overhead equipment falling, high-pressure pneumatic lines), underground utilities, equipment hauling, traffic control, and slip and trip. Power hand tools, limited work space, biological hazards (spiders, rodents)

Potential Chemical Hazards:

Chemicals of Concern	**TWA-PEL TLV, parts per million (ppm)**
Tetrachloroethene	100 ppm / 25 ppm
Trichloroethene	100 ppm / 25 ppm
Cis-1,2-Dichloroethene	200 ppm / 25 ppm
Vinyl chloride	1 ppm / 1 ppm
Chlorobenzene	75 ppm / 75 ppm
1,4-Dichlorobenzene	75 ppm / 10 ppm

Personal Protective Equipment (PPE):

Initial - Level D: Hard hat, safety toe boots, safety glasses with side shields, orange-reflective vest, and hearing protection as needed during field activities.

Although not anticipated, wear chemical resistant overalls and nitrile gloves when working with soil saturated with solvent or petroleum. Provide a hand wash station and an eye wash kit with two bottles, 1-liter each of buffered eyewash solution in work vehicle.

Safety Measures and Monitoring:

Follow *Facility-Wide Health and Safety Plan (Revision No. 3)* guidance. Do not enter any areas not intended for normal occupancy (e.g., confined spaces).

Criteria for upgrading PPE *(list threshold values in breathing zones, or other triggers for upgrading PPE)*:
Withdraw from area and re-assess PPE requirements if there are noticeable odors in any work area.

Provide dust control (water applied at surface of boring) if dust emissions are present in crawl or basement areas.

Work Zones:

Work zones will be established during construction of vapor and pressure monitoring wells and advancement of soil borings. No special work zones will be established around the wellhead for sampling. All field personnel (including subcontractors) must check in/check out with site safety officer (SSO) or field site safety officer (FSSO) on a daily basis.

Other Work Requirements:

Work only in areas with proper illumination or bring sufficient lighting to assess area for hazards.

Community Protection Measures:

Activities associated with This work plan will be conducted on the public and private property. As such, community protection measures will include direct communication with property owners and clearly established work zones. If necessary, access to the area will be cordoned off with flagging and/or fences/barricades. Assure that field activities do not present a hazard to traffic movement and do not generate dust emmissions that may migrate offsite.

Task-Specific Decontamination Procedures:

If accidentally exposed to chemicals, flush skin with water for 5 minutes. If chemicals get in eyes, flush with eyewash, then water, and seek medical attention.

Task-Specific Contact Telephone Numbers:

1. Patrick Thomson (406) 782-5220; Cell 406-490-0329

Task-Specific Coordination Requirements with BNSF and MRL:

Schedule work plan activities with property owners prior to beginning activity.

Task-Specific Requirements from the Facility-Wide HASP:

Follow all applicable requirements of *Facility-Wide Health and Safety Plan (Revision No. 3)* .

Task-Specific Deviations from Facility-Wide HASP:

None

Emergency Response (Contingency) Plan:

See *Facility-Wide Health and Safety Plan (Revision No. 3)* (Section 7.0)

ATTACHMENTS

Attachment 1 – Route to Hospital

APPENDIX B

Analysis of Environmental Requirements, Criteria, and Limitations

APPENDIX B

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
FEDERAL AND STATE CONTAMINANT SPECIFIC ERCLS		
Surface and Groundwater Quality Standards (Applicable)		
Section 75-5-605, Montana Code Annotated (MCA)	Causing of Pollution Section 75-5-605 of the Montana Water Quality Act prohibits the causing of pollution of any state waters. Section 75-5-103(21)(a)(i) defines pollution as contamination or other alteration of physical, chemical, or biological properties of state waters which exceeds that permitted by the water quality standards.	Activities proposed in the work plan will not impact surface water. To ensure the aquifer is not degraded/polluted, IDW generated during field activities associated with this task will be managed according to the hazardous and solid waste procedures specified in the Final Facility-Wide Sampling and Analysis Plan and the SAP Addendum (Facility-Wide SAP) (see in particular, Section 8.4 and Appendices 1 and 2). All development or decontamination water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or will be disposed of according to the Facility-Wide SAP. This task is being conducted to to provide additional information about the characteristics and distribution of chlorinated volatile organic compounds (CVOCs) in soil vapor and indoor air within or in the vicinity of the tetrachloroethene (PCE) dissolved-phase groundwater plume.
	Placement of Wastes Section 75-5-605, MCA states that it is unlawful to place or cause to be placed any wastes where they will cause pollution of any state waters. Any permitted placement of waste is not placement if the agency's permitting authority contains provisions for review of the placement of materials to ensure it will not cause pollution to state waters.	Investigation-derived waste (IDW) generated during field activities associated with this task will be managed as outlined in the Facility-Wide Sampling and Analysis Plan (Facility-Wide SAP). Management of IDW will not cause pollution of any state waters.
Section 75-5-303, MCA	Nondegradation Section 75-5-303, MCA states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected, with certain limited exceptions. .	To ensure the aquifer is not degraded/polluted, IDW generated during field activities associated with this task will be managed as outlined in the Facility-Wide SAP. This task is being conducted to evaluate the concentrations of volatile organic compounds (VOCs) in soil vapor within the vadose zone. Activities included in this work plan are not anticipated to generate soils. In the event soil is produced, any soil that that contains contamination that exceeds the relevant ROD cleanup levels will be disposed of according to the hazardous and solid waste procedures specified in the Facility-Wide SAP. All development and decontamination water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or will be disposed of according to the Facility-Wide SAP. Activities proposed in the this Work Plan will not degrade water quality.
Groundwater Quality Standards		
40 Code of Federal Regulations (CFR) 141	Maximum Contaminant Levels and Maximum Contaminant Level Goals (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the MCLs and non-zero MCLGs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are well-suited requirements which are ultimately to be attained by the remedy for the site[1]. Because many of the MCLs are equivalent with the State groundwater standards, the Primary Drinking Water Standards are listed below with the State groundwater standards.	Activities proposed in this work plan do not involve sampling or contacting groundwater.
40 CFR 143.3	Secondary Maximum Contaminant Levels (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the Secondary Maximum Contaminant Levels (SMCLs) specified in 40 CFR Part 143.3 are well-suited requirements which are ultimately to be attained by the remedy for the site. 40 CFR 143.3 contains standards for color, odor (3 threshold odor number) and corrosivity which are well-suited to the remedial action.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Administrative Rules of Montana (ARM) 17.30.1006	Montana Groundwater Pollution Control System (Applicable) ARM 17.30.1006 classifies groundwater into Classes I through IV based upon its specific conductance and establishes the groundwater quality standards applicable with respect to each groundwater classification. Based upon its specific conductance, the groundwater at the site must meet the standards for Class I groundwater. These standards are applicable. Concentrations of substances in Class I may not exceed the human health standards for groundwater listed in department Circular WQB-7.[2] For the primary contaminants of concern, the Circular WQB-7 standards and MCLs are listed below. For all contaminants of concern except vinyl chloride, the MCLs and Circular WQB-7 standards are equivalent.[3] All levels are ug/l and are dissolved phase. VOCs: Tetrachloroethene - 5.0; Trichloroethene - 5.0; Cis-1,2-Dichloroethene - 70; Vinyl chloride - 0.15; Chlorobenzene - 100; 1,4-Dichlorobenzene - 75 PAHs (SVOCs): Acenaphthene - 420; Anthracene - 2,100; Benzo(a)anthracene - 0.48; Benzo(a)pyrene - 0.048; Benzo(b)fluoranthene - 0.48; Benzo(k)fluoranthene - 4.79; Chrysene - 48; Dibenzo(a,h)anthracene - 0.048; Fluoranthene - 280; Fluorene - 280; Indeno(1,2,3-cd)pyrene - 0.48; Naphthalene - 28; Pyrene - 210 Lead - 15 For concentrations of parameters for which human health standards are not listed in WQB-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental or injurious to the beneficial uses listed for Class I water. This includes the following petroleum constituents. All levels are "µg/L" and are dissolved phase.	To ensure the aquifer is not degraded/polluted, IDW generated during field activities associated with this task will be managed as outlined in the Facility-Wide SAP. This task is being conducted to evaluate the concentrations of volatile organic compounds (VOCs) in soil vapor within the vadose zone. Activities included in this work plan are not anticipated to generate soils. In the event soil is produced, any soil that that contains contamination that exceeds the relevant ROD cleanup levels will be disposed of according to the hazardous and solid waste procedures specified in the Facility-Wide SAP. All development and decontamination water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or will be disposed of according to the Facility-Wide SAP. Activities proposed in the this Work Plan will not degrade water quality.
ARM 17.30.1011	ARM 17.30.1011 provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation may be allowed under the principles established in Section 75-5-303, MCA, and the nondegradation rules at ARM Title 17,chapter 30, subchapter 7.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Surface Water Quality Standards (Applicable)		
Montana Water Quality Act, Section 75-5-101, et seq., MCA Federal Clean Water Act, 33 U.S.C. §§ 1251, et seq.	The Montana Water Quality Act, Sections 75-5-101 et seq., establishes requirements for restoring and maintaining the quality of surface and ground waters and the federal Clean Water Act, 33 U.S.C. Sections 1251 et seq., establishes requirements for restoring and maintaining the quality of surface waters. Under these Acts the state has authority to adopt water quality standards designed to protect beneficial uses of each water body and to designate uses for each water body. Montana's regulations classify state waters according to quality, place restrictions on the discharge of pollutants to state waters and prohibit the degradation of state waters.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with this task will be managed as outlined in the Facility-Wide SAP. Activities proposed in the work plan do not include any purging of groundwater. Activities proposed in this work plan will not impact surface water runoff at the Facility.
ARM 17.30.611	ARM 17.30.611(1) (Applicable) provides that the waters of the Yellowstone River drainage upstream of the Laurel water supply intake, which includes the Livingston area, are classified "B-1" for water use.	
ARM 17.30.623	ARM 17.30.623 provides that concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7.	
WQB-7 standards	WQB-7 provides that "For surface waters the Standard is the more restrictive of either the Aquatic Life Standard or the Human Health Standard." For the primary Contaminants of Concern the Circular WQB-7 standards are the same as listed above in groundwater.	
ARM 17.30.623	The B-1 classification standards at ARM 17.30.623 also include the following criteria: 1) Dissolved oxygen concentration must not be reduced below the levels given in department Circular WQB-7; 2) Hydrogen ion concentration (pH) must be maintained within the range of 6.5 to 9.5; 3) the maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units; 4) Temperature increases must be kept within prescribed limits; 5) No increase are allowed above naturally occurring concentrations of sediment, settleable solids, oils, floating solids, which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish or other wildlife. 6) True color must be kept within specified limits.	
ARM 17.30.637	ARM 17.30.637 which prohibits discharges containing substances that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.	
ARM 17.30.705	ARM 17.30.705 provides that for any surface water, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.	
Water Quality Act, Title 17, Chapter 30, Sub-Chapters 6 and 13 and ARM 17.30.1332	<u>Stormwater Runoff (Applicable)</u> Pursuant to authority under the Water Quality Act, Title 17, Chapter 30, Sub-Chapter 6, and Title 17, Chapter 30, Sub-Chapter 13, including ARM 17.30.1332, the Water Quality Division issues general stormwater permits for certain activities. For construction activities, the following permit must be obtained: General Discharge Permit for Storm Water Associated with Construction Activity, Permit No. MTR100000 (May 19, 1997). Generally, the permits require the permittee to implement Best Management Practices (BMP) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, an individual MPDES permit or alternative general permit may be required.	Activities proposed in the this task work plan will not impact surface water runoff at the Facility.

APPENDIX B

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Ambient Air Quality Standards (Applicable)		
	The following standards are applicable at the site[4]:	Although particulates may be generated during well installation, activities proposed in the this task are not expected to result in exceedances of ambient air quality standards. Borehole installation will include wetting and other best management practices related to fugitive dust control. Remedial actions will be halted if significant dust is generated and will not resume until adequate dust control measures are in place. These dust control measures will ensure that ambient air standards will not be exceeded during the proposed remedial action.
40 CFR 50.12 and ARM 17.8.222	40 CFR 50.12 and ARM 17.8.222. Ambient air quality standard for lead. Lead concentrations in the ambient air shall not exceed the following 90-day average: 1.5 micrograms lead per cubic meter of air.	
40 CFR 50.9 and ARM 17.8.213 40 CFR 50.10	40 CFR 50.9 and ARM 17.8.213. Ambient air quality standard for ozone. No person shall cause or contribute to concentrations of ozone in the ambient air exceeding: 0.10 ppm 1-hour average (0.12 ppm federal standard). 40 CFR 50.10 establishes a daily maximum 8-hour average 0.08 parts per million (ppm).	
ARM 17.8.220	ARM 17.8.220. Ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the following 30-day average: 10 grams per square meter.	
40 CFR 50.6 and ARM 17.8.223	40 CFR 50.6 and ARM 17.8.223. Ambient air quality standards for PM-10. PM-10 concentrations in the ambient air shall not exceed the following standards: 150 micrograms/cubic meter of air, 24-hour average; and 50 micrograms/cubic meter of air, expected annual average.	Although particulates may be generated during well installation, activities proposed in the this task are not expected to result in exceedances of ambient air quality standards. Borehole installation will include wetting and other best management practices, as described above.
40 CFR 50.8 and ARM 17.8.212	40 CFR 50.8 and ARM 17.8.212. Ambient air quality standards for carbon monoxide. Carbon monoxide concentrations in the ambient air shall not exceed the following standards: 9 ppm 8-hour average; and 23 ppm for a 1-hour average (35 ppm for federal).	
Emission Standards (Applicable)		
Sections 75-2-101, et seq., MCA,	Montana has promulgated standards to regulate emissions of certain contaminants into the air. The state emission standards are enforceable under the Montana Clean Air Act, Sections 75-2-101 et seq., MCA.	Although particulates may be generated during well installation, activities proposed in the this task are not expected to result in exceedances of ambient air quality standards. Borehole installation will include wetting and other best management practices, as described above.
ARM 17.8.304	ARM 17.8.304. Visible Air Contaminants. No source may discharge emissions into the atmosphere that exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard is limited to point sources, but excludes wood waste burners, incinerators, and motor vehicles.	
ARM 17.8.308	ARM 17.8.308. Airborne Particulate Matter. Emissions of airborne particulate matter from any stationary source shall not exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard applies to the production, handling, transportation, or storage of any material; to the use of streets, roads, or parking lots; and to construction or demolition projects.	
ARM 17.8.315	ARM 17.8.315. Odors. If a business or other activity will create odors, those odors must be controlled, and no business or activity may cause a public nuisance.	Activities proposed in the this task work plan will not generate odors. No open burning will be conducted during implementation of this task.
ARM 17.8.604	ARM 17.8.604. Prohibited open burning. Open burning of numerous specific materials, including but not limited to oil and petroleum products and hazardous wastes, is prohibited.	
ARM 17.8.705	ARM 17.8.705 requires that permits be obtained for the construction, installation, alteration, or use of specified air contaminant sources. All air permits required for remedial actions must be obtained.	Activities proposed in the this task work plan do not require air permits.
ARM 17.8.715	ARM 17.8.715 requires sources for which air quality permits are required to use best available control technology (BACT) or to meet the lowest achievable emission rate (LAER), as applicable.	

APPENDIX B

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
FEDERAL LOCATION SPECIFIC ERCLS		
Criteria Classification of Solid Waste Disposal Facilities and Practices (Applicable and Well-Suited)		
40 CFR 257	Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable). The criteria contained in 40 CFR Part 257, establish standards with which solid waste disposal must comply to avoid possible adverse effects on health or the environment. 40 CFR Part 257 includes the following standards: Section 257.3-1(a) requires that facilities or practices in the floodplain not result in the washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources. Section 257.3-2 provides for the protection of threatened or endangered species. Section 257.3-3 provides that a facility shall not cause the discharge of pollutants into waters of the United States. Section 257.3-4 states that a facility or practice shall not contaminate underground drinking water.	IDW that is solid waste (i.e., PPE and possibly soil) will be generated during implementation of this task. Non-hazardous IDW will be disposed off of the Facility at an appropriate permitted disposal facility. See the Facility-Wide SAP for additional information on how non-hazardous IDW will be managed to comply with these ERCLs. Landspreading of soil, if approved by DEQ, will not occur in areas of a floodplain, will not be conducted in a manner to cause discharge of pollutants into water, and will not be conducted in a manner that contaminates underground drinking water sources or impacts endangered or threatened species. Other IDW or solid waste generated during implementation of this task will be disposed off of the Facility at an appropriate permitted disposal facility.
The Endangered Species Act (Well-Suited)		
16 U.S.C. §§ 1531 – 1544, 50 CFR Part 402, 40 CFR 6.302(h), 40 CFR 257.3-2	This statute and implementing regulations (16 U.S.C. § 1531 et seq., 50 CFR Part 402, 40 CFR 6.302(h), and 40 CFR 257.3-2) require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service (USFWS) and a determination of whether there are listed or proposed species or critical habitats present at the Site, and, if so, whether any proposed activities will impact such wildlife or habitat. No endangered or threatened species was identified onsite although the Yellowstone Trout is treated as a species of special concern by the State. Any action affecting federal or State endangered or threatened species must comply with all listed requirements.	Activities proposed in the this task work plan will not impact endangered species. According to the ROD, no endangered species or threatened species were identified at the Facility, although the Yellowstone Trout is treated as a species of special concern by the State.
Sections 87-5-106, -107, -111, and -201, MCA	Sections 87-5-106, 107, and 111, MCA (Applicable): Endangered species should be protected in order to maintain and to the extent possible enhance their numbers. These sections list endangered species, prohibited acts and penalties. See also, §§ 87-5-106 and 87-5-201, MCA, (Applicable) concerning protection of wild birds, nests and eggs.	
ARM 12.5.201	ARM 12.5.201 (Applicable). Certain activities are prohibited with respect to specified endangered species.	
Migratory Bird Treaty Act (Well-Suited)		
16 U.S.C. §§ 703, et seq.	This requirement (16 U.S.C. § 703 et seq.) establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial action to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Activities proposed in the this task work plan will not impact migratory birds. Migratory birds may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Bald Eagle Protection Act (Well-Suited)		
16 U.S.C. §§ 668, et seq.	This requirement (16 U.S.C. § 668 et seq.) establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial action to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagle.	Activities proposed in the this task work plan will not impact bald eagles. Bald eagles may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Historic Sites, Buildings, Objects, and Antiquities Act (Well-Suited)		
16 U.S.C. 461, et seq.	These requirements, found at 16 U.S.C. 461 et seq., provide that, in conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR 62.6(d) to avoid undesirable impacts upon such landmarks. No historic sites were identified.	Activities proposed in the this task work plan will not impact historic sites. According to the ROD, no historic sites were identified at the Livingston railyard.
Fish and Wildlife Coordination Act (Well-Suited)		
16 U.S.C. 661, et seq. and 40 CFR 6.302(g)	These standards are found at 16 U.S.C. § 661 et seq. and 40 CFR 6.302(g) and require that federally funded or authorized projects ensure that any modification of any stream or other water body affected by a funded or authorized action provide for adequate protection of fish and wildlife resources.	Activities proposed in the this task work plan do not involve the modification of any stream or other water body.
Floodplain Management Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,988	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,988) mandates that federally funded or authorized actions within the 100 year floodplain avoid, to the maximum extent possible, adverse impacts associated with development of a floodplain.	Activities proposed in this task work plan do not involve locating any wells or borings in the floodplain or floodway. Soil boring or excavation activites are not anticipated to impact the floodplain or floodway.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Protection of Wetlands Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,990 Section 404(b)(1), 33 U.S.C. Section 1344(b)(1)	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,990) mandates that federal agencies and potentially responsible parties avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Section 404(b)(1), 33 U.S.C. § 1344(b)(1), also prohibits the discharge of dredged or fill material into waters of the United States. Together, these requirements create a "no net loss" of wetlands standard.	According to Montana's Natural Resource Information System (NRIS), no wetlands have been identified in the Livingston area. Activities proposed in the this task work plan will not impact wetlands.
STATE LOCATION SPECIFIC ERCLS		
Solid Waste Management Regulations (Applicable and Well-Suited)		
Solid Waste Management Act, Sections 75-10-201 et seq., MCA	Regulations promulgated under the Solid Waste Management Act, Sections 75-10-201 et seq., MCA, specify requirements that apply to the location of any solid waste management facility. Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable).	Non-hazardous IDW such as personal protective equipment (PPE) and IDW (i.e., soil, water) that has determined to be nonhazardous through analytical testing and receipt of a "no longer contained-in" determination from DEQ, if applicable, generated during implementation of this task will be contained in 55-gallon drums or other appropriate containers and temporarily stored in a centralized storage area pending characterization and final disposition. If investigation-derived soil or water cannot be landspread at the Livingston railyard, it will be disposed off of the Facility along with other non-hazardous IDW at an appropriate permitted disposal facility. Any other solid waste (i.e., plastic wrapping, cardboard, non-indigenous waste, etc.) will be contained in a plastic bag (if necessary) [double-bagged (if necessary)], and placed in a garbage can for collection and appropriate disposal as solid waste. Activities proposed in the this task work plan do not involve the cinder pile or propose treatment of soil.
ARM 17.50.505(1)	Under ARM 17.50.505(1), a facility for the treatment, storage or disposal of solid wastes: (a) must be located where a sufficient acreage of suitable land is available for solid waste management; (b) may not be located in a 100-year floodplain; (c) may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems; (d) must be located to allow for reclamation and reuse of the land; (e) drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and (f) where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connected to a proposed disposal facility, only Class III disposal facilities may be approved.	Any IDW (i.e., water and possibly soil) generated during implementation of this task will be contained in 55-gallon drums or other appropriate containers and stored inside/near the Forest Products Building and/or the Former C&P Packing Building (see Section 8.4.4.1 of Facility-Wide SAP). The Forest Products Building and/or Former C&P Packing Building and surrounding areas represent sufficient acreage for IDW management. These buildings are not located in the floodplain or floodway. IDW will be stored in appropriate containers to prevent pollution of groundwater, surface water, and public and private water supply systems. See the Facility-Wide SAP for additional information regarding the management of IDW.
Floodplain and Floodway Management Act and Regulations (Applicable)		
	A portion of the site is in a designated floodplain. The following standards are included here to indicate the restrictions on any related activities that might occur in or affect the floodway or floodplain.	The proposed area(s) where the borings are to be located are not located in the floodway or floodplain. Therefore, the activities proposed in the manway investigation work plan will not impact a floodway or floodplain.
Section 76-5-401, MCA and ARM 36.15.601	Residential, certain agricultural, industrial-commercial, recreational and other uses are permissible within the designated floodway, provided they do not require structures other than portable structures, fill or permanent storage of materials or equipment. Section 76-5-401, MCA; ARM 36.15.601.	
Section 76-5-402, MCA and ARM 36.15.701	In the flood fringe (i.e., within the floodplain but outside the floodway), residential, commercial, industrial, and other structures may be permitted subject to certain conditions relating to placement of fill, roads, and floodproofing. Section 76-5-402, MCA; ARM 36.15.701.	
ARM 36.15.602(6)	Domestic water supply wells may be permitted, even within the floodway, provided the well casing and well meets certain conditions. ARM 36.15.602(6).	
ARM 36.15.602(5), 36.15.605, and 36.15.703	Solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials are prohibited anywhere in floodways or floodplains. ARM 36.15.602(5), 36.15.605, and 36.15.703.	
Section 76-5-402, MCA	The following are prohibited in a floodway: buildings for living purposes or place of assembly or permanent use by human beings; any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and the construction or permanent storage of an object subject to flotation or movement during flood level periods. Section 76-5-402, MCA.	
Section 76-5-406, MCA and ARM 36.15.216	Section 76-5-406, MCA and ARM 36.15.216 contain substantive factors which address obstruction or use within the floodway or floodplain.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 36.15.604, ARM 36.15.602(1), and ARM 36.15.603	Further conditions or restrictions that generally apply to specific activities within the floodway or floodplain can be found at ARM 36.15.604 (increase in upstream elevation or significantly increase flood velocities); ARM 36.15.602(1) (excavation of material from pits or pools); ARM 36.15.603 (water diversions or changes in place of diversion).	
ARM 36.15.701(3)(c)	ARM 36.15.701(3)(c) requires that roads, streets, highways and rail lines must be designed to minimize increases in flood heights.	
ARM 36.15.701(3)(d)	Structures and facilities for liquid or solid waste treatment and disposal must be floodproofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with DEQ regulations, which include certain additional prohibitions on such disposal. ARM 36.15.701(3)(d).	
ARM 36.15.702(2)	Standards applied to residential, commercial or industrial structures are found at ARM 36.15.702(2).	
ARM 36.15.606	Flood control works are subject to ARM 36.15.606, which requires compliance with safety standards for levees, floodwalls, and riprap.	
ARM 36.15.901	ARM 36.15.901 requires electrical systems to be flood-proofed.	
FEDERAL AND STATE ACTION SPECIFIC ERCLS		
Federal Hazardous Waste Management Regulations (Applicable)		
42 U.S.C. §§ 6901 et seq., and Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA	The Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Sections 6901 et seq., and the Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under these acts establish a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve the active management of hazardous wastes. Burlington Northern operated the site and generated waste through 1986-7. Therefore, in certain instances, disposal was not pre-jurisdictional and the hazardous waste requirements are applicable now. However, DEQ does not have the documentation showing the dates of individual discharges, and therefore has, for purposes of this ROD, made a determination to treat all historic waste and media containing waste as pre-jurisdictional (in accord with the NCP and EPA guidance). Therefore, under this ROD, the historic waste which is characteristic or listed becomes hazardous upon excavation (generation).	Soil is not anticipated to be generated during the installation. If soil is generated, it is not anticipated to be soil that would contain an F-listed waste, because the activities are outside of known source areas in the soil and the activities are supposed to be conducted above the groundwater. The groundwater in this area does contain F-listed constituents. Accordingly, if soil is generated during the work and it is soil that is or has been in contact with groundwater or there is other indication that it might contain PCE, it will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise (i.e., no detections of PCE, or detections of PCE below the relevant ROD cleanup levels and receipt of a "no longer contained-in" determination from DEQ under RCRA). Any hazardous IDW (i.e., soil) generated during implementation of this task will be managed as outlined in the Facility-Wide SAP, in accordance with the applicable requirements of these ERCLs. While DEQ has the authority to waive non-substantive permit requirements for remedial actions conducted entirely at the Facility, that authority does not extend to permitted activities such as transporting and disposing of hazardous waste off of the Facility. DEQ has determined that a hazardous waste transporter is not required to transport hazardous waste from a work area to the centralized storage area, provided transportation remains within the Facility. If hazardous waste needs to be transported outside the Facility, a hazardous waste transporter will be used and the hazardous waste will be manifested, labelled and containerized. Any hazardous IDW generated during implementation of this task will be contained in 55-gallon drums or tank(s) and stored inside/near the Forest Products Building and/or the Former C&P Packing Building (see Section 8.4.4 of Facility-Wide SAP). Figures 4, 5, and 6 in the Facility-Wide SAP depict how IDW generated during implementation of this task will be disposed of in accordance with these ERCLs.
		Environmental samples containing RCRA-regulated constituents submitted to the analytical laboratory are exempt from RCRA; however, they become subject to RCRA again when they are disposed of by the analytical laboratory. Analytical laboratory will dispose of environmental samples in accordance with state and federal regulations.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Identification and Listing of Hazardous Waste		
40 CFR 261 ARM 17.54.501-502	Wastes may be designated as hazardous by either of two methods: listing or demonstration of a hazardous characteristic. Listed wastes are the specific types of wastes determined by EPA to be hazardous as identified in 40 CFR Part 261, Subpart D (40 CFR 261.30 - 261.33). Listed wastes are designated hazardous by virtue of their origin or source, and must be managed as hazardous wastes regardless of the concentration of hazardous constituents. Characteristic wastes are those that by virtue of concentrations of hazardous constituents demonstrate the characteristic of ignitability, corrosivity, reactivity or toxicity, as described at 40 CFR Part 261, Subpart C.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with the Facility-Wide SAP.
	Certain of the wastes at the site demonstrate the characteristic of toxicity, and are therefore characteristic hazardous wastes upon excavation. The site also contains F001 and F002 which are listed hazardous wastes for chlorinated solvents. The various media and wastes at the site contaminated by the F001 and F002 wastes are also hazardous wastes pursuant to 40 CFR Part 261 upon excavation. The RCRA requirements specified below are applicable requirements for the treatment, storage and disposal of these wastes. See 40 CFR 261.31 (Hazardous Waste Numbers F001 and F002) and ARM 17.54.501. These ERCLs apply to remedial activities; on-going operations must comply with State and federal requirements and permits. EPA has advised EPA Regions and States that conservative, health-based levels derived from direct exposure pathways would clearly be acceptable as "contained-in" levels. [See memorandum from Sylvia K. Lowrance to Jeff Zelikson, Region IX, (January 24, 1989)]. EPA and many States specify conservative, risk-based levels calculated with standard conservative exposure assumptions (usually based on unrestricted access), or site-specific risk assessments. 61 FR at 18795 (April 29, 1996); 63 FR 28556 (May 26, 1998) [Part I of II]. For the BN Livingston Shop Complex, soils treated to below cleanup levels will be allowed to return to the site (from, for example, the electric shop) to an approved location in For media which contain hazardous waste, all standards are applicable except for disposal requirements for "contained-out" soils. For all non-media wastes, the standards are applicable. However, no on-site disposal of hazardous waste is allowed under the selected remedy. Therefore, all hazardous wastes, including all media not treated to cleanup levels must be disposed off-site at a regulated subtitle C facility. These standards specifically apply to free product removed from within the solvent plume. For free product removed from outside the solvent plume 40 CFR Part 279 is applicable.	
ARM 17.53.111 and 112, MCA	Because of the presence of listed and characteristic hazardous waste, the permit requirements specified in ARM 17.53.112 are applicable. However, DEQ is exempting remedial actions involving hazardous waste from RCRA permit requirements pursuant to 75-10-721(3), MCA (1993) as long as substantive requirements are met. This does not, however, affect the requirement to comply with ARM 17.53.111, Registration and EPA Identification Numbers for Generators and Transporters. Workplans will require detailed information on compliance with all procedural and substantive standards (as well as all ERCLs). Set out below are the hazardous waste requirements that are applicable for the types of waste management units or the waste management practices anticipated in the remedial actions at the site.	BNSF has obtained a hazardous waste identification number for the Livingston railyard (EPA ID No. MTT310010087).
Standards for Transporters of Hazardous Waste		
40 CFR Part 263	The RCRA regulations at 40 CFR Part 263, establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any on-site transportation. These standards are independently applicable (see Other Laws section) for any off-site transportation.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with the Facility-Wide SAP.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		
40 CFR 264, Subpart B	General Facility Standards The regulations at 40 CFR 264, Subpart B, establish general facility requirements. These standards include requirements for general waste analysis, security and location standards.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with the Facility-Wide SAP.
40 CFR 264, Subpart F	Releases from Solid Waste Management Units The regulations at 40 CFR 264, Subpart F, establish requirements for groundwater protection for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). The regulations at Subpart F establish monitoring requirements for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). Subpart F provides for three general types of groundwater monitoring: detection monitoring (40 CFR 264.98); compliance monitoring (40 CFR 264.99); and corrective action monitoring (40 CFR 264.100). Monitoring wells must be cased according to 264.97(c). Monitoring is required during the active life of a hazardous waste management unit. If hazardous waste remains, monitoring is required for a period necessary to protect human health and the environment.	IDW (i.e., soil, water) generated during implementation of this task will be appropriately containerized and stored in drums, tanks, or other appropriate containers, as described in the Facility-Wide SAP.
40 CFR Part 264, Subpart G	Closure and Post-Closure Monitoring and Maintenance of Waste Management or Disposal Facilities 40 CFR Part 264, Subpart G, establishes that hazardous waste management facilities must be closed in such a manner as to (a) minimize the need for further maintenance and (b) control, minimize or eliminate, to the extent necessary to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. Requirements for facilities requiring post-closure care include the following: the facilities must undertake appropriate monitoring and maintenance actions, control public access, and control postclosure use of the property to ensure that the integrity of the final cover, liner, or containment system is not disturbed. In addition, all contaminated equipment, structures and soil must be properly disposed of or decontaminated unless exempt and free liquids must be removed or solidified, the wastes stabilized, and the waste management unit covered.	IDW (i.e., soil, water) generated during implementation of this task will be either landspread at the Livingston railyard (with DEQ approval), incorporated into the final remedy (with DEQ approval), or removed from the Facility and disposed of at a permitted disposal facility (hazardous or non-hazardous, as appropriate). IDW generated during the this task SI Work Plan will not be stored in soil waste management or disposal facilities.
40 CFR Part 264, Subparts I and J 40 CFR 261.7	Waste Containers and Tanks 40 CFR Part 264, Subparts I and J apply to owners and operators of facilities that store hazardous waste in containers, and store or treat hazardous waste in tanks, respectively. These regulations are applicable to any storage or treatment in these units at the site. The related provisions of 40 CFR 261.7, residues of hazardous waste in empty containers, are also applicable.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be contained in either 55-gallon drums or tank(s) and stored in a centralized storage area (Forest Products Building and/or Former C&P Packing Building) as outlined in Section 8.4.4 of the Facility-Wide SAP.
40 CFR Part 264, Subpart L	Waste Piles 40 CFR Part 264, Subpart L, applies to owners and operators of facilities that store or treat hazardous waste in piles. The regulations include requirements for the use of run-on and run-off control systems and collection and holding systems to prevent the release of contaminants from waste piles. These regulations are applicable to any storage in waste piles at the site.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be stored in 55-gallons drums or tanks(s) not in waste piles or staging piles. If treatment of soil is proposed, a SAP addendum containing a treatment plan will be submitted to DEQ as discussed in Section 8.4.2 of the Facility-Wide SAP.
40 CFR 264.554	Staging Piles 40 CFR 264.554 sets forth a new storage unit called the staging pile. A staging pile must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the staging pile originated. The staging pile must be designed so as to prevent or minimize releases of hazardous wastes and hazardous constituents into the environment, and minimize or adequately control cross-media transfer, as necessary to protect human health and the environment (for example, through the use of liners, covers, run-off/run-on controls, as appropriate). The staging pile must not operate for more than two years and cannot be used for treatment.	
40 CFR Part 268	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site. With the exception of treated soils, hazardous wastes are prohibited from disposal on-site.	Any hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with Section 8.4 of the Facility-Wide SAP. Figures 4, 5, and 6 in the Facility-Wide SAP depict how IDW generated during implementation of this task will be disposed of in accordance with these ERCLs. If investigation-derived soil or water is proposed for landspreading, documentation showing that concentrations are below relevant ROD cleanup levels and LDR standards will be included in the request to DEQ.
HWIR Media Rule (63 Fed. Reg. 65874)	The HWIR Media Rule, promulgated at 63 Fed. Reg. 65874 (November 30, 1998) allows listed waste treated to levels protective of human health and the environment to be disposed on-site without triggering land ban or minimum technology requirements for these disposal requirements. Treated soils containing hazardous waste will need to meet cleanup levels to avoid triggering land ban or minimum technology requirements for these disposal requirements.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
40 CFR 268.45	Hazardous debris Since on-site disposal of solid and hazardous wastes is prohibited at the site, any hazardous debris remaining on-site must comply with 40 CFR 268.45 prior to off-site disposal as a solid waste (all off-site disposal must also comply with LDR certification requirements, which apply to these wastes). If the debris does not fully comply with 40 CFR 268.45, it must be disposed off-site at a regulated subtitle C facility.	If any hazardous debris is generated during implementation of this task, it will be managed hazardous waste as as outlined in the Facility-Wide SAP.
40 CFR Part 270	Substantive Permit Requirements 40 CFR Part 270 sets forth the hazardous waste permit program. The substantive requirements set forth in 40 CFR Part 270, Subpart C (permit conditions), including the requirement to properly operate and maintain all facilities and systems of treatment and control are applicable requirements.	Substantive requirements of RCRA will be met as described in the Facility-Wide SAP, including generation, storage, and disposal.
40 CFR Part 279	Used Oil 40 CFR Part 279 sets forth the standards for the management of used oil. For product removed from outside the solvent plume, 40 CFR Part 279 is applicable.	Activities proposed in the this task work plan will not result in the generation of used oil.
State Hazardous Waste Management Regulations (Applicable)		
Sections 75-10-401 et seq., MCA	The Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under this act establishes a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve listed and characteristic hazardous wastes.	Soil is not anticipated to be generated during the installation. If soil is generated, it is not anticipated to be soil that would contain an F-listed waste, because the activities are outside of known source areas in the soil and the activities are supposed to be conducted above the groundwater. The groundwater in this area does contain F-listed constituents. Accordingly, if soil is generated during the work and it is soil that is or has been in contact with groundwater or there is other indication that it might contain PCE, it will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise (i.e., no detections of PCE, or detections of PCE below the relevant ROD cleanup levels and receipt of a "no longer contained-in" determination from DEQ under RCRA). Any hazardous IDW (i.e., soil) generated during implementation of this task will be managed as outlined in the Facility-Wide SAP, in accordance with the applicable requirements of these ERCLs. While DEQ has the authority to waive non-substantive permit requirements for remedial actions conducted entirely at the Facility, that authority does not extend to permitted activities such as transporting and disposing of hazardous waste off of the Facility. DEQ has determined that a hazardous waste transporter is not required to transport hazardous waste from a work area to the centralized storage area, provided transportation remains within the Facility. If hazardous waste needs to be transported outside the Facility, a hazardous waste transporter will be used and the hazardous waste will be manifested, labelled and containerized. Any hazardous IDW generated during implementation of this task will be contained in 55-gallon drums or tank(s) and stored inside/near the Forest Products Building and/or the Former C&P Packing Building (see Section 8.4.4 of Facility-Wide SAP). Figures 4, 5, and 6 in the Facility-Wide SAP depict how IDW generated during implementation of this task will be disposed of in accordance with these ERCLs.
ARM 17.53.501-502	ARM 17.53.501-502 adopts the equivalent of RCRA regulations at 40 CFR Part 261, establishing standards for the identification and listing of hazardous wastes, including standards for recyclable materials and standards for empty containers, with certain State exceptions and additions.	
ARM 17.53.601-604	ARM 17.53.601-604, adopts the equivalent to RCRA regulations at 40 CFR Part 262, establishing standards that apply to generators of hazardous waste, including standards pertaining to the accumulation of hazardous wastes, with certain State exceptions and additions.	
ARM 17.53.701-708	ARM 17.53.701-708, adopts the equivalent to RCRA regulations at 40 CFR Part 263, establishing standards that apply to transporters of hazardous waste, with certain State exceptions and additions.	
ARM 17.53.801-803	ARM 17.53.801-803, adopts the equivalent to RCRA regulations at 40 CFR Part 264, establishing standards that apply to hazardous waste treatment, storage and disposal facilities, with certain State exceptions and additions.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 268, establishing land disposal restrictions, with certain State exceptions and additions.	
Section 75-10-422 MCA	Section 75-10-422 MCA prohibits the unlawful disposal of hazardous wastes.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 270, which establish standards for permitted facilities, with certain State exceptions and additions.	
ARM 17.53.1401	ARM 17.53.1401, adopts the equivalent of RCRA regulations at 40 CFR Part 279 which set forth the standards for the management of used oil.	Activities proposed in the this task work plan will not result in the generation of used oil.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)		
ARM 17.8.341 (Incorporates by reference 40 CFR Part 61)	Asbestos (Well-Suited) The federal Clean Air Act requires the EPA to set emission standards for hazardous air pollutants. 42 U.S.C Section 7412. Implementation and enforcement of these standards in Montana has been delegated to the State. See 40 CFR 61.04(b)(BB). Federal standards for hazardous air pollutants (NESHAPs) at 40 CFR Part 61, are incorporated by reference by ARM 17.8.341. The NESHAPs for asbestos are well-suited to the cinder pile and are discussed in the Asbestos section below; however, the solid waste requirements are the more stringent of the ERCLs that must be complied with with respect to covering of the cinder pile.	Activities proposed in this task work plan will not result in air emissions of asbestos or vinyl chloride.
40 CFR 61.145	40 CFR 61.145. (well-suited). Standard for demolition and renovation. This section contains standards for demolition or renovation of a facility. The standards are designed to reduce or eliminate asbestos emissions from such operations, and include provisions for notification regarding intended project, wetting of asbestos materials, use of exhaust systems, careful movement of asbestos materials, and presence on site of a trained asbestos removal person. This section applies to any demolition or renovation of a structure, installation, building, or waste disposal area at the site containing asbestos	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
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Federal or State ERCL Citation	Description	Compliance
40 CFR Part 61, Subpart F	40 CFR 61.151. (well-suited). Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations. There must either be no discharge of visible emissions from the site to the outside air, or the specified covering or treatment methods must be followed. Warning signs must be posted and prior notice must be given to EPA or the State before the waste material is excavated or disturbed. Vinyl Chloride (Applicable) 40 CFR Part 61, Subpart F contains the national emission standard for vinyl chloride. 40 CFR 61.64(b) requires concentrations from vinyl chloride in each exhaust gas stream from each stripper not exceed 10 ppm.	
National Pollutant Discharge Elimination System (NPDES) and the Montana Pollutant Discharge Elimination System (MPDES) (Applicable)		
40 CFR Part 122, Subpart C and ARM 17.30.1342 -.1344	40 CFR Part 122, Subpart C and ARM 17.30.1342-1344 set forth the substantive requirements applicable to all MPDES and NPDES permits. Permits must be obtained for all surface and groundwater systems that are part of remedial actions, including proper operation and maintenance of all facilities and systems of treatment and control.	To ensure state waters are not degraded/polluted, any development or decontamination water will be treated to the groundwater cleanup levels presented in the Record of Decision (ROD) (DEQ 2001) and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River.
Technology-Based Treatment (Applicable)		
40 CFR Part 125 and ARM 17.30.1344	40 CFR Part 125 and ARM 17.30.1344 set forth criteria and standards for dischargers. Based on the source, the technology-based treatment standards include the best practicable control technology (BPT), best conventional pollutant control technology (BCT), or Best Available Technology Economically Achievable (BAT).	To ensure state waters are not degraded/polluted, any development or decontamination water will be treated to the groundwater cleanup levels presented in the Record of Decision (ROD) (DEQ 2001) and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River.
Underground Injection Control Program (Well-Suited)		
40 CFR 146	The Underground Injection Control Program set forth at 40 CFR 146, sets forth the standards and criteria for the injection of substances into aquifers. Wells are classified as Class I through V, depending on the location and the type of substance injected. For all classes, no owner may construct, operate or maintain an injection well in a manner that results in the contamination of an underground source of drinking water at levels that violate MCLs or otherwise adversely affect the health of persons. Each classification may also contain further specific standards, depending on the classification.	Activities proposed in the this task work plan do not involve the construction/operation of underground injection control wells.
Solid Waste Management Regulation (Applicable and Well-Suited)		
ARM 17.50.505	ARM 17.50.505(2) specifies standards for solid waste management facilities, including the requirements that: 1. Class II landfills must confine solid waste and leachate to the disposal facility. If there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters; 2. adequate separation of group II wastes from underlying or adjacent water must be provided; and 3. no new disposal units or lateral expansions may be located in wetlands. ARM 17.50.505 also specifies general soil and hydrogeological requirements pertaining to the location of any solid waste management facility.	Activities proposed in the this task work plan do not involve siting, construction, operation/maintenance, and closure of a solid waste management facility. IDW generated during implementation of this task will be managed as outlined in the Facility-Wide SAP.
ARM 17.50.511	ARM 17.50.511 sets forth general operational and maintenance and design requirements for solid waste facilities using landfilling methods. Specific operational requirements, specified in ARM 17.14.511 are run-on and run-off control systems requirements, requirements that sites be fenced to prevent unauthorized access, and prohibitions of point source and nonpoint source discharges which would violate Clean Water Act requirements.	
ARM 17.50.530	ARM 17.50.530 sets forth the closure requirements for landfills. Class II landfills must meet the following criteria: 1. install a final cover that is designed to minimize infiltration and erosion. 2. design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 X 10-5 cm/sec, whichever is less; 3. minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth and protecting the infiltration layer from frost effects and rooting damage; 4. revegetate the final cover with native plant growth within one year of placement of the final cover.[5]	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
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Federal or State ERCL Citation	Description	Compliance
ARM 17.50.531	ARM 17.50.531 sets forth post closure care requirements for Class II landfills. Post closure care must be conducted for a period sufficient to protect human health and the environment. Post closure care requires maintenance of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 14, subchapter 7.	
Transportation of Solid Waste (Applicable)		
Section 75-10-212 ARM 17.50.523	For solid wastes, Section 75-10-212 prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted. ARM 17.50.523 requires that such waste must be transported in such a manner as to prevent its discharge, dumping, spilling, or leaking from the transport vehicle.	Solid waste (i.e., plastic wrapping, cardboard, non-indigenous waste, etc.) generated during implementation of this task will be contained in a plastic bag (if necessary) [double-bagged (if necessary)], and placed in a garbage can for collection and appropriate disposal as solid waste. IDW generated during implementation of Task F will be managed as outlined in Section 8.4 of the Facility-Wide SAP. Solid waste generated during implementation of pilot test will be transported in a manner to prevent discharge, dumping, spilling, and leaking.
Underground Storage Tank (USTs) Regulations (Applicable)		
   40 CFR Part 280, Subpart F	These standards are applicable. To the extent certain UST systems were removed prior to the effective date of the regulations, diesel is found separate and distinct from an UST system, or UST regulations are not applicable, the UST requirements remain well-suited since they address situations or problems sufficiently similar to those at the site. 40 CFR Part 280, Subpart F sets forth requirements for Release Response and Corrective Action for UST Systems Containing Petroleum or Hazardous Substances. These include initial response, initial abatement measures, site characterization, free product removal, and investigations for soil and groundwater cleanup.	Activities proposed in the this task work plan do not involve USTs.
40 CFR 280.64	40 CFR 280.64 provides that where investigations in connection with leaking underground storage tanks reveal the presence of free product, owners and operators must remove free product to the maximum extent practicable as determined by the implementing agency. This regulation also requires that the free product removal be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site, and that properly treats, discharges or disposes of recovery byproducts in compliance with applicable local, State and Federal regulations. 40 CFR 280.64 provides that abatement of free product migration is a minimum objective for the design of the free product removal system provides that any flammable products must be handled in a safe and competent manner to prevent fires or explosions.	
40 CFR Part 280, Subpart D	40 CFR Part 280, Subpart D sets forth requirements for release detection.	
40 CFR 280.43	40 CFR 280.43 (well-suited) specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 4	The Montana regulations regarding underground storage tanks include similar requirements. Title 17, Chapter 56, Sub-Chapter 4 specifies release detection.	
ARM 17.56.407	ARM 17.56.407 specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 6	Title 17, Chapter 56, Sub-Chapter 6 specifies release response and corrective action for tanks containing petroleum or hazardous substances.	
ARM 17.56.602 - 605	ARM 17.56.602 through 605 requires certain mitigation measures including removal of as much of the regulated substance from the system as is necessary to prevent further release into the environment and prevention of further migration of the released substance into surrounding soil and groundwater.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Asbestos Regulation in Building Construction and Demolition (Well-Suited)		
Sections 50-64-101, et seq., MCA	Sections 50-64-101 et seq., MCA, regulate construction and demolition of structures that contain asbestos.	Tasks included in this work plan will not generate any asbestos containing material.
50-64-104, MCA	Section 50-64-104, MCA. provides for various safeguards to prevent release of asbestos into the air. The prescribed safeguards include notification of the local fire department, posting of warning signs, wetting of surfaces, dust emission control, covering and wetting during transport, and deposition at a landfill where materials are unlikely to be disturbed and where signs warn that asbestos-containing material is buried in the landfill. The listed safeguards are well-suited to the covering of the cinder pile.	
Well Drilling (Applicable)		
Section 85-2-505, MCA	Section 85-2-505, MCA, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.	Tasks included in this work plan do not include installation of any water wells or well drilling
Section 85-2-516, MCA	Section 85-2-516, MCA states that within 60 days after any well is completed a well log report must be filed by the driller with the Montana Department of Natural Resources and Conservation and the appropriate county clerk and recorder.	
ARM 17.30.641	ARM 17.30.641 provides standards for sampling and analysis of water to determine quality.	
ARM 17.30.646	ARM 17.30.646 requires that bioassay tolerance concentrations be determined in a specified manner.	Bioassays will not be performed during implementation of this task.
ARM 36.21.670-678 and 810	ARM 36.21.670-678 and 810 specifies certain requirements that must be fulfilled when abandoning monitoring wells.	No monitoring wells will be abandoned during implementation of this task.
Reclamation Requirements (Well-Suited)		
	Certain portions of the Montana Strip and Underground Mining Reclamation Act and Montana Metal Mining Act are well-suited requirements for certain revegetation and construction activities at the site.	Activities proposed in the this Work Plan may disturb land. The excavation will be backfilled with clean fill and regraded to slopes appropriate for its usage. Final surfacing will use appropriate soil material. Seeding and planting of disturbed areas will be conducted within the first growing season after the soil has been replaced. A mulch cover will be used until an adequate cover is established. The disturbed areas will be revegetated consistent with these requirements.
Section 82-4-231, MCA	Section 82-4-231, MCA: Requires operators to reclaim and revegetate affected lands using most modern technology available.	
Section 82-4-233, MCA	Section 82-4-233, MCA: Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.	
Section 82-4-336, MCA	Section 82-4-336, MCA: Disturbed areas must be reclaimed to utility and stability comparable to areas adjacent.	
ARM 17.24.501	ARM 17.24.501: Provides general backfilling and grading requirements.	
ARM 17.24.519	ARM 17.24.519: Pertinent areas where excavation will occur will be regraded to minimize settlement.	
ARM 17.24.631	ARM 17.24.631: Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels will be minimized, to the extent consistent with the selected response alternatives. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, mulching, and control of toxic-forming waste materials.	
ARM 17.24.633	ARM 17.24.633: Surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.	
ARM 17.24.634	ARM 17.24.634: Disturbed drainages will be restored to the approximate pre-disturbance configuration, to the extent consistent with the selected response alternatives.	
ARM 17.24.638	ARM 17.24.638: Sediment control measures must be implemented during operations.	
ARM 17.24.639	ARM 17.24.639: Sets forth requirements for construction and maintenance of sedimentation ponds.	
ARM 17.24.640	ARM 17.24.640: Discharges from sedimentation ponds, permanent and temporary impoundments, must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.	
ARM 17.24.643 - 646	ARM 17.24.643 through 17.24.646: Provisions for groundwater protection, groundwater recharge protection, and groundwater and surface water monitoring.	
ARM 17.24.701 and 702	ARM 17.24.701 and 702: Requirements for redistributing and stockpiling of soil for reclamation. Also outline practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil will be employed.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.24.711	ARM 17.24.711: Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established. This provision would not be well-suited in certain instances, for example, where there is dedicated development.	
ARM 17.24.713	ARM 17.24.713: Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed.	
ARM 17.24.714	ARM 17.24.714: Mulch or cover crop or both must be used until adequate permanent cover can be established.	
ARM 17.24.716	ARM 17.24.716: Establishes method of revegetation.	
ARM 17.24.718	ARM 17.24.718: Requires soil amendments, irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.	
ARM 17.24.723	ARM 17.24.723: States that operators shall conduct approved periodic measurements of vegetation, soils, and water.	
ARM 17.24.724	ARM 17.24.724: Specifies that revegetation success must be measured by approved unmined reference areas. Required management for these reference areas is set forth.	
ARM 17.24.726	ARM 17.24.726: Sets the required methods for measuring productivity.	
ARM 17.24.728	ARM 17.24.728: Sets requirements for measurements of the composition of vegetation on reclaimed areas.	
ARM 17.24.761	ARM 17.24.761: This specifies fugitive dust control measures which will be employed during excavation and construction activities to minimize the emission of fugitive dust.	
Noxious Weeds (Applicable)		
ARM 4.5.201 through .204 Section 7-22-2109(2)(b) Section 7-22-2152 Section 7-22-2101(7)(a), MCA	§ 7-22-2101(7)(a), MCA defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.201 through 4.5.204 and must be managed consistent with weed management criteria developed under MCA § 7-22-2109(2)(b). Notification and plan must occur as set forth in § 7-22-2152, MCA, as amended.	Activities included in this work plan are not anticipated to cause disturbanced to vegetation.
OTHER LAWS		
	These laws are laws which are independently applicable rather than ERCLs for the site.	
Section 85-2-101, MCA	Surface Water and Groundwater Act Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.	Activities proposed in the this task work plan will not require any surface water or groundwater to be appropriated.
Parts 3 and 4 of Title 85, Chapter 2, MCA	Groundwater and Surface Water Appropriation Parts 3 and 4 of Title 85, Chapter 2, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state.	Activities proposed in the this task work plan will not require any water rights to be obtained.
Section 85-2-507, MCA Section 85-2-506, MCA	Controlled Ground Water Area Pursuant to Section 85-2-507 MCA, the Department of Natural Resources and Conservation may grant either a permanent or a temporary controlled ground water area. The maximum allowable time for a temporary area is four years.[6] Pursuant to 85-2-506 MCA, designation of a controlled groundwater area may be proposed if (a) that ground water withdrawals are in excess of recharge to the aquifer or aquifers within the ground water area; (b) that excessive ground water withdrawals are very likely to occur in the near future because of consistent and significant increases in withdrawals from within the ground water area; (c) that significant disputes regarding priority of rights, amounts of ground water in use by appropriators, or priority of type of use are in progress within the ground water area; (d) that ground water levels or pressures in the area in question are declining or have declined excessively; (e) that excessive ground water withdrawals would cause contaminant migration; (f) that ground water withdrawals adversely affecting ground water quality within the ground water area are occurring or are likely to occur; or (g) that water quality within the ground water area is not suited for a specific beneficial use defined by 85-2-102(2)(a).	Activities proposed in the this task work plan will not require a controlled groundwater area.
29 CFR ☐Part☐1910	Occupational Safety and Health Act The federal Occupational Safety and Health Act regulations found at 29 CFR 1910 are applicable to worker protection during conduct of RI/FS or remedial activities.	Field activities associated with this task will be conducted in accordance with the Facility-Wide Health and Safety Plan (HASP) and the task-specific HASP addendum.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.74.101 ARM 17.74.102	Montana Occupational Health Act ARM Section 17.74.101, along with the similar federal standard in 29 CFR 1910.95, addresses occupational noise. ARM Section 17.74.102, along with the similar federal standard in 29 CFR 1910.1000 addresses occupational air contaminants.	
Sections 50-71-201, 202, and 203, MCA	Montana Safety Act Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe.	Water & Environmental Technologies has a comprehensive Injury and Illness Prevention Program designed to help ensure the health and safety of its employees and provide a safe and healthful work environment. In addition, Water & Environmental Technologies has a Corporate Health and Safety Program and Hazardous Communication Program.
Section 50-78-201, 202, and 204, MCA	Employee and Community Hazardous Chemical Information Act Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.	
40 CFR Part 262 and ARM 17.53.601-604	Standards for Generators of Hazardous Waste The RCRA regulations at 40 CFR Part 262 and ARM 17.53.601-604 establish standards that apply to generators of hazardous waste. These standards include requirements for obtaining an EPA identification number and maintaining certain records and filing certain reports. These standards are applicable for any waste which will transported off-site.	Hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed as outlined in the Facility-Wide SAP and comply with these requirements. BNSF has obtained a hazardous waste identification number for the Livingston railyard (EPA ID No. MTT310010087).
40 CFR Part 263 and ARM 17.53.701-708	Standards for Transporters of Hazardous Waste The RCRA regulations at 40 CFR Part 263 and ARM 17.53.701-708 establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any off-site transportation.	Hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with the Facility-Wide SAP and comply with these requirements.
40 CFR 268 and ARM 17.53.1101-1102	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 and ARM 17.53.1101-1102 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site.	Hazardous IDW (i.e., soil, water) generated during implementation of this task will be managed in accordance with the Facility-Wide SAP and comply with these requirements.
49 CFR Chapter I, Subchapters B and C and ARM 23.5.101	Oil Transportation 49 CFR Chapter I, Subchapter B (Oil Transportation) and Subchapter C (Hazardous Materials) and ARM. 23.5.101 apply to transporters of oil and hazardous materials. These standards are applicable for any off-site transportation of oil meeting the quantity requirements set forth in Subchapter B or for the transportation of hazardous materials such as the transportation of asbestos-containing waste material.	Activities proposed in the this task work plan do not involve the use of oil and will not generate used oil.
Sections 75-2-501 et seq., MCA Sections 75-2-502(4) and -511, MCA, and ARM 17.74.302(3) ARM 17.74.314	Montana Asbestos Control Act The Montana Asbestos Control Act, Sections 75-2-501 et seq., MCA, and implementing rules establish standards and procedures for accreditation of asbestos-related occupations and control of the work performed by persons in asbestos-related occupations. A permit from DEQ is required before any person can conduct an asbestos project. The definition of "asbestos project" includes the encapsulation, enclosure, removal, transportation, or disposal of asbestos-containing waste. Section 75-2-502(4), MCA; ARM 17.74.302(3). In addition, a person who inspects, plans, designs, supervises, contracts for or works on an asbestos project must meet DEQ training and accreditation requirements. See also Section 75-2-511, MCA. ARM 17.74.314 states that no person may engage in an asbestos-type occupation unless accredited in that occupation or may employ or subcontract with nonaccredited individuals or contractors. No person may conduct an asbestos abatement project without a permit.	Activities proposed in the this task work plan do not involve asbestos work.

APPENDIX B

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR SOIL VAPOR AND VAPOR INTRUSION SAMPLING
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.74.335 29 CFR 1926.58 40 CFR 763.120-121 40 CFR Part 61, Subpart M	ARM 17.74.335 states that asbestos abatement projects require a DEQ permit. The permit conditions include but are not limited to: a. a requirement that all work performed be in accordance with 29 CFR 1926.58 (asbestos standards for the construction industry); and 40 CFR 763.120, 121 (requirements for asbestos abatement projects); b. a requirement that all asbestos be properly disposed in an approved asbestos disposal facility. "Approved asbestos disposal facility" is defined at ARM 17.54.302(1) as a A9properly operated and licensed class II landfill as described in ARM 17.50.504; c. a requirement that asbestos be disposed in accordance with 40 CFR Part 61, Subpart M (National Emission Standard for Asbestos). See discussion above on National Emission Standard for Asbestos.	
ARM 17.74.338	ARM 17.74.338 requires an accredited asbestos abatement supervisor be physically present at all times at the work-site where a permitted asbestos abatement project is being performed and must be accessible to all workers. On-site air monitoring must be conducted by an accredited asbestos contractor/supervisor, an engineer or industrial hygienist.	
ARM 17.74.341	ARM 17.74.341 requires records of each asbestos abatement project be retained for a minimum of 30 years and must be made available to DEQ at any reasonable time. This section provides a noninclusive list of the records to be retained.	
40 CFR Part 92	Locomotive Emissions 40 CFR Part 92 establishes control of air pollution from locomotives and locomotive engines.	Activities proposed in the this task work plan do not involve the use of locomotives.

Notes:

(a) These ERCLs were developed by the Montana Department of Environmental Quality and were included in Appendix A of the *Record of Decision* (ROD) (DEQ 2001).

[1] *Montana Maximum Contaminant Levels:*
Pursuant to the Public Water Safety Act, 75-6-101 et. seq., MCA and ARM 17.38.204, the MCLs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are incorporated.

[2] *Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Circular WQB-7, Montana Numeric Water Quality Standards (September, 1999).*

[3] *For vinyl chloride, the WQB-7 standard is 0.15 µg/L.*

[4] *Each of the ambient air quality standards includes in its terms specific requirements and methodologies for monitoring and determining levels. Such requirements are also applicable requirements. In addition, ARM 17.8.204 and 17.8.206, Ambient Air Monitoring; Methods and Data, respectively (Applicable), require that all ambient air monitoring, sampling and data collection, recording, analysis and transmittal shall be in compliance with the Montana Quality Assurance Manual except when more stringent requirements are determined by DEQ to be necessary.*

[5] *ARM 17.50.530(1)(b) allows the department to approve an alternative final cover design if it achieves the reduction in infiltration and protection from erosion to a level at least as equivalent as the stated criteria.*

[6] *If a temporary controlled ground water area is granted, the statute requires DNRC to commence studies to determine the designation or modification of a permanent controlled ground water area.*

APPENDIX C

Radiello Passive Vapor Sampler

how does the diffusive sampler work?

The diffusive sampler is a closed box, usually cylindrical. Of its two opposite sides, one is "transparent" to gaseous molecules which cross it, and are adsorbed onto the second side. The former side is named diffusive surface, the latter is the adsorbing surface (marked with ***S*** and ***A*** in the figure).

Driven by the concentration gradient ***dC/dl***, the gaseous molecules cross ***S*** and diffuse towards ***A*** along the path ***l***, parallel to the axis of the cylindrical box. The molecules, which can be trapped by the adsorbing material, are eventually adsorbed onto ***A*** according to the equation:

$$\frac{dm}{dt} = D\,S\,\frac{dC}{dl} \qquad [1]$$

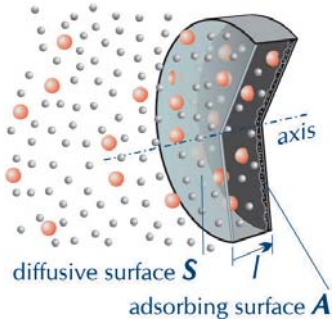
where ***dm*** is the adsorbed mass during time ***dt*** and ***D*** is the diffusion coefficient.

Let ***C*** be the concentration at the diffusive surface and C_0 the concentration at the adsorbing surface, the integral of [1] becomes

$$\frac{m}{t} = D\frac{S}{l}(C-C_0) \qquad [2]$$

If the concentration at the adsorbing surface is negligible, the equation can be approximated to

$$\frac{m}{t\,C} = D\frac{S}{l} = Q \quad \text{and then} \quad C = \frac{m}{t\,Q} \qquad [3]$$



In the diffusive sampler, the adsorbing and the diffusive surfaces are two opposing plane of a closed box. Driven by the concentration gradient, the gaseus molecules (coloured in the figure) pass through the diffusive surface and are trapped from the adsorbing surface.

Q is the ***sampling rate*** and has the dimensions of a gaseous flow (if ***m*** is expressed in µg, ***t*** in minutes and ***C*** in $\mu g \cdot l^{-1}$, ***Q*** is expressed in $l \cdot min^{-1}$).

Therefore, if ***Q*** is constant and measured, to calculate the ambient air concentration you need only to quantify the mass of analyte trapped by the adsorbing material and to keep note of the time of exposure of the diffusive sampler.

To improve the analytical sensitivity the collected mass ***m*** should be increased by enlarging ***Q***. As ***D*** is a constant term, one can only try to improve the ***S/l*** ratio, namely the ***geometrical constant*** of the sampler. Unfortunately, in the common axial simmetry sampler, if ***S*** is enlarged, the adsorbing surface ***A*** must be enlarged too, in order to keep the two parallel surfaces at a fixed distance. Since the analytes can be recovered from the axial sampler only by solvent extraction, any increase of ***A*** lead to a proportional increase of the extraction solvent volume, thus the improvement of ***Q*** is canceled out by the effect of dilution.

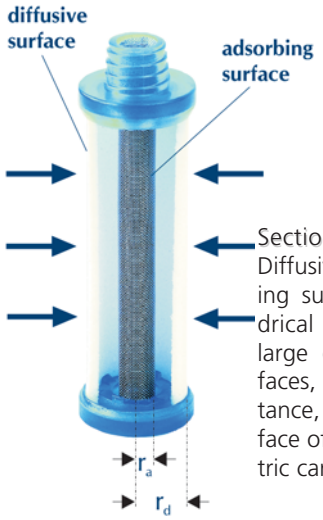
The value of distance ***l*** could also be reduced, but under the critical value of about 8 mm the diffusion law is no longer valid in the case of low air velocity values, since adsorption rate becomes higher than supplying rate of analyte molecules at the diffusive surface.

Cannot we improve ***Q*** then?

The answer is to improve the sampler geometry to a ***radial*** design.

From this idea the ***radiello*** sampler has been developed, its cylindrical outer surface acting as diffusive membrane: the gaseus molecules move axially parallel towards an adsorbent bed which is cylindrical too and coaxial to the diffusive surface.

When compared to the axial sampler, ***radiello*** shows a much higher diffusive surface without increase of the adsorbing material amount. Even if the adsorbing surface is quite smaller then the diffusive one, each point of the diffusive layer faces the diffusion barrier at the same distance.



Section of ***radiello***. Diffusive and adsorbing surfaces are cylindrical and coaxial: a large diffusive surface faces, at a fixed distance, the small surface of a little concentric cartridge.

As $S=2\pi rh$ (where h is the height of the cylinder) and the diffusive path is as long as the radius r, we can then express equation [1] as follows

$$\frac{dm}{dt} = D\,2\pi\,h\,r\,\frac{dC}{dr} \qquad [4]$$

The integral of equation [4] from r_d (radius of the diffusive cylindrical surface) to r_a (radius of the adsorbing surface) becomes

$$\frac{m}{t\,C} = D\,\frac{2\pi\,h}{ln\,\frac{r_d}{r_a}} = Q \qquad [5]$$

the ratio

$$\frac{2\pi\,h}{ln\,\frac{r_d}{r_a}}$$

is the geometrical constant of **radiello**. The calculated uptake rate [5] is therefore proportional to the height of the diffusive cylinder and inversely proportional to the logarithm of the ratio of diffusive *vs* adsorbing cylinder radii.

The microporous sintered polyethylene diffusive barrier of **radiello** photographed at the electrton microscope; the path length is much longer than the membrane thickness due to the tortuosity of the pores.

While r_a can be easily measured, r_d can only be calculated by exposure experiments. Actually the diffusive membrane has been designed with a thick tubular microporous layer. The actual diffusive path length is therefore much longer than the distance among the diffusive and adsorbing surfaces due to the tortuosity of the path through the pores. A diffusive cylinder of external diameter 8 mm, thickness 1.7 mm and average porosity of 25 µm, coupled to an adsorbing cartridge with radius 2.9 mm creates a diffusive path of 18 mm instead of the straight line path estimation of (8-2.9) = 5.1 mm.

The sampling rate Q is function of diffusive coefficient D, which is a thermodynamic property of each chemical substance. D varies with temperature (T) and pressure (p); therefore also the sampling rate is a function of those variables according to

$$Q = f\,(T, p)$$

Q values that will be quoted in the following have been measured at 25 °C and 1013 hPa. As a consequence, they should be corrected so as to reflect the actual sampling conditions.

The correction of Q for atmospheric pressure is usually negligible since its dependence is linear and very seldom we face variations of more than 30 hPa about the average value of 1013 hPa. In the worst case, if corrections for pressure are ignored you make an error of ±3%, usually it is within ±1.5%.

On the other hand, Q depends exponentially on temperature variations, therefore more relevant errors can be introduced if average temperature is significantly different from 25 °C. Moreover, when chemiadsorbing cartridge are used kinetic effects (variations of reaction velocities between analyte and chemiadsorbing substrate) can be evident, apart from thermodynamic ones (variation of D).

It is therefore very important to know the average temperature in order to ensure accuracy of experimental data. See how you can perform on-field temperature measurements on page B3.

Even if some cartridges adsorb large quantities of water when exposed for a long time in wet atmosphere, generally this does not affect sampling by **radiello**. Some consequences, neverthless, can sometimes be felt on the analysis. As an example, a very wet graphitised charcoal cartridge could generate ice plugs during cryogenic focusing of thermally desorbed compounds or blow out a FID flame.

It is therefore important to protect radiello from bad weather. See page B1 how this can be easily done.

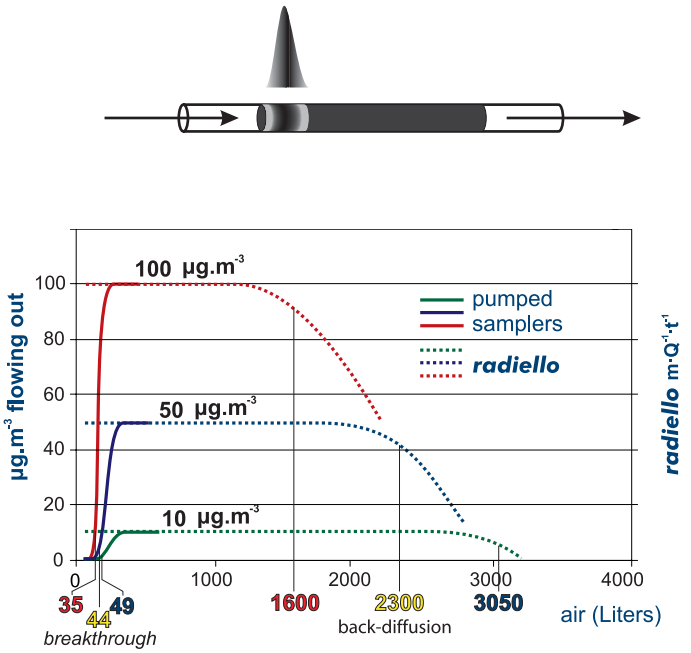
why is radiello so special?

The diffusive sampling does not involve the use of heavy and encumbering pumping systems, does not have energy power supply problems, does not require supervision, is noiseless, is not flammable and does not represent an explosion hazard, can be performed by everybody everywhere and with very low costs.

Moreover, it is not subject to the breakthrough problem, which can be serious when active pumping is performed.

In pumped sampling the adsorbed compound behaves as a chromatographic peak (top): air flow displaces it along the adsorbent bed and its concentration is distributed as a gaussian function. Eventually, the compound comes out from the opposite end. When its concentration in the outlet air is 10% of the concentration in the sampled air we say that the ***breakthrough*** *has been reached or, with a misleading expression, that the tube has been saturated. Any further pumping leads to a loss of analyte and a consequent underestimation of the environmental concentration. The extent of this phenomenon depends weakly on the concentration of target compound but rather on the value of air flow, the overall sampling volume and the chemical compound involved.*

In the graph the case of benzene is displayed, sampled at 25 °C onto an activated charcoal adsorbent bed of the same volume of a code 130 ***radiello*** *cartridge. The breakthrough is reached after 35, 44 or 49 liters of sampled air depending on benzene concentration in air (10, 50 or 100 µg·m^{-3} respectively).*



An apparently similar phenomenon is shown by ***radiello*** *also. In this case, however, we cannot speak of breakthrough, since no actual air flow is involved, but rather of* ***backdiffusion****. This consists of a decrease of the value of m·Q^{-1}·t^{1} (which is equal to the measured concentration, see eqn. [3] on page A1). This term is constant and equal to the actual concentration until the adsorbed mass of analyte is far from the maximum amount allowed by the adsorbing medium capacity. The extent of backdiffusion depends on concentration and exposure time but a decrease of 10% in the m·Q^{-1}·t^{1} term is observed along with equivalent sampling volumes of magnitude bigger than those seen before: 1600, 2300 and 3050 liters at the concentration of 10, 50 and 100 µg·m^{-3}.*

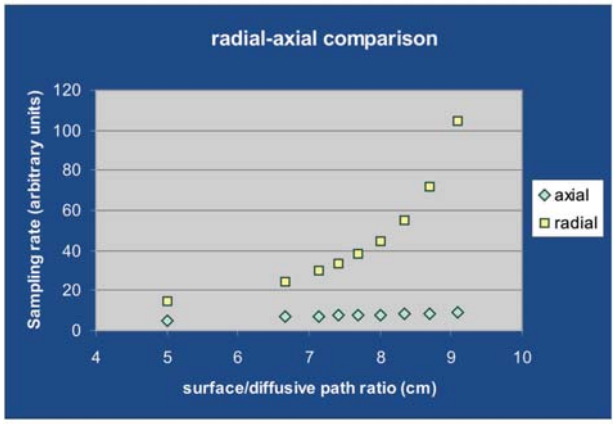
Why diffusive sampling has not been so extensively adopted up to now?

This is due to the fact that the traditional axial symmetry sampler has generally poor sensitivity and reproducibility because of the limits set by its geometry. On one side, uptake rate values are generally low, on the other, they often vary depending on environmental conditions.

These limitations have been overcome by ***radiello***.

By virtue of radial symmetry, uptake rate is:

✓ **high**, since it does not vary linearly but exponentially with the ratio diffusive surface ***vs*** diffusive path length (see eqn. [5]). With the same dimensions, radiello's uptake rate is at least three times higher than that of any axial diffusive sampler;



For a traditional axial symmetry sampler the uptake rate increases linearly with tha ratio of diffusive surface vs diffusive path length, while for the radial simmetry sampler, the corresponding increase is exponential. This means that, let the diffusive surface vs diffusive path length ratio be 8:1, for the axial sampler the uptake rate value is 8 (regardless of dimensions) while for the radial one it is 45.

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- ✓ **constant**, due to the great adsorbing capacity of the adsorbing cartridge;
- ✓ **reproducible**, by virtue of the stiffness of the diffusive membrane and the cartridge and of the close tolerances characterizing all the components of ***radiello***;
- ✓ **invariable with air speed**, due to the tortuosity of the diffusive path inside the microporous diffusive cylindrical surface;
- ✓ **precisely measured**, because it is not calculated but experimentally measured in a controlled atmosphere chamber in a wide range of concentration, temperature, relative humidity, air speed conditions and with or without interferents....

Moreover, ***radiello***

- ▶ able to work properly also with bad weather conditions due to the water-repellent diffusive body
- ▶ has blank values lower than three times the instrumental noise due to the complex conditioning procedures of the bulk adsorbing (or chemiadsorbing) materials and to the repeated quality controls along the whole production
- ▶ has low detection limits and high adsorbing capacities that allow exposure time duration from 15 minutes to 30 days and concentration measurements from 1 ppb to over 1000 ppm
- ▶ offers high precision and accuracy over a wide range of exposure values

- ▶ allows thermal desorption and HRGC-MS analysis without interferents
- ▶ is suited to the sampling of a vast range of gaseous pollutants
- ▶ is though and chemically inert, being made of polycarbonate, microporous polyethylene and stainless steel
- ▶ is indefinitely reusable in all of its components apart from the adsorbing cartridge; the latter can be recovered if thermal desorption is employed
- ▶ it comes from the efforts of one of the main European scientific research institutions that produces it directly by high technology equipment and continuously submits it to severe tests and performs research and development in its laboratory in Padova

All the images in the manual concern the Environmental Research Center of Padova of the Fondazione Salvatore Maugeri-IRCCS

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the components of radiello

The essential parts of ***radiello*** are the adsorbing cartridge, the diffusive body, the supporting plate and the adhesive label with the bar code indication. Apart from the adsorbing cartridge, if not differently stated, all of the other components can be repeatedly used for several sampling experiments.

The adsorbing cartridge

Depending on the polluting compound to be sampled, many different adsorbing or chemiadsorbing cartridges have been developed. Their dimensions are neverthless the same for all: 60 mm length and 4.8 or 5.8 mm diameter.

They are contained in glass or plastic tubes wrapped up in a transparent polyethylene thermowelded bag.

The code number, printed onto the bag along with the lot number and expiry date indicates the kind of cartridge.

Apart from the thermal desorption cartridges, all of the other kinds are for single use only. See the application section at the back for codes relevant to the different analytes.

Available in 20 pieces per package.

The cartridge has to be introduced into the diffusive body.

The supporting plate

It is identified by the **code 121**. Made of polycarbonate, it acts both as closure and support for the diffusive body, which has to be screwed onto the thread. It comes along with a clip and a transparent adhesive pocket to hold the label. The three parts are to be assembled before use (see page A6).

Available in 20 pieces per package.

code 121

The diffusive body

Four kinds of diffusive bodies are available, with like outer dimensions: 60 mm height and 16 mm diameter.

The **white** diffusive body, **code 120**, of general use, is made of microporous polyethylene 1.7 mm thick and average porosity 25 ± 5 µm. Diffusive path length is 18 mm.

The **blue** diffusive body, **code 120-1**, has the same properties of the white one but is opaque to light: it is suited to the sampling of light-sensitive compounds.

The **yellow** diffusive body, **code 120-2**, should be used whenever the sampling rate must be reduced; it is made of microporous polyethylene 5 mm thick and average porosity 10 ± 2 µm. Diffusive path length is 150 mm.

The **permeative** diffusive body, **code 120-3**, is a 50 µm thick silicone membrane strengthened by a stainless steel net and a microporous polyethylene cylinder. It is employed for anaesthetic gases and vapours sampling.

Available in 20 pieces per package.

The diffusive body has to be screwed onto the supporting plate.

code 120 **120-1** **120-2** **120-3**

code 190

The label

Self-adhesive, with printed barcode number. Since each barcode number has been printed in only one copy, it allows an unmistakable identification of the sampling tube on field and in the laboratory for the subsequent analysis.

Each package of 20 adsorbing cartridges contains also 21 labels.

If the labels are ordered separately, they are shipped in 198 pieces per package.

how to use *radiello*

before sampling

assembling the supporting plate

Before using ***radiello***, you have to assemble the supporting plate with the clip, necessary to suspend it, and the adhesive label pocket.

insert the clip strip in the slot, with the peg facing upwards

ply the strip and insert the peg into the hole

peel off the transparent pocket

user tip

Assemble the supporting plate in your laboratory before the sampling campaign to save time in the field

and place it onto the plate in a central position; if you prefer, the pocket can be applied to the rear of the plate, but **BE CAREFUL**, always with the label insertion slot on the side (otherwise, if it starts raining the label can get wet)

on-field
to start the sampling

open the plastic bag, draw the cartridge out from the tube and put it in the diffusive body. ***Keep the glass or the plastic tube and stopper in the original plastic bag.***

The lower part of the diffusive body holds a seat for the central positioning of the cartridge. **A correctly centered cartridge should not stick out even by half a millimeter. If it does, the cartridge is not correctly positioned and out of axis.**
BE CAREFUL: do not hold the diffusive body horizontally when you screw it onto the plate, otherwise the cartridge could come out from its seat and stick out.
As a consequence, when the diffusive body is screwed onto the supporting plate the cartridge is bent, the geometry of the sampler is disturbed and the results obtained become unreliable. ***To place the cartridge centrally you need only to tap on the diffusive body.***

Insert a label in the pocket without peeling it off. Keep note of the date and time and expose ***radiello***. Sampling has started.

Keeping the diffusive body in a vertical position, to screw it onto the support plate

user tip

Do not touch the cartridge with your fingers if possible, particularly if it is impregnated with reactive

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user tip

even if you can write date and time of the sampling start and end on the adhesive label, we suggest you to keep note of these parameters also separately: after a week exposure with bad weather conditions,

your writing might have become illegible!

DO NOT USE MARKER PENS to write on the label: they contain solvents that are sampled by ***radiello***!

after the sampling

Keep note of the date and time of the end of exposure.

Place the cartridge into the tube, peel off the label and stick it onto the tube **such that the barcode is parallel to the axis of the tube.**

If you have performed the sampling of different polluting compounds at the same time, ***BE CAREFUL NOT TO MIX UP THE TUBES***: place the exposed cartridge in its original tube, identified by the code printed on the plastic bag.

IMPORTANT

Always stick the label such that the barcode is parallel to the axis of the tube: any other position will compromise the barcode automated reading by the optic reading device.

radiello maintenance

When exposed outdoors or in a workplace environment, the diffusive body may get dirty from airborne dust. Fine particles (PM_{10}) are especially harmful to yellow diffusive bodies since they can obstruct the pores. When the diffusive bodies are dirty you can wash them as follows.

Immerse the diffusive bodies in a beaker with a soapy solution (e.g. dish detergent) and sonicate them for 20 minutes. As the diffusive bodies float, you may make them sink by putting a smaller beaker on them, with water inside enough to dip it a few centimeters. Rinse the diffusive bodies with plenty of water and then deionized water; let them finally dry in the air.

IMPORTANT: NEVER USE SOLVENTS TO CLEAN THE DIFFUSIVE BODIES!!!

After four or five washings, diffusive bodies need to be replaced: repeatedly adsorbed dust may have penetrated the so deeply that they cannot be removed by washing anymore.

The following table shows the advised washing schedule:

PM_{10} concentration ($\mu g \cdot m^{-3}$)	<30	40	>50
Washing after days of exposure	45	30	15

accessories for *radiello*

vertical adapter

code 122

The diffusive body can be fitted to the supporting plate either in a vertical or horizontal position, the vertical one being more comfortable when ***radiello*** is used for personal sampling.

To assemble ***radiello*** in vertical position you have to screw it to the **vertical adapter code 122**, fitted to the supporting plate.

Available in 20 pieces per package

code 122

Assembeling the vertical Adapter

place the vertical adapter over the mounting point on the plate

The adapter can be removed from the plate by lifting the ridge

press the adapter onto the plate with your thumbs till the ridge fits the edge of the plate.

IMPORTANT

when mounting the diffusive body be careful to keep it vertical with the thread upside (see page A6).

shelter

code 196

For outdoor exposures a mountable polypropylene shelter is available which can be hung from lamp posts.

It has been designed to be mounted easily and without any tools on field, so that it is not cumbersome when you transport it from your laboratory. Once assembled, it ensures the best compromise between protection against bad weather and ventilation.

It can house up to four ***radiello*** and is able to fit a wide range of pole diameters.

Its colour is quite similar to that of the majority of lampposts: being less visible, it is less subject to acts of vandalism.

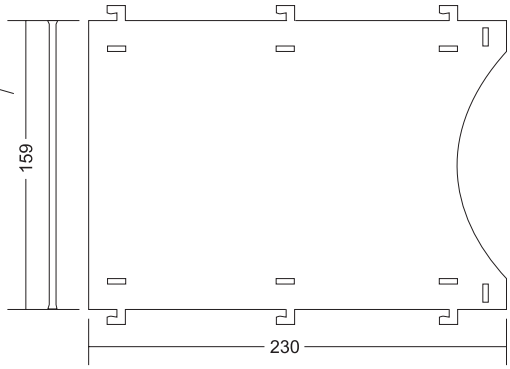
Available in 10 pieces per package

how to assemble the shelter

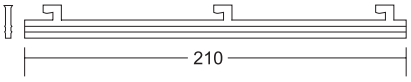
All of the components are snap-on assembled.

The shelter is composed of:

One of the three equivalent panels will act as the roof of the shelter (dimensions in mm)

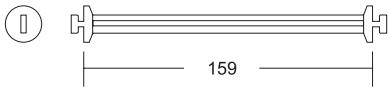


the two supports where to suspend ***radiello***



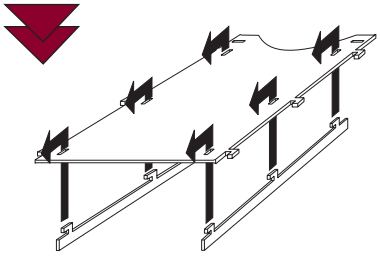
two spacers

two strips shown below left

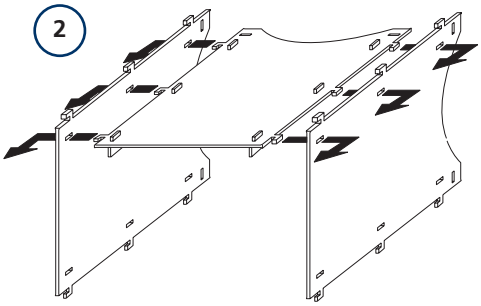


1

First of all, insert on this panel (the roof) the two supports that will be used to suspend the samplers.



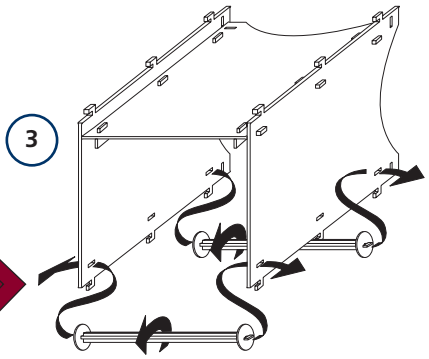
2



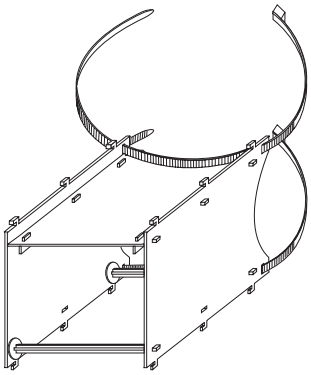
Then fix the two walls on the sides of the roof panel.

3

The whole becomes rigid by insertion of the two spacers. Fit them to the slots on bottom of the side panels and turn them by 90° (performing this rotation you may feel some resistance, but go on until you hear a clicking sound).



4



Finally, insert two plastic strips in the rear vertical slots of the side panels. The **strips** are also available as spare parts, in 100 pieces per package, identified by the **code 198**.

Suspend the shelter to the pole by closure of the strips, but ***DO NOT DRAW SO MUCH THAT THE SHELTER IS DEFORMED***. If the pole has diameter larger than 20 cm, the shelter leans on the curved edges on the rear of the sidewalls. If the pole has a smaller diameter, it leans against the curved edge of the roof panel and the rear spacer. If the diameter of the pole is very small the shelter bows down, the wind may make it go round, or the shelter may even slip down to ground. It is then advisable to choose another pole.

user tip

If the pole diameter is larger than the strip length, you can put two or more strips together to extend the fastening system. If the sampling site is very windy, do not introduce more than two ***radiello*** samplers in each shelter, otherwise rain could dampen the outermost samplers.

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Volatile organic compounds (VOCs)

chemically desorbed with CS_2

Radiello components to be used:

White diffusive body code 120
Supporting plate code 121
Vertical adapter code 122 (optional)
Adsorbing cartridge code 130

Or: *radiello*-*ready-to-use* code 123-1 (also see page A8)

Principle

Code 130 cartridge is a stainless steel net cylinder, with 100 mesh grid opening and 5.8 mm diameter, packed with 530 ± 30 mg of activated charcoal with particle size 35-50 mesh. Volatile organic compounds are trapped by adsorption and recovered by carbon disulfide displacement, analysis is performed by FID gas chromatography.

Sampling rates

The table on page D2 lists sampling rate values at 298 K (25 °C) and 1013 hPa, experimentally measured in a standard atmosphere chamber. For other compounds, whose diffusion coefficient[1] is known, sampling rate can be calculated according to equation [5] on page A2, taking into account that white diffusive body and code 130 cartridge give the geometric constant of radiello the value of 14.145 ± 0.110 cm. Several experiments performed in the standard atmosphere chamber demonstrate that the calculated sampling rates seldom deviate by more than ± 10% from the experimentally measured values.

Effect of temperaure, humidity and wind speed

Sampling rates varies from the value at 298 K on the effect of temperature (in Kelvin) as expressed by the following equation

$$Q_K = Q_{298} \left(\frac{K}{298}\right)^{1.5}$$

where Q_K is the sampling rate at the temperature **K** and Q_{298} is the reference value at 298 K. This produces a variation of ± 5% for 10 °C variation (upwards or downwards) from 25 °C.

Sampling rate is invariant with humidity in the range 15-90% and with wind speed between 0.1 and 10 $m \cdot s^{-1}$.

[1]Lugg G.A.: Diffusion Coefficients of Some Organic and Other Vapours in Air. ***Anal. Chem***. **40-7**:1072-1077 (1968).

Calculations

The listed sampling rate values already take into account for the desorption efficiency with carbon disulfide. **The average concentration over the exposure time interval is therefore calculated from the mass of analyte found onto the cartridge and exposure time <u>without introducing any corrective factor</u>**, apart from corrections due to average temperature different from 25 °C.

Average concentration over the whole exposure time is calculated according to the following expression

$$C\ [\mu g \cdot m^{-3}] = \frac{m\ [\mu g]}{Q_K\ [ml \cdot min^{-1}] \cdot t\ [min]}\ 1{,}000{,}000$$

where:
m = mass of analyte in µg
t = exposure time in minutes

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Sampling rate values Q at 25°C (298 K)

	Q_{298} ml·min^{-1}	linearity range µg·m^{-3}·min	uncertainty at 2σ %	notes
acetone	77	10,000-600·10^6	7.0	**a**
acetonitrile	73	10,000-6·10^6	8.2	**b**
acrylonitrile	75	1,000-50·10^6	2.2	
benzyl alcohol	37	1,000-800·10^6	6.5	
amyl acetate	52	1,000-800·10^6	3.4	
benzene	80	500-500·10^6	1.8	
bromochloromethane	70	50,000-1,000·10^6	1.4	
butanol	74	1,000-500·10^6	5.0	
sec-butanol	64	1,000-300·10^6	5.2	
tert-butanol	62	1,000-300·10^6	5.5	
butyl acetate	60	1,000-1,000·10^6	3.0	
2-butoxyethanol	56	1,000-100·10^6	5.7	
2-butoxyethyl acetate	41	1,000-100·10^6	5.5	
carbon tetrachloride	67	100,000-60·10^6	9.0	
cyclohexane	54	500-500·10^6	4.5	
cyclohexanone	68	5,000-120·10^6	4.2	
cyclohexanol	54	5,000-120·10^6	4.5	
chlorobenzene	68	1,000-1,000·10^6	3.6	
chloroform	75	100,000-60·10^6	9.7	**a**
n-decane	43	500-1,000·10^6	1.1	
diaceton alcohol	43	500-1,000·10^6	4.5	
1,4-dichlorobenzene	51	1,000-1,000·10^6	7.7	
1,2-dichloroethane	77	1,000-500·10^6	8.2	
1,2-dichloropropane	66	500-250·10^6	4.5	
dichloromethane	90	500-60·10^6	8.7	
N,N-dimetylformamide	82	1,000-200·10^6	14.5	**c**
1,4-dioxane	68	1,000-600·10^6	5.5	
n-dodecane	8	1,000-1,000·10^6	4.7	
n-heptane	58	5,000-1,500·10^6	3.0	
n-hexane	66	1,000-1,000·10^6	2.5	
1-hexanol	52	5,000-120·10^6	5.5	
ethanol	102	10,000-500·10^6	7.5	**a-b**
diethyl ether	78	5,000-500·10^6	12.0	**a**
ethyl acetate	78	1,000-1,000·10^6	1.5	
ethylbenzene	68	1,000-1,000·10^6	2.4	
2-ethyl-1-hexanol	43	5,000-500·10^6	10.1	
2-ethoxyethanol	55	500-50·10^6	6.7	**b**
2-ethoxyethyl acetate	54	10,000-100·10^6	2.5	
ethyl-***tert***-butyl ether (ETBE)	61	500-200·10^6	3.0	
isobutanol	77	1,000-300·10^6	2.5	
isobutyl acetate	63	1,000-1,000·10^6	5.2	
isooctane	55	500-1,000·10^6	3.2	
isopropanol	52	10,000-400·10^6	12.0	**b**
isopropyl acetate	66	1,000-1,000·10^6	9.9	
isopropylbenzene	58	1,000-1,000·10^6	2.7	
limonene	43	1,000-1,000·10^6	10.0	
methanol	125	10,000-250·10^6	9.2	**a-b**
methyl acetate	80	1,000-1,000·10^6	12.0	
methyl-***ter***-butyl ether (MTBE)	65	500-200·10^6	2.5	

	Q_{298} ml·min^{-1}	linearity range µg·m^{-3}·min	uncertainty at 2σ %	notes
methylcyclohexane	66	1,000-1,000·10^6	6.5	
methylcyclopentane	70	1,000-1,000·10^6	2.5	
methylethylketone	79	1,000-500·10^6	1.6	
methylisobutylketone	67	1,000-250·10^6	8.7	
methyl metacrylate	68	1,000-500·10^6	2.5	
2-methylpentane	70	1,000-1,000·10^6	2.5	
3-methylpentane	70	1,000-1,000·10^6	2.5	
2-methoxyethanol	35	5,000-100·10^6	11.0	**b**
2-methoxyethyl acetate	56	2,000-100·10^6	3.0	
1-methoxy-2-propanol	55	1,000-350·10^6	6.0	
1-methoxy-2-propyl acetate	60	2,000-350·10^6	6.2	
naphthalene	25	1,000-1,000·10^6	7.0	
n-nonane	48	1,000-1,000·10^6	5.4	
n-octane	53	500-1,000·10^6	3.2	
pentane	74	1,000-1,000·10^6	1.9	
α-pinene	53	1,000-1,000·10^6	7.0	
propyl acetate	65	500-1,000·10^6	7.5	
propylbenzene	57	1,000-1,000·10^6	2.9	
styrene	61	1,000-500·10^6	3.0	
tetrachloroethylene	59	10,000-500·10^6	2.5	
tetrahydrofuran	74	2,000-250·10^6	11.0	**b**
toluene	74	500-1,000·10^6	1.5	
1,1,1-trichloroethane	62	5,000-1,000·10^6	5.5	
trichloroethylene	69	5,000-1,000·10^6	2.4	
1,2,4-trimethylbenzene	50	500-1,000·10^6	6.6	
n-undecane	24	1,000-1,000·10^6	10.0	
m-xylene	70	500-1,000·10^6	2.5	
o-xylene	65	500-1,000·10^6	2.5	
p-xylene	70	500-1,000·10^6	2.5	

Notes:

a = weakly adsorbed compound. If its concentration is higher than the TLV for the workplace environments it may be partially displaced by other compounds that are more strongly trapped if their concentration is also high. If this is the case, it is advisable to reduce sampling time under 8 hours.

b = prolonged exposure of charcoal cartridges at relative average humidity higher than 80% causes adsorption of up to 100 mg of water. Water does not interfere with adsorption mechanisms but is displaced by carbon disulfide and gives raise to a separate layer. Some very water soluble polar compounds will distribute between the two solvents, thus provoking an underestimation of the actual air concentration since only the carbon disulfide is injected in the gas chromatograph. When the concentration of polar compounds has to be determined, the calibration curve should be prepared by spiking 50 µl of water in each tube containing the cartridge and the 2 ml of carbon disulfide standard solution (see Analysis).

c = better reproducibility obtained by use of methanol as extraction solvent instead of carbon disulfide.

Limit of quantitation

The limit of quantitation depends on the instrumentation and on the analytical conditions. The minimum revealable environmental concentration can be estimated on the basis of the equation on page D1, where ***m*** is the minimum revealable mass, experimentally measured for each compound. Under the analytical conditions described on page D4, the limit of quantitation for 7 days exposure usually ranges from 0.05 to 1 µg·m^{-3}, depending on the compound.

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Exposure

Code 130 cartridge has a very large loading capacity: about 80 mg, corresponding to an overall VOCs concentration of 3,000-3,500 mg·m^{-3} sampled for 8 hours or 70,000-80,000 µg·m^{-3} sampled for 14 days. Neverthless, if the quantified overall adsorbed mass should be near 80 mg, sampling rate could have deviated from linearity. If this is the case, it is advisable to repeat the sampling experiment reducing exposure time.

Workplace environment

In workplace environments complex mixtures of airborne solvent vapours are often found at concentrations of 2,000-3,000 mg·m^{-3}. The outstanding adsorbing capacity of code 130 cartridges allows you to sample them for the whole working shift of 8 hours. On the other hand, the very high values of sampling rates for a variety of compounds allow you to perform accurate concentration measurements even after very short exposures. For example, 15 minutes are enough to measure 0.1 mg·m^{-3} of benzene.

radiello can therefore be employed to evaluate both *TWA* and *STEL* concentrations.

Other indoor sampling experiments and outdoor campaigns

High sampling rates of ***radiello*** ensure very low limits of detection also for short exposure time intervals. For example, you may measure benzene concentrations as low as 2 µg·m^{-3} with an error not exceeding 4% after 8 hours of exposure. If ***radiello*** is exposed for 7 days, limit of quantitation becomes 0.1 µg·m^{-3}.

Generally speaking, we suggest exposure time duration ranging from 8 hours to 30 days, the ideal value being 7 days.

Storage

The activated charcoal cartridges have undergone a complex conditioning process that ensures an outstanding chromatographic blank level, never exceeding three times the instrumental noise of a FID detector at the lowest attenuation.

Kept in a cool place and away from volatile organic compounds, the cartridges mantain unchanging blank level and adsorbing capacity for at least two years. Expiry date and lot number are printed onto the plastic bag wrapping each cartridge: its integrity stands as warranty seal.

After exposure the cartridges, well capped and kept in a cool and solvent-free place, mantain their content unalterated for at least six months.

Analysis

Extraction

Introduce 2 ml of CS_2 and 100 µl of internal standard solution (see next page) directly in the ***radiello*** glass tube without drawing out the cartridge. **Always use class A volumetric pipettes or dispensers.** Stir from time to time for 30 minutes. If analysis is not performed soon after, draw out the cartridge and discard it.

Calibration

Outdoor environment sampling

If benzene, toluene, ethylbenzene and xylenes (BTEX) have to be analyzed, prepare three or four standard solutions in CS_2 having decreasing concentrations of the analytes in the following ranges (in mg·l^{-1}):

benzene	0.04-17.6	ethylbenzene	0.04-17.7
toluene	0.09-34.8	m-xylene	0.04-17.2
o-xylene	0.04-17.6	p-xylene	0.04-17.2

It is advisable to proceed via consecutive dilutions, starting for example from a stock solution containing 1 ml of each compound in 100 ml. Always use class A volumetric glassware. Introduce 2 ml of each standard solution, along with 100 µl of internal standard, onto a blank code 130 cartridge in its glass tube.

IMPORTANT

always use high purity grade CS_2, for example Fluka Cat. No. 84713 or Aldrich Cat. No. 34,227-0

BE CAREFUL

even refrigerated, CS_2 permeates the tube plastic cap: its volume decreases by 4-5% a day. If the internal standard has been added, it is only matter of unpleasant odour...

Analysis of unknown samples

Identify the sample that has been exposed for the longest time or at the highest expected concentration. Introduce 2 ml of CS_2 but do not add the internal standard, stir and let the sample stand for 30 minutes. Without discarding the cartridge, inject the CS_2 solution in the gas chromatograph with FID detector (see below), identify the compounds appearing in the chromatogram and make an estimation of the order of magnitude of their concentrations.

USER TIP

For a very accurate calibration we offer the **preloaded cartridges code 405** (outdoor environment) and **code 406** (workplace environment).

Prepare a CS_2 solution of the identified compounds with doubled concentration with respect to the sample. Dilute this solution in order to obtain standard solutions of concentration respectively about 0.1, 0.5 and 1 times the concentration estimated in the sample. Introduce 2 ml of each standard solution onto a blank code 130 cartridge in its glass tube, along with the chosen internal standard solution.

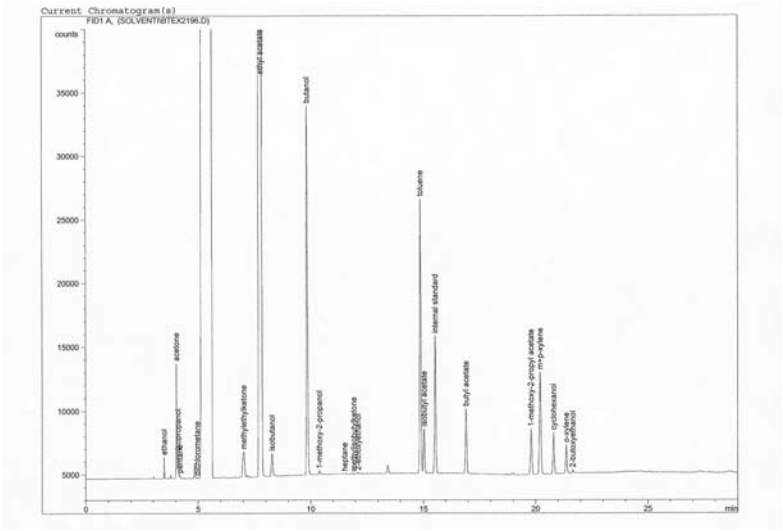
The chosen **internal standard** should have a retention time that does not interfere with other compounds in the chromatogram. Compatibly with this requirements, we suggest to employ a solution of **2-fluorotoluene** (e.g. Aldrich F 1,532-3 or Fluka 47520) in CS_2 with concentration of 100 $\mu l \cdot l^{-1}$ for outdoor samples and 2 $ml \cdot l^{-1}$ for workplace samples. Add 2 ml of CS_2 and the internal standard to all of the samples, stir, let the samples stand for 30 minutes and discard the cartridges prior to the analysis.

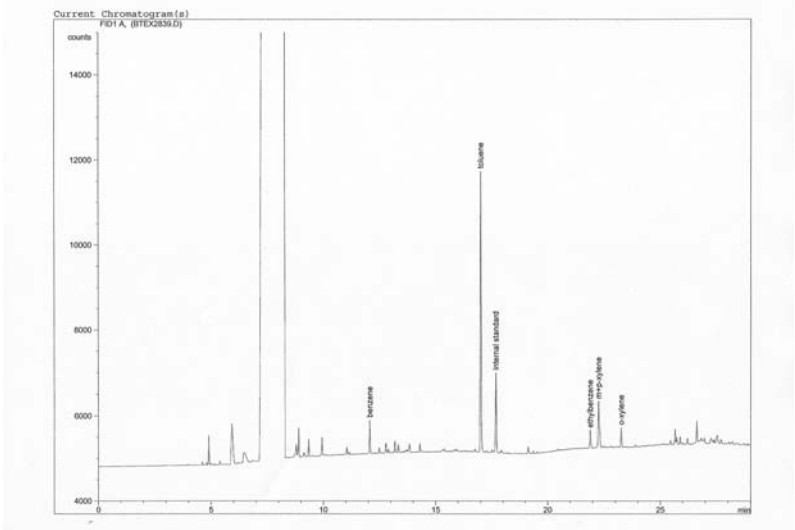
Instrumental analysis (advised)

Capillary gas chromatography with FID detection

outdoor environment samples: 100% dimethylpolysiloxane column 50m x 0.2mm, film thickness 0.5 µm; (e.g. Petrocol DH 50.2, Supelco Cat.No. 24133-U) split injection of 2 µl; split ratio 25:1; nitrogen carrier gas at constant pressure of 20 psi; injector temperature 240 °C; oven initial temperature 35 °C for 5 minutes, 5 °C/min up to 90 °C, maintain for 3 minutes, 10 °C/min up to 220 °C, final isotherm for 5 minutes.

workplace samples: 100% dimethylpolysiloxane column 0.2 mm·50 m, film 0.5 µm; split injection of 3 µl, split ratio 100:1; carrier N_2 at constant pressure of 20 psi; injector temperature 240 °C; oven initial temperature 50 °C for 5 minutes, 5 °C/min up to 80 °C, 15 °C/min up to 135 °C, 20 °C/min up to 220 °C, final isotherm 10 minutes. Total time: 29 minutes. The retention times for several compounds analyzed under the described conditions are listed in the table on next page.





On top: *FID chromatogram of a real workplace sample*

on the left: *chromatogram of a real urban outdoor sample*

USER TIP

If you perform several analyses, a barcode reader will greatly improve productivity in your laboratory and will also minimize the possibility of errors in the copying of sample labels.

Please contact us to help you in the implementation of the reader.

We have also developed software solutions for the analytical data processing and automated production of analysis reports.