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GENERAL GUIDELINES FOR THE OPERATION OF A SOIL TREATMENT FACILITY TO BIOREMEDIATE PETROLEUM CONTAMINATED SOILS FROM MULTIPLE SOURCE SITES, AND SUMP SOLIDS FROM VEHICLE SERVICE SHOPS AND CAR WASHES

In an effort to provide legal and environmentally sound mechanisms for the remediation of contaminated soils from multiple sources, the Solid Waste Section (SWS) has prepared the following guidelines for the operation of a Solid Waste Management System Soil Treatment Facility. The Soil Treatment Facility (STF) must be approved by the SWS through an application procedure to license the facility. The license application review process includes a 30-day public comment period, and the preparation of either an Environmental Assessment or an Environmental Impact Statement. STF's can be licensed as a free standing solid waste operation, or as a component to an existing licensed Class II Solid Waste Landfill.

Section 75-10-221(1), Montana Code Annotated (MCA), states that "No person may dispose of solid waste or operate a solid waste management system without a license from the department". Section 75-10-115, MCA, requires that fees be collected to apply for a solid waste management system, and for the annual license to operate a solid waste management system.

Petroleum contaminated soils and sump solids from vehicle service centers and car washes that are not RCRA listed or characteristic hazardous waste, are regarded as Group II solid waste. Storage, treatment, recycling, recovery or disposal of solid wastes are regarded as solid waste management systems and are therefore required to be licensed by the State of Montana. The agency directed to license solid waste management systems is the Montana Department of Environmental Quality, Permitting and Compliance Division, Solid Waste Section. Soil Treatment Facility license applications can be obtained from the Solid Waste Section at 1520 E. 6th Ave., P.O. Box 200901, Helena, Montana 59620-0901. (406-444-5300)

Additional guidelines for licensing and operating a Solid Waste Management System (SWMS) Soil Treatment Facility are specified in the SWMS Soil Treatment Facility license application, the Solid Waste Management Act (Section 75-10-201, et seq., MCA), and Title 17, Chapter 50 of the Administrative Rules of Montana (ARM). Other requirements* may be imposed by the Department, if necessitated by the site-specific characteristics of the proposed facility.

Thermal soil treatment facilities will be required to obtain all other necessary Permitting and Compliance Division permits (406) 444-0286.

For information regarding the landfarming of fuel contaminated soils from underground storage tank sites, with a volume less than 1,600 cubic yards, for a one-time basis only, contact the Remediation Division, Petroleum Release Section at 841-5000.

Non-Underground Storage Tank Program related contaminated soils, that will undergo remediation through land application at a one-time only landfarm can contact the Solid Waste Section for guidance at 444-5300.

For information on landfarming or land application of domestic wastewater sludges, contact the Prevention, Planning, and Assistance Division at (406) 444-5321.

**SPECIFIC REQUIREMENTS MAY BE DETERMINED BY THE SITE ENVIRONMENTAL REVIEW*

Solid Waste Management Soil Treatment Facilities are evaluated on a case-by-case basis, taking into account the volume and type of contaminated soils they will receive, the acreage they impact, and the type of remediation technology utilized. It is possible to combine different remediation technologies under one STF license as long as the operations of each are addressed in the operation and maintenance plan for the proposed facility. Remediation technologies applicable to this guidance include solid phase bioremediation employed through landfarming, biopile and compost (soil heap) management. STF's may be required to document the treatability of a particular contaminant when proposing bioremediation as a treatment tool.

STF's that will landfarm only petroleum contaminated soils with total volumes between 500-1,600 yd^3 can be licensed as minor landfarms. Landfarms proposing to land apply larger volumes of petroleum contaminated soils as well as sump solids, crude oils, tank sludges, or unknowns will have to be licensed as intermediate or major landfarms. These landfarms will undergo stricter siting requirements and must have waste cell segregation for the different waste streams. Soil heaps require less land surface area than landfarms, therefore soil treatment facilities using soil heap technology will be categorized solely on the basis of waste material volume managed.

STF's are broken down into the three categories shown in Table I.

TABLE I: SOIL TREATMENT FACILITY CATEGORY

STF Category	**Total Acreage**	**Contaminated Soil Volume*[1]**		
		6-inch till	**12-inch till**	**Soil Heap**
Minor	2 Acres	1,600 yd^3	3,200 yd^3	
Intermediate	2 – 5 Acres	>3,200 yd^3	8,000 yd^3	8,000 yd^3
Major	> 5 Acres	*[2]	>8,000 yd^3	>8,000 yd^3

*1 Represents Approximate Maximum Volume Under Remediation At One Time.

*2 1 Acre of Land Can Support Approximately 806 yd^3 of Contaminated Soil

(Depending on the extent of contamination and soil characteristics of the landfarm site, 806 cubic yards may not be an absolute).

The licensed landfarm acreage will be dependent on the amount of land needed to effectively spread and manage the amount of contaminated soils anticipated at the solid waste management system. For example: If the licensed STF landfarm operator wants to landfarm 1,000 cubic yards (X) of contaminated soil spread at 6 inches (Y) deep, what square footage of land (Z) would be needed?

We know that 1 cubic yard (yd^3) = 27 cubic feet (ft^3); therefore [(X yd^3) x (27 ft^3) divided by (Y) = (Z ft^2)]

If: X = 1,000 and Y = 6 inches (.5 foot); then, [(1,000 yd^3) x ($\frac{27\ ft^3}{}$)] / .5 ft = 54,000 ft^2

An acre of land equals 43,560 ft^2. 54,000 ft^2 of contaminated soil divided by 43,560 ft^2 means that 1.24 acres would be required for the treatment cell. The dimension of the cell to handle 1,000 yd^3 of contaminated soil laid down at a depth of 6 inches can be determined by taking the square root of (Z), or in the case of our example, the square root of 54,000 ft^2 equals ~232 ft by 232 ft.

TABLE II: SOIL TREATMENT FACILITY LICENSE FEES*[1]

STF CATEGORY	APPLICATION REVIEW FEE*[2]	ANNUAL LICENSE FEE*[3]
Minor	$1,200.00	$ 600.00
Intermediate	$2,400.00	$1,200.00
Major	$3,600.00	$1,800.00

*[1] Fees for free standing commercial soil treatment facilities are as listed in Table II. Licensed Class II landfills seeking to add soil treatment as a component of the solid waste management system must file an application to amend the existing license, and pay an application review fee of $500.00. The licensed Class II landfill already pays an annual license fee, therefore no additional annual fee is required for adding a STF to the license.

*[2] The application review fee can be submitted along with the STF application, or is due within sixty days of receipt of the application. Applicants who fail to meet the deadline for review fees may have their application considered null and void. This fee is good for the life of facility barring substantial change or expansion to the proposed license area.

*[3] The annual license fee can be paid quarterly starting when the license is granted.

I. SITE SELECTION AND PREPARATION

*The **treatment cell** at the soil treatment facility is the prepared area where the waste is undergoing remediation. The **treatment zone** is the area within the treatment cell that is being managed to promote biodegradation of individual incoming waste streams. **Below treatment zone** (BTZ) is the area within the treatment cell directly underlying the lowest area of applied waste in the treatment zone.*

1) Treatment cells must be located out of zoned residential areas and more than 1,000 feet away from domestic wells. Designated flood plains, areas within 100 feet from the edge of surface waters, areas within 100 feet from the centerline of an intermittent drainage, and locations where ground water is less than 25 feet below ground surface will not be considered for an approved site. It is preferable that the soil treatment area itself has a slope no greater than 0.5 to 1.0% in order to prevent significant erosion from rainfall or irrigation. However, sites may be evaluated on a case by case basis.

2) Areas containing permeable soil and subsoil (i.e. sands, gravels and cobbles) should be avoided. The soil below the treatment zone (BTZ) should not exceed a permeability of 1×10^{-5} cm/sec for a depth of at least 3 feet. If these conditions cannot be met, additional site preparation such as composite or synthetic liners may be necessary.

3) The STF may either till the incoming solid waste into the existing topsoil, or salvage the topsoil to a minimum of six inches (6"), and a maximum of twelve inches (12") prior to application of the contaminated solids. If salvaged, the topsoil can be used for run-on/run-off control, or stockpiled for use as final closure cover material.

4) Flow of storm water into the treatment cell shall be prevented and storm water run-off from the site shall be contained. Any sites that potentially discharge to state water will be required to obtain a Montana Pollutant Discharge Elimination System (MPDES) Permit from the Water Protection Bureau. Berms must be installed prior to application of contaminated soils and must be maintained throughout treatment. Berms must be vegetated to control fugitive dust and maintain soil productivity. Run-off that is contained may be usable toward treatment cell irrigation.

5) Baseline soil samples will be collected from the proposed land treatment site prior to waste application. One soil sample, composed of 5 sub-samples from 1 to 3 feet below the treatment zone (BTZ), will be collected per acre of the proposed landfarm treatment area. In the case of a soil heap treatment zone, the composite sample will be taken from the area directly underlaying the treatment zone. BTZ soil samples will be analyzed for total petroleum hydrocarbons (TPH) by EPA Method 8015, Benzene, Toluene, Ethylbenzene, Xylene (BTEX) by EPA method 8020 or 8260, and total metals using EPA method 3050. Additional parameters may be added depending on the nature of the waste to be applied. Sample holes will be back-filled and compacted with clean soil of the same or lower permeability, or bentonite.

6) Soil Treatment Facilities accepting liquid loads incapable of passing a paint filter test (EPA Method 9095), are required to include a plan for the construction of a de-watering or drying bed. The purpose of these beds is to prevent the migration of potentially harmful liquids into the subsoil or water table. The bed should be lined to meet a compacted soil standard of at least two feet of 1×10^{-7} cm/sec permeability, contain synthetic fabric meeting this requirement, or both.

I.(A) SOIL TREATMENT FACILITY GROUNDWATER MONITORING REQUIREMENTS

1) There shall be no degradation of state waters. (Section 75-5-303, MCA)

2) The STF will characterize the hydrologic conditions at the treatment area including identification of the uppermost aquifer, and all potentially affected aquifers. Primary criteria for this characterization should include depth to water, hydraulic conductivity, transmissivity, and flow direction. Existing well data and borings may be used to evaluate site hydrology.

3) Following characterization of the local hydrologic conditions, a properly configured monitoring well network may be required at the discretion of the Department, or if any of the following conditions are present at the proposed site: (a) Ground water is within 50 feet of the surface; (b) BTZ soil conditions do not meet permeability standards set forth in I.2).

4) For those sites where ground water monitoring is required, the static water level must be measured in each well on a seasonal basis (April, July, October) and samples collected if water is present. Ground water samples will be collected and analyzed 2 to 4 times a year depending on the vulnerability of the ground water regime. Samples will be analyzed for total petroleum hydrocarbon (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX) for STF's with petroleum contaminated soils. For STF's with other contaminated soils, the ground water sampling will characterize the potentially harmful constituents identified in the initial sampling of those materials.

5) The Department maintains the right to inspect and sample the monitoring wells or the materials undergoing remediation at any time without notice.

TABLE III: SUMMARY OF REQUIRED SITE CHARACTERIZATION SAMPLING

Background Sample	Parameters	Minimum EPA Analytical Methods
Ground water (If within 50' depth of treatment zone)	Depth to Water Transmissivity Conductivity Flow Direction	
Soils (To a depth of at least 2' BTZ)	Soil Profile Permeability TPH BTEX Total Metals	 SW-846 Method 8015 SW-846 Method 8020, 8260 SW-846 Method 3050

II. CRITERIA FOR SOLID WASTES ACCEPTED AT THE LANDFARM

No waste that meets the definition of a hazardous waste, including conditionally exempt small quantity generator hazardous waste, as specified in ARM 17.54.301 et seq. may be treated, stored or disposed of at the site. No waste fuel may be applied to the treatment site. The minimum sampling requirements specified in this outline apply only to soils characterized as being non-hazardous waste and are not intended to satisfy the minimum sampling requirements of ARM 17.54.402, that require the generator to determine if a waste is hazardous. No PCB contaminated oil or soil is allowed for storage, treatment or disposal at the Soil Treatment Facility.

1) Contaminated soil to be treated must be characterized for contaminants selected and approved by the SWS prior to being delivered to the treatment site. Soil removed from emergency spill sites of known origin may be transported and stockpiled on a lined or impermeable bed with run-on/run-off control, at the STF prior to receipt of analytical data if approved by the Department.

2) Soils contaminated with materials other than gasoline or diesel petroleum hydrocarbons will be expected to perform a treatability study prior to application of that material to demonstrate that a particular remediation technology will effectively lower or eliminate the contaminant.

3) At least 1 composite sample, composed of 5 sub-samples, will be analyzed per waste stream, regardless of amount, prior to acceptance at the STF. A minimum of 1 composite sample per 200 yd^3 of contaminated soil from a single source must be collected. Waste from areas where numerous contaminants are believed to exist, or contaminated soils with non-heterogeneous matrix will require a greater number of samples to characterize the waste.

4) The location and texture of each waste source must be recorded. Soil contaminated with diesel fuel must be analyzed at a minimum for TPH as diesel by EPA 8015 or by Diesel Range Organics (DRO). Gasoline contaminated soil must be analyzed at a minimum for TPH as gasoline (8015) or by Gasoline Range Organics (GRO), and for BTEX by EPA method 8020. Waste materials generated from a car wash sump will be tested for Volatile Organic Compounds (VOCs) and BTEX by EPA 8260 Long List, TPH by EPA 8015 Modified, and total Chromium, Lead, Zinc, and Cadmium metals. Sump solids from a vehicle service center will be tested under the same parameters as car wash sumps. For vehicle service sumps it may be possible to apply knowledge of the potential contaminants used at the shop. By examining the Material Safety Data Sheets (MSDS) for the materials used at that particular shop, a determination can be made of the potential compounds that could show up in the sump solids, and should therefore be tested prior to landfarming.

5) Contaminated soils from waste oil spills will be analyzed for TPH (8015), VOCs and BTEX by (8260), and total cadmium, chromium, lead, and zinc metals. Samples of unknown origin or those originating where solvents, volatile organic compounds (VOCS.), semi-volatiles, or unknown contaminants are suspected may require Toxicity Characteristic Leaching Procedure (TCLP) extraction.

6) With regard to tank sludges, crude oils, or oil rich solids from an unknown source, it is generally best to handle these through an oily waste contractor. If the STF operator chooses to accept these materials for the purpose of bioremediation, they should be tested for polynuclear aromatic hydrocarbons (PAH) in addition to TPH, BTEX, VOCS.'s and metals. The preferred method for testing semi-volatile organics is EPA method GC/MS 625(water)/8270(solids). Contaminants testing high in metal concentrations may impede bioremediation and should not be accepted at the STF without documentation of treatability. Metal concentration limits are listed in Table IV.

7) Analytical results, source location, and physical soil characteristics must be submitted to the Department to obtain approval prior to waste application. This information must be submitted on a form to be developed by the permittee and approved by the Department. All originals and records shall be maintained at the STF, or be available upon departmental inspection of the facility.

TABLE IV: TCLP LIMITS FOR METALS IN APPLIED WASTES AND IN TREATMENT ZONE

Element and/or Compound as (X)	Maximum Concentration
Arsenic (As)	5.0 ppm
Barium (Ba)	100.0 ppm
Cadmium (Cd)	1.0 ppm
Chromium (Cr)	5.0 ppm
Lead (Pb)	5.0 ppm
Mercury (Hg)	0.2 ppm
Selenium (Se)	1.0 ppm
Silver (Ag)	5.0 ppm

III. SAMPLING PROTOCOL AND QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Analytical methods used to establish background soil conditions and initial concentrations in waste to be treated will be the most precise methods available. The appropriate test method for a particular waste stream is presented in Sections II.4, II.5, and II.6.

1) Minimum analytical methods for testing incoming waste samples prior to acceptance, during remediation, and at closure include:

*** EPA 8020.....benzene, toluene, ethylbenzene & xylenes (BTEX)**
*** EPA 8015(modified).....total petroleum hydrocarbons (TPH) by gas chromatograph(GC)**
*** Gasoline Range Organics(GRO)....TPH by GC as gasoline**
*** Diesel Range Organics(DRO).....TPH by GC as diesel**
*** EPA 413.1.....TPH as oil and grease**
*** EPA 8260.....purgeable organics by GC/mass spectrometer (MS)**
*** EPA 8270.....semi-volatile organics by GC/MS**
*** EPA 3050.....total metals**

EPA 8015 can be modified for the analysis of TPH as gasoline, jet fuel, kerosene, diesel, other light fuel oils, used oil, motor oil, or hydraulic oils. GRO and DRO are standardized versions of EPA 8015 modified for gasoline and diesel respectively. EPA 8260 is used if solvents are suspected. EPA 413.1 was originally developed for aqueous samples and was subsequently modified for use with soil samples.

2) All samples must be collected in soil sample containers recommended by the laboratory, and be large enough to insure representative sample sizes.

3) The container must be as full as possible to minimize volatilization.

4) The sample must meet appropriate sample preservation required by test method after sampling and during transport to the laboratory.

5) The sample will be delivered to the laboratory according to the amount of time dictated by sample preservation method requirement.

The applicant shall submit a quality assurance/quality control (QA/QC) plan for waste, soil and water sampling events at the STF. The following (QA/QC) program represents the minimum Department standards. The STF QA/QC program must be approved by the Department prior to implementation.

Sampling equipment will be decontaminated prior to sampling by a soap wash, tap water rinse, methanol wash, tap water rinse, and deionized water triple rinse. A decontamination blank must be taken after the last deionized water or tap rinse of the compositing bowl.

Samples will be collected using a shovel, scoop or hand auger as appropriate. Composite samples will be collected by placing equal sub-sample volumes in a decontaminated glass or stainless steel bowl, thoroughly mixing the contents, and removing a representative sample from the bowl.

Samples destined for VOC analysis will be collected by placing an equal quantity of soil from each sub-sample directly into an appropriate sample container to prevent loss of volatile compounds during handling. (Refer to "Soil Sampling and Analysis for Volatile Organic Compounds", EPA/540/4-91/001, February 1992.)

Each sample container will be labeled with the waste stream code, cell code, time and date, required analysis, and any preservatives used. Information regarding the sample process will also be recorded in a field notebook dedicated to that cell. Chain-of-custody will be recorded from sampling through completion of laboratory analysis, and subject to inspection.

Sample bottles will be placed in ice chests and kept cool (at 4°C) until delivered to the laboratory. Delivery time will conform to analysis requirements.

IV. OPERATION AND MAINTENANCE REQUIREMENTS AT THE SOIL TREATMENT FACILITY

Different types of contaminants may rely on different natural processes to promote degradation. For example: Lighter hydrocarbon chain or volatile contaminant concentrations (i.e. gasoline) can be reduced through evaporative processes such as wind, air temperature, mixing and some biodegradation.
Heavier hydrocarbons, chlorinated and complex carbon chain compounds, (i.e. waste oils, tank sludges, solvents) degrade more through biological processes enhanced by proper STF management such as oxygenation by mixing, supplying moisture and nutrients, and by monitoring the contaminant decay.

Some contaminants may require additional parameters, or alternative treatment technologies. The STF is not a land disposal system, the purpose is to remediate the contaminated product toward an eventual beneficial use of the soils. The operator of the STF is expected to know the basic processes involved with bioremediation of whatever types of contaminated soil accepted at that facility. This chapter is intended to provide basic operational and maintenance requirements toward enhancing bioremediation, protecting the environment, and monitoring the progress of contaminant degradation.

1) For intermediate and major STF's accepting contaminated soils from vehicle and car wash sumps in addition to petroleum contaminated soils, it will be necessary to segregate treatment cells to manage the various waste streams. The STF cannot mix incoming waste streams or non-remediated contaminated soils unless they have been documented to have similar levels and types of contaminants. The treatment cell should be managed to provide the quickest and most environmentally sound remediation for the type of contaminant being managed.

2) Each treatment zone within the treatment cell should be flagged or staked at each corner, and be easily identifiable as to which load(s) are being remediated in that area.

3) Contaminated soils at STF's will not contain over 5% by weight (50,000 ppm) TPH or a quantity of other contaminants which may be toxic to soil microbes or cause leaching into sub-soils. It may be possible, with prior Department approval, to mix clean soil or documented remediated soils with crude oils, tank sludges, or other contaminated materials that are non-hazardous but are in excess of 5% or 50,000 ppm TPH. The intent of this is to lower contaminant concentrations to the point where they can be effectively remediated through microbial activity. The Department supports the use of toxicity screening analysis to determine the potential impact of contaminated waste on native soil biota as an aid to determine the appropriate loading rate.

4) Contaminated soils at STF landfarm treatment cells will not be applied in lifts greater than 12 inches and must be tilled twice during the first month after initial application and monthly thereafter, until remediation levels are attained. Tillage shall occur in varying directions to disrupt compaction patterns and prevent hardpan development, and must occur within the entire depth of the soil lift undergoing remediation. Tilling is also needed to supply oxygen, nutrients, and microbial populations throughout the treatment zone. The Department considers the minimum tillage season to be April through October, (depending on elevation).

5) When treating waste streams where microbial activity is the primary remediation tool to degrade contaminants, the treatment zone will be analyzed for available nutrients (phosphorus as P, nitrogen as N, and total organic carbon (TOC)), pH, and soil moisture. This sampling should take place as soon as possible after establishment of the waste material treatment zone, and continue throughout the remediation period of the treatment cell.

Fertilizer application rates should be adjusted to achieve an available carbon to nitrogen to phosphorus (C:N:P) ratio of 100:10:1 in the treatment zone. Additional nitrogen should be applied if the C:N ratio exceeds 30:1. The optimum pH range for bioremediation is 6 - 8 and should be adjusted if pH falls out of this range.

Soil moisture content is commonly expressed as a percentage of the soil water holding (field) capacity. The optimum field capacity of soils to promote biological activity is 50 - 70%. In general, keep the treatment zone moist, but not saturated. Other parameters that effect the rate of biodegradation are soil temperature and the amount of colony-forming units (CFU's). The preferred soil temperature range is 5-30 degrees centigrade (41°- 86° Fahrenheit). CFU's are the amount of bacteria present in the soil that may be available to feed on the carbon chain contaminants. Proper STF management will increase the number of CFU's and therefore more readily degrade the contaminated materials.

6) Contaminated soils under treatment must be sampled three times annually during the months of April, July, and October (seasonal sampling) for parameters outlined in TABLE VI on pages 11 & 12. Each sample (excluding VOCS.'s) will be a composite of five sub-samples per sample area collected from the lower half of the active treatment zone. The number of samples per landfarm acre will conform to Table V.

7) Any use of non-naturally occurring bio-remediation agents must be approved by the Department before introduction to the treatment zone.

8) Landfarms exceeding 25 tons per year of VOC emissions will be required to obtain an Air Quality permit. Landfarms may not cause any nuisance odors.

9) Best management practices (BMPs), including irrigation, shall be required when necessary to control fugitive dust emissions from the landfarm.

10) Two samples per acre from 1 to 3 feet BTZ will be collected annually in October to determine if contaminant migration (leaching) is occurring. If leaching is evidenced by change in the BTZ baseline character, the Solid Waste Section must be notified, and landfarm practices will be modified, in consultation with and pending approval of the Department.

11) If landfarming practices cannot be modified to prevent contaminant leaching, no additional contaminated soils may be added to the site and reclamation shall proceed as soon as final treatment levels are attained. If necessary, additional corrective action will be required to prevent degradation of state waters.

12) If there is no leaching of contaminants, the landfarm operator may stockpile de-watered contaminated material in an impermeable stripped and bermed area for up to 6 months. Contaminated soils may not be applied in lifts greater than 12 inches in the treatment cell. If contaminated soils contain cobbles, stones, boulders, or other consolidated materials and debris that would impede soil mixing and passage of air and water through the soil, or damage tillage equipment, the materials should be removed and treated separately.

13) Waste stream records must be available for inspection and contain, at a minimum, the following information: (Records will be kept on file for the life of facility & post-closure care)

a. Identification letter/number tracking code
b. source
c. volume
d. contaminant(s)
e. initial concentration
f. treatment cell location
h. application date
i. treatment schedule and method (i.e. tillage frequency, nutrient additions, moisture enhancement, organic amendments etc.)
j. sample dates
k. analyses performed
l. analytical results
m. final placement, if removed

TABLE V: SOIL SAMPLING REQUIREMENT PER WASTE STREAM UNDER TREATMENT

Acreage of Site or Cell	Number of Samples
<1/2	2 total
1/2-1	3 total
1-2	4 total
2-4	5 total
>4	1 per acre

TABLE VI: SUMMARY OF REQUIRED OPERATION AND MAINTENANCE SAMPLING*[1]

OPERATION

Sample	Parameters*2	Minimum EPA Analytical Methods*2
Ground Water Monitoring *(If required)*	TPH	602
	BTEX	602
	VOCs	624
Contaminated Soils*[3] *(Three times per season - April, July, October)*	TPH	8015 Modified Gasoline Range Organics(GRO) Diesel Range Organics(DRO)
	BTEX	8020/8260
	VOCs	8260 Short or Long List
	Halogens	8260 Short or Long List
	PAH's	8270
	Total Metals	3050

MAINTENANCE

Treatment Zone*[4] (As needed to maintain optimum bioremediation)	pH	
	Field Capacity	
	Carbon/Nitrogen	Fertilizer Recommendation
	Nitrogen/Phosphorus	N=Total Kjeldahl + Nitrate

Below Treatment Zone*$_5$	TPH	8015
(Once per season)	BTEX	8020/8260
	Total Metals	3050

$*_1$ The reader is advised to refer to the appropriate text for details.

$*_2$ The sampling parameters, suggested EPA test methods, and sampling episodes depend upon the type and character of the wastes accepted at the landfarm.

$*_3$ The test method used to establish a baseline reading for the BTZ, contaminated soils, and treatment zone should be the same method used throughout remediation.

$*_4$ The baseline treatment zone sample should occur after application of the waste to be remediated. The second treatment zone sample should analyze the waste constituents identified during the initial waste characterization as well as the parameters in Table VI.

$*_5$ If the waste stream in the treatment zone has been identified to have any parameters other than, or in addition to parameters outlined in Table VI, those parameters will also be analyzed.

V. LANDFARM REMEDIATION AND CLOSURE REQUIREMENTS

Waste will not be considered totally remediated until TPH levels are permanently reduced to below 100 ppm and total BTEX concentrations are less than 10 ppm of which benzene can only equal 0.5 ppm. *The attainment of desired remediation levels of contaminated soils through bioremediation at landfarm facilities is a complex procedure that is dependent on management practices as well as contaminant characteristics and soil matrix. It may not be possible to achieve total remediation for some types of contaminated soils. If the STF operator can demonstrate through analytical results that contaminant degradation has reached a maximum, and that the operation of the treatment cell and treatment zone were according to proper management techniques outlined in this document, it may be possible to stop further treatment and utilize the end-use criteria in TABLE VII. Carbon 6 through carbon 24 (C6-C24) hydrocarbon contaminants must have undergone one remediation season in the treatment cell and have had at least three seasonal sampling episodes performed and documented. Heavier hydrocarbon (>C24) and complex contaminants may be required to undergo longer treatment periods and more sampling episodes. Remediation levels for recalcitrant contaminants will be evaluated case by case based on demonstration that biodegradation has occurred to the maximum extent possible under proper operating conditions.*

1) Sampling for the purpose of determining the remediation level of the treatment cell will be sufficient to prevent the omission of "Hot Spots". Sampling must take in the total depth of the soil under treatment and be spaced in a uniform grid pattern throughout the total area of the treatment cell. Remediation sampling episodes should be statistically valid and maintain a 90% confidence level.

2) When remediation of a contaminated soil lift is complete, the following options for managing the cell are available: (a) the remediated material may be removed and replaced by additional contaminated soils for treatment; (b) an additional lift may be applied to the cell for treatment. The maximum depth of remediated soil within any cell may not be greater than five feet without prior Department approval. In the case of adding additional lifts over a remediated soil layer, the landfarm operator is required to sample to whatever depth is necessary to reach the original BTZ; and (c) the cell may be closed and reclaimed.

3) Cell closure requires that the site be covered with two feet (2') of clean topsoil, revegetated with a mixture of native species approved by the Department, and/or returned to the pre-permitted STF land use. Monitoring of reclaimed cells for vegetative success, weed control, and sub-soil and water contamination will occur for 2 years after reclamation work is complete. Final closure will be subject to Department approval.

4) The final topography of the landfarm area may not result in ponded drainage, accelerated erosion, or preclude agricultural or any pre-landfarm use.

VI. END USES OF SOILS THAT HAVE UNDERGONE REMEDIATION TREATMENT

TABLE VII is meant to provide the soil treatment facility operator with general guidance on what end use may be appropriate for soils that appear to have reached maximum effective remediation levels through bioremediation treatment. This chart is to be used for treated soils only, and is not meant to be used to determine end-use of untreated soils. The operator of the STF will be held responsible for environmental degradation resulting from the improper placement of treated soils. The Department assumes no liability from the end-use placement of treated soils, or the improper use of this TABLE.

TABLE VII: END USE CRITERIA FOR TREATED*$_1$ CONTAMINATED SOILS

Major Contaminant*$_2$	Soil Use Class (ppm) 1	2	3	4
Heavy Fuel hydrocarbons (C24-C30)	<60	60-200	200-2000	>2000
Diesel (C12-C24)	<10	10-200	200-500	>500
Gasoline (C6-C12)	<20	20-100	100-250	>250
Benzene	<0.005	0.005-0.5	≤0.5	>0.5
Ethylbenzene	<0.005	0.005-20	≤20	>20
Toluene	<0.005	0.005-40	≤40	>40
Xylenes (Total)	<0.005	0.005-20	≤20	>20

**$_1$ Even though a treated and untreated soil may have similar levels of contamination, the treated soil has undergone management to specifically reduce the level of contaminants originally present in the soil, and is therefore less likely to adversely impact the environment.*

**$_2$ Soils with contaminants other than those listed above will be evaluated case by case on the basis of biodegradation performance. Concentrations of metals must not exceed those listed in TABLE IV on page 7 unless the end-use intended is Class 3 or 4.*

Class 1 Uses: Any use which will not cause threat to human health or the environment. Use as residential topsoil is not allowed.
Class 2 Uses: Backfill at the cleanup site, fill in industrial areas, daily cover or fill at licensed landfills, road sub-grade or road construction fill.
Class 3 Uses: Daily cover or disposal in licensed municipal landfills, road sub-grade that will be completely covered by impermeable road surface material, re-treatment or disposal in a licensed facility.
Class 4 Uses: Re-treatment or disposal in a licensed solid waste facility.

Questions or comments concerning this guidance document may be referred to the Solid Waste Section, P.O. Box 200901, Helena, Montana 59620-0901. (406) 444-5300.