CLOSURE PLAN REVIEW FORM

GROUND WATER
Last Updated: July 2005

Facility Name		Reviewer / District Office	
Facility ID Number		Date Review of Plan Completed	
Date of Plan		Date Reviewed by Closure Coordinator	
Plan is: New, Amended, Revised		Date Reviewed by DDAGW (if applicable)	

This Closure Plan Review Form is #		of		forms completed in the review of this closure plan.

Relevant Guidance Document: Closure Plan Review Guidance for RCRA Facilities - OEPA/DHWM - http://epa.ohio.gov/portals/32/pdf/2008CPRG.pdf

	YES	NO	N/A	Page #	Notes - NOD Comment #
I. General					
A) Facility Permit Status:					
Part A?					
Part B?					
Unpermitted Treatment, Storage, and Disposal Facility?					
B) Type of Closure:					
Full?					
Partial? If yes, list the other regulated units remaining (unclosed) at the facility in the Notes.					
C) Does the submitted plan describe closure for more than one unit? If yes, a separate closure plan review form shall be completed for each individual unit.					

	YES	NO	N/A	Page #	Notes - NOD Comment #
II. Description of Unit to be Closed					
A) Does the plan indicate if the unit is land or non-land based? If yes, provide the type in the notes. (Land based - landfill, LTU, surface impoundment, etc... Non-land based - container, storage area, above-ground storage tank, etc...)?					
B) Does the plan indicate what type of closure is being pursued? If yes, provide what kind in the notes (clean closure by removal, risk-based clean closure, landfill closure)?					
C) Is there a need for urgent action?					
1) Is there any evidence that ground water may be contaminated above primary MCLs or health based standards?					
2) If yes to 1, is there any possible imminent danger to human health or the environment?					
3) If yes to 2, immediate action may need to be taken. The closure coordinator should be contacted for immediate action. Please include when the closure coordinator was notified.					
D) Is an integrated ground water monitoring program proposed? (An integrated program is one that may involve compliance/corrective action, RCRA/CERCLA, US EPA/Ohio EPA, etc...) If yes, provide a description in the notes.					
III. Soil Leaching Standards					
A) Is soil contamination present? (If not, proceed to Section IV for land based units or Section V for non-land based units)					

	YES	NO	N/A	Page #	Notes - NOD Comment #
B) If soil contamination is present, does the plan propose to remove all contamination? (If yes, proceed to Section IV for land based units or Section V for non-land based units)					
C) If no, does underlying ground water contamination exist?					
1) If yes, clean-up standards for soils should be determined by taking into account leaching and direct contact. Has a ground water monitoring plan (GWMP) been submitted in accordance with RCRA rules?					
2) If no, an analysis needs to be made on whether there is any current or potential risk to ground water. Was the attached scoring sheet completed?					
3) If it's unknown whether underlying ground water contamination exists, soil sampling and analysis, within 2 sampling intervals above the ground water table, must be done to determine the full extent of soil and ground water contamination. Please include in the Notes information on sampling and analysis.					
D) Has the attached scoring system been completed to identify conditions where leaching to ground water needs to be considered? (It must be completed during the review)					
1) Was enough hydrogeologic information available in the closure plan to complete the scoring sheet? If no, please include what information is needed in the Notes.					
2) Was the DDAGW consulted in completion of the scoring sheet? If no, please include the reasons in the Notes.					

	YES	NO	N/A	Page #	Notes - NOD Comment #
3) Is there information that is still needed? If yes, please include in the Notes.					
4) If the score indicated a potential risk to ground water, did the clean-up standards for soils take into account both direct contact and leaching?					
E) If landfill closure is being pursued, did the owner/operator include an evaluation of site suitability?					
IV. <u>Land Based Units</u>					
A) If the unit is land based, did the submittal include a GWMP?					
B) If a GWMP was submitted as part of closure, was it reviewed by DDAGW? If yes, please include in the Notes when it was reviewed.					
C) Did the closure plan state that ground water monitoring during closure or post-closure activities will be in compliance with OAC Rules 3745-65-90 through 94 or OAC Rules 3745-54-90 through 54-101?					
D) Does the plan include the type of evidence which indicates that ground water has been impacted? (e.g., ground water sampling results, soil contamination within 2 sampling intervals above the ground water table) If yes, please include this information in the Notes.					
E) Did the closure plan or GWMP define any ground water related corrective action? If yes, please include in the Notes.					

	YES	NO	N/A	Page #	Notes - NOD Comment #
F) Have any portions of the closure plan relating to ground water monitoring, which are not included in the GWMP, been provided to the DDAGW in order to provide a thorough review? Such information may be the following, please include it in the Notes.					
1) Recordkeeping and reporting schedules and formats.					
2) Procedures and schedules for operations, maintenance, and inspections of monitoring wells and equipment as required by OAC Rules 3745-54-15, 54-73(B)(5) & (6), 65-15, 65-73(B)(5) & (6).					
3) Other relevant information.					
V. <u>Non-Land Based Units</u>					
A) Is soil contamination present? If yes, please describe in the Notes.					
B) Did soil contamination extend to within two (2) sampling intervals of the seasonal high ground water table?					
1) If yes, was a GWMP part of the submittal?					
2) If a GWMP was submitted as part of the closure plan, was it reviewed by the DDAGW? If yes, please include the date in the Notes.					
3) Also, if the answer to V(B) was yes, did the closure plan state that ground water monitoring during closure or post-closure activities will be in compliance with OAC Rules 3745-65-90 through 94 or OAC Rules 3745-54-90 through 54-101?					

	YES	NO	N/A	Page #	Notes - NOD Comment #
C) Does the plan state the type of evidence which indicates that ground water has been impacted? (e.g., ground water sampling results, soil contamination within 2 sampling intervals above the ground water table) Please include in the Notes.					
D) Did the closure plan or GWMP define any ground water related corrective action? If yes, please include information in the Notes.					
E) Have any portions of the closure plan relating to ground water monitoring, which are not included in the GWMP, been provided to the DDAGW in order to provide a thorough review? Such information may be the following, please include it in the Notes.					
1) Recordkeeping and reporting schedules and formats.					
2) Procedures and schedules for operations, maintenance, and inspections of monitoring wells and equipment as required by OAC Rules 3745-54-15, 54-73(B)(5) & (6), 65-15, 65-73(B)(5) & (6).					
3) Other relevant information.					
F) If soil contamination did <u>not</u> extend to within 2 sampling intervals above the ground water table, has the attached scoring system been completed?					
1) If the score indicates a potential risk to ground water, did the soil remediation standards include leach-based standards?					

	YES	NO	N/A	Page #	Notes - NOD Comment #
2) If a potential threat to ground water exists, the DHWM inspector must decide whether a ground water investigation needs to be performed. Does the closure plan include information about such an investigation?					
3) If a GW investigation was included in the closure plan, was it reviewed by DDAGW? Please include in the Notes the date.					
G) If the 3 to 5-foot soil zone above ground water was not contaminated and the scoring sheet did not indicate that leaching remediation is a concern, does a potential threat to ground water still exist? This is possible if the soils at or above the ground water table are sand and gravel and constituents may permeate through without leaving a trace in soil.					
1) If there is cause to believe that the threat to ground water still exists, did the closure plan include information about a investigation?					
2) If a ground water investigation was included in the closure plan, was it reviewed by DDAGW? Please include the date in the Notes.					

Attachment I
Ground Water Scoring Matrix

This information can be found in Appendix E of the Closure Plan Review Guidance
Closure Plan Review Guidance - http://epa.ohio.gov/portals/32/pdf/2008CPRG.pdf

The ground water scoring matrix is one tool that may be used as an indicator that soil contamination has not and probably will not reach ground water. However, in addition to using the ground water scoring matrix, multiple lines of evidence are necessary to make this demonstration. As discussed in Section 3.12 - Ground Water Sampling and Analysis, of the CPRG, this demonstration may be applicable in deciding whether an owner/operator may be released from the closure performance-based ground water sampling and/or whether the ground water risk assessment pathway exclusion as discussed in Section 7.2 - Exposure Assessment, of the CPRG is applicable.

The scoring matrix contained in this appendix should not be used if any of the following apply:

- Any underlying ground water zone is known to be contaminated;
- Soil contamination is known to extend to the uppermost saturated zone or to the top of a coarse-grained layer such as sand and gravel;
- Soil contamination is known to extend to within five feet or less of the uppermost saturated zone;
- Secondary pathways to the ground water (piping, fractures, etc.) are present; or
- Constituents of concern are very soluble and do not adhere to soil.

The ground water scoring matrix may not be used to relieve an owner/operator of their responsibility for sampling ground water under a permit condition or OAC Rules 3745-54-90 through 3745-54-100 or OAC Rules 3745-65-90 through 3745-65-94.

TABLE E-1: GROUND WATER SCORING MATRIX / LEACHING EVALUATION SCORING SHEET

I. LAND SURFACE CHARACTERISTICS	*low (score 1)*	*moderate (score 2)*	*high (score 3)*	*score*
1. Surface Soil Permeability	$< 10^{-6}$ cm/s	10^{-6} to 10^{-4} cm/s	$> 10^{-4}$ cm/s	_____
2. Proximity to Flood Plains	outside 100 yr flood plain	25 to 100 year flood plain	within 25 year flood plain	_____
3. Terrain Slope	$\geq$ 6%	6 to 2%	$\leq$ 2%	

II. VADOSE ZONE CHARACTERISTICS	**Hydraulic Conductivity (cm/sec)**	**Thickness of Lowest Hydraulic Conductivity Layers (feet)**				*score*
		$\leq$ 15	15 to 50	50 to 200	> 200	
1. Thickness and Hydraulic Conductivity *(2 factor matrix)*	$\geq 10^{-3}$	*score 6*	*score 6*	*score 6*	*score 6*	_____
	$< 10^{-3}$ to 10^{-5}	*score 6*	*score 6*	*score 5*	*score 4*	
	$< 10^{-5}$ to 10^{-7}	*score 4*	*score 4*	*score 3*	*score 2*	
	$<10^{-7}$	*score 3*	*score 4*	*score 2*	*score 2*	

	low (score 2)	*moderate (score 4)*	*high (score 6)*	*score*
2. Feet from Deepest Known Soil Contamination to Uppermost Saturated Zone	> 30 feet	5 to 30 feet	$\leq$ 5 feet	_____
3. Secondary Characteristics (Directional Flow)	none present	**seams or fractures are present but do not appear to act as conduits**	**significant seams, high density fractures, desiccation cracks, buried utility lines that may act as conduits**	_____

III. GROUND WATER CHARACTERISTICS	*low (score 1)*	*moderate (score 2)*	*high (score 3)*	*score*
1. Uppermost Saturated Zone Type	confined	leaky confined	unconfined	_____
2. Aquifer Type[1]	*low (score 1)*	*high (score 6)*		
	other	unconsolidated aquifer yielding >100 gpm, sole source aquifer, or drinking water source water protection area		_____

IV. CHEMICAL CHARACTERISTICS	*low (score 1)*	*moderate (score 2)*	*high (score 3)*	*score*
1. Mobility in Soil a. Organic - K_{oc}	> 2000 ml/gm	150 to 2000 ml/gm	< 150 ml/gm	
b. Metals[2]	Al, Cr, Tl, Th, Sn	Ba, Be, Co, Cu, Pb, Mn, Ni, P	As, B, Br, Cd, F, I, Mg, Hg, Mo, Ra, Sb, Se, Ag, U, V, Zn	_____
2. Persistence	Refer to Table E-2	Refer to Table E-3	Refer to Table E-4	_____

3. Specific Gravity	*low (score 1)*	*high (score 3)*	score
	<1	>1	_____

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1 If there is evidence of sloppy maintenance or a large number of identifiable WMUs at the site, or if it is in close proximity to an outstanding resource surface water that may be interconnected w/ground water or near a salt dome, underground mine, cave or other geologically unstable area, add a point for each of these factors.

2 For Cr, Ni, Pb, Co, and Cu, increase mobility factor value by one if there is evidence of an acidic leachate (pH < 3) OR the metals are present in solution in liquid hazardous substances at the site (*e.g.,* plating wastes). Decrease by one the assigned mobility value for a metal in alkaline areas (pH > 8), if it can be determined that the metal is present in solid form. Don't assign a value <1. (Note: This doesn't apply to Se and As, which are more mobile under alkaline conditions.)

Table E-2: Low - Nonpersistent Compounds	Table E-3: Moderate - Persistent to Somewhat Persistent Compounds		Table E-4: High - Highly Persistent Compounds	
acetaldehyde	acenaphthylene	guaiacol	aldrin	dihexyl phthalate
acetic acid	acetylene dichloride	2-hydroxyadiponitrile	antimony compounds	di-isobutyl phthalate
acetone	atrazine	idene	arsenic compounds	dimethyl phthalate
acetophenone	(diethyl) atrazine	isoborneol	barium compounds	4,6-dinitro-2-aminophenol
benzoic acid	barbital	isodecane	benzopyrene	dipropyl phthalate
di-isobutyl carbinol	behenic acid, methyl ester	isophorone	benzothiazole	endirin
docosane	benzene	isopropehnyl-r-isopropyl benzene	benzothiophene	heptachlor
eicosane	benzene sulfonic acid	isoprophyl benzene	benzyl butyl phthalate	heptachlor epoxide
ethanol	borneol	limonene	beryllium compounds	1,2,3,4,5,7,7-
ethylamine	bromobenzene	methane	bromochlorobenzene	heptachlorobornene
hexadecane	camphor	2-methoxy biphenyl	bromodichloromethane	hexachlorobenzene
methanol	e-caprolacam	methyl biphenyl	bromoform	hexachloro-1,3-butadiene
methyl benzoate	carbon disulfide	methyl chloride	bromoform butanol	hexachlorocyclohexane
3-methyl butanol	chlorobenzene	methyl ester of lignoceric acid	bromophenyl phytyl ether	hexachloroethane
methyl ethyl ketone	1,2-bis-chloroethoxy ethane	2-methyl-5-ethyl-pyridine	cadmium	lead compounds
2-methylpropanol	b-chloroethyl methyl ether	methyl naphthanlene	carbon tetrachloride	mercury compounds
octadecane	chloromethyl ether	methyl palmitate	chlordane	methyl benzothiazole
pentadecane	chloromethyl ethyl ether	methyl phenyl carbinol	chlormochloromethane	nickel compounds
pentaol	3-chloropyridine	methyl stearate	chlorofrom	pentachlorobiphenyl
propanol	o-cresol	methylene chloride	chlorohydroxy benzephenone	pentachlorophenol
propylamine	decane	methylindene	bis-chloroisopropyl ether	selenium compounds
tetradecane	n-decane	naphthalene	m-chloronitrobenzene	silver compounds
n-tridecane	di-t-butyl-p-benzoquinone	nitroanisole	chromium compounds	1,1,3,3-tetrachloroacetone
n-undecane	1,2-dichloroethane	nitrobenzene	DDE	tetrachloroethane
	dichloroethyl ether	nonane	DDT	tetrachlorophenyl
	dihyrocarvone	octane	dibromobenzene	thallium compounds
	1,2-dimethoxy benzene	octyl chloride	dibromodichloroethane	thiomethylbenzothiaole
	1,3-dimethyl napthalene	pentane	dibutyl phthalate	trichlorbenzene
	1,4-dimethyl phenol	phenyl benzoate	1,4-dichlorobenzene	trichlorobiphenyl
	dimethyl sulfoxide	phthalic anhydride	dichlorodifluoroethane	1,1,2-trichloroethane
	2,4-dinitrotoluene	propylbenzene	dieldrin	trichlorofluormethane
	dioctyl adipate	1-terpineol	diethyl phthalate	2,4,6-trichlorophenol
	ethyl benzene	toluene	di(2-ethylhexyl)phthalate	triphenyl phosphate
	2-ethyl-n-hexane	1,1,2-trichloroethylene		
	cis-2-ethyl-4-methyl-1,3-dioxolane	trimethyl-trioxo-hexahydro-triazine isomer		
	trans-2-ethyl-4-methyl-1,3-dioxolane	vinyl benzene		
	o-ethyltoluene	xylene		

I. LAND SURFACE CHARACTERISTICS

1. Surface Soil Permeability

Soil permeability is a measure of the tendency of a liquid (usually water) to permeate the soil or an indicator of the potential for precipitation to lead to runoff. Lower surface permeabilities are associated with greater runoff and a smaller chance that any surface contamination will filter down to the ground water. Higher exponents indicate lower permeability and lower risk. The presence of any engineered containment structures and/or site controls (*e.g.,* fencing, paving, etc.) that modify surface permeability should not be considered in evaluating this factor. Surface permeability should be estimated from field or laboratory determinations.

2. Proximity to Flood Plains

Flooding potential is a measure of the potential for surface contaminants to be transported by flood waters both horizontally and verically to the ground water. Flooding potential is measured by the frequency (observed or estimated) of inundation due to stream flooding, high lake levels, or other causes. Facility engineering offices or the U.S. Army Corps of Engineers should be contacted to obtain flood plain maps or engineering reports that provide the information needed to evaluate this factor. County or state agencies responsible for planning, zoning, or flood plain management may also be able to supply relevant information. For flood insurance maps, contact the Federal Emergency Management Agency in Baltimore, Maryland at 1-800-333-1363.

3. Terrain Slope

To assign a score for terrain slope, the slope should be determined from a topographic map. The slope between the site and the nearest downgradient body of surface water (if it is within reasonable distance from the unit) is then used to determine the value. Surface water may be defined as perennial streams and impounded waters, including wetlands. If more than one surface water body is present, utilize the one for which the shortest distance can be calculated. If a surface water body is on site and downhill from the source of contamination, record the highest values. The higher the slope, the greater the runoff, the less chance for surface contamination to permeate to the ground water.

The slope of the terrain between the site and nearest downgradient body of surface water is determined by the following steps:

1. Determine the pathway by which runoff will flow from the site to surface water (*i.e.,* downhill, perpendicular to topographic contours).

2. Measure the distance along the flowpath, and assign this value to X (*e.g.,* X = 800 feet).

3. Subtract the surface water elevation from the site elevation, and assign this value to Y (*e.g.,* Y =50: 900 - 850 = 50 feet).

4. Calculate the slope using the formula below:

   Slope (%) = Y/X * 100: 50/800 * 100 = 6.25%

II. VADOSE ZONE CHARACTERISTICS

1. Thickness and Hydraulic Conductivity

Evaluation of whether ground water will be affected by the unit/site may be based on the thickness of the least permeable continuous unit in the interval between the lowest point of known contamination and the top of the first saturated zone. Only consider continuous layers that are at least five (5) feet in thickness.

Hydraulic conductivity is a measure of the ease with which water may move through the subsurface and is expressed in units of length per time.

If site-specific values for hydraulic conductivity are not available, then the following default values for hydraulic conductivity can be assigned based on regional information.

Table E-5: Default Hydraulic Conductivity Values

Description	Hydraulic Conductivity (cm/sec)
Unfractured clay, shales, claystone, mudstone, clay, sility clay, low permeable tills	$\leq 10^{-7}$
Clayey silt, moderate permeable till, silty shale, unfractured siltstone-sandstone-limestone	$> 10^{-7}$ to 10^{-5}
Sandy silt, silty sand, permeable till, clayey sand, cemented sandstone, fracture geologic material, coal, peat	$> 10^{-5}$ to 10^{-3}
Well sorted sand, sand and gravel, highly fractured rock, poorly lithified sandstone, karst limestone	$\geq 10^{-3}$

Assign a value from Table E-1 based on the thickness and hydraulic conductivity of the most impermeable continuous unit(s) in the interval between the lowest point of known contamination to the top of the uppermost saturated zone. If contiguous layers are within the same hydraulic conductivity range categories in Table E-1, then the entire thickness for those layers can be used. If contiguous layers are combined that are in different hydraulic conductivity range categories, then the total thickness can be used if the greatest hydraulic conductivity value is assigned.

If the depth to the uppermost saturated zone is less than ten (10) feet, then the value for this score is maximized.

2. Feet from Deepest Known Soil Contamination to Uppermost Saturated Zone

The depth shall be measured from the deepest point of known contamination to the uppermost saturated zone. For facilities that may not be required by rule/regulation to conduct site-specific ground water investigations (*e.g.,* hazardous waste storage pad), the depth criteria can be estimated from regional information. This information is best obtained from reviewing individual well logs in the area of the facility. Well logs are on file at Ohio Department of Natural Resources. Reviewing site-specific investigations that were conducted in close proximity to the facility is also beneficial. State water level information can be reviewed in conjunction with geologic description, the length of casing, and well depth to determine the appropriate depth to the saturated zone.

If contaminated soil extends to the bedrock and if the potentiometric surface of the uppermost saturated zone is within the bedrock, then well logs within one-half mile of the unit should be evaluated to determine if it is possible to calculate the feet from the deepest known contamination (the bedrock surface) to the uppermost zone. In some areas of Ohio with large surface elevation variations, it may be difficult or impossible to calculate this distance. In such cases, the score should be maximized to be conservative.

3. Secondary Characteristics

The potential for discrete features in the unsaturated zone (both unconsolidated and consolidated deposits) to act as a conduit to the water table should be assessed qualitatively, considering the presence, character, and density of faults, fractures, joints, subsidence fissures, solution channels, significant sand seams and other similar features that might act as conduits for contaminant travel through the unsaturated zone. If anthropogenic excavations occur within the saturated zone, then the value for this score is maximized.

III. GROUND WATER CHARACTERISTICS

1. Uppermost Saturated Zone Type

The type of saturated zone will affect the susceptibility of the zone to site-specific contaminant releases. The saturated zone may be either unconfined (water table aquifers), confined, or leaking. An unconfined zone is one where ground water possesses a free surface open to the atmosphere. Recharge to the saturated zone is from downward seepage through the unsaturated zone, lateral flow, or upward seepage from underlying strata. A confined saturated zone is under pressure by overlying subsurface materials. Recharge to confined zones occurs in recharge areas, where the strata crops out (*i.e.,* becomes unconfined) or by slow downward leakage through a confining layer (*i.e.,* leaking aquifer).

Unconfined saturated zones are typically more susceptible to contamination. Because they are unconfined, the vadose zone materials are usually fairly permeable also. The presence of a semi-confined saturated zone suggests the presence of a partially confining, lower permeability layer that could inhibit the movement of contaminants. It is important to note that discontinuities (secondary characteristics) often occur in these partially confining layers, including fractures, significant sand seams, or thinning or absence of a clay bed in some areas providing a "window" of leakage across the semi-confining unit.

The seasonal high water table needs to be taken into consideration as part of the saturated zone.

2. Aquifer Type

While a high likelihood of extensive current and/or potential ground water use does not by itself indicate that there is high potential for contamination to reach the uppermost saturated zone, it does indicate that a degree of conservatism is needed in the evaluation. Conditions warranting a higher score include location of the facility over a drinking water source water protection area, a Sole Source aquifer, or a 100 gpm unconsolidated aquifer. Information on Sole Source Aquifers and drinking water source water protection areas may be obtained from Ohio EPA, Division of Drinking and Ground Waters.

IV. CHEMICAL CHARACTERISTICS

1. Mobility in Soil

Mobility is a measure of the tendency of a substance to migrate through soil to the ground water. The constituent which is most mobile in the soil should be used.

2. Persistence

Persistence of each hazardous substance is evaluated on its biodegradability. The score

for the persistence of metals is always maximized. The constituent which is most persistent in the soil should be used.

3. Specific Gravity

The K_{oc} addressed in the mobility factor does not take into account whether the constituent is a floater or a sinker (Dense Non-Aqueous Phase Liquid). A more thorough ground water investigation should be required if the specific gravity is >1.

V. DETERMINING WHETHER TO INCLUDE A GROUND WATER INVESTIGATION

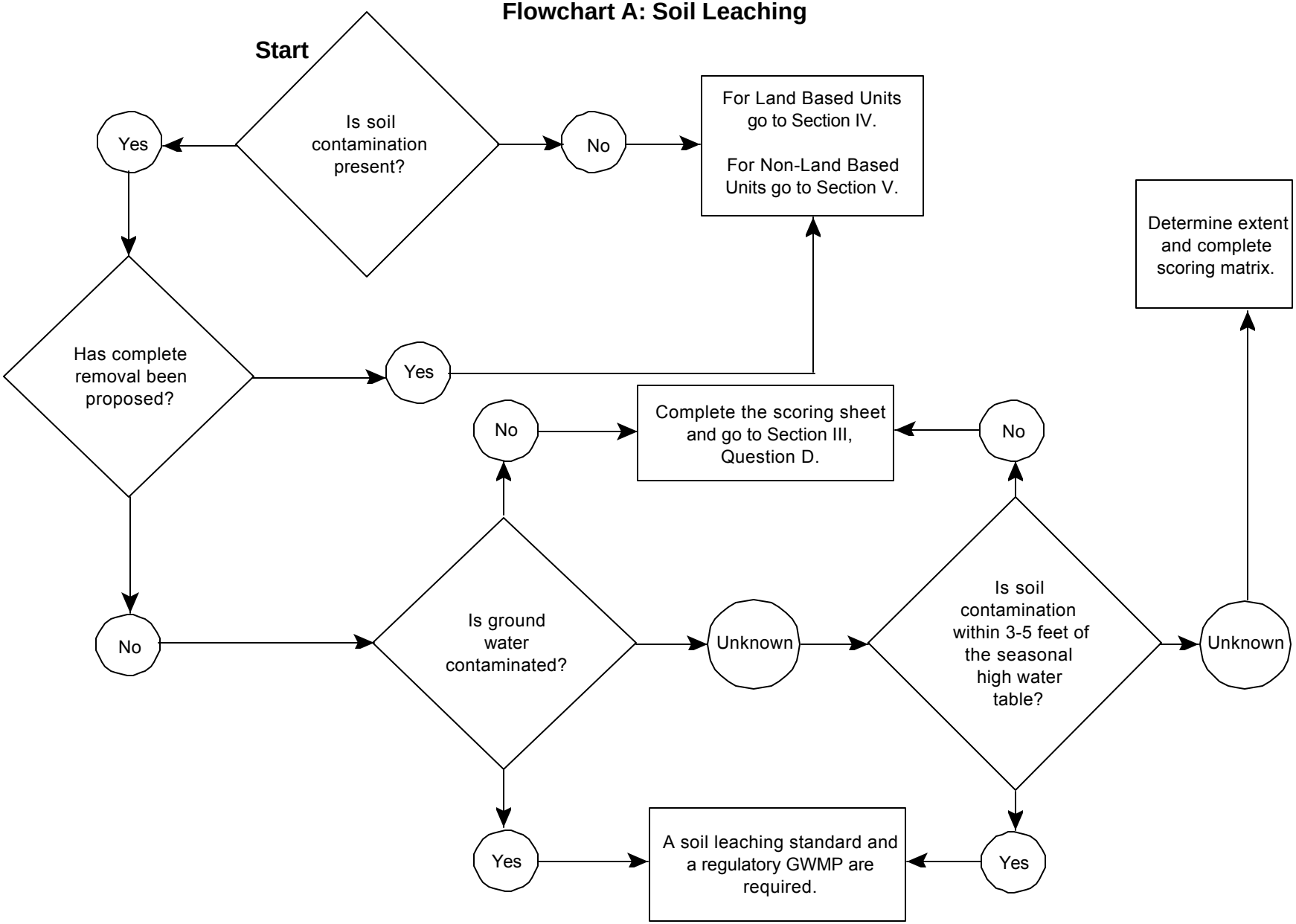
Table E-6: Determining if a Ground Water Investigation Should be Performed

Should a ground water investigation be performed as part of closure?	Total Point Range
Total Possible Points	45
Definitely	30-44
Possibly	0-29

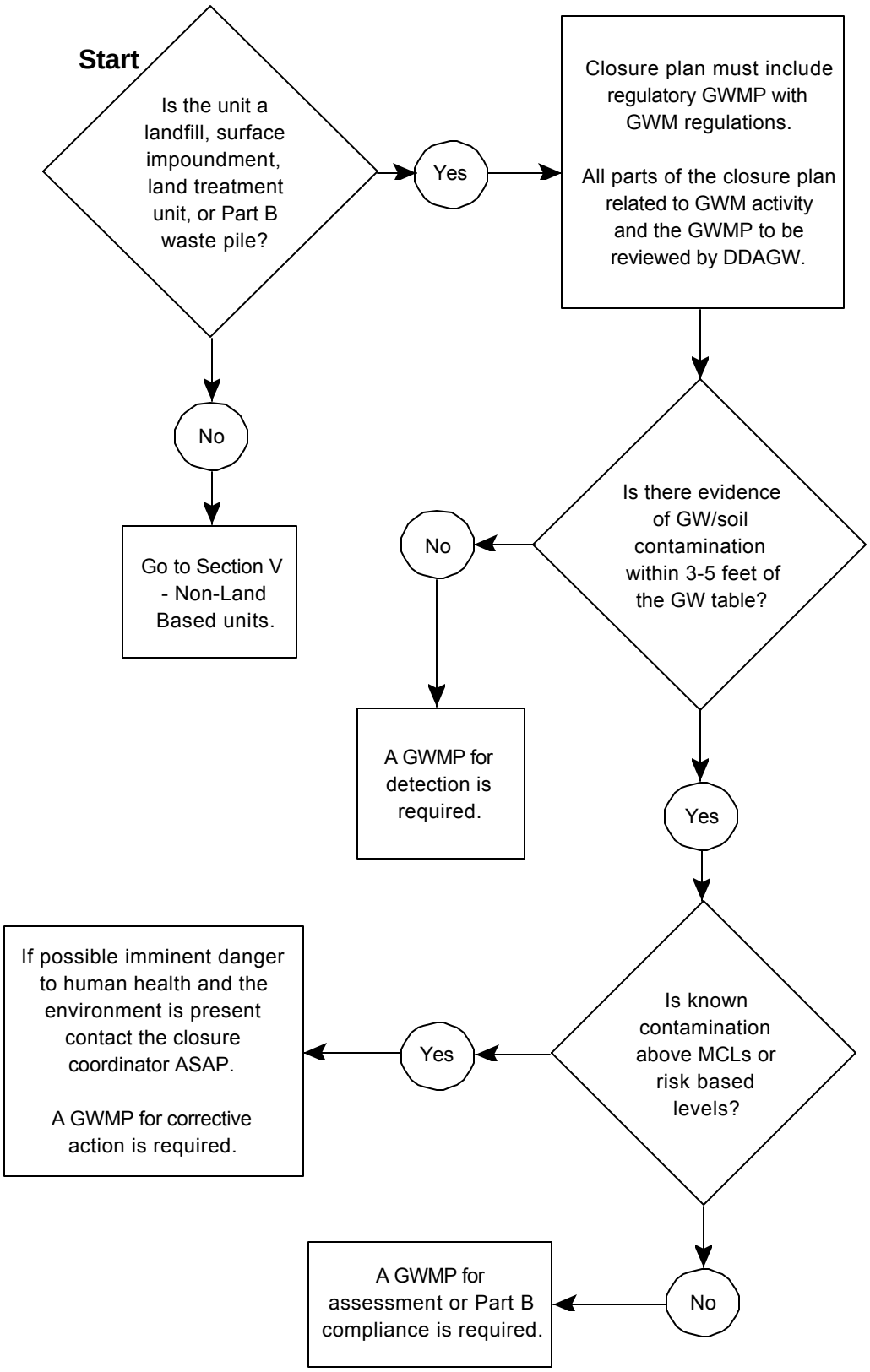
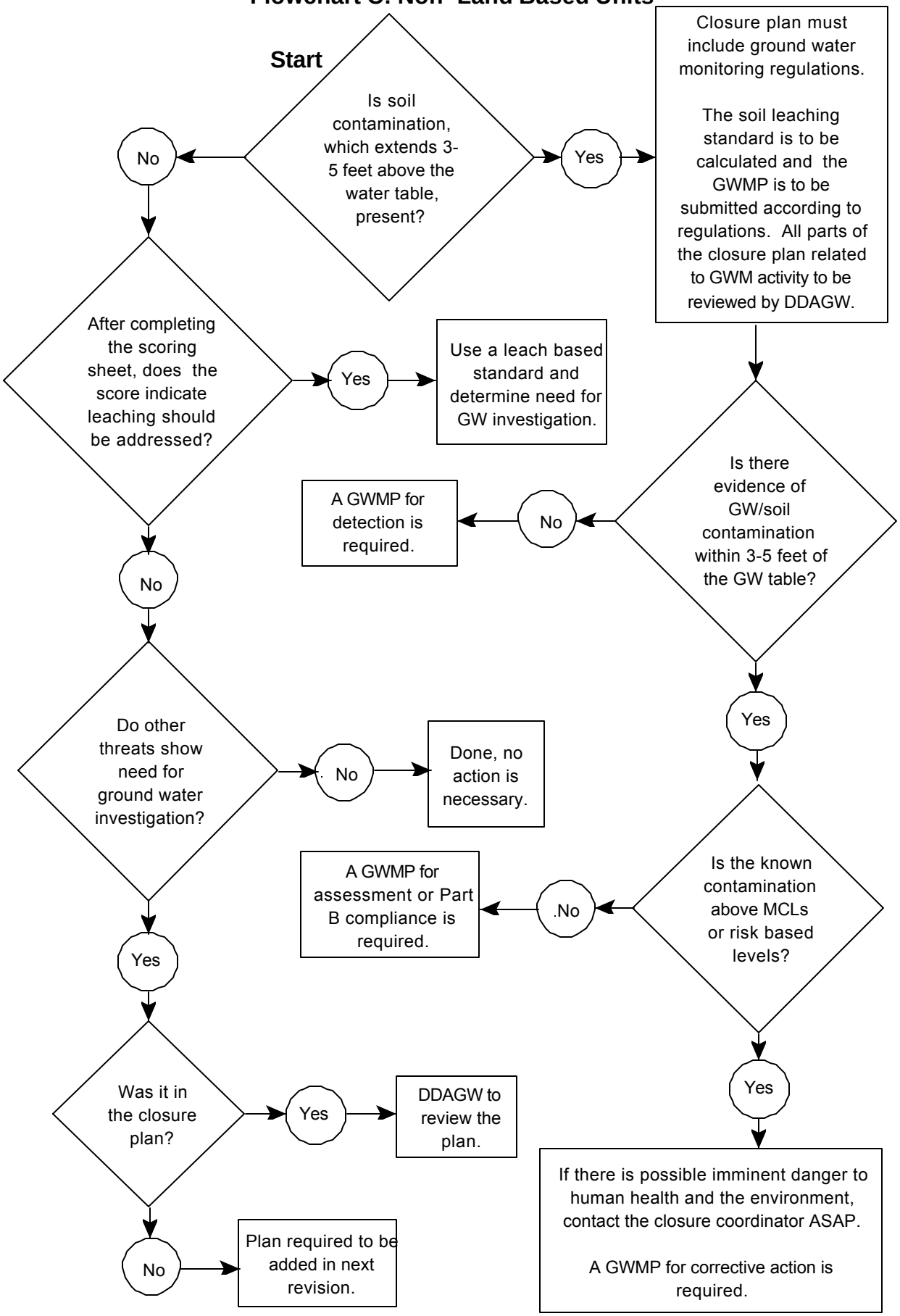
Attachment II
Flow Charts for Ground Water Closure Plan Reviews

Flowchart A: Soil Leaching
Flowchart B: Land Based Units
Flowchart C: Non-Land Based Units

Flowchart A: Soil Leaching



Flowchart B: Land Based Units



Flowchart C: Non- Land Based Units