SOLID & HAZARDOUS WASTE DIVISION
STORAGE TANK PROGRAM
GUIDANCE DOCUMENT #1

SUBJECT: SITE CLOSURE

SCOPE: This document provides site closure guidance to Storage Tank Program (STP) project managers, consultants, and operation & maintenance (O&M) contractors. In case of conflict with any rule or regulation, the rule or regulation will prevail.

INTRODUCTION: The philosophy and goal of the STP is to protect human health, safety, welfare, and the environment from soil and/or groundwater contamination caused by leaking aboveground storage tanks (ASTs) and underground storage tanks (USTs).

State rules and regulations have been promulgated that contain STP-specific soil and groundwater environmental remediation standards for petroleum contaminants, fuel oxygenates, and some metals and lead scavengers (collectively termed "contaminants of concern" [CoCs] in this document). The primary goal of the STP is to remediate groundwater and soil at eligible sites using the best available technology (BAT). State remediation standards are provided in Wyoming Water Quality Rules and Regulations, Chapter 17, Part J (referred to herein as "Chapter 17").

At contaminated sites where the BAT has been applied, but the remediation standards cannot be achieved in a timely and cost-effective manner, alternative (asymptotic) CoC concentrations in groundwater have been developed. These alternative concentrations are based on acceptable human health risk and protection of groundwater quality. Sites cannot be closed when CoC concentrations in groundwater reach asymptotic conditions. However, STP project managers and consultants should use these alternative CoC concentrations to effectively manage the final remediation phase of a site (e.g., shut off remediation systems and move into monitored natural attenuation, evaluate other technologies, implement "low priority" (LP) guidance, etc.).

GUIDELINES:

1. Initial Soil Evaluation

During the design phase of a remediation system, site-specific STP soil CoC concentrations are evaluated by the consultant using procedures in Chapter 17. This evaluation provides initial estimates of maximum site-specific residual soil CoC concentrations that can remain after remediation and still ensure protection of human health and groundwater quality. This initial evaluation is a theoretical tool used to predict possible soil remediation requirements. Actual groundwater and/or soil monitoring data collected during active remediation is used to determine if the remediation standards can be achieved in a timely and cost- effective manner, or if the alternative groundwater remediation goals presented herein should be used.

2. Alternate Asymptotic Groundwater Quality Concentrations

Chapter 17 provides state groundwater standards for STP CoCs. Depending on the CoC, these standards are maximum contaminant levels (MCLs), drinking water equivalent levels (DWELs), or action levels (Table 1). STP experience is that remediation to these standards may not always be achievable due to limitations of available technologies. Therefore, the STP has developed alternative

asymptotic concentrations (Table 1) for CoCs in groundwater. Asymptotic concentrations are not considered final groundwater remediation standards, and sites cannot be closed when these concentrations have been achieved. Asymptotic concentrations are used by STP project managers and consultants to effectively manage final remediation at sites.

TABLE 1
CONTAMINANTS OF CONCERN (CoCs) IN GROUNDWATER

CONSTITUENT	ASYMPTOTIC VALUE	MCL	DWEL	ACTION LEVEL
Benzene	0.05	0.005	--	
Ethylbenzene	7	0.7	--	
Toluene	10	1.0	--	
Xylenes	100	10	--	
Naphthalene	7	--	0.7*	
Methyl *tert*-Butyl Ether (MTBE)	0.4	--	0.04	
tert-Butyl Alcohol (TBA)	2.2	--	0.22	
Ethyl *tert*-Butyl Ether (ETBE)	1.9	--	0.19	
Diisopropyl Ether (DIPE)	12	--	1.2	
tert-Amyl Methyl Ether (TAME)	1.28	--	0.128	
TPH-GRO	73	--	--	7.3**
TPH-DRO	10	--	--	1.1**
Dissolved Lead	NA	0.015	--	--
Dissolved Cadmium	NA	0.005	--	--
Dissolved Chromium	NA	0.1	--	--
EDB (1,2-dibromoethane or ethylene dibromide)	0.0005	0.00005	--	
1,2-DCA (1,2-dichloroethane)	0.05	0.005	--	

All values are in milligrams per liter (mg/L)
TPH-GRO – Total petroleum hydrocarbon as gasoline range organics
TPH-DRO – Total petroleum hydrocarbon as diesel range organics
* EPA Health Advisory Level
**See TPH discussion in Section 3 below. If naphthalene is detected above the DWEL (0.7 mg/L), the TPH-DRO action level is 1.1 mg/L. However, if naphthalene and BETX concentrations are below the respective DWEL and MCLs and free product is not present on the groundwater table, the TPH-DRO plus TPH-GRO concentration must be equal to or less than 10 mg/L (sheen criteria).
NA- Not Applicable – asymptotic values are not established for metals

Benzene is the primary petroleum CoC and typically controls remedial actions. Historically it has been difficult to remediate benzene in groundwater to the MCL of 0.005 milligrams per liter (mg/L) with the BAT.

The substantial additional cost of operating and maintaining a remediation system to reduce the concentration of benzene in groundwater from 0.05 mg/L (the asymptotic value) to 0.005 mg/L (the MCL) is not considered a best management practice or wise use of taxpayers' money. The STP assumes that once the asymptotic concentration is met using the BAT, monitored natural attenuation

(MNA) will likely reduce the residual concentration to the MCL. Further, this reduction will occur in an acceptable time frame at significantly lower cost than active remediation.

3. Total Petroleum Hydrocarbon (TPH)

There is no MCL for TPH, nor is it appropriate to calculate a DWEL for TPH, as TPH is not a specific chemical substance but rather a series of separate organic compounds. However, TPH as a large group of organic compounds has been found to exhibit some degree of toxicity. Therefore, TPH action levels (Table 1) are tools that may assist in the determination of when a site is nearing cleanup or if a site is clean during a tank removal.

In the STP, TPH is based on fraction-specific petroleum hydrocarbons:

Gasoline Range Organics (GRO): C_6 through C_{10}
Diesel Range Organics (DRO): C_{10} through C_{32}

The action level for TPH-GRO concentration in groundwater is 7.3 mg/L. The asymptotic value for TPH-GRO in groundwater is 73 mg/L. If naphthalene is detected above the DWEL (0.7 mg/L), the TPH-DRO action level is 1.1 mg/L. However, if naphthalene and BETX concentrations are below the respective DWEL and MCLs and free product is not present on the groundwater table, the TPH-DRO plus TPH-GRO concentration must be equal to or less than 10 mg/L (sheen criteria). These values for TPH have been calculated based on protection of groundwater to drinking water quality.

TPH data are used as indicators of impacts to soil or groundwater. Research has shown that TPH concentrations in groundwater samples frequently do not represent dissolved petroleum hydrocarbons and can be attributed to sources other than petroleum. To remove polar nonhydrocarbon compounds (compounds from sources other than petroleum), the STP requires that the laboratory include a silica gel cleanup step (EPA Method 3630) when analyzing groundwater samples for TPH-DRO. If TPH-DRO is the only constituent found in groundwater, the STP project manager may have the well(s) resampled using a peristaltic pump or other low-flow sampling method. Low-flow sampling may reduce the influence of nondissolved particle entrainment on the TPH-DRO analyses. If results from resampling indicate TPH-DRO concentrations are below the standard, the site may be closed.

The TPH-GRO soil cleanup level ranges from 28 to 15,600 milligrams per kilogram (mg/kg). The cleanup level is based on a fate and transport evaluation for protection of groundwater to 7.3 mg/L. The cleanup level depends on the average depth (d) to seasonal high groundwater from the bottom of the contaminated zone and the average thickness (t) of the contaminated zone. Four graphs are attached for use in determining the acceptable concentration of TPH-GRO in soil. The TPH-DRO soil cleanup level is 2,300 mg/kg.

4. System Shut Down and Site Closure

Sites may not be considered for closure until concentrations of CoCs in groundwater reach DWELs, MCLs, or action levels for three consecutive quarterly sampling events with the remediation system shut off. Prior to site closure, confirmation soil sampling must be completed (if applicable) as described in Section 5 below.

If the concentrations of the CoCs in groundwater are at or less than asymptotic values, but higher than MCLs, DWELs, or action levels for three consecutive quarterly sampling events, the consultant and STP project manager may place the site in monitored natural attenuation (MNA). MNA

will continue at a site until DWELs, MCLs, or action levels are reached. The STP project manager will determine the monitoring frequency during MNA. When DWELs, MCLs, and action levels are reached for the CoCs, groundwater monitoring will be increased to quarterly to determine if the site can be closed. If CoC level(s) spike above asymptotic values during MNA, the consultant and the STP project manager may place the system back into operation.

If CoC concentrations in groundwater do not reach asymptotic values during active remediation (or DWELs, MCLs, or action levels during MNA) in a reasonable time frame (as determined by the STP project manager), the consultant and project manager may recommend evaluation of other remedial options be completed, the site move into MNA, or the site be reinvestigated for possible new sources or sources not previously known. If any of these options are used, the site cannot be closed until criteria in this document are met (i.e., CoCs in groundwater must reach cleanup objectives for three consecutive quarterly groundwater monitoring events).

5. Confirmation Soil Sampling

After conditions in Section 4 above have been met, the consultant shall determine if confirmation soil samples are necessary. If the depth from the bottom of the contaminated zone to the groundwater table is less than 12 inches, or is within the groundwater table, the soils will be considered to be within the capillary fringe/smear zone, and soil samples will not be required. For these situations, satisfactory remediation of the groundwater will govern the decision to close the site. For all other conditions, confirmation soil sampling will be required before closing a site.

One soil sample should be collected immediately adjacent to the source area groundwater monitoring well. At least three soil samples should be collected near down-gradient groundwater monitoring wells where groundwater sample results are within acceptable concentrations for the CoCs or at other locations identified by the STP project manager.

The O&M contractor shall collect confirmation soil samples and have them analyzed for the CoCs specified in the O&M manual. Samples shall be collected in the appropriate contaminated soil zone(s) where maximum contamination is indicated using a properly calibrated photoionization detector (or other instrument approved by the STP project manager). Analytical results of these soil samples will be evaluated using the oral and inhalation risk assessment standards and fate and transport model contained in Chapter 17. These evaluations will be made to verify that an unacceptable human exposure will likely not occur after the site is closed and that groundwater quality will be protected to groundwater standards or site-specific remediation goals.

If the results from soil sample analyses meet the soil remediation standard(s) calculated from the fate and transport model or the oral/inhalation risk assessment criteria contained in Chapter 17, the remediation system may remain off until the next scheduled groundwater sampling event.

If three additional consecutive quarterly groundwater sampling events document that groundwater standards are being maintained, the system may proceed to decommissioning. If any one of the three additional consecutive groundwater monitoring events indicates that groundwater quality cannot be maintained to groundwater standards or asymptotic values, the guidelines in Section 4 above will be followed.

6. Operational Storage Tank Facilities. A potential contamination source exists with any operational storage tank facility. When the requirements of all previous sections have been met, the

remediation system at an operational facility may be mothballed or decommissioned. This includes all project-related groundwater monitoring wells. Mothballing, rather than decommissioning, a remediation system may be appropriate due to the likelihood of future tank system releases.

7. Tank Removals. If it is apparent that groundwater has not been contaminated by a release or groundwater is not encountered during a tank removal inspection, the fate and transport model (Chapter 17) will be used to evaluate soil impacts. At sites where gasoline was stored, possible soil impacts from BETX and TPH-GRO will be evaluated. At sites where diesel or waste oil was stored, possible soil impacts from naphthalene and TPH-DRO will be evaluated. Collection of groundwater grab samples from the bottom of the excavation is not necessary as these samples may not be representative of actual groundwater conditions. Information concerning the approximate depth to groundwater and the thickness of the petroleum contamination may be determined on a site-by-site basis or previous field experience of the STP project manager.

8. Issues Not Addressed. Issues arising at a site that are not addressed in this guidance document should be discussed with the consultant, STP project manager, and STP manager.

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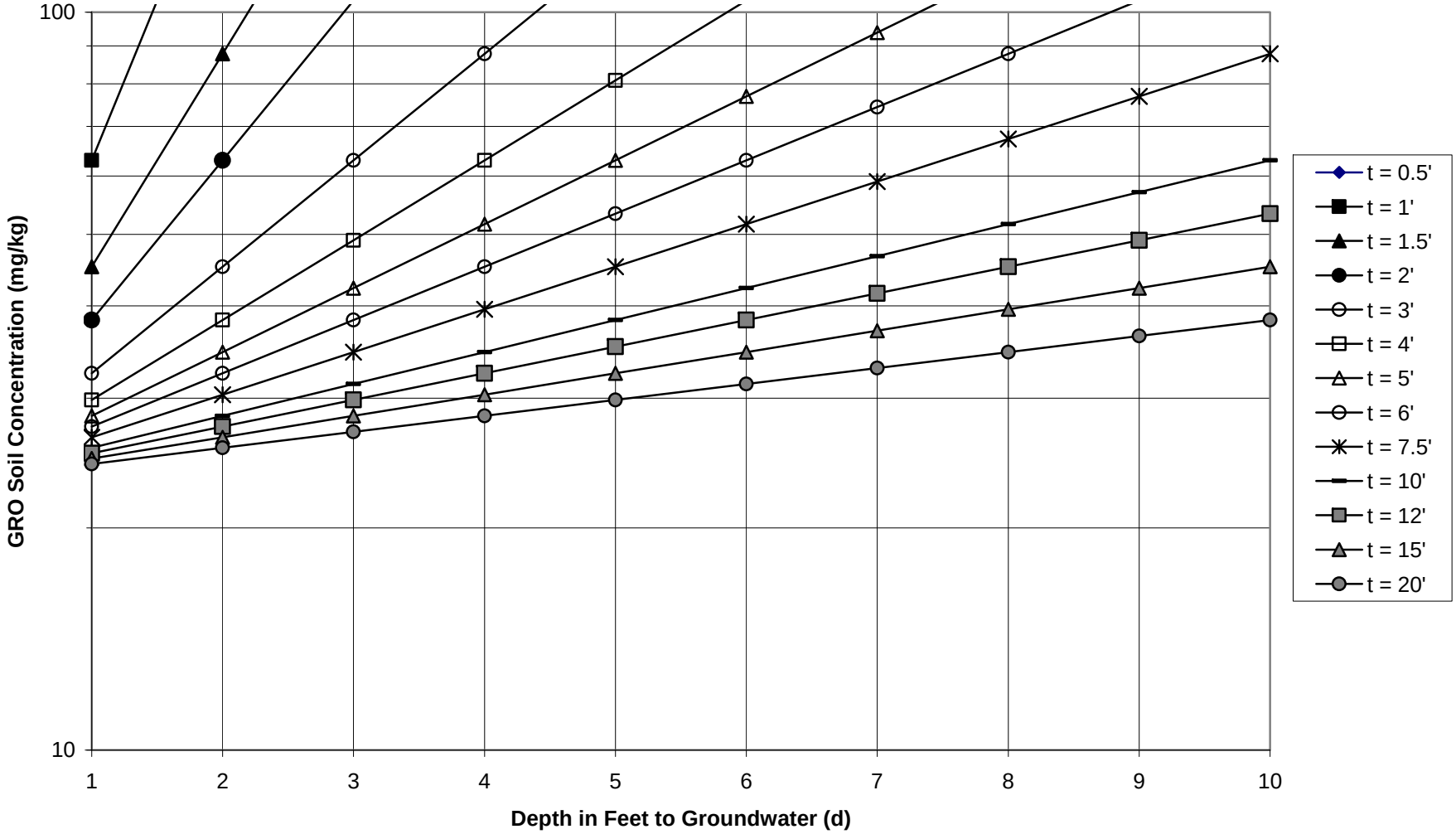
STORAGE TANK PROGRAM SITE CLOSURE

ATTACHMENTS

Acceptable Concentrations of GRO in Soil
That Limit Groundwater Concentrations to 7.3 mg/L
(t = thickness of contaminated soil zone)



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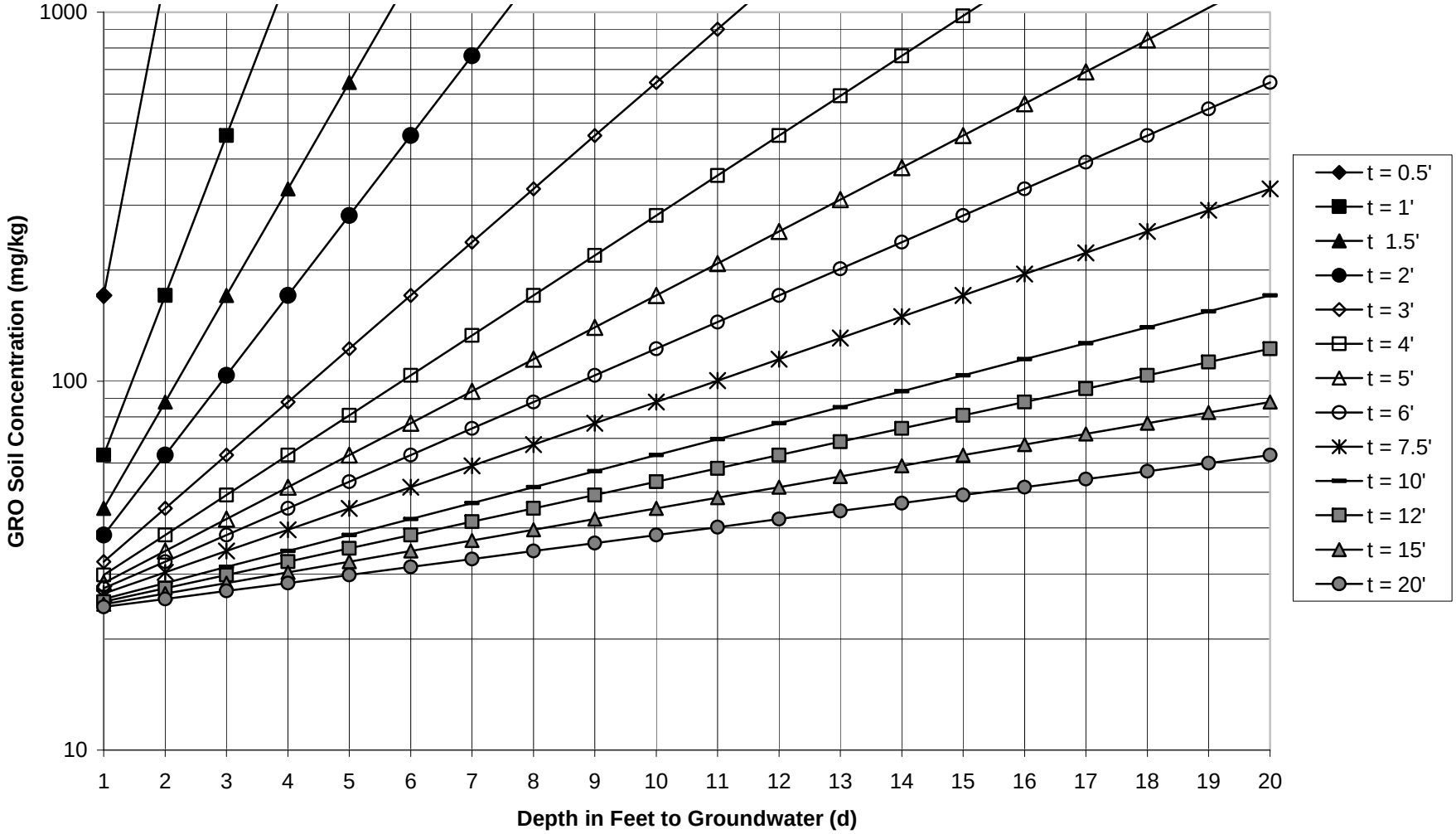

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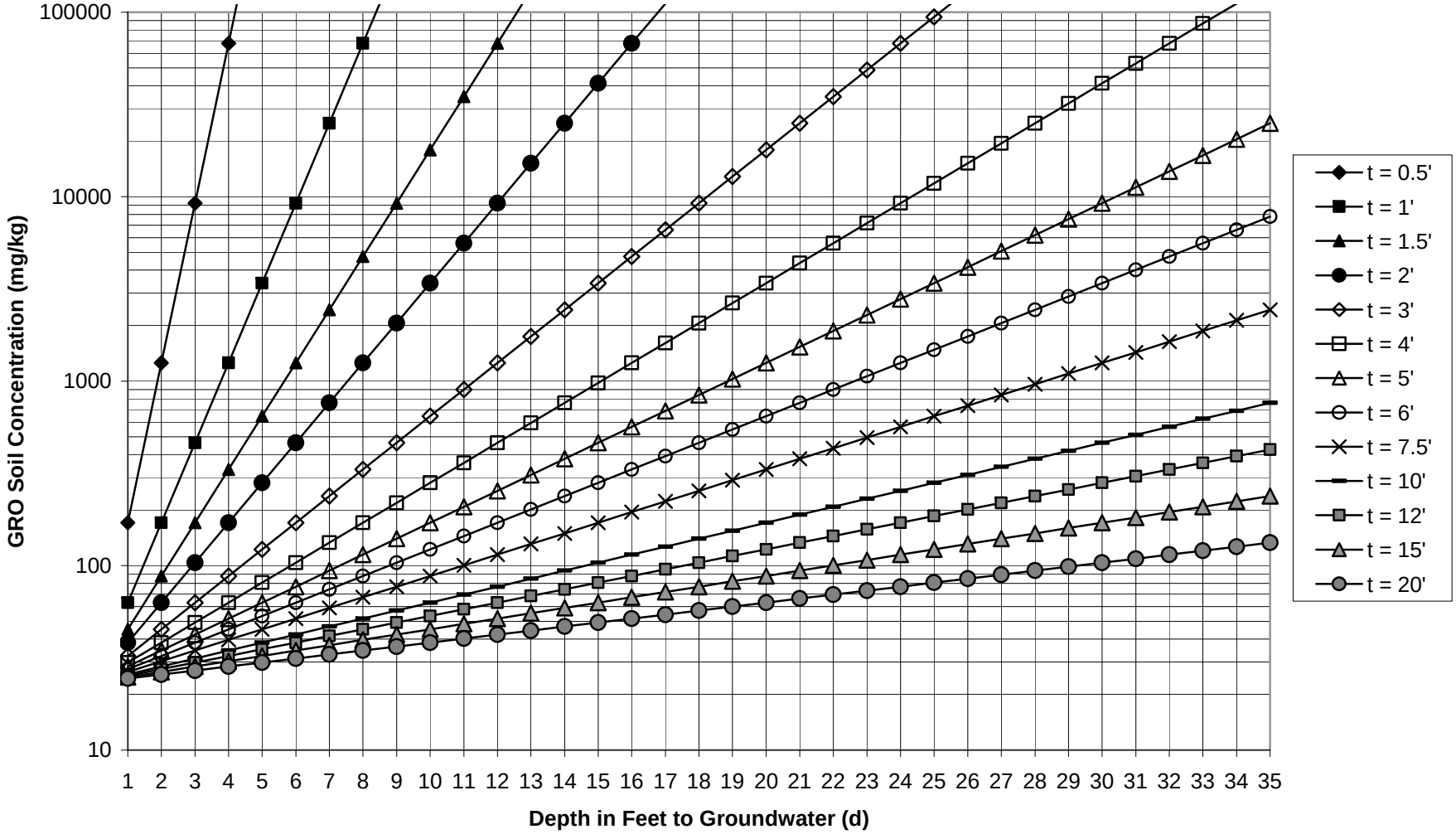

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