APPENDIX C

Time to Cleanup Determination Procedure

TIME TO CLEANUP DETERMINATION PROCEDURE

C.1 PURPOSE

The purpose of this calculation procedure is to determine times to cleanup based on one-dimensional advection and dispersion in groundwater with retardation and first-order decay.

The program "SOLUTE" Version 3.0 by the International Groundwater Modeling Center at the Colorado School of Mines is used to model the site plumes. "SOLUTE" contains a one-dimensional model, ONED-1, which includes retardation and first-order decay with a constant concentration inlet boundary condition (constant source concentration). The hydrogeologic conditions at the Base are kept constant, and the duration of the contaminant release is changed until the present day site contamination profile is generated. The release is "turned off", and the modeled site plume is then run into the future to determine the time to cleanup for a specific cleanup goal.

Table C-1 contains the input parameters required by ONED-1.

Table C-1
ONED-1 Input Parameters

Description	Symbol	Units
Groundwater (Seepage) Velocity (average linear velocity)	v	ft/yr
Longitudinal Dispersivity	a_L	ft
Retardation Factor	R	dimensionless
Initial Concentration	C_o	mg/l
Concentration at Source	C_s	mg/l
Duration of Solute Pulse	T	yr
Half-life	$t_{1/2}$	yr

C.2 ASSUMPTIONS, INPUTS, AND REFERENCES

1. Constant v and a_L (the aquifer is homogenous).

2. Constant λ and R.

3. Modeling with the concentration distribution of one contaminant (usually TCE) is representative of all the contaminants contained within the plume.

4. A one-dimensional advection-dispersion model with retardation and first-order decay accounts for the major contaminant transport mechanisms.

   Transverse dispersion is much smaller than longitudinal dispersion, so a one-dimensional model along the longitudinal axis is a reasonable assumption. The sites have relatively small saturated thicknesses, so longitudinal transport should be much more significant than vertical transport. In addition, very little vertical distribution data is available for the sites.

5. A standardized set of hydraulic input parameters can be used for all sites. Site-specific data, such as hydraulic conductivity, effective porosity, and influence from pumping, are not available for all sites, so the application of the available data to all sites is warranted.

   Two values of velocity were used to represent the effects of pumping the aquifer, 25 and 50 ft/yr. The velocity of 25 ft/yr was used to account for the average effect of pumping at the downgradient edge of the plume. The velocity of 50 ft/yr was used to account for the average effect of pumping at the plume hot spot as well as pumping at the plume downgradient edge.

Table C-2 contains the input parameters, assumptions made to determine the input parameters, and references.

Table C-2

Input Parameters, Assumptions, and References

Input Parameter	Assumption	Reference
v = 10 ft/yr v = 25 ft/yr v = 50 ft/yr	Varied from 5 to 50 ft/yr based on natural gradient, well logs, aquifer tests, and typical K's Matched model to current plume with natural gradient Pumping induced gradient 2.5 times larger than natural gradient (average effect of downgradient interception well) Pumping induced gradient 5 times larger than natural gradient (average effect of hot spot and downgradient interception wells)	Freeze & Cherry 1979 Radian 1994b Radian 1995a Radian 1996 Weston 1992 Weston 1995
D = 200 ft	Varied from 15 to 300 ft until the model matched the current plume	Common modeling assumption
R = 2	$R = 1+\rho_b/\theta_w K_d$ $K_d = K_{oc}\ f_{oc}$ $f_{oc} = 0.002$ $K_{oc} = 126$ ml/g (TCE) $\theta_w = 0.2$ $\rho_b = 1.8$ g/cm^3	Freeze & Cherry 1979 Pankow & Cherry 1996
$C_o = 0$	Background concentration assumed to be zero	
$C_s = 1000$ mg/l	Solubility = 1,100 mg/l	Pankow & Cherry 1996
T = 0.2	Matched model to current plume with natural gradient (varied from site to site)	
$t_{1/2} = 1{,}300{,}000$	Half-life of TCE	Pankow & Cherry 1996

C.3 METHOD

1. Validate the inputs by matching the model to the current plume with natural gradient conditions.

   Figure C-1 shows a plot of concentration versus distance along the longitudinal axis of the Site SS030 plume. The figure also includes the model plume concentration versus distance curves for 5, 10, 15, and 30 years. The curve for year 15 provides the best fit for the actual site plume curve.

   The 15 year curve has a slightly higher peak concentration and is slightly narrower than the actual site plume. The model peak concentration was 20% higher than the actual site peak concentration. Since the actual site plume curve was based on limited data, this was considered a reasonable fit.

   The starting point for the model (x=0) is the source.

   Case 1 was not run forward in time, because times to cleanup under natural gradient conditions will be much larger than under pumping conditions.

2. Reset the model time to zero and rerun the model for the pumping induced velocity (pumping gradient) cases.

   Adjust the duration of the solute pulse to match the 15 year model curve. The duration is decreased by the same factor that the velocity is increased, and produces an exact match of the natural gradient model curve at an earlier time (time decreased by the same factor).

Table C-3

Model Parameter Changes for Cases 1, 2, and 3

	Case 1	Case 2	Case 3
Velocity	10 ft/yr	25 ft/yr	50 ft/yr
Factor	1	2.5	5
Duration	0.2 yr	0.08 yr	0.04 yr
Model Time	15 yr	6 yr	3 yr

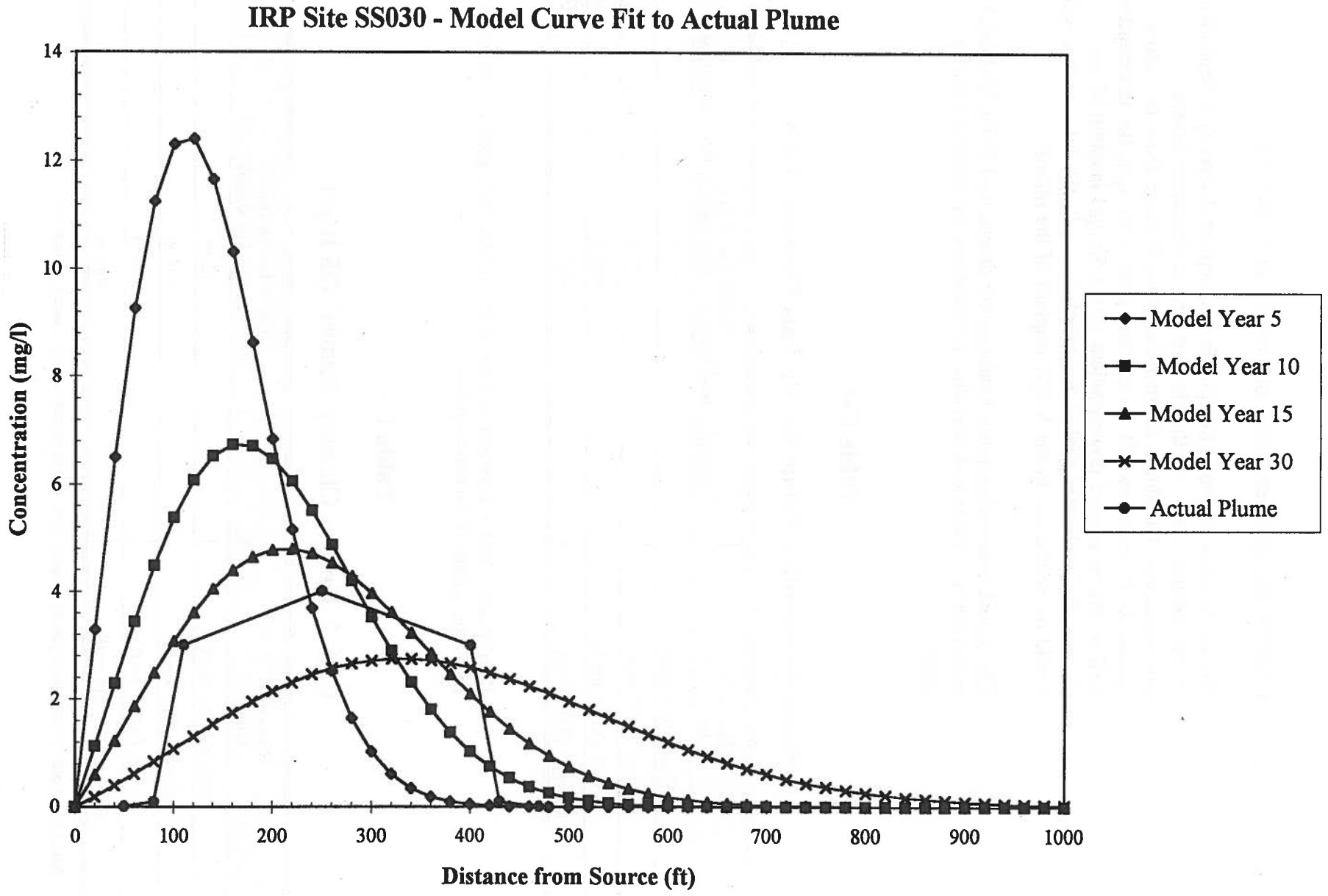


Figure C-1. Model Curve Pit to Actual Plume

3. Establish downgradient model observation point locations.

The model observation point (plume interception distance) is dependent on the cleanup goal. As the cleanup goal is decreased (lower concentration), the plume interception point distance from the source (model x=0) increases. If the cleanup goal is 50 ug/l, the interception well would be located downgradient of the 50 ug/l isopleth of the plume. If the cleanup goal is decreased to 5 ug/l, the interception well would be moved out to the 5 ug/l isopleth of the plume.

The model observation point locations are determined from the model match curve. Table C-4 contains the locations for various cleanup goals.

Table C-4

Plume Interception Points for Various Cleanup Goals

Cleanup Goal	Interception Point (Distance from Source - Interception Well Location)
500 ug/l (0.5 mg/l)	531 ft
50 ug/l (0.05 mg/l)	675 ft
5 ug/l (0.005 mg/l)	785 ft
0.5 ug/l (0.0005 mg/l)	880 ft

4. Run model Case 2 forward in time until the cleanup goal is reached at the appropriate observation point.

Table C-5

Case 2 Time to Cleanup Results[1] (25 ft/yr)

Cleanup Goal	Times to Cleanup (at Observation Point)
500 ug/l (0.5 mg/l)	53 yr
50 ug/l (0.05 mg/l)	154 yr
5 ug/l (0.005 mg/l)	278 yr
0.5 ug/l (0.0005 mg/l)	413 yr

[1] Case 1 is run only to calibrate the model; cleanup times are not estimated for the natural gradient case.

5. Run model Case 3 forward in time until the cleanup goal is reached at the interception points as well as in the hot spot of the current plume.

Since the center of the site plume is targeted for cleanup as well as plume interception, the plume must be divided into three sections for modeling: a) an upgradient section, b) the hot spot, and c) a downgradient section.

The hot spot is defined by the 1.0 mg/l (1000 ug/l) isopleth.

a) The upgradient section of the plume can be modeled with interception at the upgradient edge of the hot spot.

The upgradient edge of the hot spot (1.0 mg/l) occurs at 475 ft on the natural gradient model curve.

Table C-6

Case 3a Time to Cleanup Results (50 ft/yr, Upgradient Section)

Cleanup Goal	Time to Cleanup (at Observation Point, 475 ft)
500 ug/l (0.5 mg/l)	5 yr
50 ug/l (0.05 mg/l)	18 yr
5 ug/l (0.005 mg/l)	48 yr
0.5 ug/l (0.0005 mg/l)	87 yr

b) The extraction and treatment of contaminated groundwater from the hot spot is modeled with a source in the center and wells downgradient at the 1.0 mg/l (1000 ug/l) isopleth. A new model curve is produced and matched to the natural gradient model at the peak of the plume.

The source concentration is set at 1.2 times the peak concentration of the natural gradient model in order to get a reasonable approximation of the hot spot. The duration of the solute pulse is increased until the hot spot model curve reasonably matches the natural gradient model curve.

The matched hot spot model is then run forward in time until the cleanup goal is reached at the observation point (initial 1.0 mg/l isopleth distance).

The initial 1.0 mg/l isopleth for the hot spot model curve occurs at 290 ft.

Table C-7

Case 3b Time to Cleanup Results (50 ft/yr, Hot Spot Section)

Cleanup Goal	Time to Cleanup (at Observation Point, 290 ft from peak)
500 ug/l (0.5 mg/l)	10 yr
50 ug/l (0.05 mg/l)	36 yr
5 ug/l (0.005 mg/l)	77 yr
0.5 ug/l (0.0005 mg/l)	127 yr

c) The downgradient section of the plume modeled is similar to the hot spot section. A source is placed at the upgradient edge of the section to generate that portion of the plume, then the plume is moved forward in time.

ONED-1 cannot take a section of a plume and move it forward in time; ONED-1 must generate a plume from a source and then move it forward in time.

The source concentration is set at 1.2 times 1.0 mg/l, the concentration at the upgradient edge of this plume section at time zero. The duration of the solute pulse is varied until the downgradient model curve reasonably matches the natural gradient model curve downgradient of the 1.0 mg/l isopleth. The pulse is "turned off", and the downgradient model is then run forward in time until the cleanup goal is reached at the appropriate observation points.

Table C-8

Case 3c Observation Points
(50 ft/yr, Downgradient Section of Plume)

Cleanup Goal	Observation Points (from natural gradient 1.0 mg/l isopleth)
50 ug/l (0.05 mg/l)	200 ft
5 ug/l (0.005 mg/l)	310 ft
0.5 ug/l (0.0005 mg/l)	405 ft

Table C-9

Case 3c Time to Cleanup Results
(50 ft/yr, Downgradient Section of Plume)

Cleanup Goal	Observation Points (from natural gradient 1.0 mg/l isopleth)
50 ug/l (0.05 mg/l)	6 yr
5 ug/l (0.005 mg/l)	33 yr
0.5 ug/l (0.0005 mg/l)	81 yr

C.4 RESULTS AND CONCLUSIONS

1. When the Site SS030 plume is modeled with three sections, the hot spot section takes the longest time to cleanup. The time to cleanup the site should therefore be based on the hot spot section results. Figure C-2 shows a plot of cleanup goal versus time to cleanup for the hot spot section model.

2. Targeting the hot spot for cleanup (Case 3b) instead of only intercepting the plume (Case 2), reduces the cleanup time by more than a factor of 3.

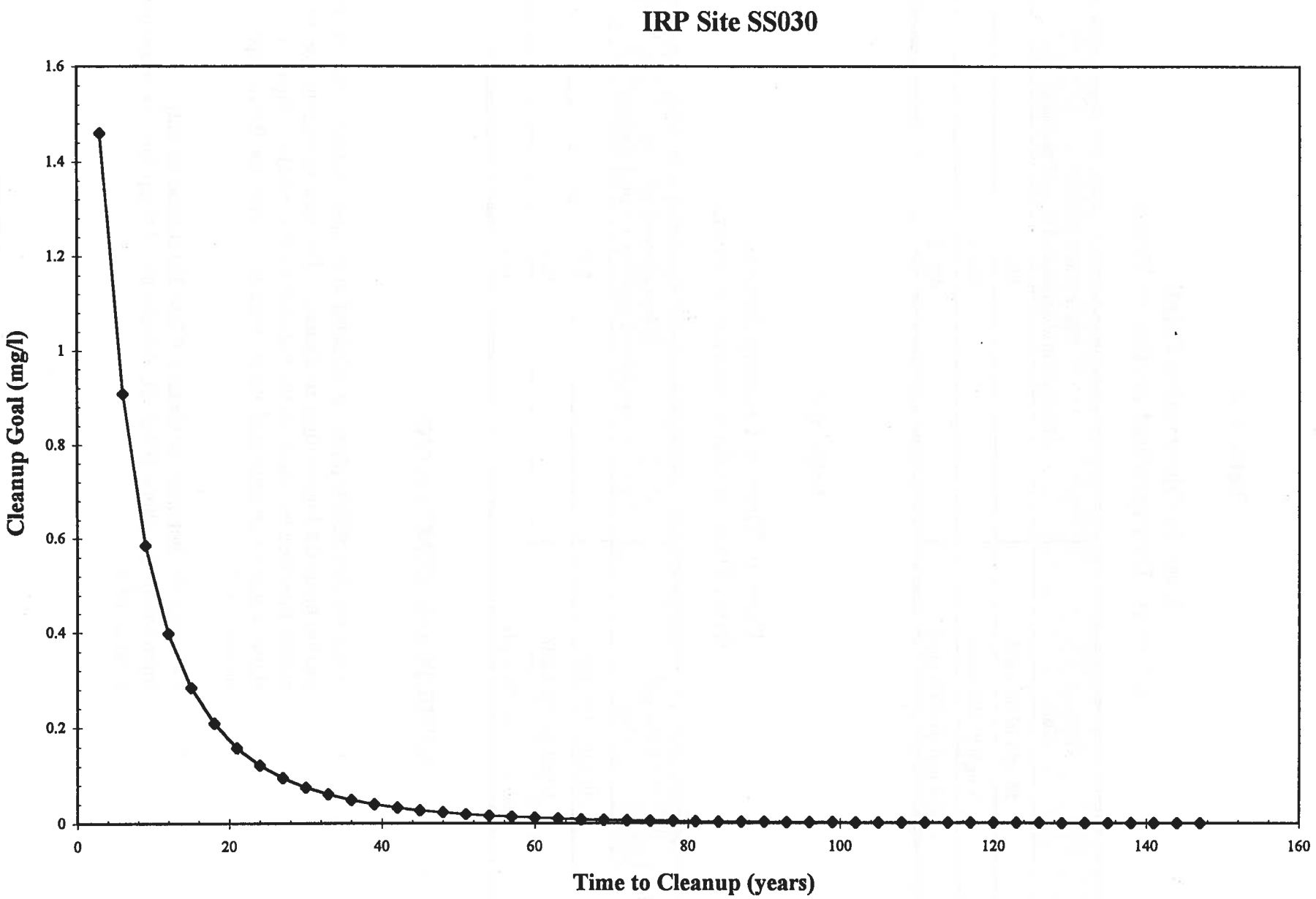


Figure C-2. Time to Cleanup Curve

3. The hot spot cleanup times calculated for Site SS030 are plotted in Figure C-2.

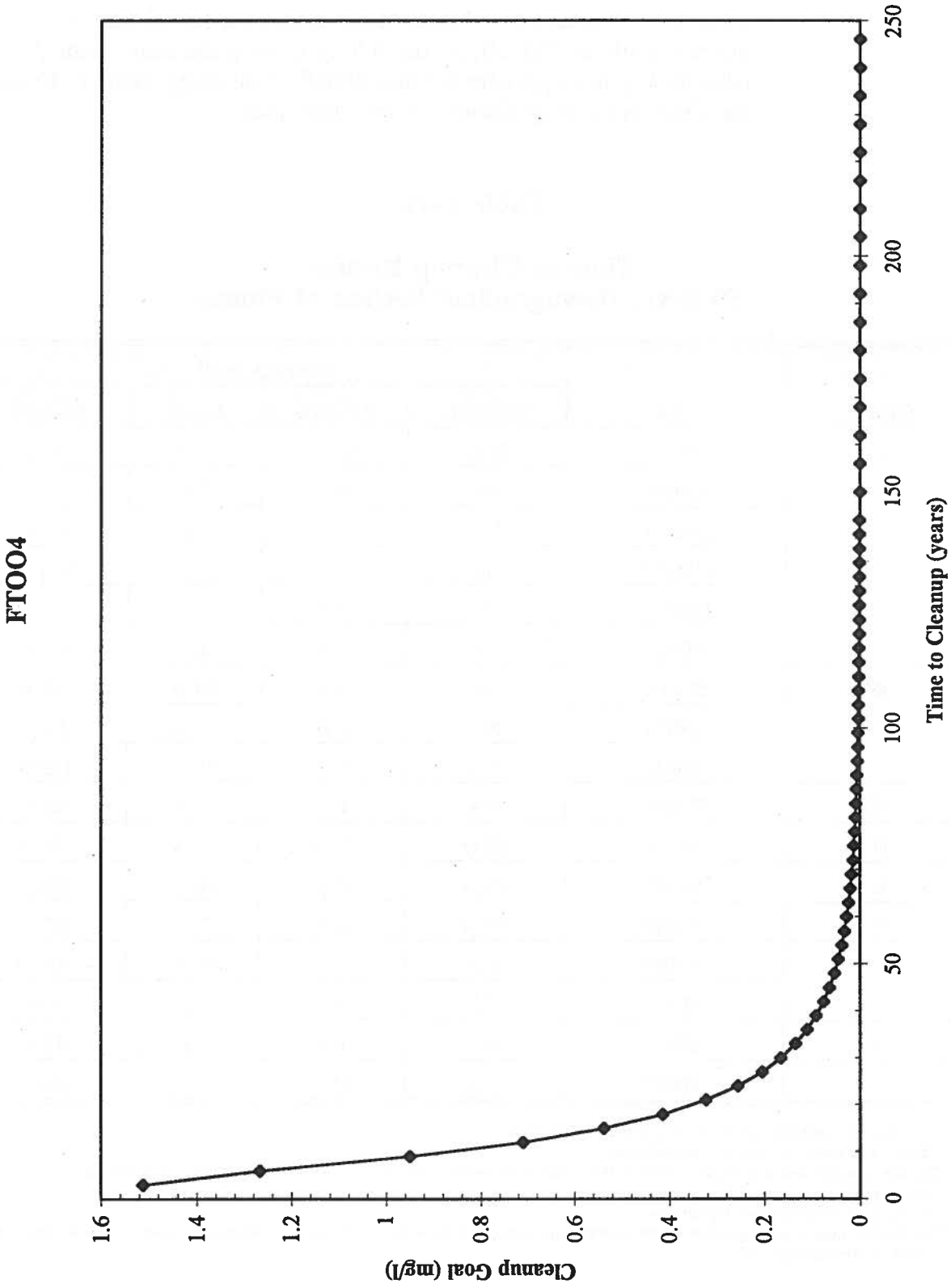
4. Table C-10 contains the cleanup times calculated for all sites for cleanup goals of 500, 50, 5, and 0.5 ug/l, using the same method described in this appendix for Site SS030. Following Table C-10 are the Time to Cleanup Curves for the other sites.

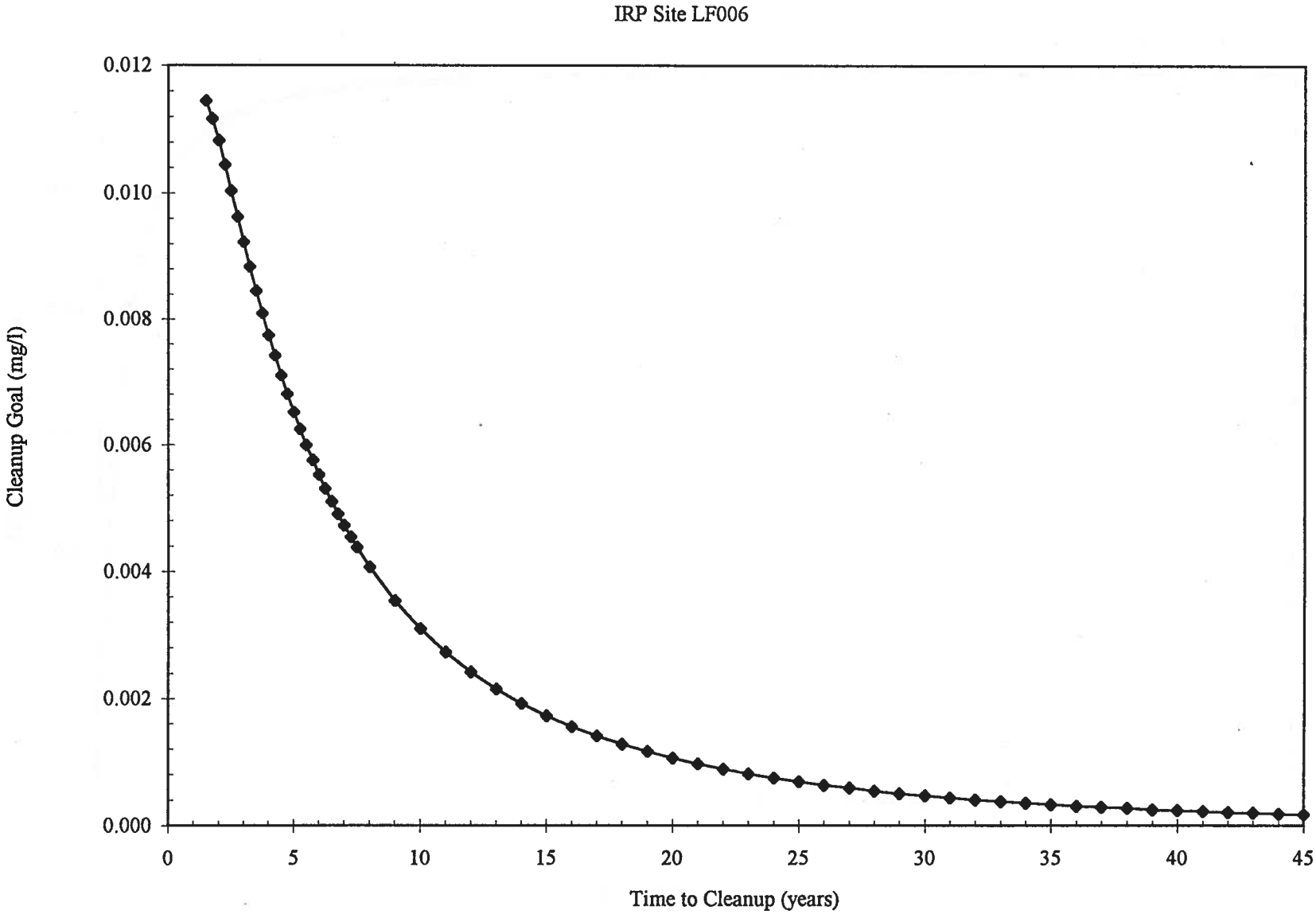
Table C-10

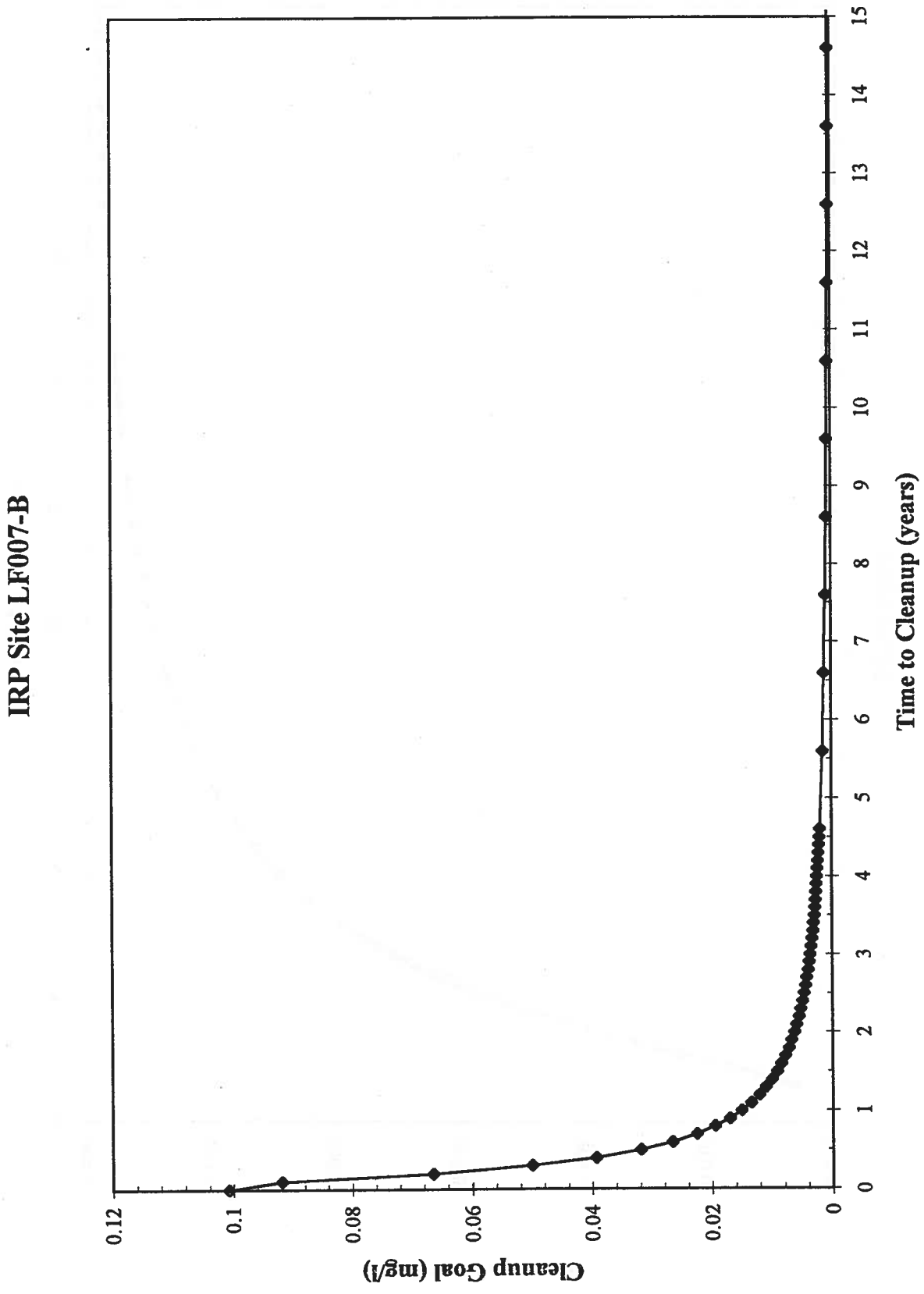
Time to Cleanup Results (50 ft/yr, Downgradient Section of Plume)

Group	Site	Cleanup Goal[1]			
		500 µg/L	50 µg/L	5 µg/L	0.5 µg/L
A	FT004	16 yr	49 yr	95 yr	149 yr
	LF006	NA	NA	7 yr	29 yr
	LF007-B[2]	NA	NA	3 yr	12 yr
	LF007-C	NA	NA	12 yr	38 yr
	LF007-D[2,3]	NA	NA	2 yr	10 yr
	SD031	2 yr	9 yr	28 yr	63 yr
B	SDO36	NA	23 yr	60 yr	112 yr
	SS015	NA	5 yr	17 yr	45 yr
	SD033	5 yr	31 yr	85 yr	150 yr
C	FT005[4]	NA	NA	15 yr	65 yr
D	SS016	82 yr	135 yr	193 yr	254 yr
E	SSO29	35 yr	92 yr	149 yr	209 yr
F	SS030	10 yr	36 yr	77 yr	127 yr
G	SD034	2 yr	25 yr	60 yr	107 yr
	ST032[5]	NA	NA	2 yr	4 yr
H	SS035	NA	NA	3 yr	21 yr
I	SD037	27 yr	63 yr	111 yr	166 yr

1 Cleanup goal concentrations for TCE unless otherwise noted.
2 Cleanup goal concentrations for chlorobenzene.
3 This site was modeled with radial flow from the center of the plume. All other sites modeled with linear flow through the plume.
4 Cleanup goal concentrations for 1,2-DCA.
5 Cleanup goal concentrations for benzene.
NA This cleanup goal is not applicable for the contaminant concentrations at this site because the maximum concentration is already below or close to the cleanup goal.


FTOO4
Cleanup Goal (mg/l)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
Time to Cleanup (years)


IRP Site LF006
Cleanup Goal (mg/l)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
5
10
15
20
25
30
35
40
45
Time to Cleanup (years)


IRP Site LF007-B
Cleanup Goal (mg/l)
0.12
0.1
0.08
0.06
0.04
0.02
0
Time to Cleanup (years)
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1
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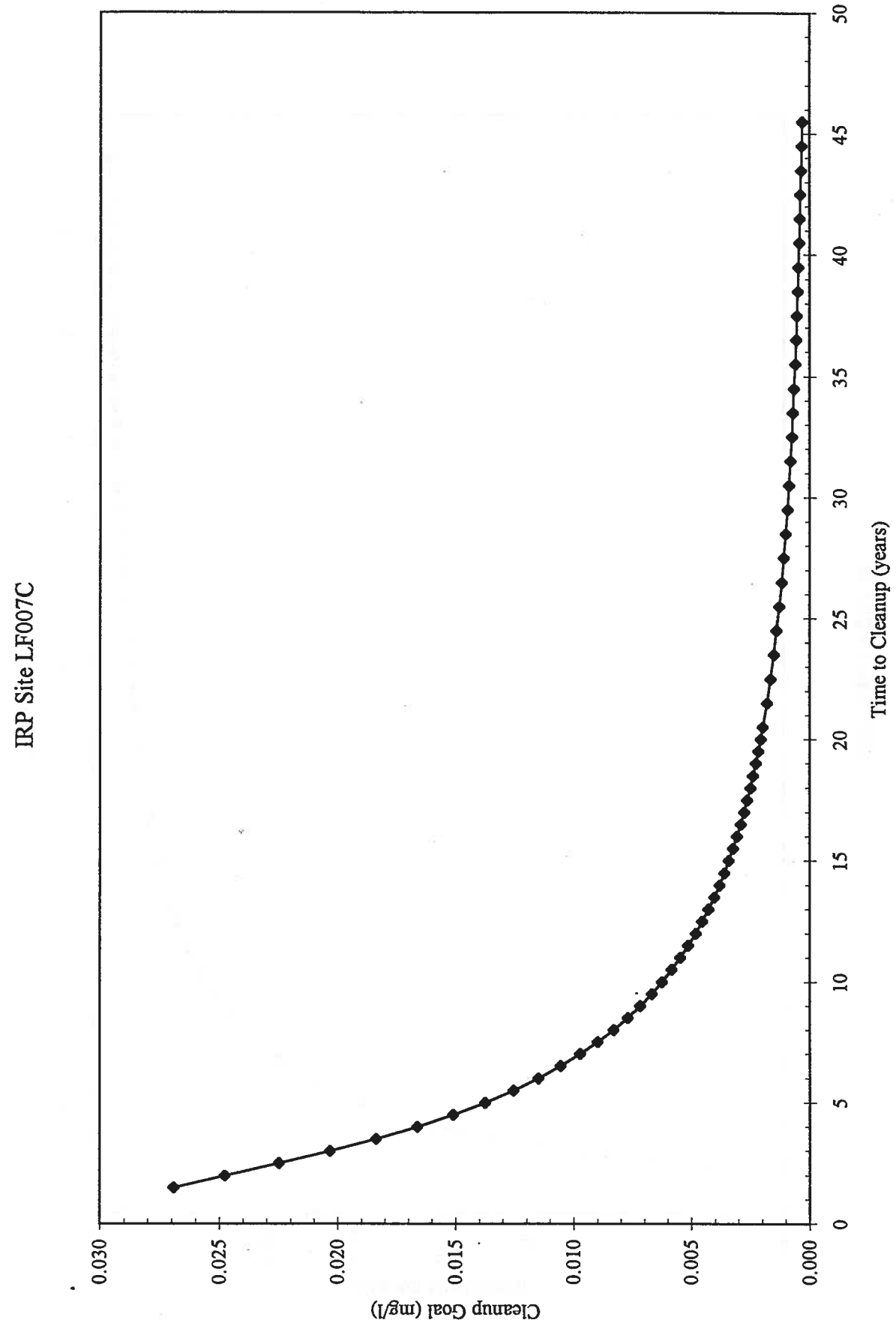
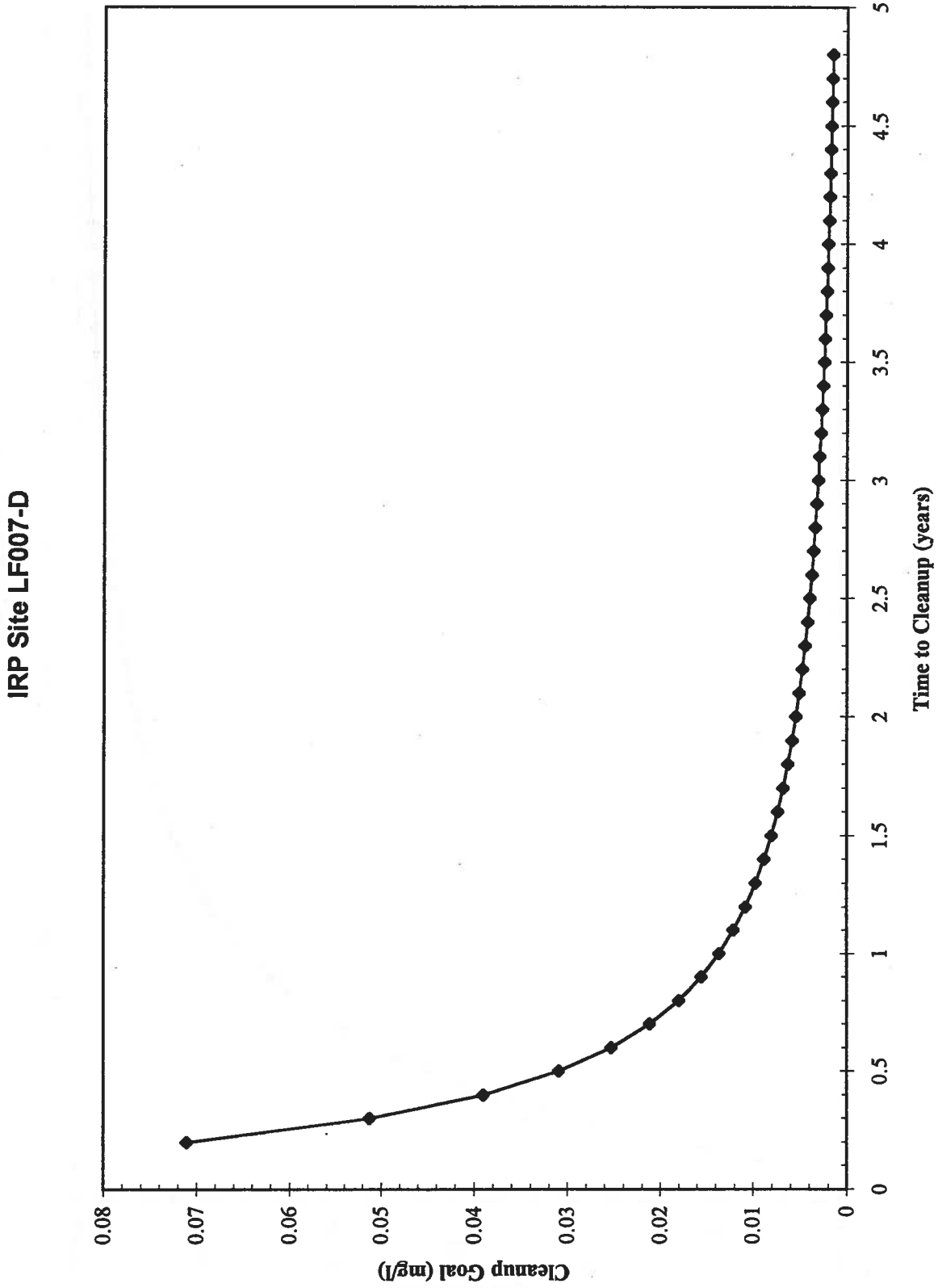
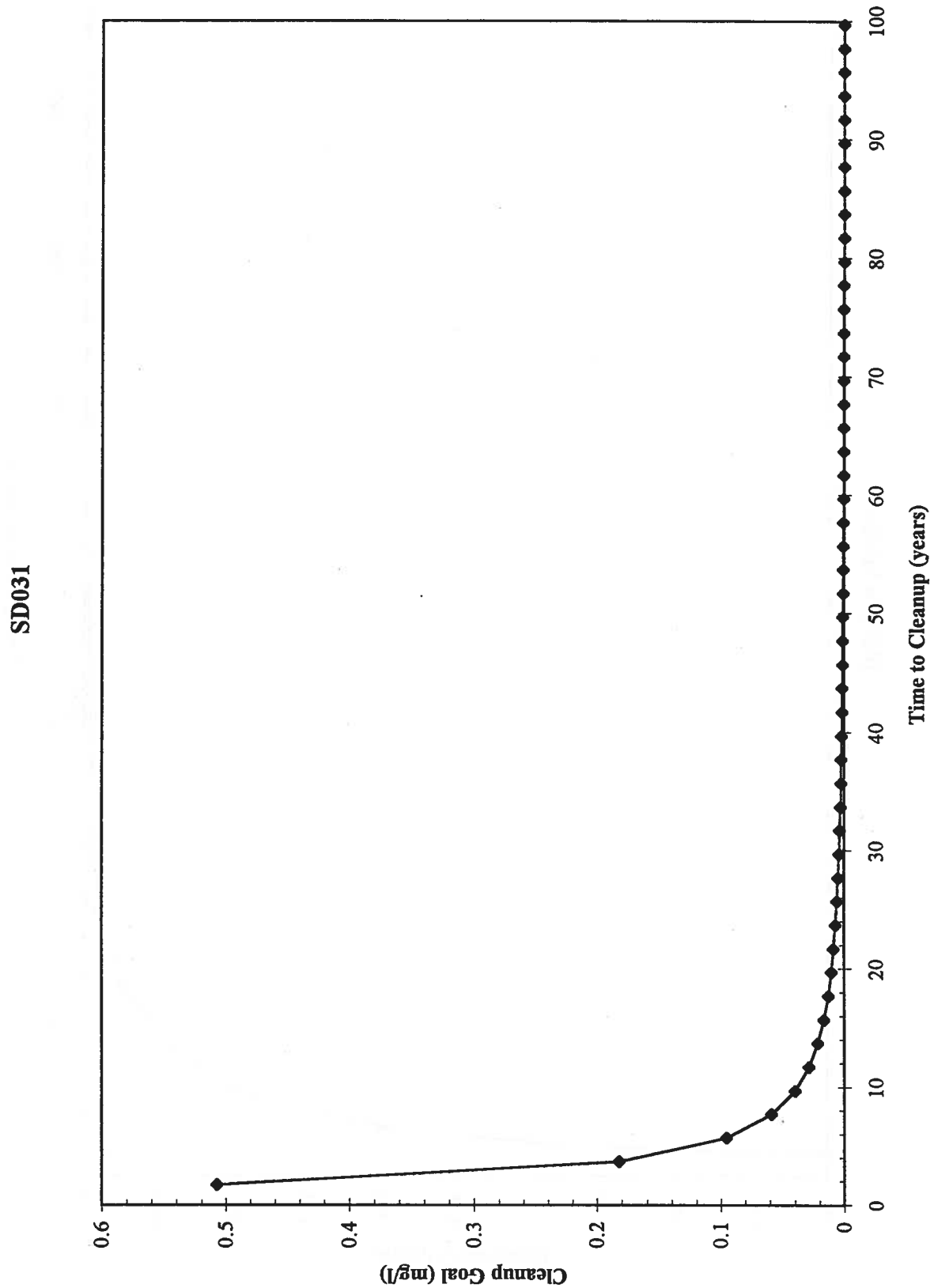
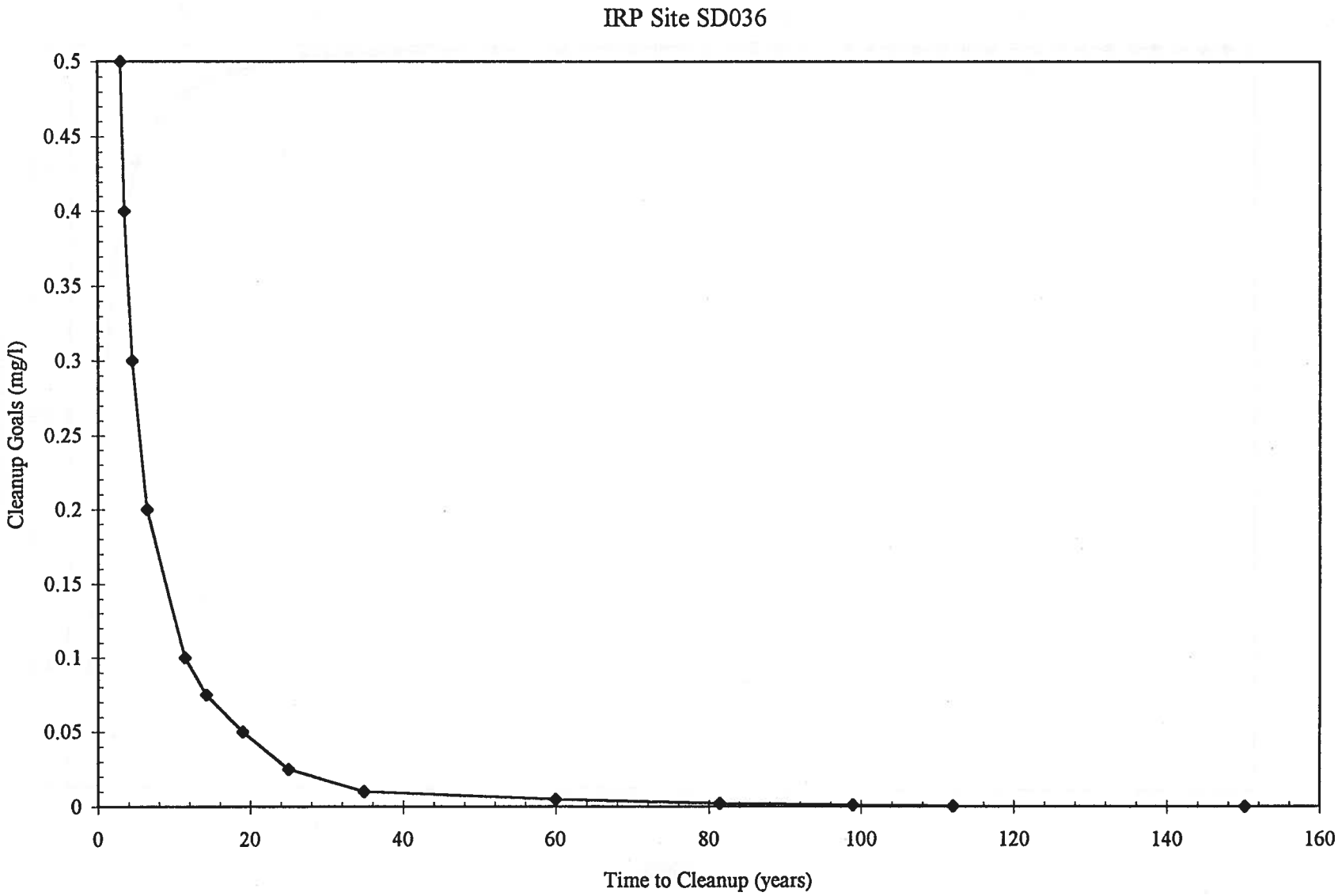
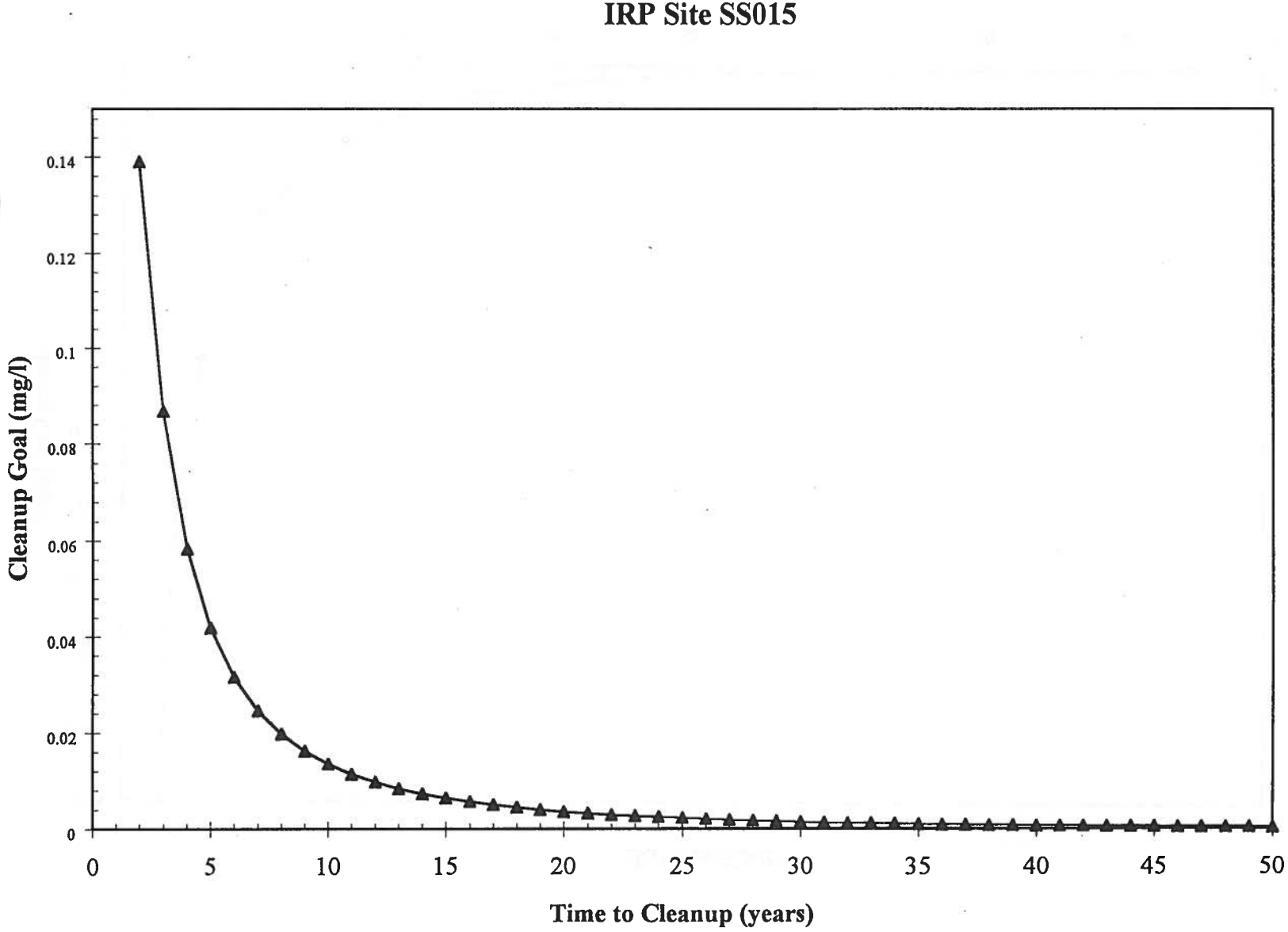
3
4
5
6
7
8
9
10
11
12
13
14
15

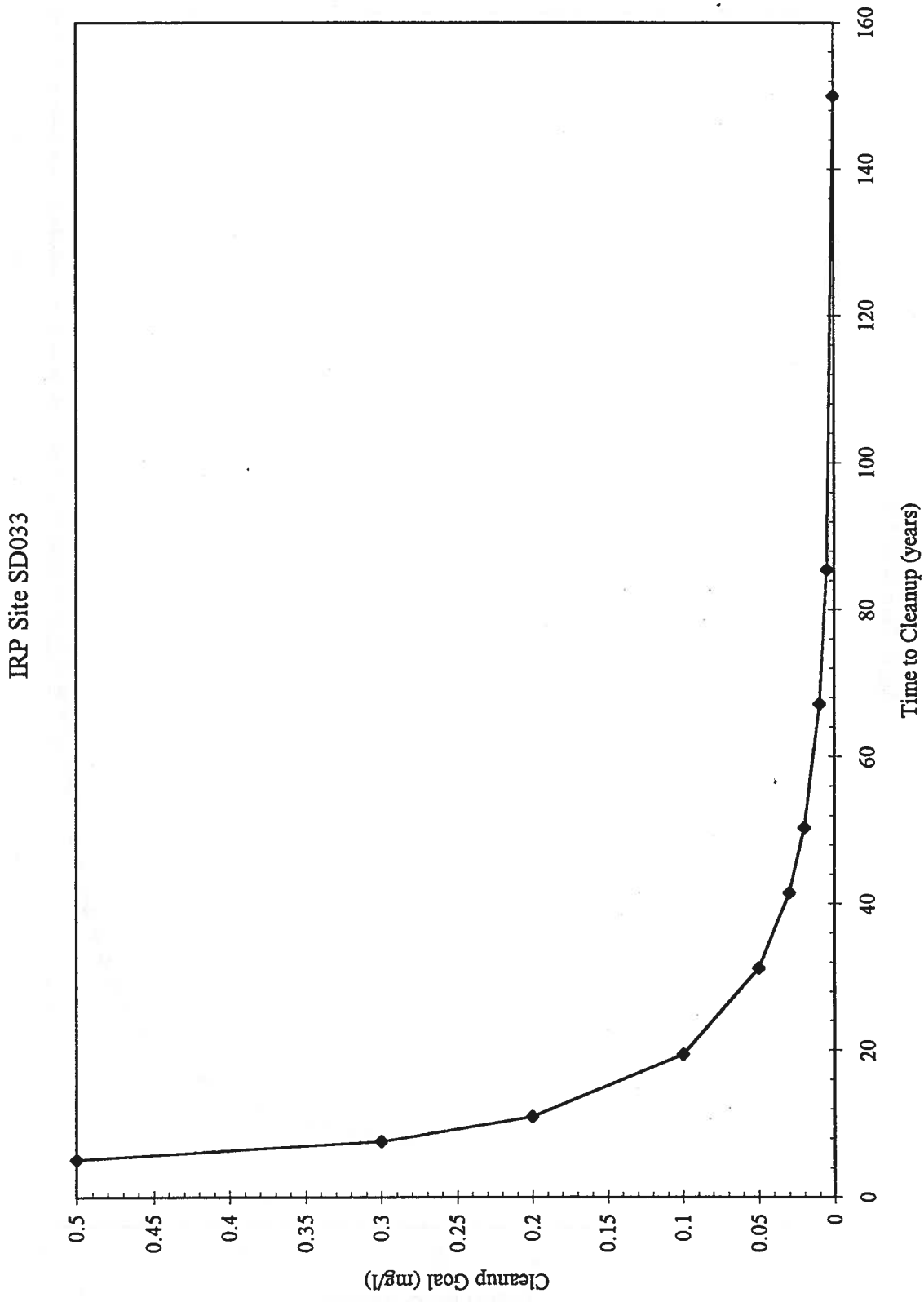

IRP Site LF007C
Cleanup Goal (mg/l)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Time to Cleanup (years)
0
5
10
15
20
25
30
35
40
45
50

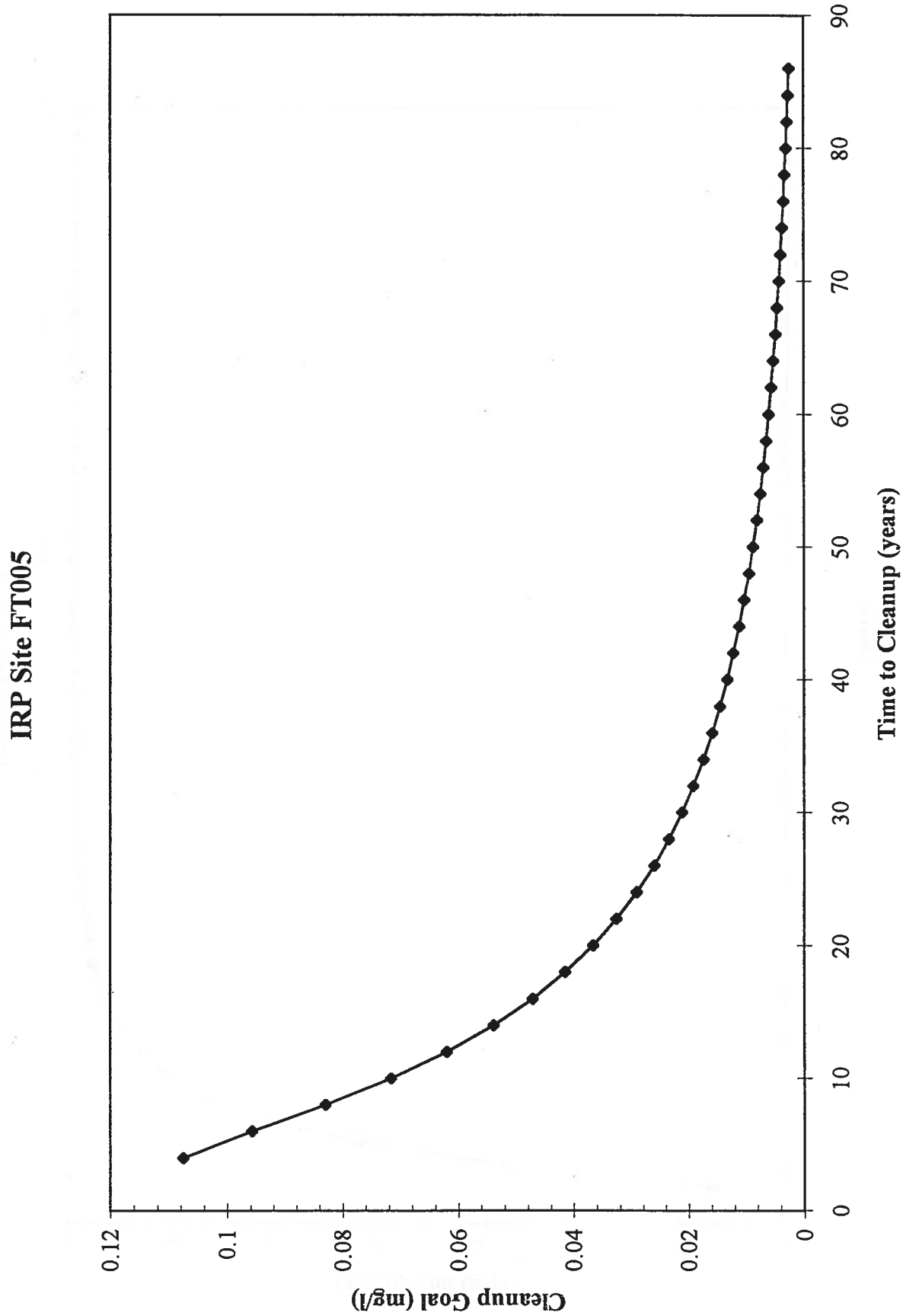

IRP Site LF007-D
Cleanup Goal (mg/l)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Time to Cleanup (years)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

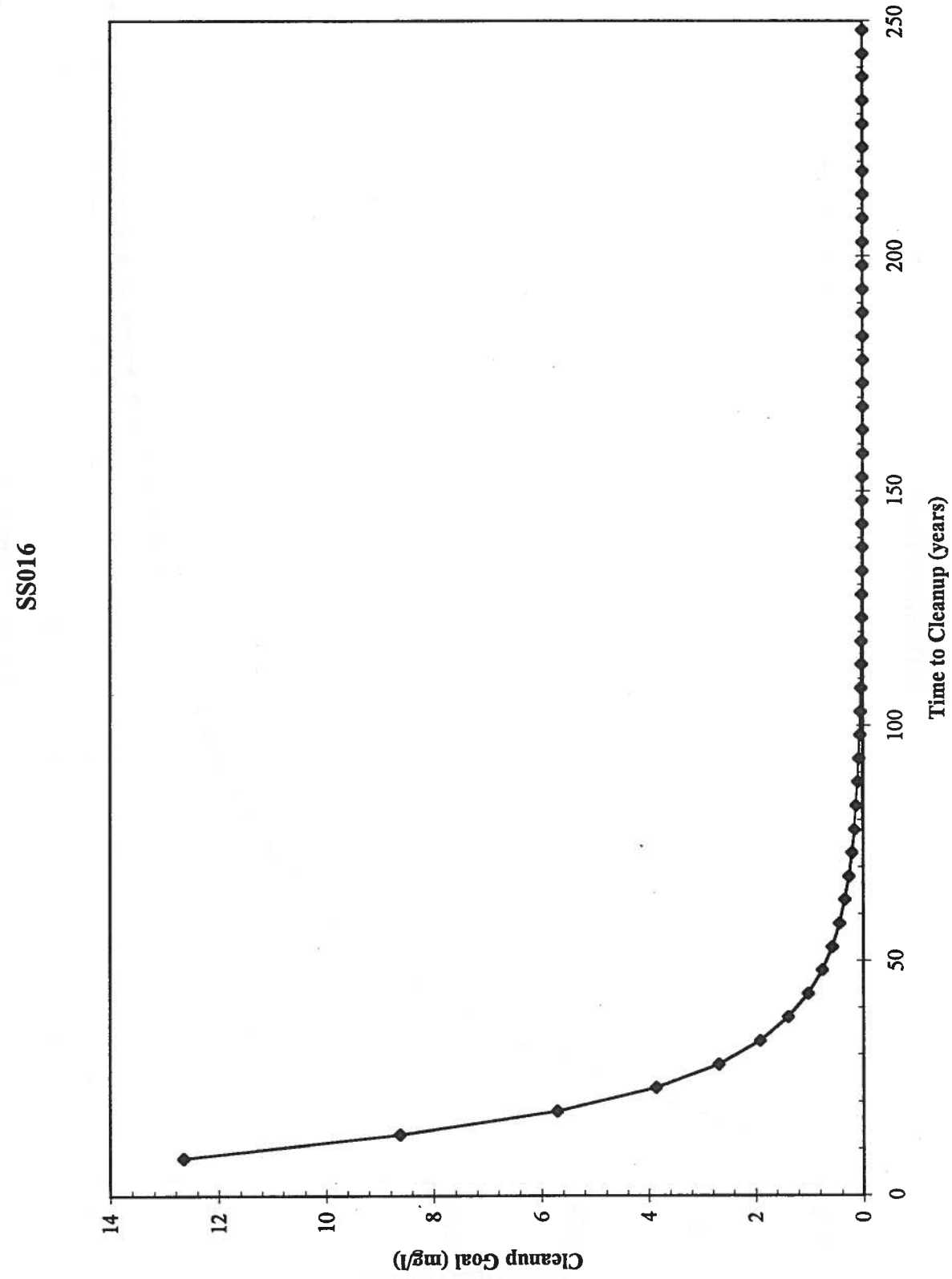

SD031
Cleanup Goal (mg/l)
0.6
0.5
0.4
0.3
0.2
0.1
0
Time to Cleanup (years)
0
10
20
30
40
50
60
70
80
90
100


IRP Site SD036
Cleanup Goals (mg/l)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
20
40
60
80
100
120
140
160
Time to Cleanup (years)

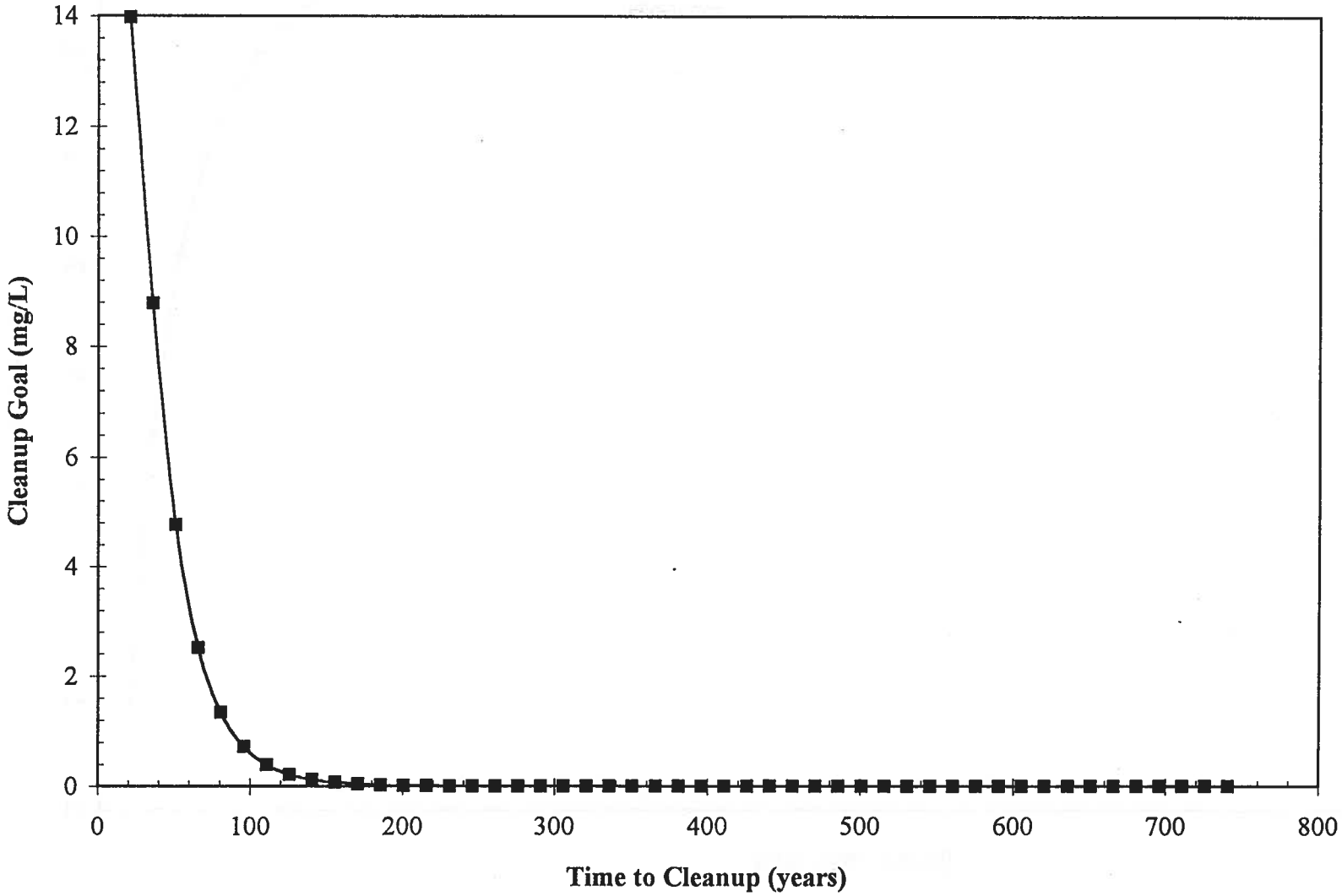

IRP Site SS015
Cleanup Goal (mg/l)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
5
10
15
20
25
30
35
40
45
50
Time to Cleanup (years)

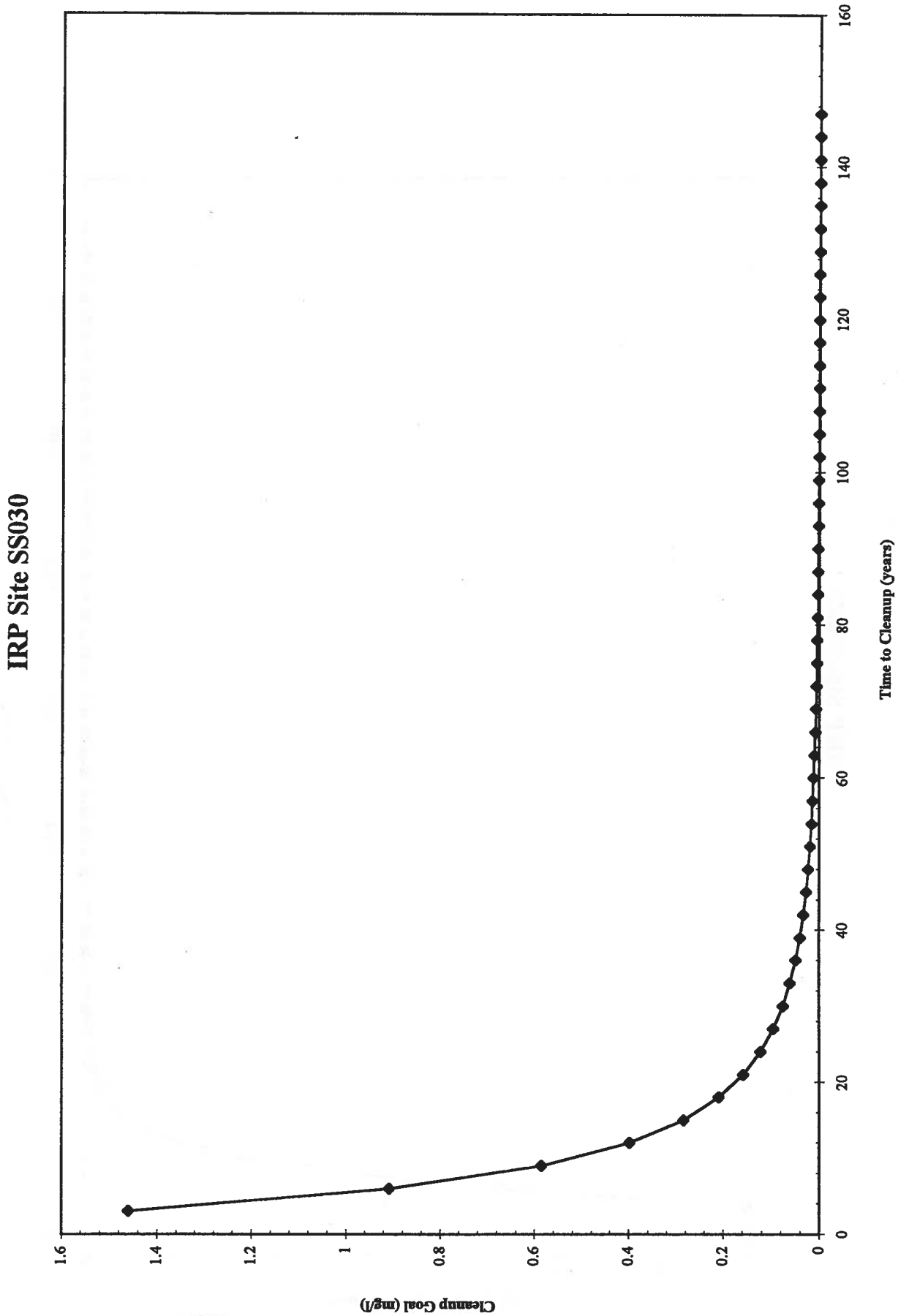

IRP Site SD033
Cleanup Goal (mg/l)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Time to Cleanup (years)
0
20
40
60
80
100
120
140
160

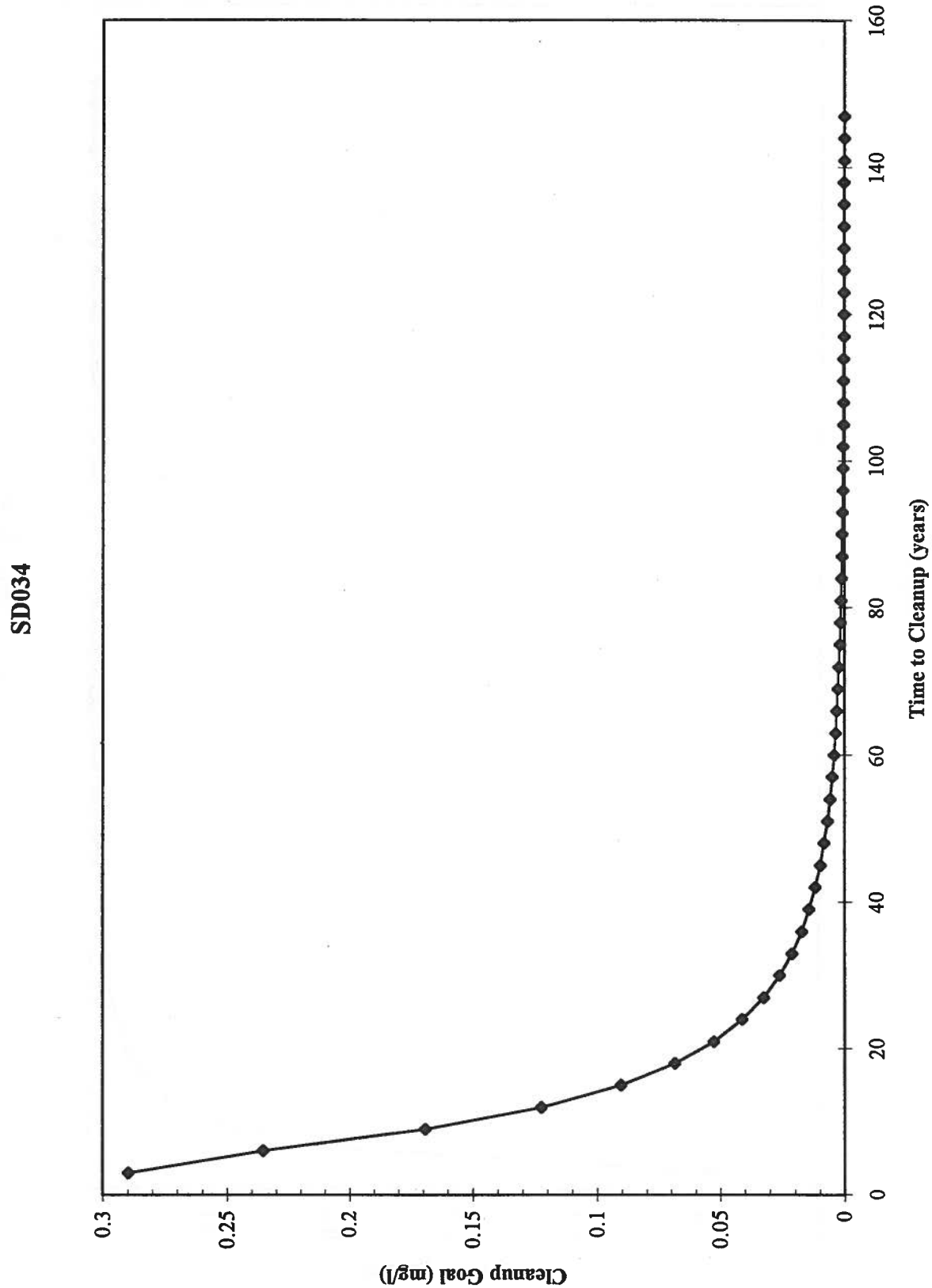

IRP Site FT005
Cleanup Goal (mg/l)
0.12
0.1
0.08
0.06
0.04
0.02
0
Time to Cleanup (years)
0
10
20
30
40
50
60
70
80
90

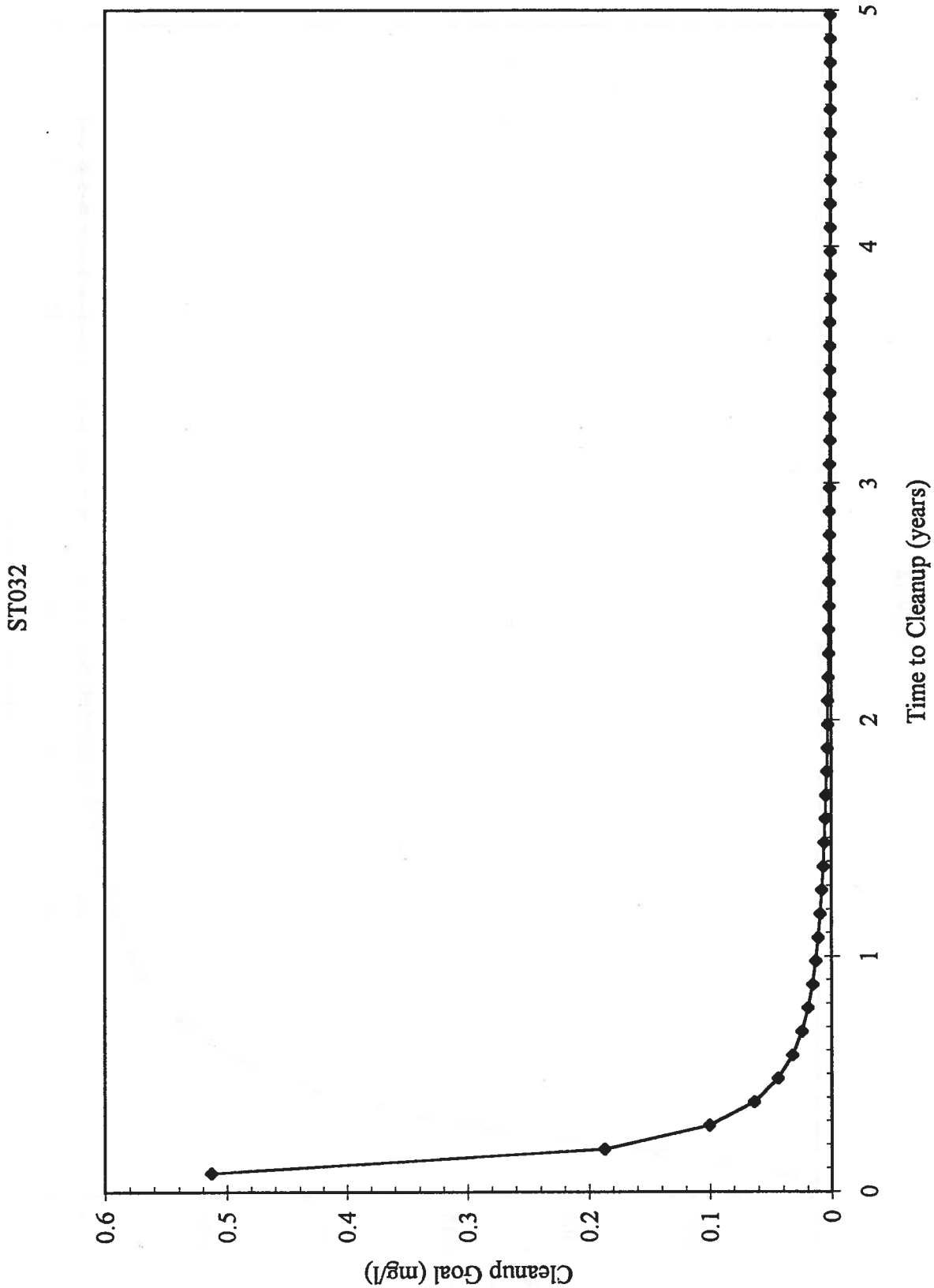

SS016
Cleanup Goal (mg/l)
0
2
4
6
8
10
12
14
0
50
100
150
200
250
Time to Cleanup (years)

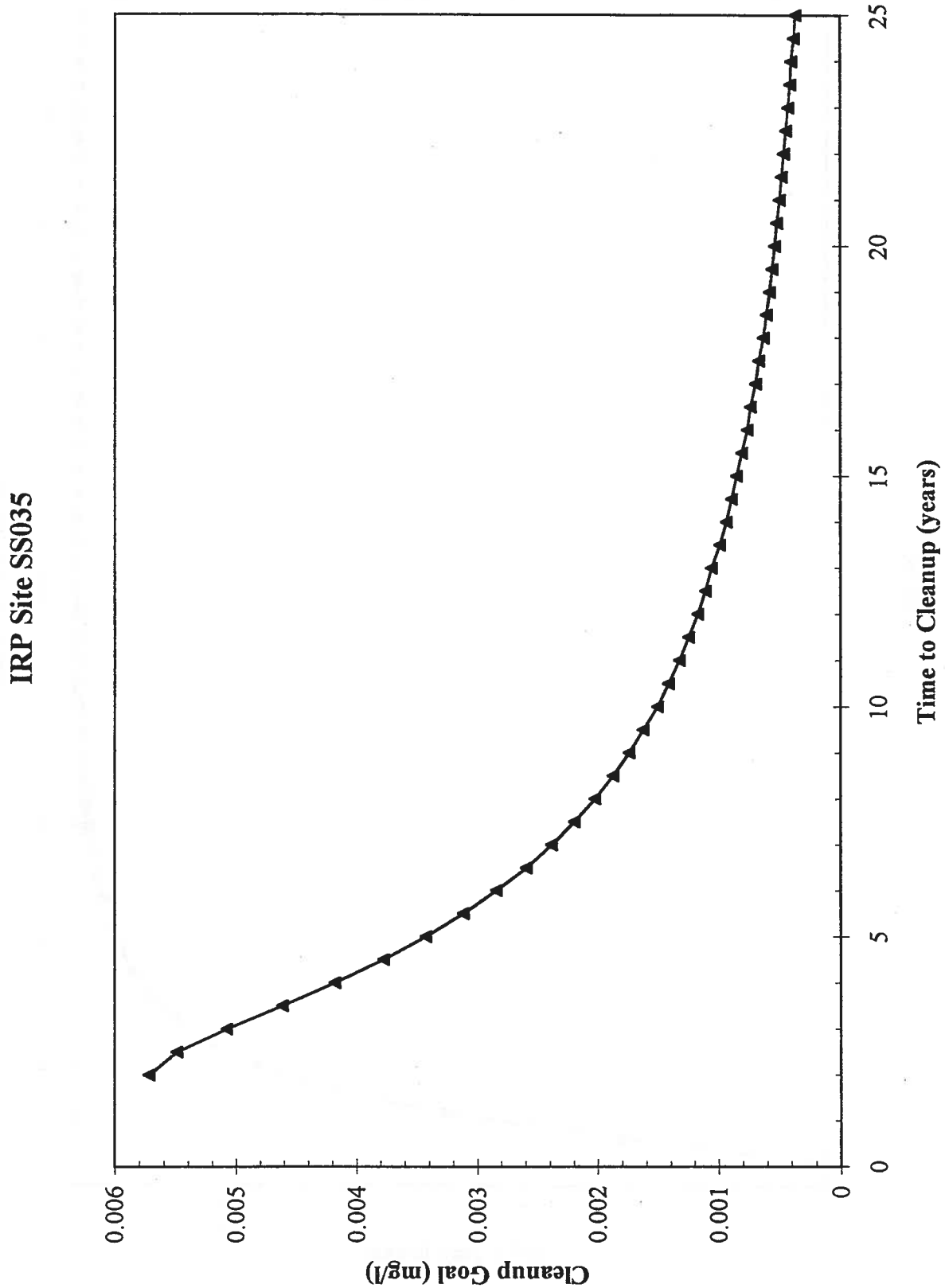
IRP Site SS029

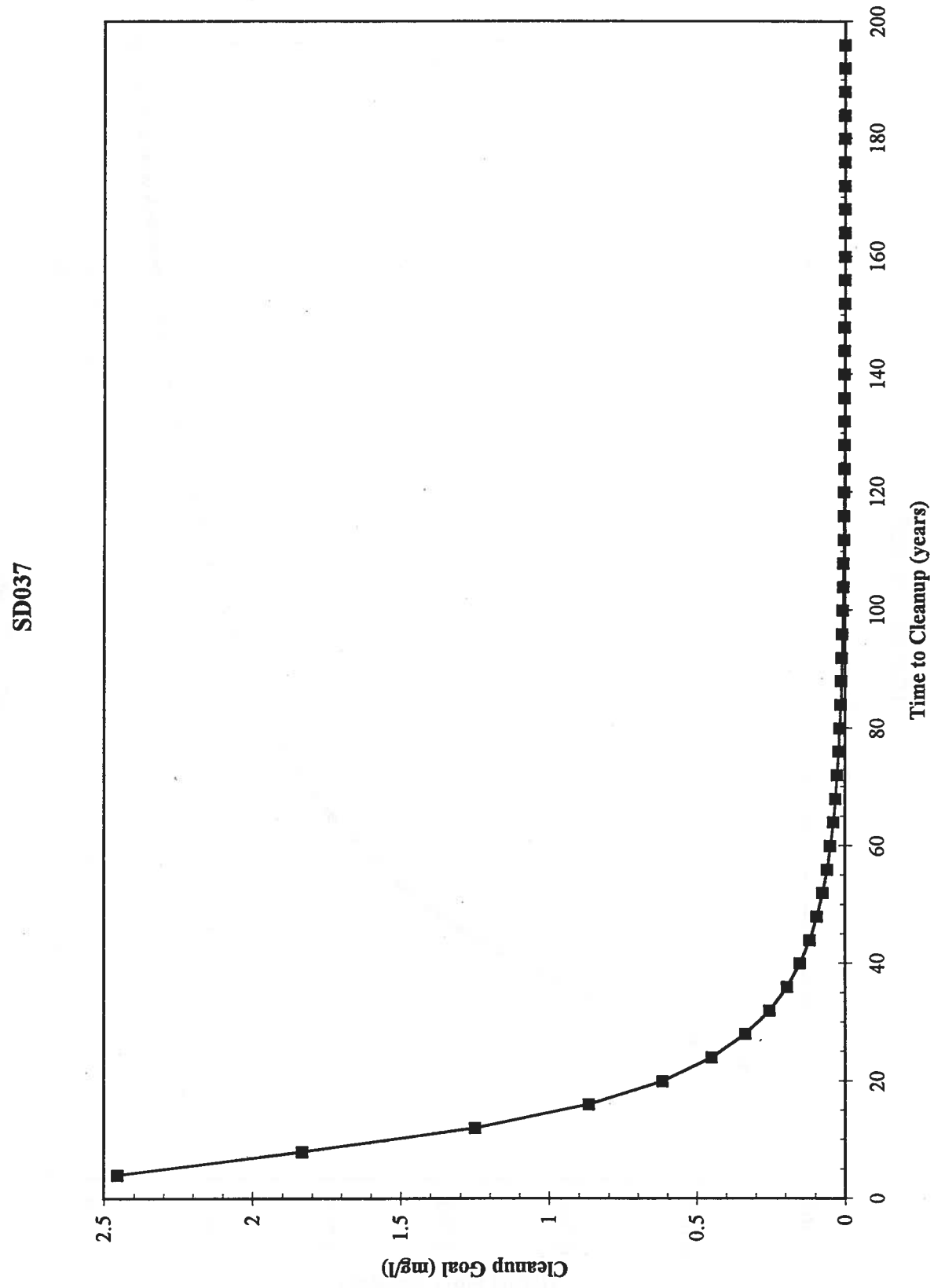



IRP Site SS030
Cleanup Goal (mg/l)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Time to Cleanup (years)
0
20
40
60
80
100
120
140
160


SD034
Cleanup Goal (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
Time to Cleanup (years)
0
20
40
60
80
100
120
140
160


ST032
Cleanup Goal (mg/l)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
Time to Cleanup (years)


IRP Site SS035
Cleanup Goal (mg/l)
0.006
0.005
0.004
0.003
0.002
0.001
0
Time to Cleanup (years)
0
5
10
15
20
25


SD037
Cleanup Goal (mg/l)
2.5
2
1.5
1
0.5
0
Time to Cleanup (years)
0
20
40
60
80
100
120
140
160
180
200

APPENDIX D

Response to Comments
on the
Draft NEWIOU Feasibility Study

Response to CIWMB Comments on the Draft Feasibility Study for the NEWIOU

No.	Comments	Responses/Notes
GENERAL COMMENTS		
1	**Presumptive Remedy:** In order to expedite the Feasibility Study process for the landfills located in the North Operable Unit, it was determined during the May 15, 1996 meeting that a presumptive remedy approach should be taken. The presumptive remedy of capping has already been evaluated and determined to be the chosen alternative in two Records of Decision for similar landfills at Mather Air Force Base. This would save the time and effort of evaluating and reviewing the other landfill alternatives that may not meet the nine criteria established in the National Contingency Plan.	This decision is consistent with the FS as now written. No changes to the FS required. Specific details concerning decision making and presumptive remedies are more appropriately provided in the Proposed Plan and ROD.
2	**Applicable or Relevant and Appropriate Requirements (ARARs):** The ARARs table provided in the Feasibility Study is not consistent with previous rulings on CIWMB ARARs by Air Force, DTSC, CIWMB, and U.S. EPA legal counsel. Several of the CIWMB ARARs were listed as "not ARARs." Enclosed is a table of the CIWMB ARARs that, after legal review, have been incorporated into previous landfill Records of Decision. Please notify staff if the ARARs presented in the Feasibility Study represent a change in the Air Force's legal position on the CIWMB ARARs so that CIWMB legal counsel can be notified. If this is not the case, please incorporate the enclosed table as potential CIWMB ARARs.	We concur with the changes recommended by CIWMB. Our original classification of some of these ARARs as not applicable or relevant omitted consideration of the potential for Site 007 to be used as a consolidation site. The previously omitted ARARs are applicable to consolidation activities at this site.
3	**Landfill Closure Costs:** To assist in the determination of landfill closure costs, CIWMB staff have compiled the enclosed closure cost data base. Please consider in the Travis Air Force Base landfill closure cost estimates that clean and acceptable levels of contaminated soil can be incorporated into the landfill cap. Using the existing landfill for the disposal of soils will result in a substantial cost savings by eliminating soil disposal costs and the cost of importing fill material that would be required to bring the final cover up to the appropriate grades.	Thank you for your efforts to compile the cost information. This information is appreciated and will be useful to us in evaluating remedial actions. This strategy will be incorporated into the Proposed Plan and ROD. FS text has been modified to include the option of on-site disposal of contaminated soils and the cost data compared to the costs in the FS. However, we suggest that the FS cost estimates remain unchanged as it is more conservative not to assume the availability of onsite soils for landfill construction. More precise cost estimates will be determined in the remedial design phase.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU

No.	Comments	Responses/Notes
GENERAL COMMENTS		
1	In general the Department of Toxic Substances Control (DTSC) finds this document to be well organized and complete. This in part is due to the Initial and Detailed Screening of Alternatives provided by the United States Air Force to the agencies for earlier comments. This document presents a practical approach in addressing site remediation based on media of contamination (groundwater and soil), and proximity of sites to one another in consideration of the "Groundwater Basins."	Comment noted. No response needed.
SPECIFIC COMMENTS		
	Section 1.0, Remedial Investigation (RI) Summaries for the North Operable Unit (NOU), East Industrial Operable Unit (EIOU), and West Industrial Operable Unit (WIOU)	
1	**Section 1.2, NOU RI Summary and Conclusions** This Section describes the conclusions of the RI conducted for the NOU. Table 1-2 gives a summary of NOU areas, media, contaminants, and risk recommended for evaluation in the Feasibility Study (FS). It is noted that only ecological risk for metals is given for Site LF007 (Landfill 2). Provide a discussion in the text or table that explains why only ecological risk for metals was done and no human risk for metals was done for Site LF007.	The information in the table presents all COCs recommended for carryover to the FS, and their respective risk drivers, as determined by the RI. Human health risk for metals was calculated in the RI, but did not lead to significant human health risk from metals, except at LF007, Area E. Text has been added to the end of Section 1.1 to stress that only COCs and media identified in the RI are carried forward to the FS.
2	**Section 1.3, EIOU RI Summary and Conclusions** This Section describes the conclusions of the RI conducted for the EIOU. Table 1-3 gives a summary of North, East, and West Industrial Operable Unit (NEWIOU) areas, media, contaminants, and risk recommended for evaluation in the FS. It is noted that only ecological risk for metals is given for Sites SD001, FT002, FT003, FT004, FT005, OT010, SS015, and WP017. Provide a discussion in the text or table that explains why only ecological risk for metals was done and no human risk for metals was done for the aforementioned sites.	The information in the table presents all COCs recommended for carryover to the FS, and their respective risk drivers, as determined by the RI. Metals in soil were not shown to present a significant risk to human health at the sites in question. Text has been added to the end of Section 1.1 to stress that only COCs and media identified in the RI are carried forward to the FS.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
3	**Section 1.4, WIOU RI Summary and Conclusions** This Section describes the conclusions of the RI conducted for the WIOU. Table 1-5 gives a summary of WIOU areas, media, contaminants, and risk recommended for evaluation in the FS. It is noted that only ecological risk for metals is given for Sites SD033, SS035, and SD037. Provide a discussion in the text or table that explains why only ecological risk for metals was done and no human risk for metals was done for the aforementioned sites. In addition, it is noted that no risk assessment, human or ecological, was performed for soil gas at Sites SD003 and SD034; soil gas and groundwater at Site SS035; and soil and soil gas at Sites SD036 and SD037. Provide a discussion in the text or table that explains why no risk assessment was done for these sites.	The information in the table presents all COCs recommended for carryover to the FS, and their respective risk drivers, as determined by the RI. Metals were not shown to present a significant risk to human health at the sites in question. Risk assessment was not performed on soil gas as soil gas measurements were rather screening level assessments meant to indicate the possible presence of soil and groundwater contamination. Text has been added to the end of Section 1.1 to stress that only COCs and media identified in the RI are carried forward to the FS.
	Figures of Section 1.0	
4	**Figures 1-6 through 1-11, RI Summary Information for LF007** The lower portion of these figures show the direction of groundwater flow by "bold" arrows. No distinction is made as to the "regional" groundwater flow direction and the "local" groundwater flow direction. DTSC recommends that the two arrows pointing north and northeast, respectively, be modified. Since these two arrows show local groundwater flow directions a result of the topographic and structural expression of the landfill in Area B, they should be smaller or described as local groundwater flow direction.	The figures will be modified accordingly.
5	**Figure 1-14, RI Summary Information for FT003** The conceptual model cross section view is misleading. In the cross section view, both soil and groundwater contamination are shown. However, the figure description only identifies soil as the affected medium. Modify this figure accordingly.	The groundwater contamination shown is for Fire Training Area 3 (FT004) which is shown on the FT003 figure since the sites are so close. A footnote has been added to explain this. In a related comment, reference to groundwater contamination will be deleted per agreement at the last RPM meeting to remove groundwater as a medium of concern at FT002 and FT003.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
6	**Figure 1-23, RI Summary Information for SD031** The conceptual model cross section is misleading. In the cross section view, it appears as though the contaminated groundwater plume is under Buildings Number 373 and 1204. However, in plan view the plume is not shown under these buildings. The cross section view also shows soil contamination. However, the figure description only identifies groundwater as the affected medium. Modify this figure accordingly.	The figure has been modified accordingly.
7	**Section 3.0, Identification and Screening of Technologies and Development of Potential Alternatives** Various subsections in this section discuss deed restrictions as a means of applying institutional actions for land access and land use. Since Travis Air Force Base (AFB) is an active base with no immediate future plans for closure, it is DTSC's understanding that deed restrictions on land use do not apply. Deed restrictions would only apply when property is being transferred from the Air Force to some private nonfederal ownership. Please provide further detail on how such deed restrictions will be administered. As an alternative, land use restrictions for Travis AFB could be administered/documented in the "Base Plan" and Record of Decision. All subsections in the report referring to deed restrictions should be modified accordingly.	The text (Sections 3.3.2, Tables 3-1, 3-2, 3-3, and 3-4, Section 3.6, 3.7, and 3.8, pages 5-9, 7-5, 7-14, 7-23, 7-35, 7-39, 7-48, 7-57, and 7-66) will be clarified, in accordance with this comment, to refer to "administrative controls" as the mechanism to restrict land use while the base is active. These controls would be managed by personnel in the base Civil Engineering office, who will ensure that specified land use restrictions are followed and are reflected in the base use plan. If the base were to close, the text will refer to deed restrictions or other forms of land use restrictions as potential land use control mechanisms.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
8	**Section 3.8, Remedial Alternatives** This Section discusses the remedial alternatives for soil. The process options are derived from Table 3-1, Summary of Evaluation of Process Options for Groundwater and Surface Water. Among the alternatives selected for further evaluation is landfill disposal (Alternative 18), and soil and bentonite cap (Alternative 19). Alternative 18 discusses offsite disposal in Class I and Class II landfills. Alternative 19 discusses containing soil contamination in place by means of a cap. However, one alternative not discussed is onsite disposal of selected contaminated soil having low Total Petroleum Hydrocarbon (TPH) at Site LF007. This selected contaminated soil could potentially be used as foundation material in the preparation of a cap for Site LF007. However, placement of petroleum contaminated waste in LF007 must meet the requirements of California Code of Regulations, Title 23, Chapter 15. DTSC recommends including this alternative in the discussion.	The text will be modified to incorporate this comment. A new alternative will not be needed as Alternative 19, "soil and bentonite cap" could include the use of on-base soils as part of the cap. The noted regulatory restriction will be discussed as a potential action-specific ARAR. Page 3-54, which discusses the option of using uncontaminated soil as part of the cap foundation of Alternative 19, will be expanded to additionally include the use of contaminated soil, as long as environmental protectiveness can be provided. Alternative 20 (Page 3-58) also currently points out the acceptability of on-site disposal of treated soil as part of a cap foundation. The possible use of contaminated soil will also be included in Alternatives 18 and 19. Table 3-2 will also be revised to clearly state this process option.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
9	**Section 7.0, Detailed Analysis of Soil Sites** This Section gives a detailed discussion of seven alternatives applicable to soil contamination for Groups K through R. Treatment alternatives and design assumptions are displayed in representative figures for each group. Also included are estimated costs which are for cost comparison to implement the designs. DTSC recommends that consideration be given to include the additional alternative of onsite disposal for selected contaminated soil. Including this additional alternative could potentially achieve significant cost savings for individual sites in these groups. For example, for Site SD036, (Group O), TPH is the contaminant in the soil. This TPH contaminated soil could be treated to some agreed upon level (action level), and then used (disposed) as foundation material in Site LF007. In other cases where TPH contaminated soil is at or below the action level, the soil could be used as foundation material in Site LF007 without treatment. Therefore, offsite hauling and disposal costs would be eliminated. Cost savings would be realized at individual sites involving soil removal as well as LF007 in a cap closure design.	We agree with this comment, but suggest that the existing FS framework can accomodate this potential action. For example, the use of some or all of the SD036 contaminated soils as a foundation for a cap at LF007 is a combination of the excavation portion of Alternative 18 for SD036 and the capping portion of Alternative 19 for LF007. The discussion in Section 10.0 supports such combination of alternatives, where cost-effective and protective. However, the text throughout the FS, specifically a new paragraph added to Section 7.0, will be revised to more clearly emphasize the potential acceptability of on-site disposal of contaminated soils. Specific cost reductions associated with disposal of contaminated soil on site will be discussed in the Proposed Plan and ROD. Also see response to Specific Comment #8.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
10	**Appendix A, Applicable or Relevant and Appropriate Requirements (ARARs)** This Section discusses ARARs for chemical, location, and action specific requirements.	
11	**Section A.2.2.2 and Section A.2.2.3, Chronology of Efforts to Identify State ARARs and General Approach to Addressing State ARARs Responses** These Sections identify the Air Force's efforts to request ARARs from the State of California. It states that the Action-Specific request was made by the Air Force on February 21, 1996 and that the State response was not received until April 10, 1996. Although the Air Force request for ARARs was made on February 21, 1996, it was necessary for DTSC to prepare solicitation letters to all relevant State agencies. DTSC also modified the solicitation to include chemical specific ARARs. This task was completed on March 5, 1996. DTSC then required a 30 day response time from these agencies. Additional time was also required to compile and summarize these responses. For the February 21, 1996 ARARs request, most State agencies provided no additional ARARs different from the initial August 30, 1995 ARARs request, except for the Bay Area Air Quality Management District (BAAQMD). Therefore, the Action and Chemical Specific ARARs from the BAAQMD should be the only ARARs incomplete for the purpose of this review. Please rephrase these Sections to include this information.	The text of Section A.2.2.2 will be changed to reflect that the status of ARARs submissions by the state is complete. As of 18 July 1996, a review of all ARARs submissions has been completed and incorporated into the attached table. As of 8 August 1996, no additional comments on the air remediation ARARs identified by Travis AFB were received from the BAAQMD. As such, the ARARs (as identified in the Draft Feasibility Study) have been incorporated into the revised format.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
12	**Section A.2.3, ARARs Analysis** Please refer to attached comments provided by the DTSC Office of Legal Services. Make necessary changes as noted.	All comments, except as otherwise noted below, have been incorporated as recommended by DTSC. Note that the comment section for some of the ARARs identified has been changed to reflect the potential applicability of the ARAR to a site or action alternative. These changes were necessary in order to conform with the RPM's requests for a new format, but should create no issues with respect to the substantive requirements of each ARAR. The following sections of 22 CCR were determined not to be ARARs for NEWIOU sites: a. Sections 66264.278 through 66264.303 - Although valid substantive requirements, the use of land treatment zones will not be used in NEWIOU remediation actions, thereby making these requirements not applicable or relevant. b. Section 66264.1053 - Although a valid substantive requirement, the use of compressors with this type of seal system will not be used in NEWIOU remediation actions, thereby making this requirement not applicable or relevant. c. Sections 66264.571 through 576 - Although valid substantive requirements, the use of drip pads will not be used in NEWIOU remediation actions, thereby making these requirements not applicable or relevant.

Response to DTSC Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
13	**Appendix C, Time to Cleanup Determination Procedure** **Table C-10, Time to Cleanup Results** For Group A sites, LF007B, LF007C, and LF007D, there is an apparent discrepancy in the calculated time to clean up the corresponding plumes and the relative size of those plumes. For example, the plumes under LF007D and LF007B are larger than the plume under LF007C and yet the calculated clean up time for LF007C is approximately ten times greater than LF007D and LF007B. DTSC recommends that the calculations be redone to check for possible errors. If the calculations are correct, then a discussion is needed to explain why there is such a large variation in cleanup times between LF007C and LF007B/LF007D. Any changes made to this table will also require modification of corresponding figures and discussion in the rest of the report.	The calculations for LF006 and LF007C were incorrect. The times to cleanup LF006 and LF007C should be lower. These times to cleanup have been corrected. In addition, an explanation of the following differences will be added to the Appendix: LF007B and LF007D were modeled based on chlorobenzene, while LF007C was modeled based on TCE, as noted in the summary table. In addition, LF007B and LF007C were modeled for linear flow through the plume, while LF007D was modeled for radial flow from the center of the plume.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1]

No.	Comments	Responses/Notes
GENERAL COMMENTS		
1	There are several inconsistencies in the ranking of alternatives relative to each other based on the benefit/cost ratio (see specific comments for examples). The criteria for making comparisons should be more clearly defined and consistently applied.	Refer to response to Specific Comment #2.
2	Because ARARs have not been specifically applied to sites, compliance with ARARs cannot be evaluated for individual sites. When these have been provided by the Air Force, we will complete our review of the evaluation of alternatives.	The "Remarks" section of the ARARs tables has been changed to provide a general description of the sites or actions to which each ARAR will apply, but with sufficient specificity that the type actions or the sites to which the ARARs apply should be readily discernible.
3	We do not agree with the ARARs compliance determination with respect to Alternative #15 for Surface Water Group J. Remediation of upstream groundwater sources does not contain or stop the discharge of contaminated groundwater into Union Creek in a reasonable length of time and, therefore, does not comply with the Porter-Cologne Act.	Refer to response to Specific Comment #21.
4	The ARARs Section (Appendix A) is not complete, as it does not include San Francisco Bay Regional Water Quality Control Board plans and policies included in the Water Quality Control Plan. Nor does it consider State location-specific ARARs, such as the California Endangered Species Act (see specific comments).	Both the San Francisco Bay Regional Water Quality Control Board Plans and applicable or relevant California Fish and Game Code requirements have been incorporated into the revised tables.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
SPECIFIC COMMENTS		
1	**Page ES-3, Third Paragraph** The word "five" should be changed to "six", as there are six criteria.	The term "five" is correct. The text has been revised to clarify that all of the seven criteria, excluding implementability and cost, are summed when calculating the benefit/cost ratio.
2	**Pages ES-3, ES-4** The evaluation of remedial alternatives is not always supported by the results as shown in Figures ES-1 through ES-4, and is sometimes arbitrary. It is not clear what criteria were used to compare and rank alternatives with respect to benefit/cost. For example, for Groundwater Group G the difference in ratio between Alternatives 5 and 9 was 40.4. The text concludes that these Alternatives have similar cost-effectiveness. Similarly, the text concludes that Alternatives 6 and 8 for Groundwater Group H are similar in cost-effectiveness, when the difference in benefit/cost is 34. Yet, for Surface Water Group J, the text states that Alternative 25 has the greatest cost-effectiveness, when the difference in ratios between Alternative 14 and Alternative 12 is only 25. For Soil Group Q, the text states that Alternative 17 is the most cost-effective, when the difference in ratios between Alternatives 17 and 22 is 31. A firm criterion, based upon the sensitivity of the analysis, should be developed and applied consistently in comparing cost-effectiveness of remedial alternatives.	The text has been revised to specify only the alternative that ranked highest for each site and media. Text has been added, both to the Executive Summary and Section 9.0, discussing that the highest ranking alternative does not necessarily result in the "best" alternative, in consideration of the assumptions involved. Additional text has also been added to Section 9.0 discussing how the sensitivity analysis results factor into the alternatives comparison.
3	**Page ES-4, Second Bullet** For Group P, the most cost-effective alternative (as shown in related figure) is Alternative 17, not Alternative 21, as stated in the text.	The text will be modified.
4	**Page ES-7, Table ES-2** The TCE concentration (32,000 ppb) cited for Site SS016 is no longer the maximum value, as higher concentrations (approximately 180,000 ppb) have since been measured. This value should be revised or a footnote added to update this information.	The 32,000 ppb result is Monitoring Well data, while 180,000 ppb is CPT data. The CPT data should not be directly compared to the monitoring well data. A footnote has been added to this table, as well as to Table 1-3 and Figures 1-19, 5-4, and B-11.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
5	**Page ES-5, Third and Fourth Paragraphs** The text describing the Proposed Plan "plug in" process and the associated Figures (ES-6 through ES-10) should be deleted. The selection process should not be included in the FS, as discussed in the June 11 RPM meeting on the Proposed Plan.	The text will be modified accordingly and the figures deleted.
6	**Page 1-1, Second Paragraph** Surface water and sediment contamination are not included in this summary of the results of the three RIs. This summary should be expanded to include results for all media.	The text will be modified accordingly.
7	**Page 1-1, Second Paragraph** Important reasons for combining the OUs were to create a more efficient FS/ROD process and to minimize costs associated with generating separate documents. These reasons should also be stated.	The text will be modified accordingly.
8	**Page 1-2, Second Line** Risks associated with surface water and sediment contamination are not mentioned. Please add these.	The text will be modified accordingly.
9	**Page 1-4, Second Paragraph** Since COCs for groundwater and soils are listed, then COCs for surface water and sediment should also be listed. In addition, surface water is not limited to Union Creek. There are also many vernal pools at Travis AFB. These should be mentioned.	The text will be modified accordingly.
10	**Table 1-2** Ecological Interim Remediation Goals are not provided. These must be established prior to finalization of the FS.	Based on the results of the recently finalized Tier 2 Report, these preliminary IRGs will be added to the Draft Final FS.
11	**Page 1-10, Second Paragraph** Vernal pools should be mentioned in this description of the EIOU.	The text will be modified accordingly.
12	**Table 1-3** Ecological Interim Remediation Goals are not provided. These must be established prior to finalization of the FS.	Based on the results of the recently finalized Tier 2 Report, these preliminary IRGs will be added to the Draft Final FS.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
13	**Table 2-1, First Bullet** Contaminant-specific ARARs for surface water are not MCLs, as stated here, but the more stringent of MCLs and EPA Ambient Water Quality Criteria.	The text will be modified accordingly.
14	**Table 2-1, Second Bullet** Contaminant-specific ARARs for sediment include ecological benchmark values.	Travis AFB legal counsel and RWQCB, SWRCB, and other appropriate state agency's legal counsel are in the process of determining ARARs for the NEWIOU.
15	**Table 2-1, Sixth Bullet** Outfall III is no longer an ongoing remedial action. Therefore, this reference to it should be deleted.	The text will be modified accordingly.
16	**Table 2-1, Tenth Bullet** The words "applicable discharge regulations" should be revised to read "substantive NPDES requirements."	The text will be modified accordingly.
17	**Table 2-2** IRGs associated with ecological health risk should also be listed here or in a separate table.	Table 2-2 has been footnoted to reference the ecological IRGs in Tables 1-2, 1-3, and 1-5. These IRGs are not included in Table 2-2 as they are specific for each IRP site.
18	**Table 3-1, Page 3-19** For direct discharge to storm drain, discharge limits, monitoring, and reporting are required. Please add the reporting requirement. It should also be noted that applications and Regional Board approval are required for each additional discharge.	The text will be modified accordingly.
19	**Table 3-6, Page 3-39** Alternative #14, as described in the text on page 3-51, includes collaring. This should be added to this footnote and to all other footnotes in which Alternative #14 appears.	The text will be modified accordingly.
20	**Page 6-5, Second Paragraph** As noted in previous comment, Alternative #14 includes collaring. Therefore, the discussion regarding the sand pack around the storm sewer should be revised.	The text will be modified accordingly.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
21	**Page 6-5, Second Paragraph** This analysis of compliance with ARARs is incorrect. The groundwater discharge to the storm sewer is an unauthorized discharge resulting in adverse effects on the beneficial uses of Union Creek. Pursuant to the Act of Porter-Cologne, this discharge must be treated or contained. Treating the groundwater source (Alternative 15) would not stop the discharge of contaminated groundwater, and compliance with water quality objectives would not be achieved at some sites, for over a century, as estimated by the Detailed Analysis of Alternatives. The only alternatives that would achieve compliance with ARARs are 12 and 14.	The need to treat or contain groundwater discharged to Union Creek, due to ARARs, depends on negotiations of ARARs currently ongoing between Travis AFB legal counsel and the legal counsel of appropriate state agencies. The FS acknowledges in this section that Alternative 15 (source control) would not likely fully meet ARARs (only scores 3 out of 5). This section will be revised to further emphasize how source control, by itself, is unlikely to meet all ARARs. Per agreement at the agency teleconference, the current scoring will remain unchanged.
22	**Page 6-6, Second Paragraph** This analysis is incorrect. Alternative 14 should be rated 5 because slip-lining the storm sewers would stop the discharge of contaminated groundwater into the creek. Since Union Creek is a receptor, not a source, breaking the contaminant pathway by preventing flow into the storm sewer is very effective means of achieving compliance.	Sliplining will close one pathway for contamination of Union Creek by groundwater; but will not effect downstream disposition of contaminants. Also, contamination is not actively removed by this alternative. The rating of 3 was therefore given. In addition, the "3" rating distinguishes sliplining from the more effective alternative of active treatment, which was given a 5. Per agreement at the agency teleconference, the ratings will remain unchanged. As also agreed at the agency teleconference, the FS will be revised to include periodic cleaning of sediments from storm drains and sumps as an element of Alternative 14. The current Travis AFB study of the storm drains will provide additional information in formulating the most appropriate alternative.
	Alternative 15, on the other hand, should be rated zero for short-term effectiveness, as it will not stop the discharge or reduce contaminant concentrations to acceptable levels in the short-term.	A rating of 0 is reserved for alternatives with no short-term effects. Immediate pumping of groundwater should have some beneficial effect by immediately removing some discharge to the creek through altering hydraulic gradients. The text will be revised to further discuss the limited short-term benefits of source control. Per agreement at the agency teleconference, the scores will remain unchanged.
23	**Page 7-22, Last Paragraph** What is meant by "obtaining ARAR waivers?" Please elaborate.	As agreed at the agency teleconference, text related to ARAR waivers will be deleted from the FS.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
24	**Page 7-69, Last Paragraph** Alternatives 18 and 20 will both achieve IRGs, since the IRGs are applied to the contaminated site, not the landfill that will receive the excavated sediment. The level of sediment treatment will be determined by the limitations imposed by the landfill, not by the sediment clean-up goals. Also, it is not clear why potential leakage of contaminants at an off-site landfill is being considered in evaluating the effectiveness of a remedial alternative at Travis AFB.	According to the EPA CERCLA Guidance, the CERCLA criteria are to be applied to both on-site and off-site effects of the COCs from the site.
25	**Page 7-72, First Paragraph** Why is the level of treatment of the excavated soil relevant to this evaluation when the soils will be disposed of off-site? There is no possibility of exposure to ecological receptors, regardless of treatment method.	The criteria "Reduction of Toxicity, Mobility, and Volume Through Treatment" requires "treatment" to be evaluated and treatment alternatives to be preferentially scored.
26	**Page 7-72, Last Paragraph** The nature and extent of ecological risks at this site have been fully characterized in the Basewide Ecological Risk Assessment - Tier 2 (May 31, 1996). This information should be incorporated into this document. There are many contaminants that pose a medium to high risk to ecological receptors. Therefore, Alternative 17 would not achieve compliance with ARARs.	Reference to the Final Tier 2 Report, specifically the sediment PERGs in Table 9-2, has been made at the end of Section 7.0. Final cleanup levels will be negotiated as part of the Proposed Plan/ROD process.
27	**Page 9-8** As explained in Comment 21, only Alternatives 12 and 14 will meet the threshold criteria of compliance with appropriate ARARs. The discussion on this page should be revised. The overall conclusion that slip-lining the storm sewer has the highest benefit/cost ratio will, however, be unchanged by revising the analysis.	Refer to response to Comment #21.
28	**Page 9-16, Third Paragraph** The reference to "ARAR waivers" is inappropriate in the FS and should be deleted.	The reference will be deleted.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
29	**Table 10-3** The description for Site SS016 is confusing. The third sentence says that groundwater remediation will have little beneficial effect on groundwater contamination.	The text will be clarified.
30	**Table 10-3** The qualitative statements regarding the potential for soil/groundwater interactions presented in this table are not adequate for developing soil clean-up levels that will be protective of groundwater. A more rigorous approach, based on modeling or leaching tests, is needed to establish appropriate soil clean-up levels for the Record of Decision.	The purpose of Table 10-3 is to qualitatively discuss potential cross-media benefits. It is acknowledged that further rationale would be required after the FS to select alternatives and cleanup levels. Such an effort is now occurring in the Proposed Plan process.
31	**Pages 10-9 through 10-18, Sections 10.1.2 to 10.1.3** This discussion of groundwater interactions with surface water and sediment is well reasoned, and correctly points out that slip-lining the conduits would not only improve water quality in Union Creek, but would reduce the need for groundwater action if there were no other threats to human health or the environment. It suggests that an alternative to slip-lining is a large-scale lowering of the groundwater level to decrease flow into the storm sewers and creek, then provides a discussion of the pros and cons of this approach. The implication of this text is that lowering the groundwater is an alternative remedial action for Union Creek, including its West Branch, rather than simply a possible consequence of upstream pump-and-treat that should be considered in the selection of alternatives. Remedial Alternatives for consideration in the Proposed Plan must be analyzed according to CERCLA criteria.	The text has been revised to state that lowering of the groundwater level is a consequence of groundwater pump-and-treat alternatives, not a stand-alone alternative for remediation of the creek. The Proposed Plan process will provide further rationale for the selection of alternatives.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
32	**Appendix A** Appropriate sections of the California Fish and Game Code are not considered in this appendix, including the California Endangered Species Act (Fish and Game Code § 2050 and 2065); relevant policies for the general protection and conservation of fish and wildlife resources (Fish and Game Code § 1600; 1700; 1750; 1801; and 2014); requirements for endangered or rare species at Fish and Game Code § 1900 et seq; 2050 et seq. to 2068; 2070; 2080; and 2909 et seq. to 2096.	Applicable or relevant sections of the California Fish and Game Code have been included in the revised tables. All sections identified in the comments are not substantive provisions of the code, and therefore, not all have been identified as potential ARARs. Sections which impose procedural or other duties upon state agencies, or those sections which declare the generalized policies and intents of the legislature, provide no substantive criteria for remediation purposes. For ARARs purposes, we have incorporated those sections which provide some substantive requirements for cleanup.
33	**Appendix A** San Francisco Bay Regional Water Quality Control Board Plans and Policies, included in the Water Quality Control Plan (June 1995) are not included in this section (see attached pages). Of particular importance are Disposal of Extracted Groundwater from Clean-up Projects - Resolution No. 88-160, as well as the resolutions on Discharger Reporting and Responsibilities.	San Francisco Bay Water Quality Control Plan has been included as a requirement in the revised tables.
34	**Appendix A, Table A-1, Page 2** The U.S. Army Corps of Engineers should be consulted to determine whether Union Creek is a navigable waterway. According to our information, this creek meets the definition of navigable waterway below the high water mark.	Mr. Bill Casales, U.S. Army Corps of Engineers (USACOE), was contacted concerning this issue. After researching this question, he informed us that the USACOE has not identified Union Creek as a navigable waterway.

Response to SFBRWQCB Comments on the Draft Feasibility Study for the NEWIOU[1] (Continued)

No.	Comments	Responses/Notes
35	**Appendix A, Table A-1, Page 3** 40 CFR 231 and 231, pertaining to the discharge of dredged or fill material into wetlands, is applicable. Alternatives 18 and 20, as applied to Soil Group R, involves the disposal of dredged sediments into Union Creek (particulates released during excavation of a wetland constitute fill), and Alternatives 18, 19, and 20 for Soil Group L involves filling of vernal pools.	The requirements of 40 CFR have been identified as applicable.

1 In addition to these comments on the Draft FS, the SFBRWQCB also made several informal comments on the Draft Final FS, which have been addressed as follows:

1) Addition of the sentence, "when final cleanup levels are determined, they will take into account the potential for soil contamination to leach to groundwater," to the end of the second paragraph in Section 1.1.

2) Minor changes/corrections to pages 1-6 of the Water Remediation Requirements of Appendix A.

Response to SWRCB Comments on the Draft Feasibility Study for the NEWIOU

No.	Comments	Responses/Notes
GENERAL COMMENTS		
1	The ARARs table is incomplete because it does not specify the ARARs for each alternative and each site addressed in the feasibility study. There are different ARARs depending on the nature of the action.	The "Remarks" section of the ARARs tables has been changed to provide a general description of the sites or action to which each ARAR will apply, but with sufficient specificity that the type actions or the sites to which the ARARs apply should be readily discernible.
2	The format of the ARARs should be changed to identify the source, i.e., the statutory authority for the requirement. I have attached an example from the ARARs table for one of the operable units at Castle Air Force Base. This format has been used at many facilities and was originally proposed by an attorney at the U.S. Environmental Protection Agency.	The format of ARARs submitted by the Water Board have been changed to reflect the source of each requirement.
3	Dividing the ARARs table into "chemical," "action," and "location" specific is somewhat confusing in this table because many requirements do not fit into those categories or fit into more than one.	Grouping by these categories has been deleted. To facilitate the review process, all potential state ARARs are now grouped by type of remediation action. ARARs which are derived from federal statutes and regulations are grouped separately.

Response to SWRCB Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
SPECIFIC COMMENTS		
1	**Table A.5, Page 2 of 3, Second Row** The Table specifies Title 23, California Code of Regulations, Section 2550.4 as a "Relevant and Appropriate (only as invoked by 92-49 IIIG)" ARAR for "All Contaminants." This row is confusing because it is not clear what action is being proposed; but it appears, based on the comment, to be directed at determining aquifer cleanup levels. I disagree with the characterization of Section 2550.4 as used in State Water Resources Control Board (SWRCB) Resolution No. 92-49 as a "relevant and appropriate" requirement. Resolution No. 92-49 and Title 23, California Code of Regulations, Section 2550.4 apply to all discharges, including the federal government. Thus, the provision is "applicable." At other sites, the Record of Decision has included a statement that the parties do not agree on the characterization of an ARAR as "applicable" or "relevant and appropriate." I do not agree with the comment that since cleanup to background is not feasible, the requirement is not an ARAR. The requirement is to perform the analysis and determine what level is feasible. Therefore, the requirement must be listed as an ARAR even if the determination is made that background is not feasible. Note that this provision is listed under "chemical-specific" ARARs, but it is also action-specific.	We concur that Section 2550.4 is an ARAR but do not agree with the classification of Section 2550.4 as an "Applicable" requirement. The "Remarks" section has been modified to provide a description of the action to which this section is relevant. Finally, the reference to the "feasibility of cleanup to background" has been omitted. However, we do not agree with the Regional Water Board's interpretation that cleanup to background is required absent a demonstration that such cleanup is not technologically and economically feasible. We will agree to disagree with the Water Board on the characterization of this ARAR and the interpretation of these sections. (Also, see comments to Resolution 92-49 below.)
2	**Table A.5, Page 3 of 3, First Row** This row is an example of why it is a good idea to use the Castle Table as a model for an ARARs table. References to the California Water Code generally should be included as sources, except for certain specific substantive requirements.	We concur with the suggestion to reformat the table.

Response to SWRCB Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
3	**Table A.6, Page 32 of 41, Row 6** This row is confusing because it is not clear what action is being taken. I disagree with the characterization of Section 2510(d) as "relevant and appropriate." It is applicable to all existing waste management units. I also disagree with the comment that it is invoked only through Section 2511(d). That section applies to unauthorized and unintentional discharges, but an existing waste management unit would not usually be considered an unauthorized and unintentional discharge.	We concur with the characterization of "Applicable." We will agree to disagree with respect to the application of these requirements to unintentional or unauthorized releases.
4	**Table A.6, Page 33 of 41, Row 1** This row is confusing because it is not clear what action is being taken. I disagree with the characterization of Section 2510(g) as "relevant and appropriate." The provision requiring monitoring under Article 5 applies to all closed, abandoned, or inactive waste management units. Section 2511(d) would be appropriate where corrective action is taken.	We concur with the characterization of "Applicable." We do not concur with the Board's position that the monitoring requirements of Chapter 15 apply to all units. Regulatory language does not mandate monitoring requirements; to the contrary, the language states that persons "may be required to develop and implement a monitoring program." We will agree to disagree with respect to the application of this requirement.
5	**Table A.6, Page 33 of 41, Row 2** The citation column should be corrected to refer to Section 2511(d), not Section 2511. The comment section is inaccurate. Section 2511(d) is applicable to all waste management units, not just those operating after November 27, 1984. Section 2511(d) does not exempt unintentional discharges, rather Section 2511(d) applies to unintentional or unauthorized discharges. Also, Section 2511(d) is only a partial exemption from other provisions of Chapter 15 for actions taken by or at the direction of public agencies to cleanup and abate waste. It's a partial exemption because where waste is contained, Chapter 15 provisions apply only to the extent feasible.	We concur with correction of the citation from 2511 to 2511(d). The description has also been modified and has been taken directly from the regulation. We will agree to disagree with respect to the application of this requirement to unauthorized or unintentional releases.
6	**Table A.6, Page 33 of 41, Row 3** The characterization of Section 2522 as "relevant and appropriate" is incorrect. Section 2522 is "applicable" to all new discharges of designated waste.	We concur with the classification as "Applicable" for sites where solid wastes are being removed from landfills and bioremediation units.

Response to SWRCB Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
7	**Table A.6, Page 33 of 41, Row 4** This row states in the second column that Section 2523 is "applicable" and in the fifth column that it is "relevant and appropriate." The provision is applicable to new discharges of nonhazardous solid waste.	We concur with the classification as "Applicable" for landfill sites receiving consolidation materials.
8	**Table A.6, Page 33 of 41, Row 5** If corrective action is required at a CERCLA site, Section 2550.10 would be applicable, not relevant and appropriate. This provision contains many substantive requirements, such as establishment and compliance with water quality protection standards.	We concur with the classification as "Applicable" for sites where corrective action to remediate releases from a waste management unit is required.
9	**Table A.6, Page 33 of 41, Row 6** This provision is applicable, not relevant and appropriate.	We concur with the classification as "Applicable."
10	**Table A.6, Page 34 of 41, Rows 1 and 2** These two provisions are applicable, not relevant and appropriate.	We concur with the classification as "Applicable."
11	**Table A.6, Page 34 of 41, Row 6** Chapter 15 should be identified as shown on the enclosed general ARAR tables.	The revised table has been modified to more closely reflect the Castle AFB example provided by the Board.
12	**Table A.6, Page 35 of 41, Rows 1 and 2** See comment 11.	The revised table has been modified to more closely reflect the Castle AFB example provided by the Board.
13	**Table A.6, Page 35, Row 6** Water Code Section 13000 is a source for certain requirements.	The identification of CWC Section 13000 et seq have been identified as sources for certain requirements in the first column of the revised tables.
14	**Table A.6, Pages 36-39** See enclosed RWQCB tables showing format for statutory requirements. The descriptions are either wrong or inadequate. See sample tables.	The format for the statutory requirements is incorporated. Statutory sections which arguably have a substantive element has been identified as ARARs. Other sections have been identified as sources.
15	**Table A.6, Page 40 of 41, Row 3** The description is incorrect for Resolution No. 68-16. See sample tables.	The description has been changed. The language now incorporated has been taken directly from the resolution, with minor paraphrasing for brevity purposes.

Response to SWRCB Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
16	**Table A.6, Page 40 of 41, Row 5** I disagree that Resolution No. 92-49 is relevant and appropriate. The requirement to evaluate cleanup to background is applicable and, therefore, the Resolution should be listed as an ARAR for determining cleanup levels.	We concur that Resolution 92-49 is an ARAR, but do not concur that the classification should be applicable. We will agree to disagree with respect to this classification. We also do not concur with the Board's position that cleanup to background levels is mandated without a demonstration that cleanup to background is not technologically and economically feasible. We interpret Resolution 92-49 as providing the regional boards with the ability and discretion to consider a wide range of factors as well as a wide range of remediation and/or abatement alternatives. The cleanup to background levels, albeit the most stringent requirement, is but one of the many contemplated. Until such time as agreements or regulatory revisions occur, or at such time as our engineers can agree upon a technological solution which will resolve these issues, we will agree to disagree.
	The Table does not include the Basin Plan. Water quality objectives and beneficial uses and other substantive standards from the Basin Plan should be included as ARARs. See the RWQCB table for examples.	The substantive portions of the Basin Plan have been included as an applicable requirement.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU

No.	Comments	Responses/Notes
GENERAL COMMENTS		
1	The Draft FS is well written, successfully integrating the elements of the DAA into a coherent FS strategy. The site-specific figures included in Sections 5.0, 6.0, and 7.0, and reiterated in Appendix B are an excellent presentation of site characteristics, COCs, treatment alternatives, and design assumptions. These figures render the document very accessible to the general public and regulators alike, and provide a source of rapid reference to cross-check between sites.	Comment noted. No response needed.
2	Prior EPA comments submitted as review comments to the DAA have generally been well addressed in this document. The principal exceptions are: comments regarding dioxin contamination at FT003 (and other Group K sites), and comments regarding the cost summary appendix. These are addressed in Specific Comments 20 and 22 of these review comments.	Comment noted. No response needed.
3	The accuracy of cost estimates given for the Group K sites is questionable, since the implications of dioxin/furan contamination do not appear to have been properly considered. The volume of soils not acceptable for land disposal (due to dioxin/furan contamination) should be estimated in order for an adequate cost estimate for cleanup to be developed.	See response to Specific Comment #22.
4	The basis for the groundwater extraction rates listed on the Figures in Section 5.0 and in Appendix B is not given in the document. The assumptions used to generate the extraction rates should be stated somewhere in the document, referencing relevant pump test data where applicable.	The last paragraph of Page 5-5 presents rationale. This section will be revised to provide additional rationale on groundwater extraction rate assumptions.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
SPECIFIC COMMENTS		
1	**Executive Summary, pages ES-1 to ES-2 and Table ES-1** On page ES-1 the document refers to 20 sites expected to require remediation; page ES-2 states there are 22 sites and references Table ES-1, which in fact contains 20 sites. Please resolve these inconsistencies.	The text has been modified to change "22" to "20" on page ES-2.
2	**Executive Summary, Table ES-2, page ES-8** This table states that no metals treatment is required for Group H. However, Appendix B, Group H includes Alternative #4, which is a metals treatment option, including as it does ion exchange. No metals COCs, however, are listed for Group H in this appendix. Please resolve this contradiction (it appears that the Appendix should list Alternative #3 and not #4).	Figures 5-8 and B-16 will be corrected to delete the words "ion exchange", which were incorrectly included in the definition of Alternative 4.
3	**Executive Summary** The Executive Summary should be revised to include Figures 1-1, 1-2, and 1-3 from Section 1. These figures show the three constituent OUs and also the locations of the soil and groundwater contamination, and would render the executive summary more accessible to the general public.	These figures will be added to the Executive Summary as requested.
4	**Section 1.0, Tables 1-2 through 1-5, pages 1-7 to 1-35** These tables present an excellent summary of the COCs, associated risks, and maximum reported contaminant concentrations per site.	Comment noted. No response needed.
5	**Section 5.1.1: Description of Alternatives and Conceptual Design for Groundwater Groups, page 5-7** On paragraph 2 of this page it is stated that the horizontal extraction wells will have an extraction rate of approximately 15 gpm per 300 foot well. Please give the basis for this estimate.	See Page 5-5, Third Paragraph. Additional rationale will be provided.
6	**Section 5.0: Table 7-8, page 7-60** The alternatives for Group Q have been amended to include bioventing (Alternative #22) as requested in the Agency review comments for the DAA.	Comment noted. No response needed.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
7	**Section 8.0: Sensitivity Analysis, pages 8-1 to 8-14** This section has been amended to include Agency comments submitted in response to the Draft DAA of January 1996. In particular, the sensitivity to cleanup goals (and thus cleanup times) for groundwater is now delineated.	Comment noted. No response needed.
8	**Section 10.1: Inter-media Relationships and the Influence on Developing Integrated Alternatives, pages 10-2 to 10-9** Both the EIOU and WIOU contained excellent material on the potential for contaminant migration from shallow groundwater via storm or sanitary sewer systems. The WIOU RI in particular included excellent figures showing storm drain locations, and groundwater plume intersections (Plate 5-9, TCE in Groundwater: Figure 8.19-9, TCE in Surface Water at Storm Sewer System B). This section of the FS should be expanded by including appropriate figures from the WIOU and the EIOU, and by including additional text.	Figure 10-2 has been revised to show the intersection of all areas of soil and groundwater contamination with basewide storm drainage and sanitary sewer systems.
9	**Section 10.1.1: Soil and Groundwater, pages 10-6 to 10-9** This section correctly references SD034 as an example site at which a groundwater action (bioslurping) would remediate both groundwater and soil, as was stated in Agency comment 22 for the DAA.	Comment noted. No response needed.
10	**Section 10: Figure 10-2, page 10-2** This is a very useful figure showing the location of groundwater and soil contamination relative to surface water. It would, however, be much enhanced if the storm and sanitary sewers were clearly marked, since these present potential contamination conduits, linking contaminated groundwater plumes to Union Creek. The screening data presented in the EIOU RI show high levels of contamination by TCE (3,100 µg/L) and trans-1,2-dichloroethene (1,600 µg/L) in Storm Sewer System A, for example. The SSS-A outfall treatment system was instigated specifically to mitigate the TCE contamination discharging into Union Creek. Table 10-5 alludes to potential interactions between groundwater and surface water "through underground utilities". It would be very beneficial to the FS to clearly show the intersections of storm and sanitary sewer lines with groundwater contaminant plumes.	This addition will be made to Figure 10-2.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
11	**Table 10-3: Sites with Potential for Cross-Media Benefits of Remedial Actions, page 10-7** This table states that for LF006 and LF007, "Actions to address buried debris could reduce the scale of groundwater remediation..." The text should be amended to include: "Actions to reduce rainwater percolation through contaminated debris resulting in the leaching contaminants into the shallow groundwater, would also support a groundwater containment strategy."	The requested addition will be made.
12	**Table 10-5: Potential Interactions Between Groundwater and Surface Water, page 10-12** This table would be vastly enhanced if referenced to a figure showing the intersections of underground utilities and groundwater contamination plumes, as requested in the previous comment.	Figure 10-2 has been revised (and referenced from Table 10-5) to indicate this information.
13	**Figure 10-3: Example Site Alternative Considering Media Interactions, page 10-17** This figure is a very good representation of a multimedia site alternative for Site SS016. It would be a good addition to the executive summary, after page ES-4, in the section "Combining Remedial Alternatives to Reduce Costs."	Figure 10-3 will be added to the Executive Summary, as requested.
14	**Figure 10-4: Hydrogeologic Boundaries and Geographic Proximity of Sites, page 10-19** This is an excellent figure, showing the areas of contaminated groundwater basewide, together with bedrock highs and site boundaries. The legend should denote that the red line depicts surface water (including Union Creek).	The requested addition will be made.
15	**Figure 10-5: Example of Combining Sites for Remedial Action, page 10-21** This figure shows the hypothetical combination of sites FT005, SS029, and SS030 to utilize one treatment facility, located at the existing Outfall III plant. Figure 10-4 suggests that SS016 could also be included in this group of sites using the centralized treatment plant, since it is located in the same general area. Please add discussion of this possibility.	We will investigate this option further, however it is not likely to be feasible due to the presence of the runways between SS016 and the hypothetical centralized treatment plant. Only the southern portion of the plume could likely be treated at the hypothetical plant. Unless the entire plume could be treated at the hypothetical plant, the cost estimates for SS016 cannot be easily applied to the plant. Text will be added discussing this possibility.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
16	**Figure 10-6: Outfall III Centralized Treatment Facility Process Flow Diagram, page 10-22** **Section 10.2, Benefits of Combining Sites for Action, pages 10-20 to 10-23** Figure 10-6 distinguishes between two influent streams: high and low concentrations. The text does not indicate whether an ongoing sampling regime is planned to support this segregation, or whether real-time influent stream monitoring will be conducted. FT005 (TCE maximum 120 µg/L) would appear to be the only site with TCE concentrations consistently less than 500 ppb (SS030 has TCE concentrations ranging from 958 - 3,860 µg/L; SS029 has TCE concentrations ranging from 315 - 1,300 µg/L). Please justify the cost of the segregating influent groundwater based on these results.	This section is presented as an example design option which may reduce the overall treatment cost. Specific design details will be addressed during the design phase. Additional text has been added to Section 10.2 to emphasize how TCE concentration can effect design parameters.
17	**Table 10-6: Cost Comparison for the Centralized Treatment Facility, page 10-24** There is an addition error in this table; the total present worth for FT005 should be $5,000,000 and not $4,900,000. Therefore, the subtotal for the separate systems should be $14,200,000, and not $14,100,000. Accordingly, the total present worth savings presented by the centralized system becomes $1,300,000.	Each line item and the totals have been correctly rounded off from the calculated figures. This results in the totals not adding up exactly. We will add a footnote to the table explaining this.
	It is not possible to corroborate any of the figures given, since no basis of estimate or assumptions are given. Please provide the basis for the capital cost and O&M costs or the individual systems and centralized system. From a qualitative view point, both the capital cost and O&M costs given for the centralized system appear too high, when compared to the respective sums for the individual systems. It is, however, not possible to validate these figures as presented without the corroborating information requested.	The text will note that the costs developed for this system are taken from RACER using the same assumptions and methodologies as for the individual sites. The cost backup summary sheets for the centralized treatment facility, in the same format as for the individual sites, will be added to the end of Appendix B.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
18	**Section 10.4: The Benefits of Staged Remedial Action, pages 10-27 to 10-31** This is a well-written section, supported by a clear and informative figure, Figure 10-8. The focused remedial action used in the example (SS016) is an excellent approach, optimizing cost/benefit for this site.	Comment noted. No response needed.
19	**Section 10.5: Decision Process to Develop Integrated Alternatives for IRP Sites, pages 10-31 to 10-40** This section is clearly and methodically written, with excellent flow charts.	Comment noted. However, as agreed at the last RPM meeting, these flow charts will be deleted from the FS, as it was agreed that the logic of selecting remedial actions for sites is more appropriately included in the Proposed Plan process. The text in Section 10.5 has been shortened considerably to more generally defer to the Proposed Plan process for developing integrated alternatives.
20	**Appendix B: Cost Summaries** Additional text has not been included in Appendix B or elsewhere in the document in response to Agency comments regarding this cost information that were submitted when the cost appendix was first reviewed as part of the DAA. Appendix B presents cost estimates for each constituent site of each group. However, insufficient data regarding the design parameters is presented, so that the cost summaries cannot be fully reviewed, as was previously noted in the Agency comments to the DAA. For example, the O&M costs for catalytic oxidation for the sites in Group A vary from $21,111 per annum (pa) to $43,494 pa; capital costs for catalytic oxidation for the Group A sites varies from $48,820 to $89,034. Capital and O&M costs for catalytic oxidation as listed in the DAA and FS, together with the total organic loading (TCE plus other VOCs plus TPH, as listed under maximum contaminant levels in Figures B-1 to B-6) are tabulated below. Bold figures indicate costs that have been changed between the DAA and the FS.	In the response to EPA Comment #26 on the DAA (same as this comment) cost estimate details (i.e., outputs from RACER) for the indicated sites were sent to James Chang at U.S. EPA on 17 April 1996.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

<table>
<tr><th>No.</th><th>Comments</th><th>Responses/Notes</th></tr>
<tr><td></td><td>
<table>
<tr><th>Site</th><th>Total Organic Load (µg/L)</th><th>Flow Rate (gpm)</th><th>Capital Cost: Catalytic Ox ($) DAA</th><th>Capital Cost: Catalytic Ox ($) FS</th><th>O&M Cost (pa) Catalytic Ox ($) DAA</th><th>O&M Cost (pa) Catalytic Ox ($) FS</th></tr>
<tr><td>FT004</td><td>11,400</td><td>45</td><td>73,584</td><td>73,584</td><td>30,064</td><td>30,064</td></tr>
<tr><td>LF006</td><td>350</td><td>45</td><td>48,820</td><td>73,584</td><td>21,111</td><td>30,064</td></tr>
<tr><td>LF007B</td><td>4,420</td><td>45</td><td>51,222</td><td>51,222</td><td>25,588</td><td>25,588</td></tr>
<tr><td>LF007C</td><td>439</td><td>30</td><td>50,525</td><td>50,525</td><td>21,111</td><td>21,111</td></tr>
<tr><td>LF007D</td><td>6,981</td><td>105</td><td>86,034</td><td>89,034</td><td>43,494</td><td>43,494</td></tr>
<tr><td>SD031</td><td>15,100</td><td>30</td><td>48,820</td><td>50,990</td><td>21,111</td><td>24,094</td></tr>
</table>
Explanation should be presented as to why the capital costs for the 45 gpm catalytic oxidation systems for FT004 and LF007B differ by so much, when the order of magnitude organic loadings are similar. Why is the capital cost for the 30 gpm system at LF007C more than the 45 gpm system at LF006, when organic loadings are virtually the same? These concerns were expressed in the review comments for the DAA, and do not appear to have been answered.
</td><td>(Refer to previous page)</td></tr>
<tr><td></td><td>It is appreciated that including all pertinent design and estimation data for each site would render the document unwieldy; however, it is recommended that the pertinent information be provided for sample sites, in order for the cost estimates to be adequately verified. In particular, further detail regarding the derivation of O&M costs must be presented, since for the extended operational periods considered in this document, the O&M costs are the cost drivers. As previously requested, a detailed cost analysis for two of these sites would be beneficial in presenting the assumptions and approximations used in generating these costs.</td><td>As requested, the full RACER output for Sites FT004, LF006, and LF007B was sent to EPA as part of the 17 April 1996 package.</td></tr>
<tr><td>21</td><td>Appendix B: Cost Summaries, Cost Summary Sheets
The cost summary tables included for each site are an excellent presentation of the line item costs per alternative.</td><td>Comment noted. No response needed.</td></tr>
</table>

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
22	**Appendix B: Cost Summaries, Group K - Figure B-21 FT003 & Associated Cost Information** Figure B-21 lists areas of contaminated soil for human and ecological risk. However, no attempt is made to estimate the area/volume of dioxin contaminated soils. This is considered a substantial oversight, since due to the land ban for dioxin contaminated wastes, the overall cleanup strategy for this site could be substantially changed. Dioxins/furans are known to be ecological risk drivers for FTA-3. These analytes should be represented on a figure, together with SVOCs, to delineate near surface source areas that may post a direct contact/inhalation risk to on-site workers, and which would thus warrant mitigation. It is noted from the EIOU RI that the total TCDD equivalent for FTA-3 is 740 pg/g, whereas that for FTA-2 is only 1.4 pg/g; therefore, the dioxin/furan human health risk is much more substantial at FTA-3. (Note, for comparison, the total TCDD equivalents for FTA-4 and FTA-1 were 180 pg/g and 1.9 pg/g, respectively). This difference should be discussed in the text in Section 7.0; an estimate of the area/volume of dioxin/furan contaminated soil must be included in this section. The basis of estimate for the volume of soil acceptable for landfill disposal must be given. Under Alternative 18, a cost of $884,087 is given; it is not possible to determine the volume of soil slated for landfill disposal, or whether low-level dioxin/furan contamination may preclude this cleanup option. If Alternative 18 (Backhoe, Disposal at Off-site Landfill) is to be considered for these sites, then the volume of soil not acceptable for landfilling due to dioxin/furan contamination must be estimated if an adequate cost estimate is to be developed.	Agreed. We have estimated volumes of dioxin-containing soils to be 0, 2,200, 1,500, and 1,950 yd^3 at the respective Sites FT002, FT003, FT004, and FT005. The text and figures have been revised to reflect these soils being thermally treated as part of Alternative 18. The final disposition of the soils between landfilling and thermal treatment will be decided with confirmatory sampling during the cleanup action.
23	**Appendix B: FT003 Cost Summary Sheet** The unit cost of $40/ton for thermal destruction appears far too low. Please provide clarification.	Cost estimates have been revised upward for the incineration alternative, based on recent vendor information.

Response to U.S. EPA Comments on the Draft Feasibility Study for the NEWIOU (Continued)

No.	Comments	Responses/Notes
24	**Appendix C: Time to Cleanup Determination Procedure** The half-life stated for TCE (Table B-2, page B-3) is unreasonable at 1,300,000 years, as commented previously in response to the DAA. Other sources indicate that anaerobic degradation of TCE in groundwater can result in an 89% removal over a 40 week period (Fate and Exposure Data for Organic Chemicals, Philip H. Howard). Please amend Table B-2 to include a reasonable half-life estimate or estimates.	The 1,300,000 year estimate was taken from the reference Pankow & Cherry, 1996 and a copy of the relevant section is attached. This value was selected as a conservative value, not considering the possible effects of degradation, for costing purposes. The Howard reference was evaluated and a copy of its relevant section is also attached. The Howard reference presents mixed results for biodegradation of TCE. The anaerobic degradation rate for TCE may be applicable to small portions of the plumes, but the Travis AFB data does not support that fast of a degradation rate on a large scale basis. Half-lifes on the order of 40 weeks certainly are not supported by the length of time from disposal of TCE to the RI sampling. The assumption of essentially no degradation of TCE appears reasonable, because it simplifies the analysis without underestimating cleanup time by ignoring degradation byproducts. We can adjust the analysis to an alternate half-life, or select a range of values to apply, though the effect on the conclusions will not likely be significant. In any case, ongoing monitoring during the implementation of remedial actions will help to define the TCE half-life at Travis AFB more specifically.
	For the sites with exceptionally long cleanup times to achieve MCL (e.g., Group D - 193 years; Group E - 149 years; Group I - 111 years) it would be useful to give the cleanup times for cleanup goals greater than MCLs, as was agreed upon during discussion of the Agency comments for the DAA. Therefore, in Table C-10, columns for 50 µg/L and 100 µg/L (or 500 µg/L) should be added. When the cleanup time for Group D is already 193 years, using the MCL as a cleanup goal, it is difficult to see the utility in listing the time to cleanup to 0.5 µg/L (254 years) since this generates an even more unrealistic cleanup scenario.	As discussed in the DAA response to comments, higher cleanup goals were included in the sensitivity analysis for an example site. Columns will be added to Table C-10 for 50 µg/L and 500 µg/L for all sites. The 0.5 µg/L scenario was added to the sensitivity analysis, per the request of the agencies, to represent cleanup down to detectable levels of TCE, to reflect a potential cleanup to background levels.

DENSE CHLORINATED SOLVENTS

and other DNAPLs in Groundwater: History, Behavior, and Remediation

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halogens, typically producing a C=C double bond from a C-C single bond (*i.e.*, producing an alkene from an alkane). Reductions are commonly microbially-mediated, but abiotic reductions have been observed.

9.2.2 Substitution Reactions

9.2.2.1 Hydrolysis and dehydrohalogenation

Hydrolysis and dehydrohalogenation are probably the most thoroughly studied abiotic transformations of the halocarbons (see Table 9.1). Early work by Dilling *et al.* (1975), the review and compilation by Mabey and Mill (1978), the predictive methodology of Lyman *et al.* (1982), the review of Vogel *et al.* (1987), and the recent experiments by Jeffers *et al.* (1989) summarize the most significant information. Hydrolysis reactions are usually first order (*i.e.*, dependent on the concentration of halocarbon), but are usually composed of a **neutral reaction** and a **base-catalyzed reaction** that are individually first order. The latter is pH dependent and, when it is important, the overall hydrolysis rate also depends on the concentration of the hydroxide ion. In some cases, the base-catalyzed reaction is faster than the neutral reaction even at neutral pH (*e.g.*, as with pentachloroethane and 1,1,2,2-tetrachloroethane in Table 2 of Jeffers *et al.*, 1989). Our discussions here will focus on *relative* hydrolysis rates, with the total hydrolysis rate at pH = 7 serving as the basis for comparison; the actual hydrolysis reaction mechanisms will not be considered.

TABLE 9.1 Abiotic Hydrolysis (Substitution and Dehydrohalogenation) Half-Lives at 10 to 25 °C of Halocarbons (Best Values).

Compound	Half-life in years (*ref*)	Compound	Half-life in years (*ref*)
Methanes		Ethanes	
Chloromethane	no data	Chloroethane	0.12 (*4*)
Dichloromethane	704 (*1*)	1,1-Dichloroethane	61 (*3*)
Trichloromethane	3500 (*1*), 1800 (*3*)	1,2-Dichloroethane	72 (*3*)
Tetrachloromethane	41 (*3*)	1,1,1-Trichloroethane	1.1(*3*), 1.7 (*5*), 2.5 (*6*)
Bromomethane	0.10 (*1*)	1,1,2-Trichloroethane	140 (*3*), 170 (*5*)
Dibromomethane	180 (*1*)	1,1,1,2-Tetrachloroethane	47(*3*), 380 (*5*)
Tribromomethane	690 (*1*)	1,1,2,2-Tetrachloroethane	0.3 (*8*), 0.4 (*3*), 0.8 (*5*)
Bromochloromethane	44 (*1*)	Pentachloroethane	0.01 (*3*, *5*)
Bromodichloromethane	140 (*1*)	Hexachloroethane	1.8×10^9 (*3*)
Dibromochloromethane	270 (*1*)	Bromoethane	0.08 (*1*)
		1,2-Dibromoethane	2.5 (*7*)
Ethylenes			
1,1-Dichloroethylene	1.2×10^8 (*3*)		
Trichloroethylene	0.9 (*2*), 1.3×10^6 (*3*)		
Tetrachloroethylene	0.7 (*2*), 1.3×10^8 (*3*)		
1,2-Dichloroethylene	2.1×10^{10} (*3*)		

References: (*1*) Mabey and Mill (1978); (*2*) Dilling *et al.* (1975); (*3*) Jeffers *et al.* (1989); (*4*) Vogel *et al.* (1987); (*5*) Mabey *et al.* (1983); (*6*) Vogel and McCarty (1986); (*7*) Weintraub *et al.* (1986); (*8*) Cooper *et al.* (1987).

A considerable amount of laboratory data for **homogeneous substitution reacti** (*i.e.*, in aqueous solution, without solid surface catalysts) has been produced at elev temperatures of 40 to 200 °C; the slow rate of reaction at environmental temperat (0 to 30 °C) does not permit reasonable experiment times at ambient temperatures. **rate constant** k at an environmental temperature (T_2) is usually extrapolated from measured rate at an elevated temperature (T_1) using the Arrhenius equation.

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \frac{(T_2 - T_1)}{T_1 T_2}$$

where temperature (T) is in degrees Kelvin (°C + 273.15), E_a is the activation en (typically about 80 to 120 kJ/mol),and R is the gas constant, 8.314 J/mol-K. For ty activation energies, the reaction rate will decrease dramatically with decreasing tem ature, about 3 to 4 fold for each 10 °C decrease. Before proceeding, we should also that the reaction mechanisms and products observed at elevated temperatures may always be representative of what occurs at ambient groundwater temperatures.

Hydrolysis will produce an alcohol from an alkane or alkene:

$$\text{R-X} + \text{H}_2\text{O} \rightarrow \text{R-OH} + \text{H-X}$$

where R is the part of the organic molecule unaffected by the reaction, -X is a hal substituent, and -OH is the alcohol functional group. Non-alcohol products have also found (Vogel *et al.*, 1987; Jeffers *et al.*, 1989). In some cases, these other products are ther transformation products, but in many cases they are products of one or more con ing dehydrohalogenation reactions. 1,2-dichloroethane has been found to yield some ylene glycol (Jeffers *et al.*, 1989), as has 1,2-dibromoethane (Vogel *et al.*, 1987); ethy glycol represents a classic replacement of both halogen atoms in these molecules by

Chloroethane has been found to yield chloroethylene, also known as vinyl chl (Jeffers *et al.*, 1989), and 1,2-dibromoethane has been found to yield bromoethylene Table 3 of Vogel *et al.*, 1987), indicating that dehydrohalogenation can occur accordi

$$\text{CH}_2\text{X-CH}_2\text{X} \rightarrow \text{CH}_2 = \text{CH}_2\text{X} + \text{HX}, \quad \text{X} = \text{Cl or Br.}$$

Vogel *et al.* (1987, see their Table 3) indicate that such dehydrohalogenation reac are common. Jeffers *et al.* (1989) found that pentachloroethane yielded tetrachlor ylene (PCE). Roberts and Gschwend (1991) found the same reaction to be rapid noted that the reaction of hexachloroethane to PCE could proceed, in large part pentachloroethane.

Considerable discrepancies often arise when comparing older reviews and experimental studies. For example, compared to the study of Dilling *et al.* (1975), J *et al.* (1989) reported a much shorter ambient **half-life** ($t_{1/2}$) for carbon tetrachlorid *vs.* 7000 years), and the opposite for TCE and PCE. Due to the experimental dif ties encountered by Dilling *et al.* (1975), the more recent data of Jeffers *et al.* (are usually accepted as correct. Where significant conflicts exist, the data from D