Disposal Analysis of I-129 Bearing Waste Streams at the Intermediate Level Vault

by

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INTERMEDIATE LEVEL VAULT

RETENTION: Permanent

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EXECUTIVE SUMMARY

This report examines the effects of new waste-specific sorption characteristics reported for I-129 bearing wastes on inventory limits in the Intermediate Level Vault (ILV). The Performance Assessment (PA) (DOE, 1994) limited the I-129 inventory in any vault to 5.3E-4 Ci. A draft PA revision would limit the I-129 inventory in any vault to 2.59E-4 Ci. The ILV currently contains four Activated Carbon vessels with a combined I-129 inventory of 1.92E-3 Ci that exceeds both inventory limits.

PA inventory limits are based on computer modeling results that rely on a literature value for the I-129 retention capability (Kd[1]) of the waste. The PA used a Kd of 30 ml/g for I-129 for the ILV waste form, while the PA revision used a Kd of 2 ml/g. The recently measured Kd's for these waste forms are much higher (see Table i), thus increasing the inventory limits. This document describes inventory limits based on the revised PA model using the waste-specific Kd's. Results are compared with inventory projections of waste streams for the next ten years. The ten-year duration was selected because that is the anticipated operational lifetime of the existing ILV.

Table i. Waste-Specific I-129 Kd Values

Waste	Kd based on Laboratory Measurements (ml/g)
F-Area Dowex 21K	1800
ETF Activated Carbon	600
ETF GT-73	3100

Each waste stream and the existing ILV inventory of Activated Carbon vessels were modeled independently using their respective Kd's. Models were executed for measured waste-specific Kd's and for a set of hypothetical Kd's ranging from 2 ml/g (the revised PA value) to 2,000 ml/g. The key modeling result is the I-129 concentration at a hypothetical 100-m downgradient well. This concentration is compared with the Maximum Contaminant Level (MCL) of 0.5 pCi/L to establish the total inventory limit for the ILV. Waste-specific I-129 inventory limits are plotted against Kd to show the effect of each Kd.

This modeling indicates new inventory limits based on the draft PA revision. It also introduces new waste categories that are dependent on both the contaminant (i.e., I-129) and the waste form (e.g., Dowex 21K). New modeling results are provided in Table ii. Based on the revised PA and the new waste-specific Kd's, the existing carbon vessels are of minor concern, as is the GT-73. The projected inventory of the carbon vessels essentially matches its inventory limit. The projected inventory of the Dowex 21K consumes about one-half of its inventory limit.

Table ii. Projected Inventory versus Inventory Limit

Waste Form	Inventory Limit (Ci)	Projected Inventory (Ci)	Projected Inventory / Inventory Limit * 100%
Existing Carbon Vessels in ILV	7.13E-2	1.92E-3	2.7
Activated Carbon Vessels	7.13E-2	7.11E-2	99.7
GT-73	3.68E-1	1.13E-3	.3
Sludge	No Kd available	5.16E-4	
Dowex 21K	3.33E-1	1.78E-1	53.5

Waste streams with waste-specific Kd's must be treated like separate contaminants when conducting the "sum-of-fractions" analysis. The "sum-of-fractions" analysis must be completed to determine the effects of all contaminants in the ILV.

[1] The Kd or distribution coefficient represents the partitioning of waste between solids and liquids. It is defined as the ratio of the concentration in the solids (Ci/g) to the concentration in the liquid (Ci/ml).

INTRODUCTION

Waste streams from water treatment systems, namely the Effluent Treatment Facility (ETF) and the F- and H-Area Water Treatment Units, were discovered to have I-129 levels much higher than expected. In some cases, new characterization data indicated concentrations several orders-of-magnitude greater than Waste Acceptance Criteria (WAC) for the Intermediate Level Vault (ILV). An immediate problem is that Activated Carbon vessels placed in the ILV exceed the Waste Acceptance Criteria (WAC) for I-129.

Materials in the water treatment systems unexpectedly performed as sorbents for I-129. This behavior was contrary to what was assumed in the Performance Assessment (PA) for the E-Area Vaults (DOE, 1994) which formed the basis for the WAC. To rectify this discrepancy, the sorption property for the waste streams was measured in the laboratory and revised computer models were executed for possible disposal in the ILV. The options of disposing wastes with high I-129 levels in the Low Activity Waste (LAW) vault or in trenches were not addressed in this report.

This Disposal Analysis examined six identified waste streams as follows:

1. ETF Activated Carbon Vessels
2. ETF GT-73 resin
3. ER F-Area Dowex 21K
4. ER H-Area Dowex 21K.
5. ER F-Area sludge/filtercake
6. ER H-Area sludge/filtercake.

Zeolites were the most recently discovered waste stream with elevated levels of I-129, but they were not examined in this report.

This Disposal Analysis examined the existing ILV inventory of I-129 and the projected inventory for each identified waste stream for the next ten years. Each waste stream was analyzed separately to determine its waste-specific I-129 inventory limit.

The Disposal Analysis incorporated laboratory results for I-129 sorption properties with numerical models used in the revision of the E-Area PA of the ILV (DOE, 1998). The sorption property is called the distribution coefficient or Kd; it represents the partitioning of a contaminant between solids and liquids. The waste-specific Kd's are much higher than the values used in the PA revision, resulting in higher inventory limits. The I-129 distribution coefficients (Kd's) were measured for the waste material only; the Kd used for I-129 migration in the sediments of the vadose zone and aquifer was 0.6 ml/g from the PA (DOE, 1998).

1. METHOD OF ANALYSIS

Modeling results based on unit contaminant inventories were obtained at a hypothetical 100-m downgradient well. Modeling results were scaled by the actual or projected inventories to produce individual waste-stream well concentrations. These concentrations were compared with the Maximum Contaminant Level (MCL) of 0.5 pCi/L to establish the total inventory limit for all ILV's. Because two ILV's may be operated and their leachate may intermingle, the inventory limit for one ILV is calculated by dividing the total inventory limit by two.

Models were established and initially executed before laboratory results were available; hence, separate models were executed to cover the range of expected laboratory Kd values. Laboratory Kd values were used to establish final models. Curves of I-129 inventory limits versus Kd were generated for each waste stream.

2. WASTE STREAM INVENTORY PROJECTIONS

Two waste streams from ETF and four waste streams from ER contain elevated levels of I-129. These waste streams are identified in Table 1. The existing I-129 ILV inventory from these four waste streams consists of four Activated Carbon vessels. Comparing the I-129 inventory in the Activated Carbon vessels in the vault with the inventory in a vessel currently awaiting transport and disposal (the first ETF waste stream in Table 1) indicates that the amount of I-129 in each Activated Carbon vessel can vary significantly. The inventory amount is a function of the concentration in the influent, the efficiency of the medium in removing I-129 from the influent, and the service duration for the medium.

Table 1. I-129 Bearing Waste Stream Descriptions

Source	Description	Annual Volume (ft^3)	I-129 Conc. (pCi/g)	Density (pcf)	Annual Inventory (Ci)
Exists	Current Activated Carbon Vessel				1.92E-3[2]
ETF	Activated Carbon Vessel	1,032 (1 vessel)[3]	301[4]		7.11E-3[5]
ETF	GT-73 Resin • OR Hg Col • IX Hg Col	140[3] (3 every 2 yrs) (1 per year)	36.3[6] 3.71E-5 (Ci/Col)[7] 5.77E-5 (Ci/Col)[7]	50[3]	1.13E-04
ER	F-Area sludge/filtercake	NA[8]	Very low conc. [9]	70[9]	0
ER	H-Area sludge/filtercake	850 one yr[9]	19.1	70[9]	5.16E-4
ER	F-Area Dowex 21K	5,400[9]	119	55[9]	1.78E-2
ER	H-Area Dowex 21K	600[9]	94	55[9]	Included with F-Area

Inventories for F-Area sludge are not included because of its low concentration. The H-Area sludge will only be produced for one year. The projected inventories for F- and H-Area Dowex 21K are combined, because only one sample was provided for measuring Kd. The projected inventories for the next ten years are listed in Table 2. and are plotted in Figure 1. Figure 1 also includes the PA and revised PA limits for generic I-129 wastes (without waste-specific Kd's) of 5.3E-4 Ci and 2.59E-4 Ci, respectively.

Table 2. Projected I-129 Inventories

Source	Annual Inventory (Ci)	Ten-Year Inventory (Ci)	Ten-Year Percentage
Existing (Activated Carbon)	1.92E-3	1.92E-3	0.8
Activated Carbon	7.11E-3	7.11E-2	28.1
GT-73 Resin	1.13E-4	1.13E-3	0.4
F- and H-Area WTU sludge / filtercake	5.16E-4	5.16E-4[10]	0.2
F- and H-Area Dowex 21K	1.78E-2	1.78E-1	70.5
Sum		2.53E-1	100.0

[2] E-Mail from Sink on June 14, 1999 and personnel communication.
[3] E-Mail from Sink on May 24, 1999 included in E-Mail from Lucha on June 3, 1999.
[4] E-Mail from Walliser on June 7, 1999.
[5] E-Mail from Walliser on June 7, 1999. Although not applied, he recommended increasing the value by a factor of ten. Wiggins recommended using a factor no larger than two in E-Mail on June 28, 1999.
[6] E-Mail from Walliser on June 28, 1999.
[7] Based on E-Mails from Walliser on June 7, 1999 and June 28, 1999.
[8] Not applicable due to very low concentrations
[9] E-Mail from Lucha on June 3, 1999.
[10] H-Area sludge is only for one year, F-Area sludge has low concentrations – see Table 1.

The highest inventory source of 0.178 Ci for the Dowex 21K represents 70.5 percent of the total projected inventory. The Activated Carbon is the other major contributor to inventory with a projection of 0.0711 Ci, representing 28.1 percent of the total. If the Activated Carbon inventory is increased by a factor of two, as recommended by Wiggins, or by a factor of ten, as recommended by Walliser (see Table 1), then its contribution increases to about 44 percent and 89 percent of the total, respectively. The combination of the Existing inventory, the GT-73 Resin, and the sludge account for about one percent of the total projected inventory.

3. WASTE-SPECIFIC Kd's

Four samples of different materials bearing I-129 were submitted for Kd testing (Kaplan, et. al., 1999) to represent six waste streams. Because of similarities in operations and materials for the Waste Treatment Units in F-Area and H-Area the sludge/filtercake were considered as the same material. The F-Area and the H-Area Dowex 21K were treated similarly.

The sludge/filtercake will not be considered further, because it had too low of an I-129 concentration in the sample for a Kd to be determined. The Activated Carbon had the lowest Kd of 600 ml/g, while the GT-73 had the highest value of 3,100 ml/g. These values are significantly higher than literature values of 30 ml/g and 2 ml/g used in the PA and its revision for cement-based wastes.

Table 3. Waste-Specific I-129 Kd Values

Waste	Kd based on Laboratory Measurements (ml/g)
ETF Activated Carbon	600
ETF GT-73	3100
F-Area Dowex 21K	1800

4. RESULTS

Modeling was conducted over a range of waste Kd values from 2 ml/g, the value from the draft PA revision, to 2,000 ml/g. The Kd range was extended to include the GT-73 waste-specific Kd of 3,100 ml/g. The model results were converted to inventory limits. The vault inventory limits for each waste stream are plotted against the input Kd's in Figures 2 to 6 as follows:

- Figure 2 Existing ILV inventory of Activated Carbon
- Figure 3 Projected Activated Carbon Excluding Existing Inventory
- Figure 4 GT-73
- Figure 5 Dowex 21K

The results for waste-specific Kd's (see Table 3) based on laboratory measurements are plotted in those figures as a shaded circle. The results for the waste Kd from the PA revision (2 ml/g) are highlighted as a shaded diamond in the plot.

Table 4 provides a comparison of each waste form's projected inventory with inventory limits generated from modeling results. The existing inventory of activated carbon vessels in the ILV is only about three percent of the proposed inventory limit. The projected Activated Carbon Vessel inventory almost exactly matches its proposed inventory limit. The projected GT-73 inventory is less than one percent of its proposed inventory limit. The projected Dowex 21K inventory is about one-half its projected inventory limit. This information is graphed in Figure 7 with the PA limits for generic I-129 waste to show the advantages of having waste-specific Kd's.

Table 4. Projected Inventory versus Inventory Limit			
Waste Form	Indicated Inventory Limit (Ci)	Projected Inventory (Ci)	Projected Inventory / Inventory Limit * 100%
Existing Carbon Vessels in ILV	7.13E-2	1.92E-3	2.7
Activated Carbon Vessels	7.13E-2	7.11E-2	99.7
GT-73	3.68E-1	1.13E-3	.3
Dowex 21K	3.33E-1	1.78E-1	53.5

5. CONCLUSIONS

The activated carbon vessels pose the greatest challenge, because the projected inventory is the closest to the inventory limit. The Dowex 21K is important because its projected inventory is about one-half the inventory limit. The existing carbon vessels and the GT-73 are much less significant.

The individual waste-specific results provide information for the selection of an optimum disposal strategy. Based on the volumes of each waste stream and the costs of disposal at different locations, it will be possible to minimize disposal costs. For example, I-129 bearing wastes may be disposed in the LAW vault or off-site.

Waste-specific Kd's must be determined for waste stream materials that significantly sorb I-129 if WAC revisions are desired. The H-Area sludge/filtercake and some zeolites have been identified as belonging to this category of significant I-129 sorbents. As stated in the laboratory report, the use of "getter" materials may prove beneficial for seemingly intractable problem wastes, such as the activated carbon.

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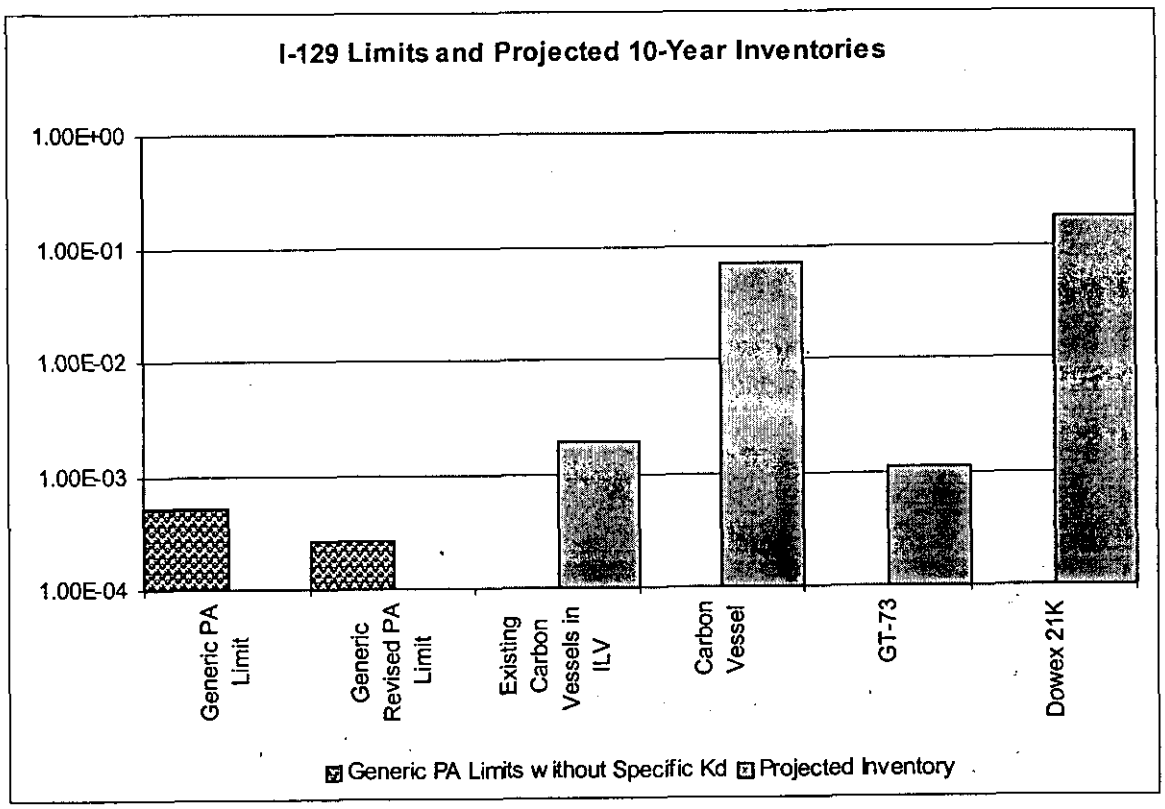

Figure 1. I-129 Projected Inventories with Generic Limits

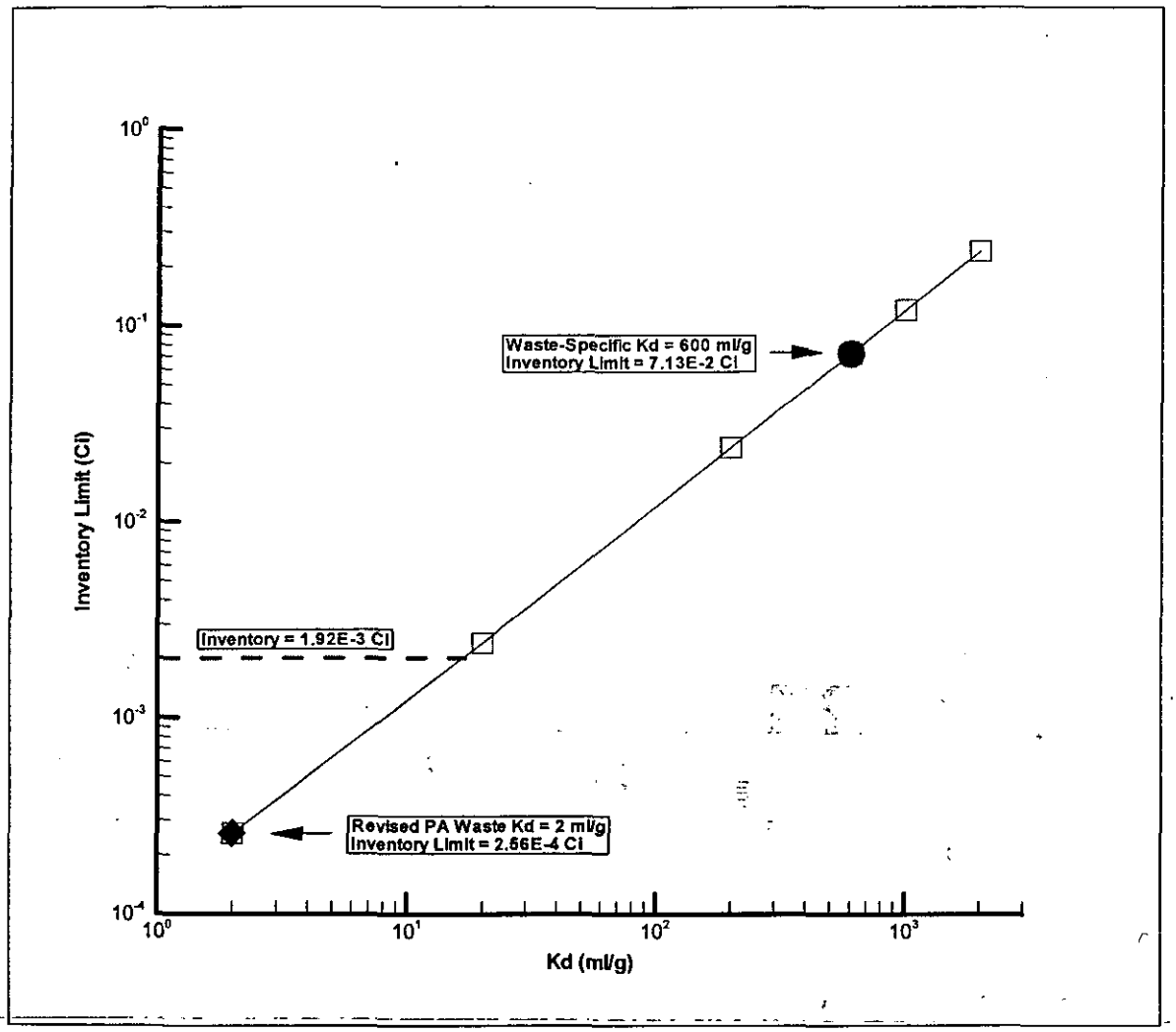

Figure 2. I-129 Inventory Limit for Existing Carbon Vessels in ILV over a Range of Waste Kd's

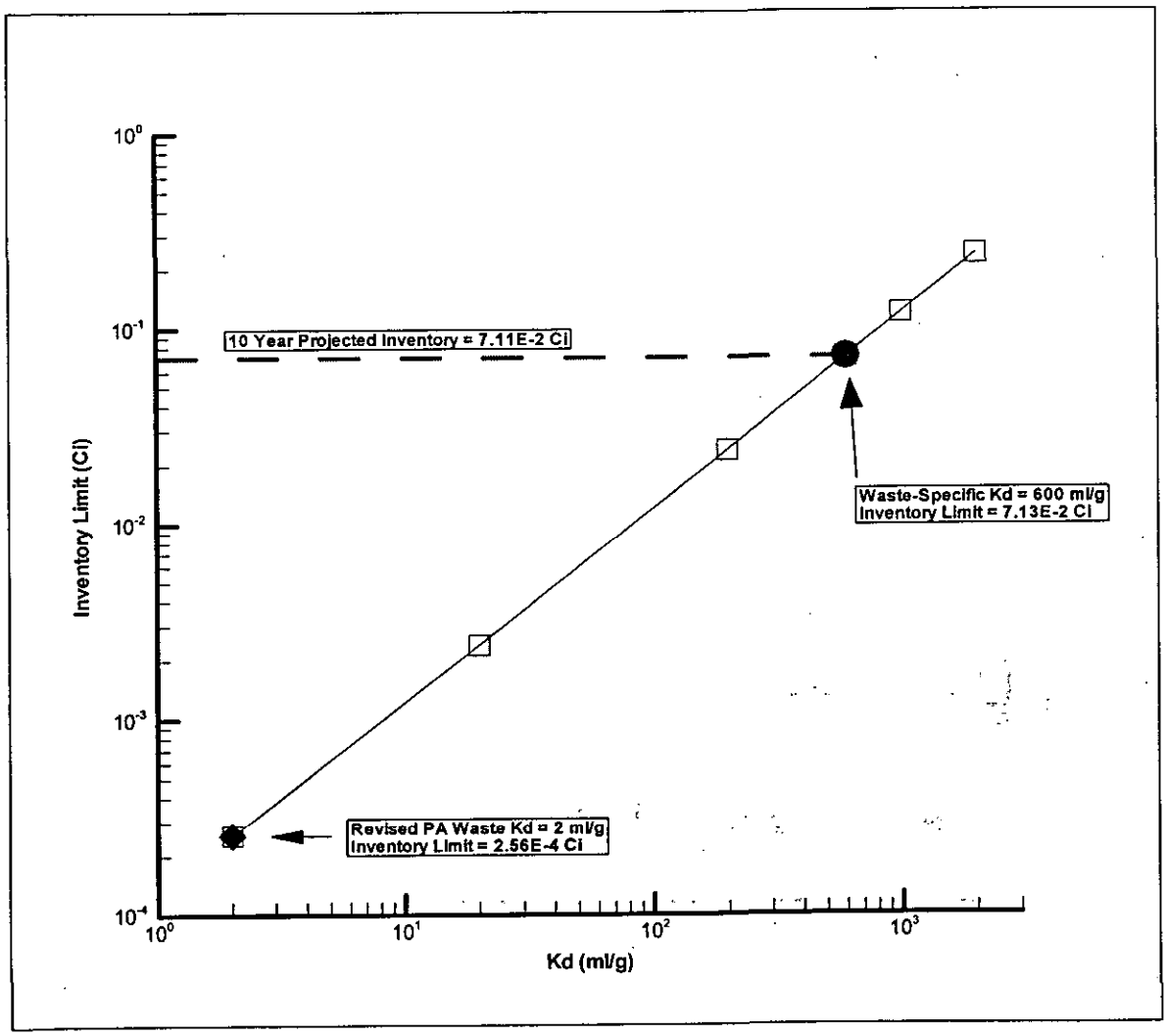

Figure 3. I-129 Inventory Limits for 10-Year Projected Activated Carbon Inventory over a Range of Waste Kd's

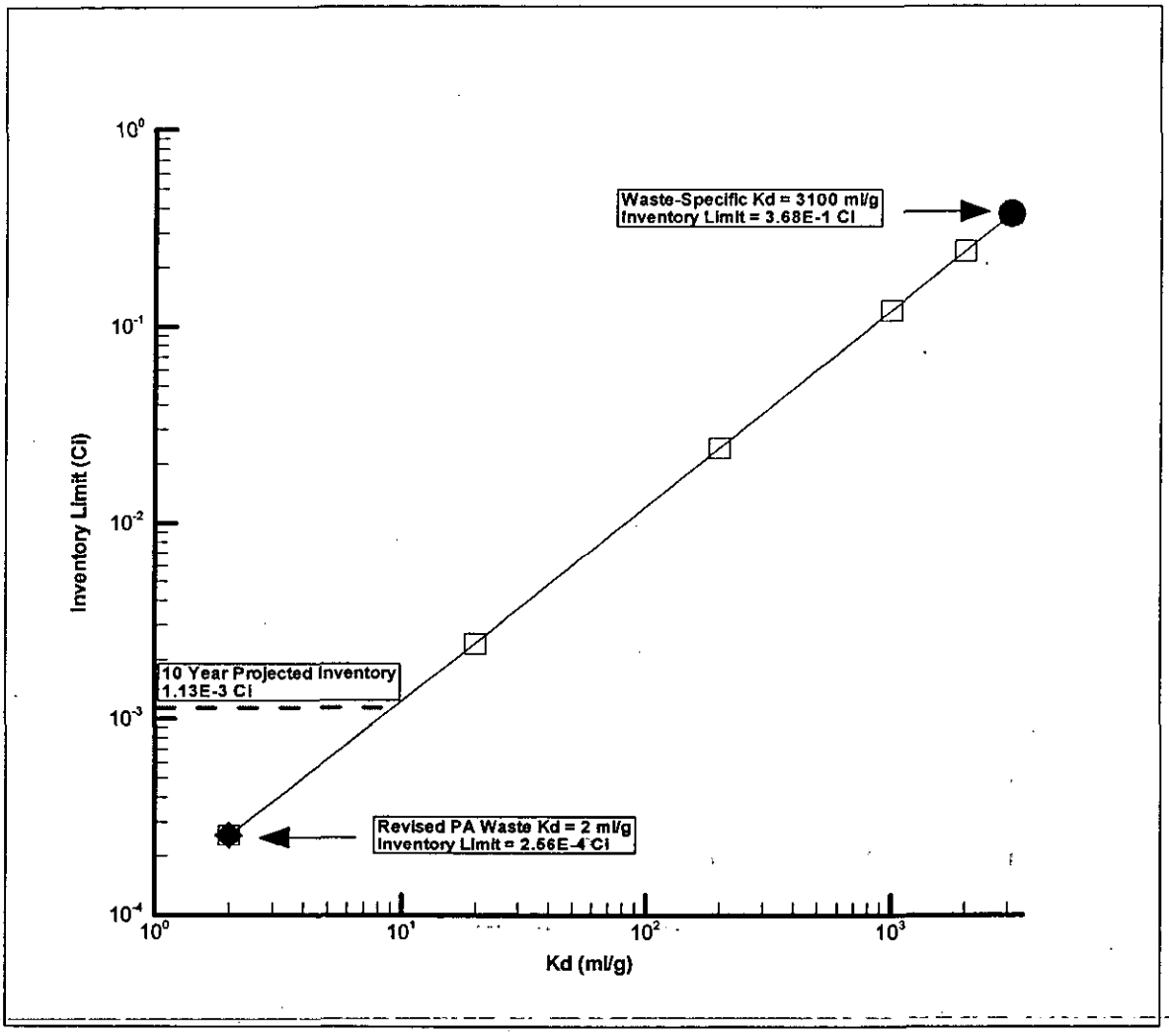

Figure 4. I-129 Inventory Limits for 10 Year Projected GT-73 Inventory over a Range of Waste Kd's

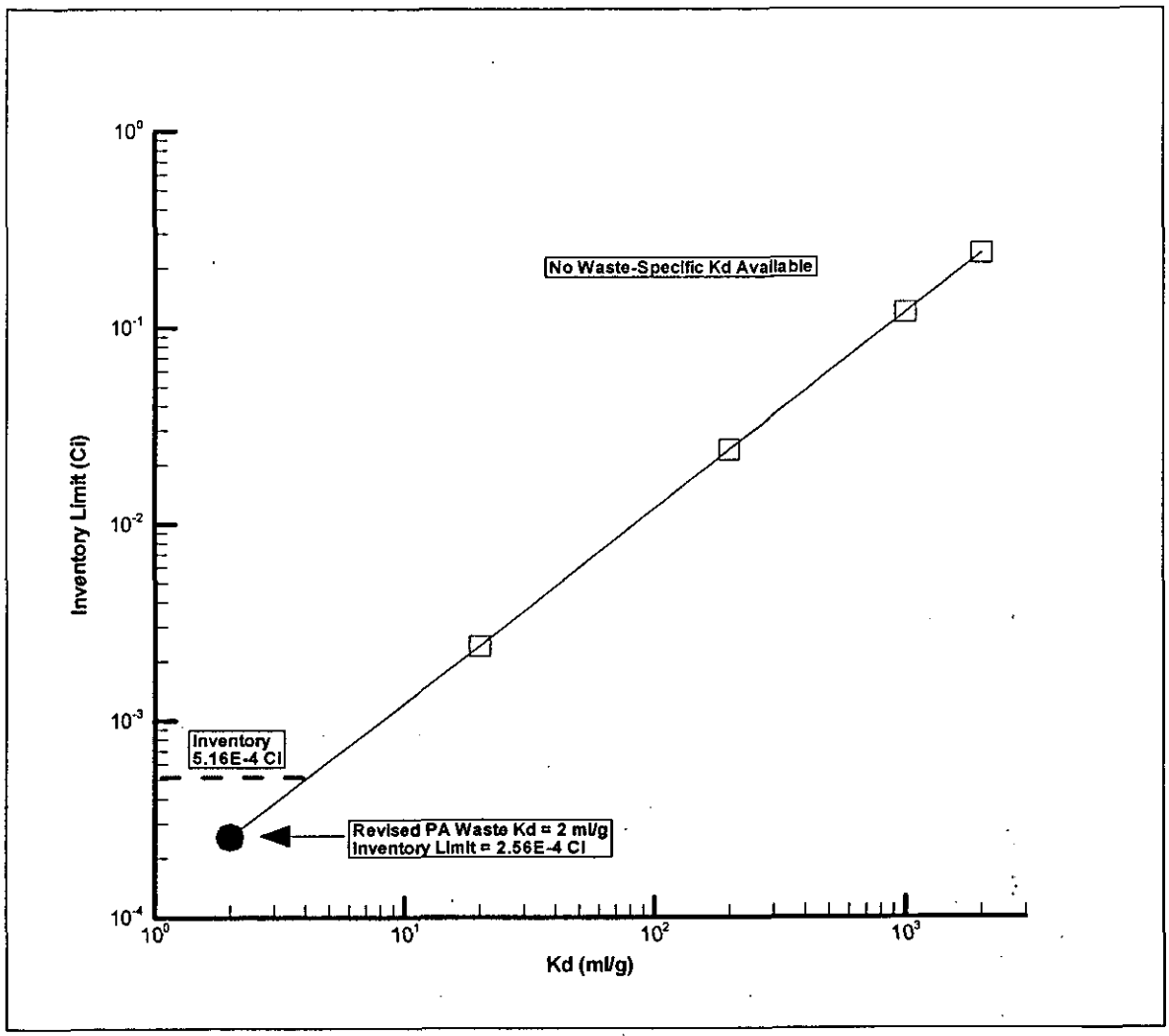

Figure 5. I-129 Inventory Limits for 10-Year Projected Sludge Inventory over a Range of Waste Kd's

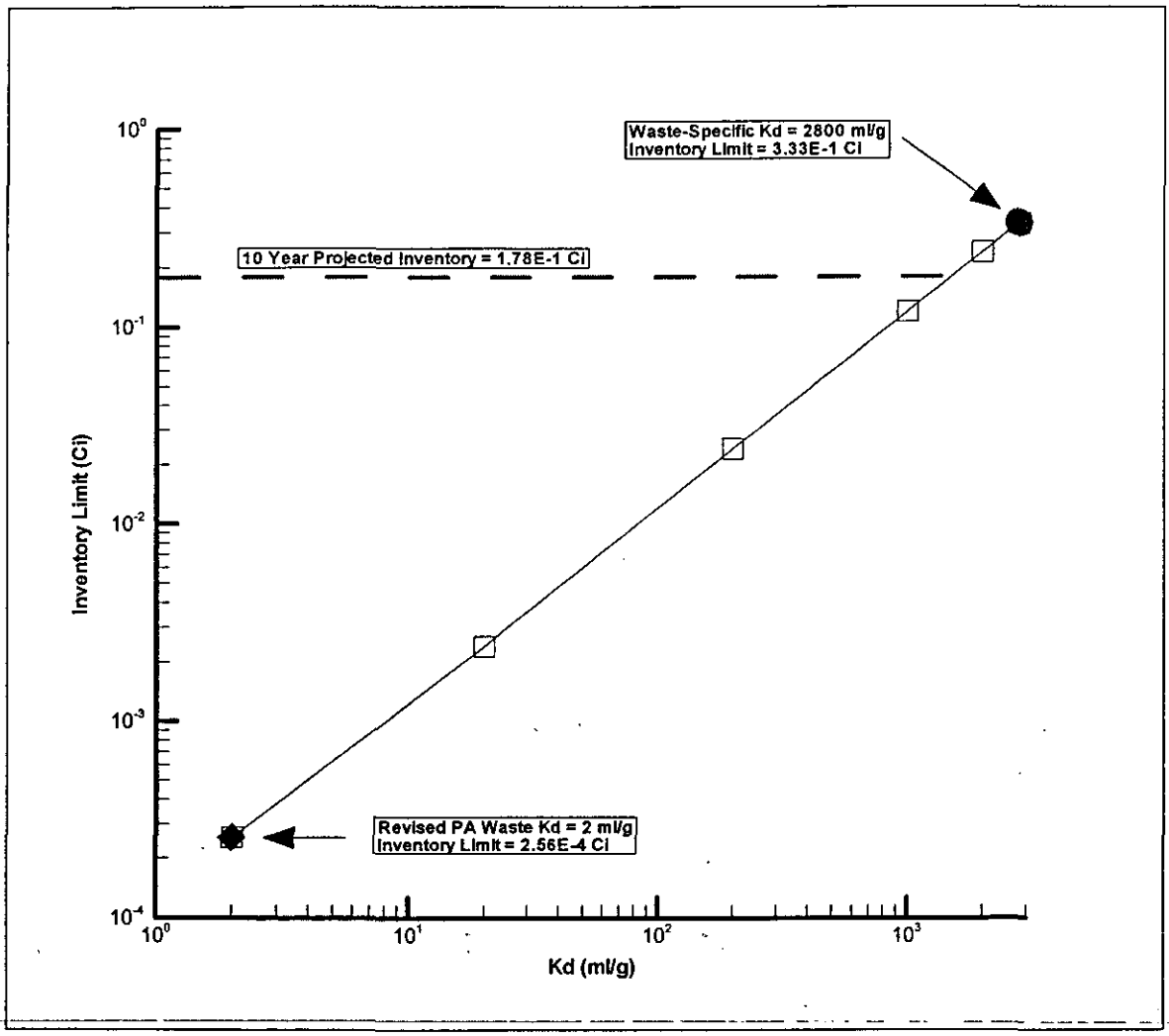

Figure 6. I-129 Inventory Limits for 10-Year Projected Dowex 21K Inventory over a Range of Waste Kd's

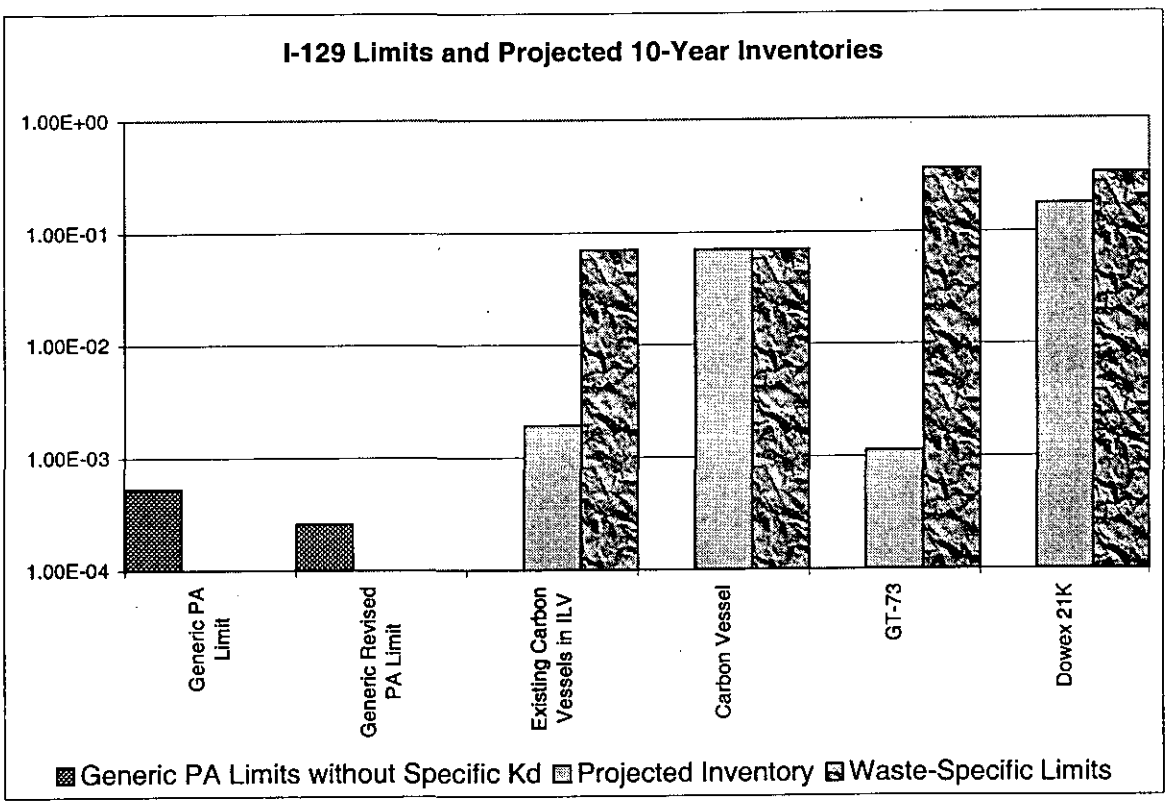

Figure 7. I-129 Projected Inventories with Generic and Waste-Specific Limits