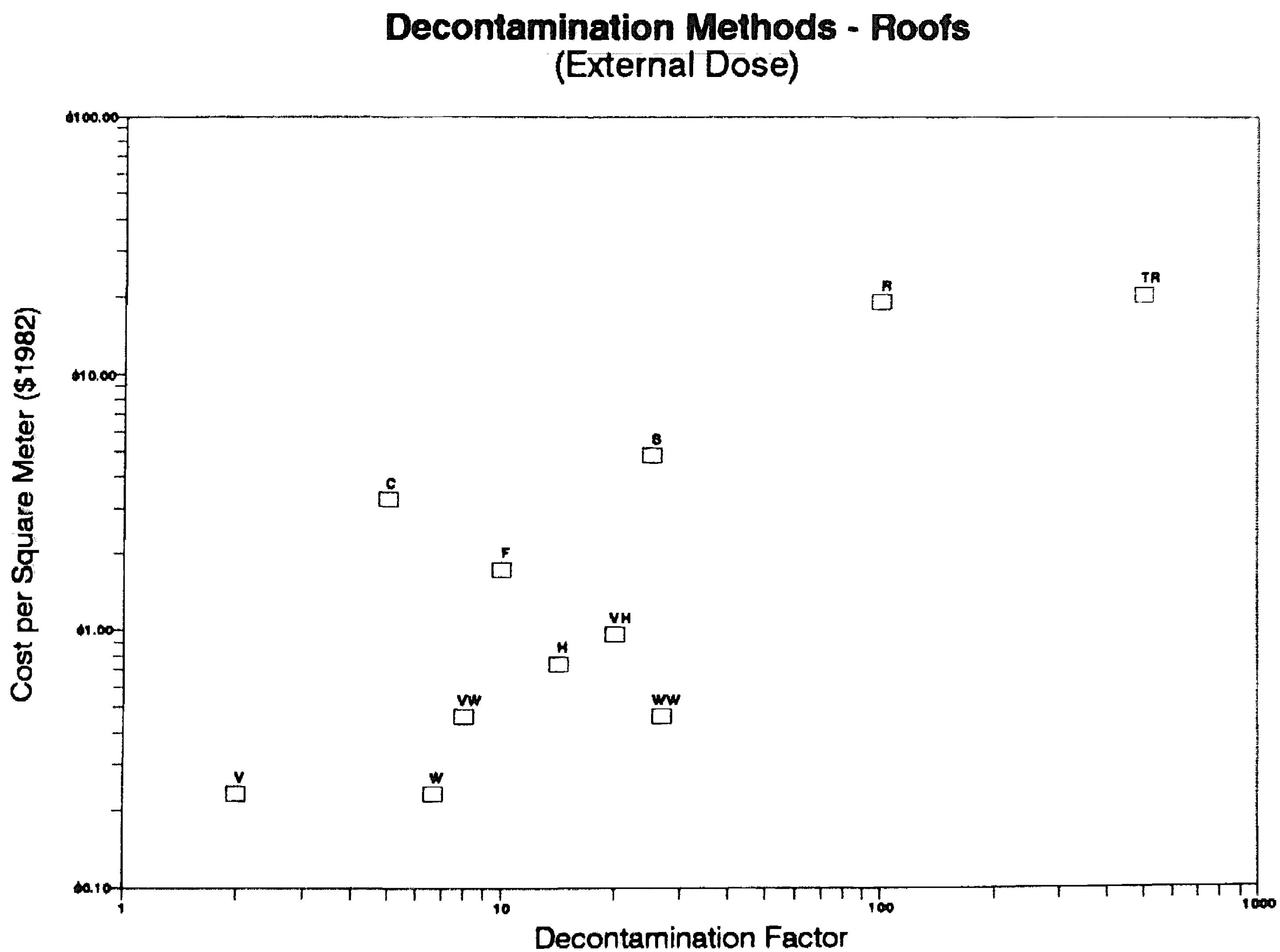

Figure 2.11. Costs and Efficiencies of Decontamination Methods: Roofs

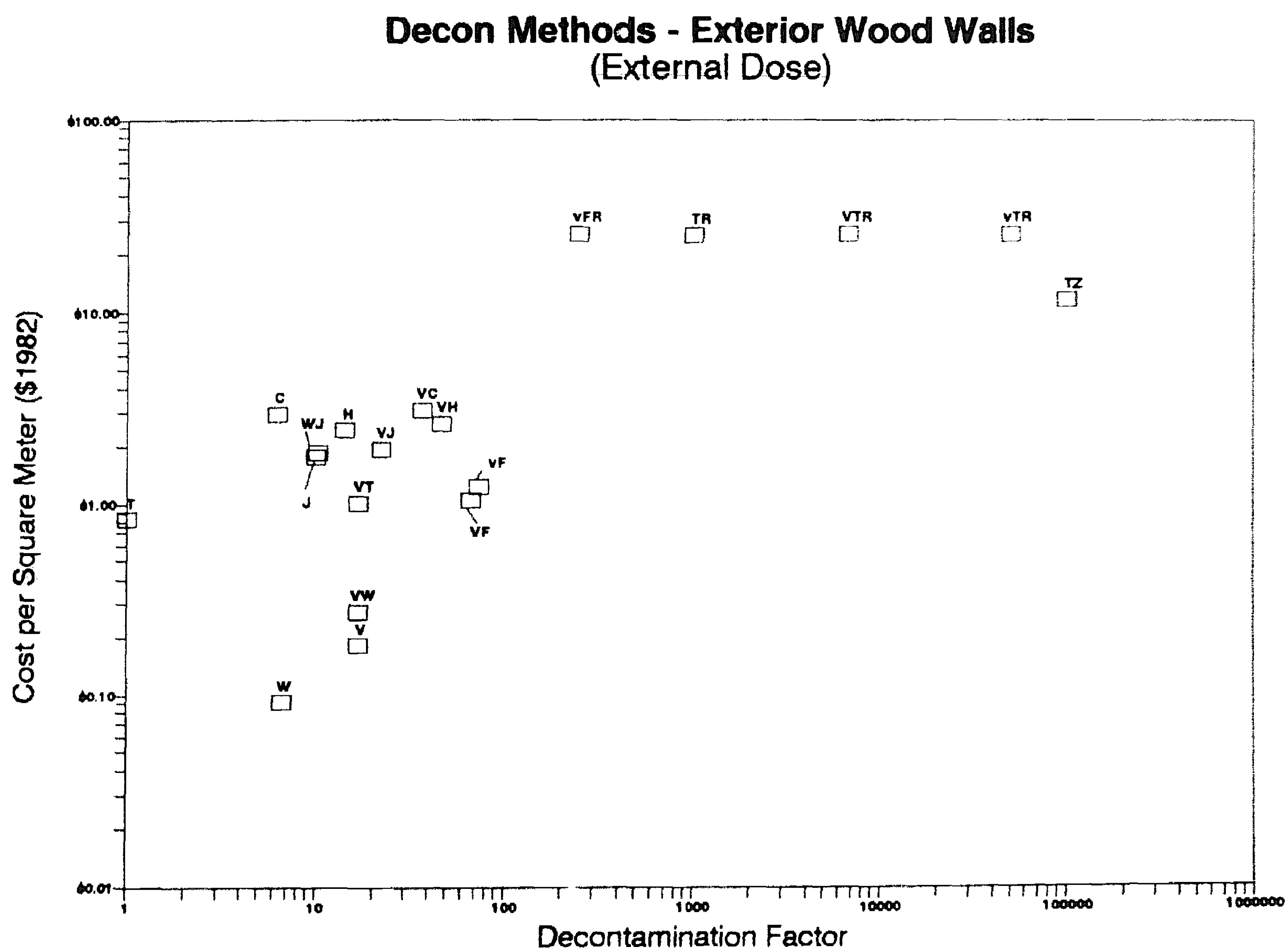

Figure 2.12. Costs and Efficiencies of Decontamination Methods: Exterior Wood Walls

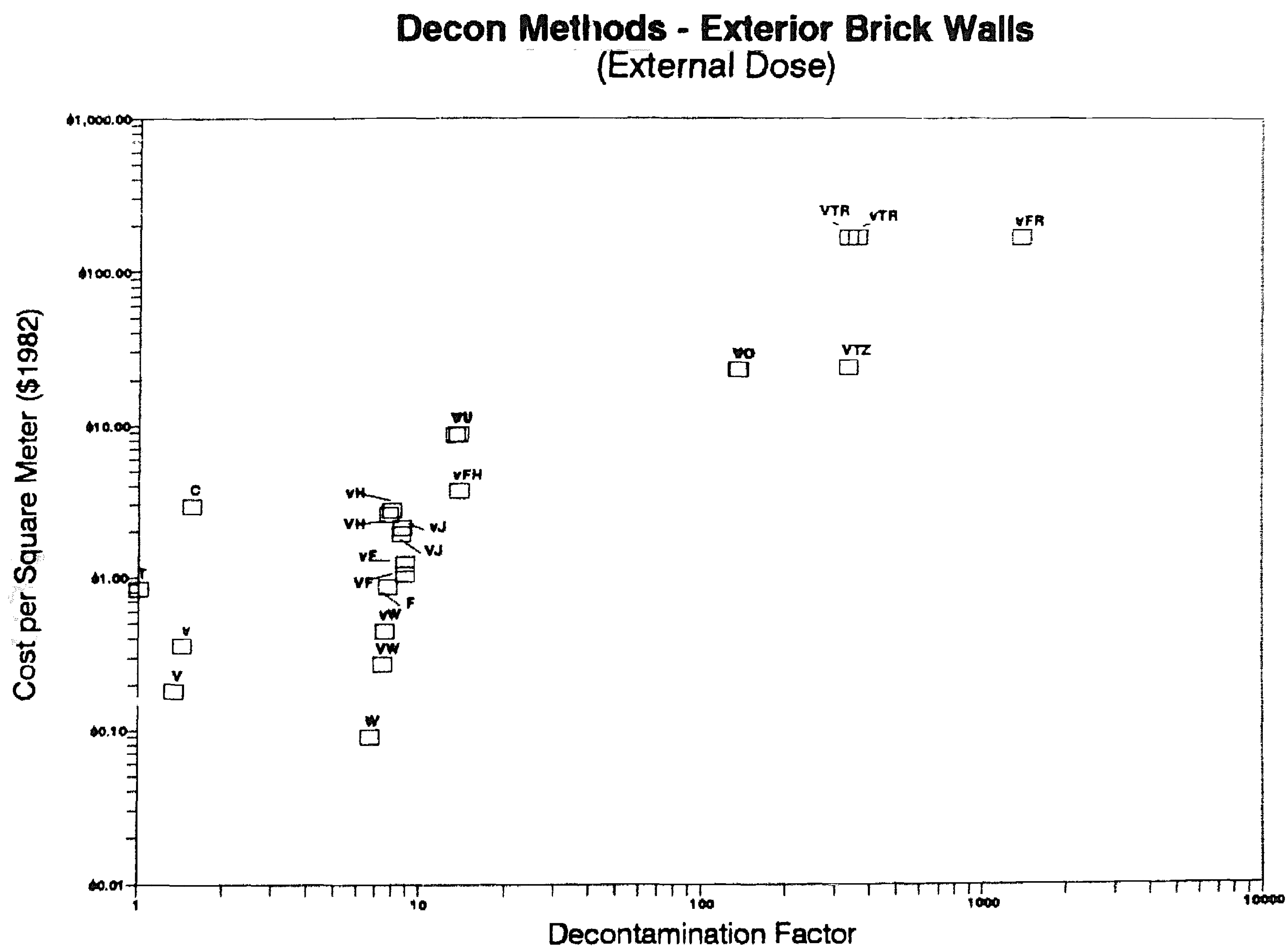

Figure 2.13. Costs and Efficiencies of Decontamination Methods: Exterior Brick Walls

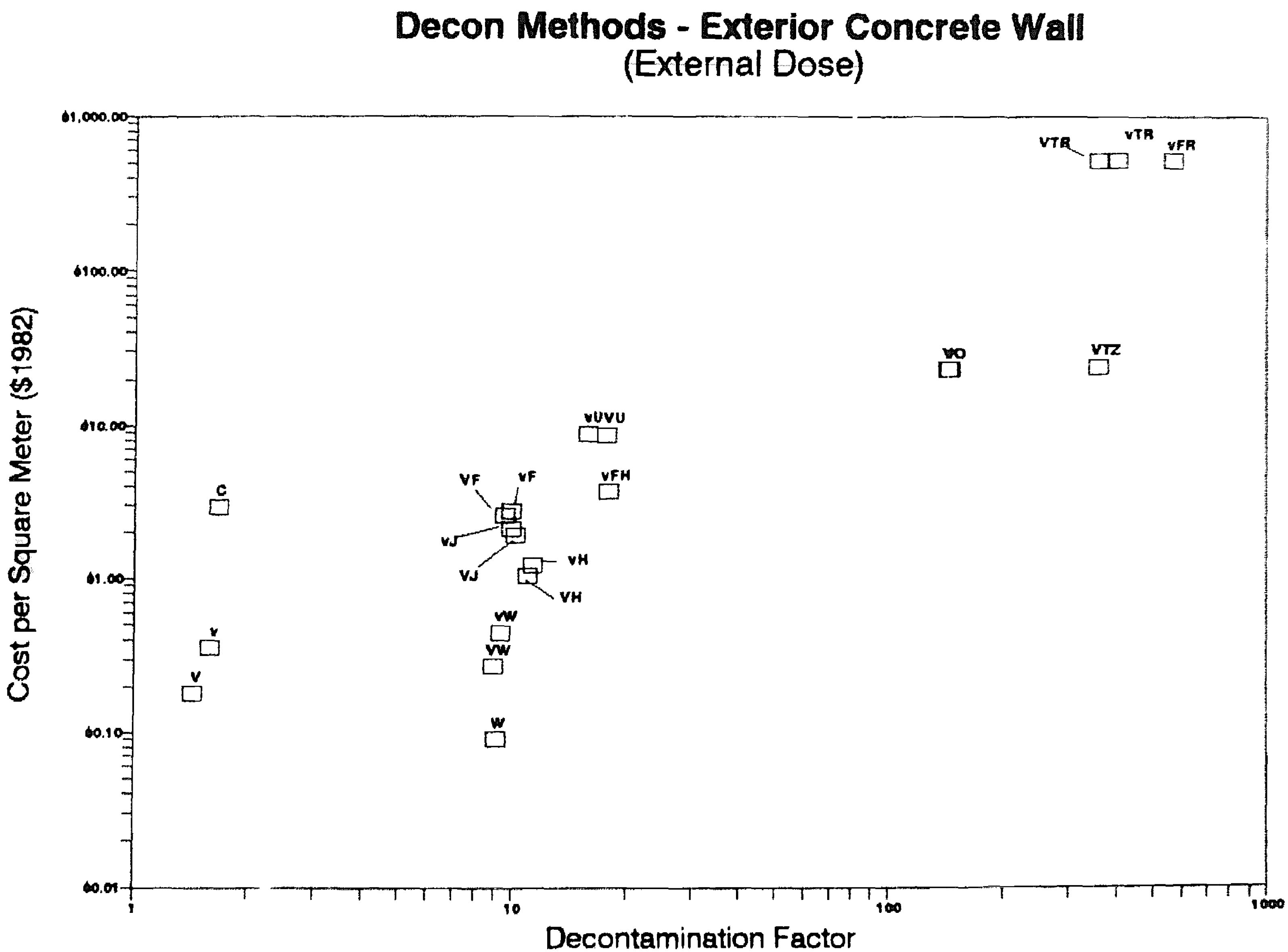

Figure 2.14. Costs and Efficiencies of Decontamination Methods: Exterior Concrete Walls

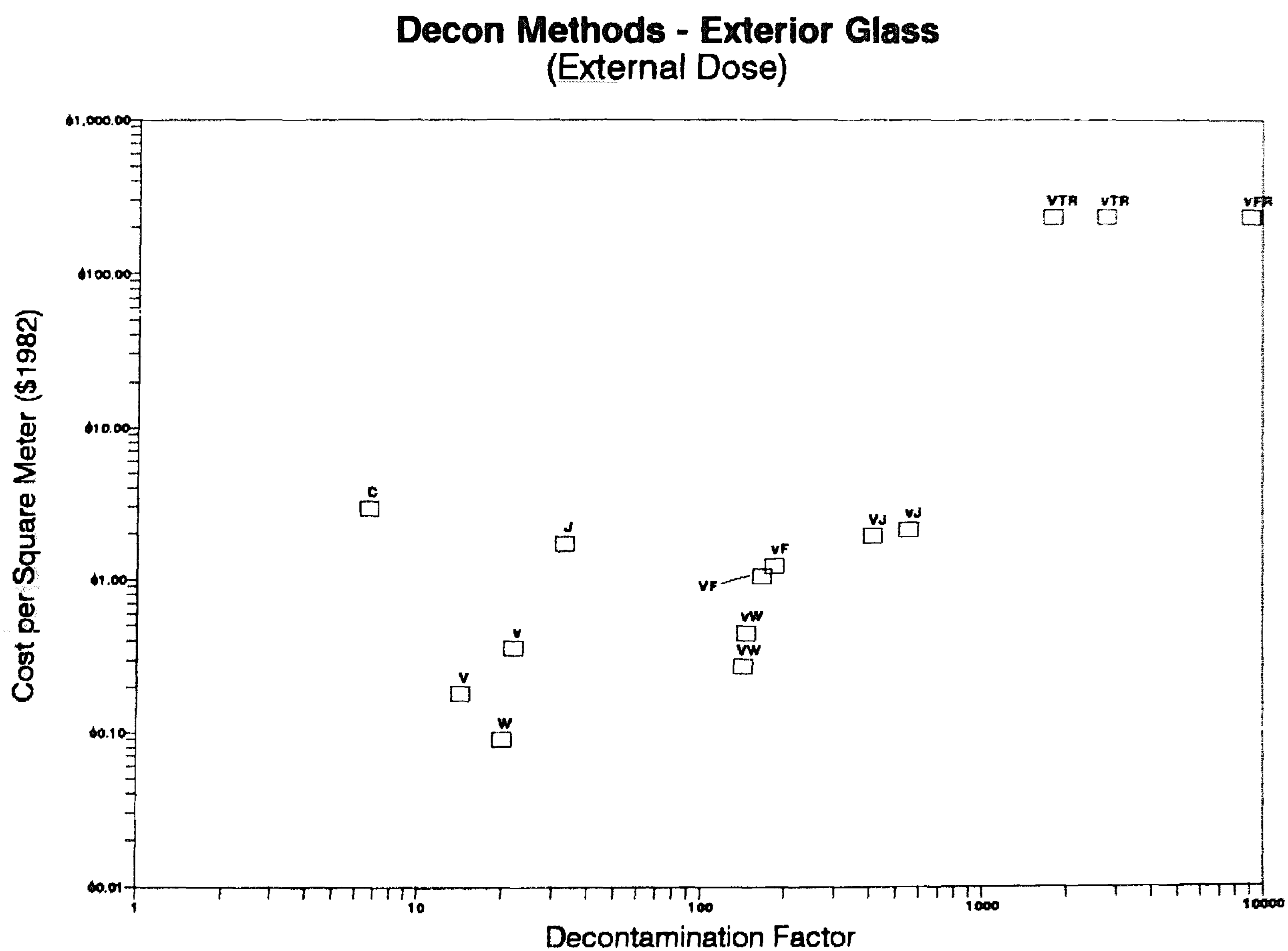

Figure 2.15. Costs and Efficiencies of Decontamination Methods: Exterior Glass

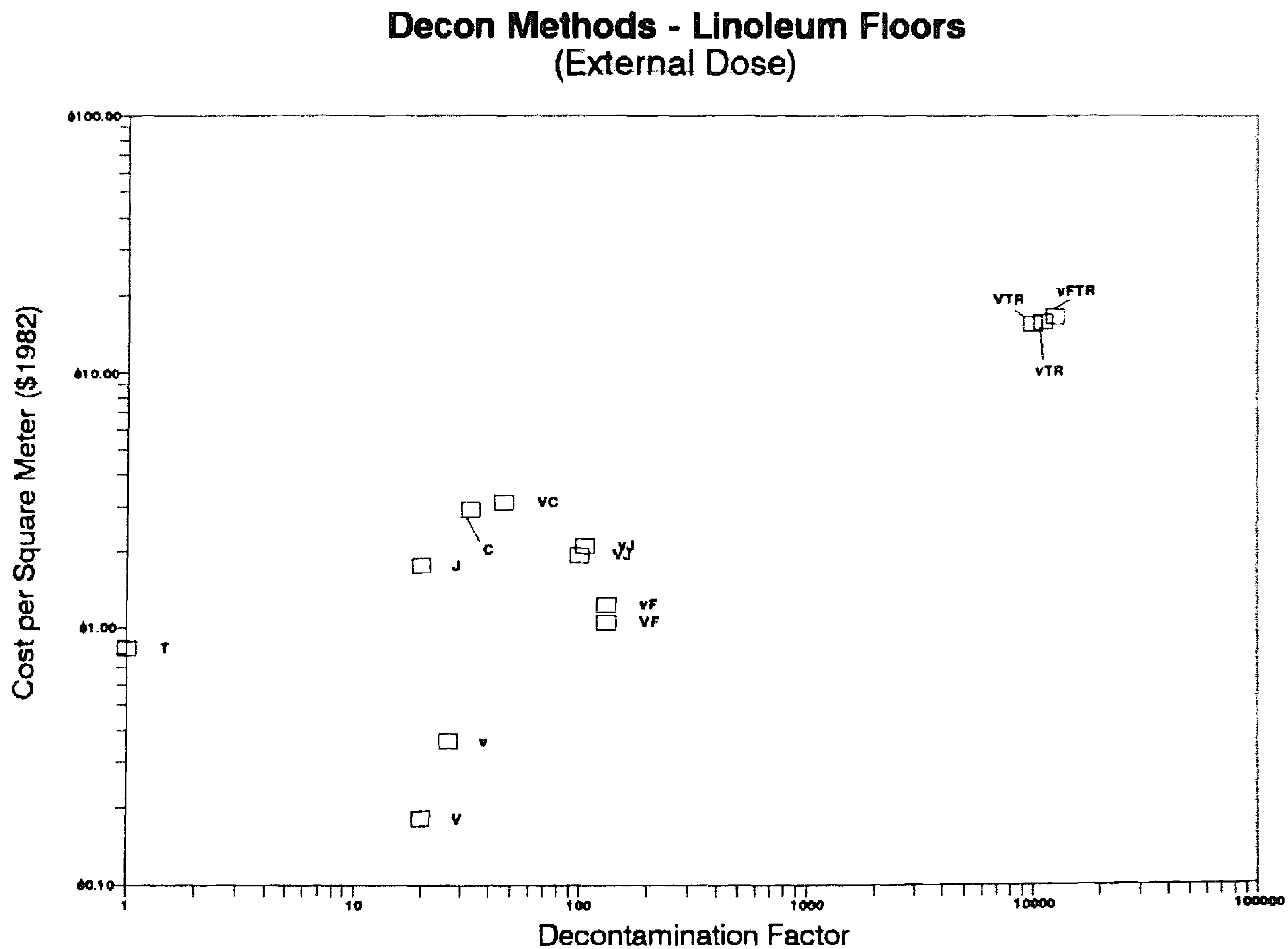

Figure 2.16. Costs and Efficiencies of Decontamination Methods: Linoleum Floors

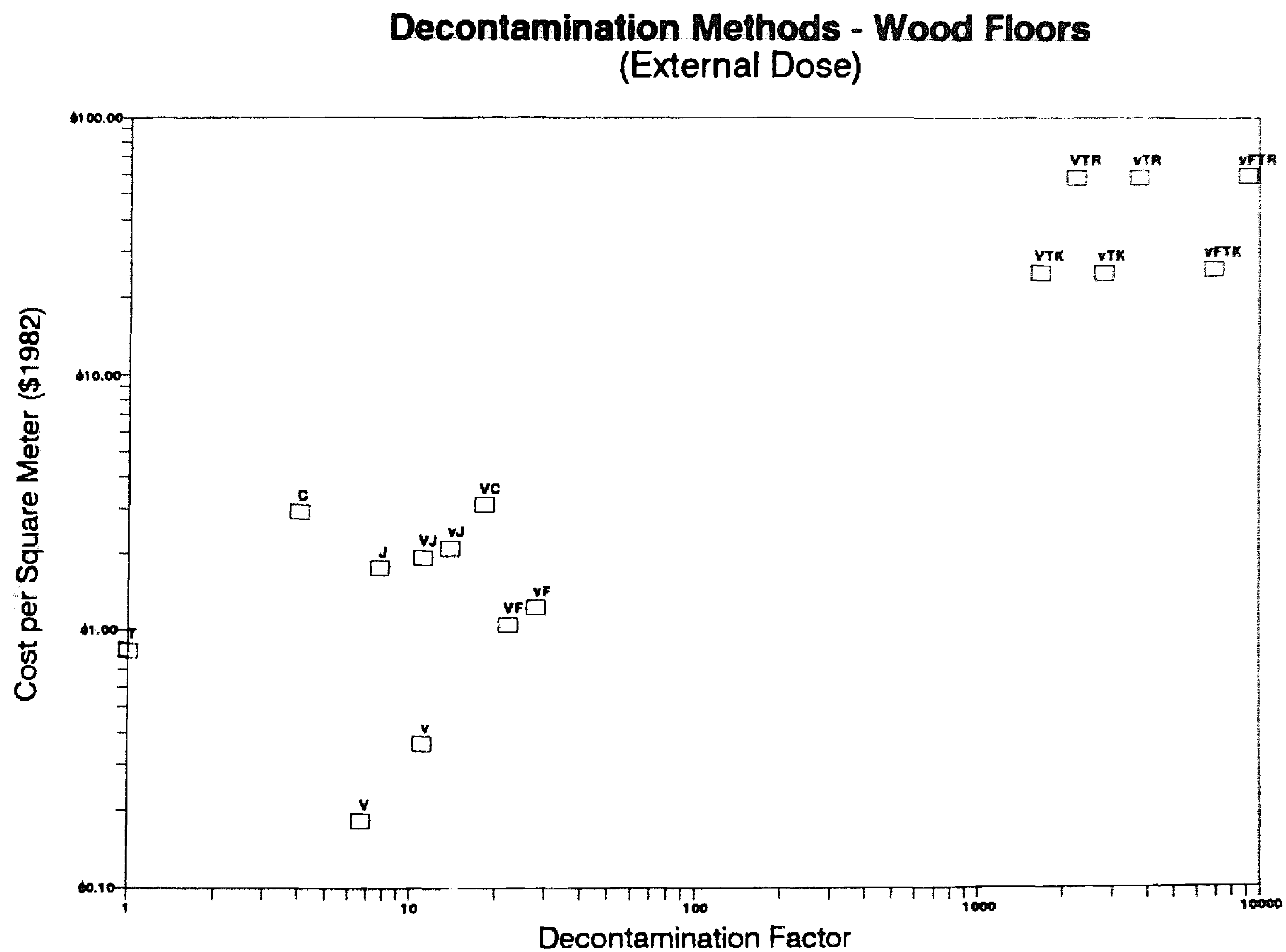

Figure 2.17. Costs and Efficiencies of Decontamination Methods: Wood Floors

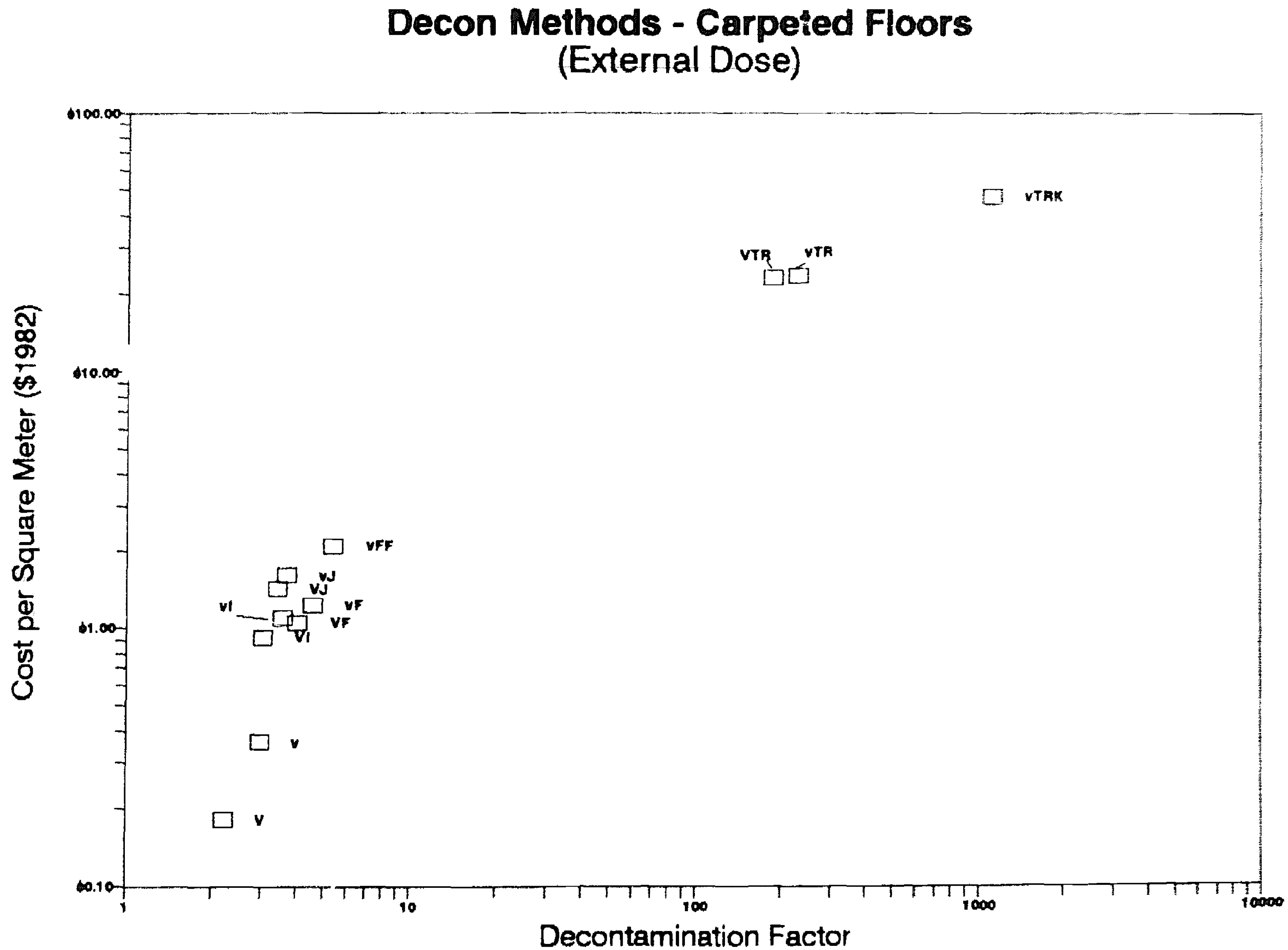

Figure 2.18. Costs and Efficiencies of Decontamination Methods: Carpeted Floors

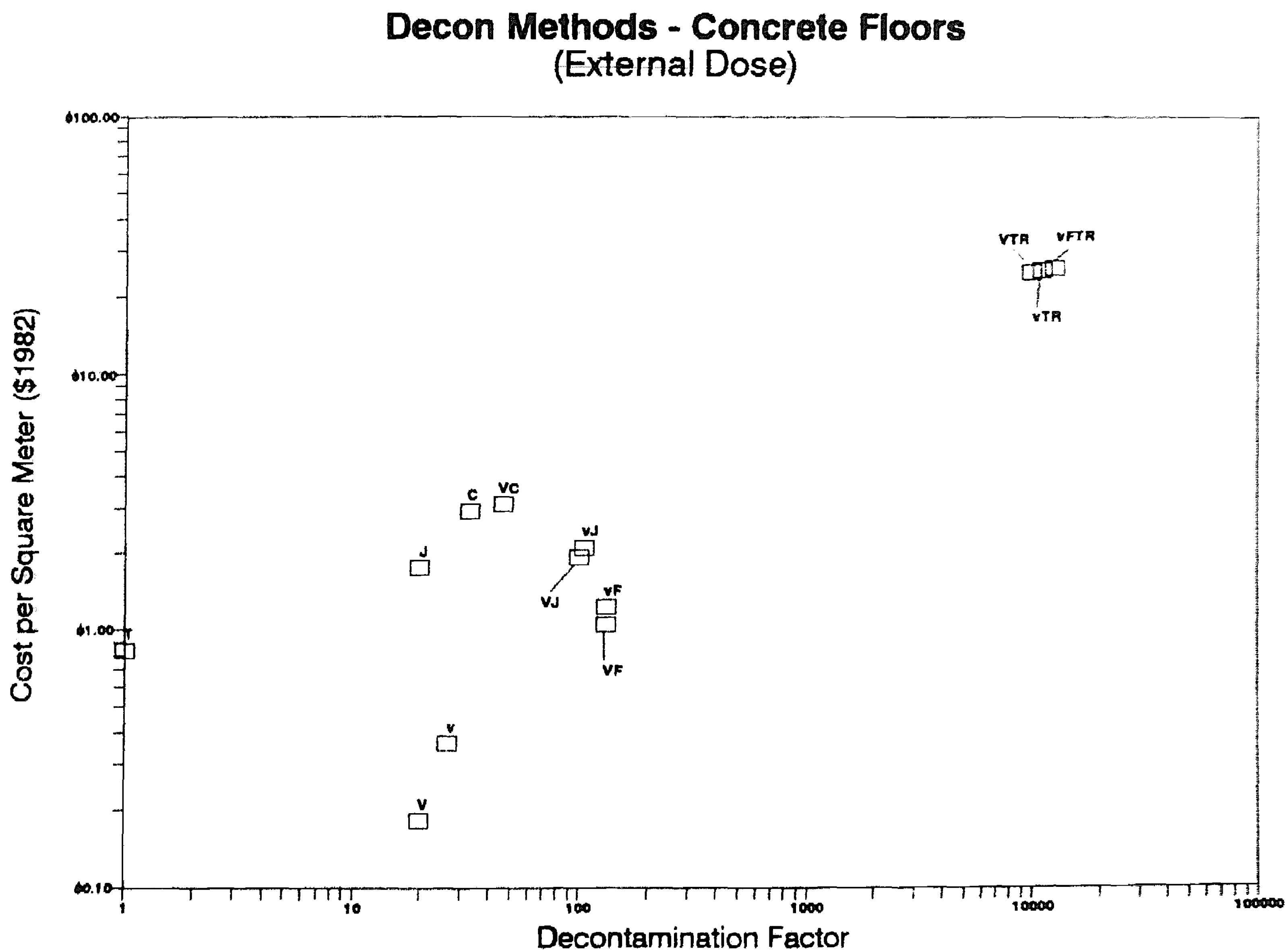

Figure 2.19. Costs and Efficiencies of Decontamination Methods: Concrete Floors

Decon Methods - Int. Wood/Plaster Walls
(External Dose)

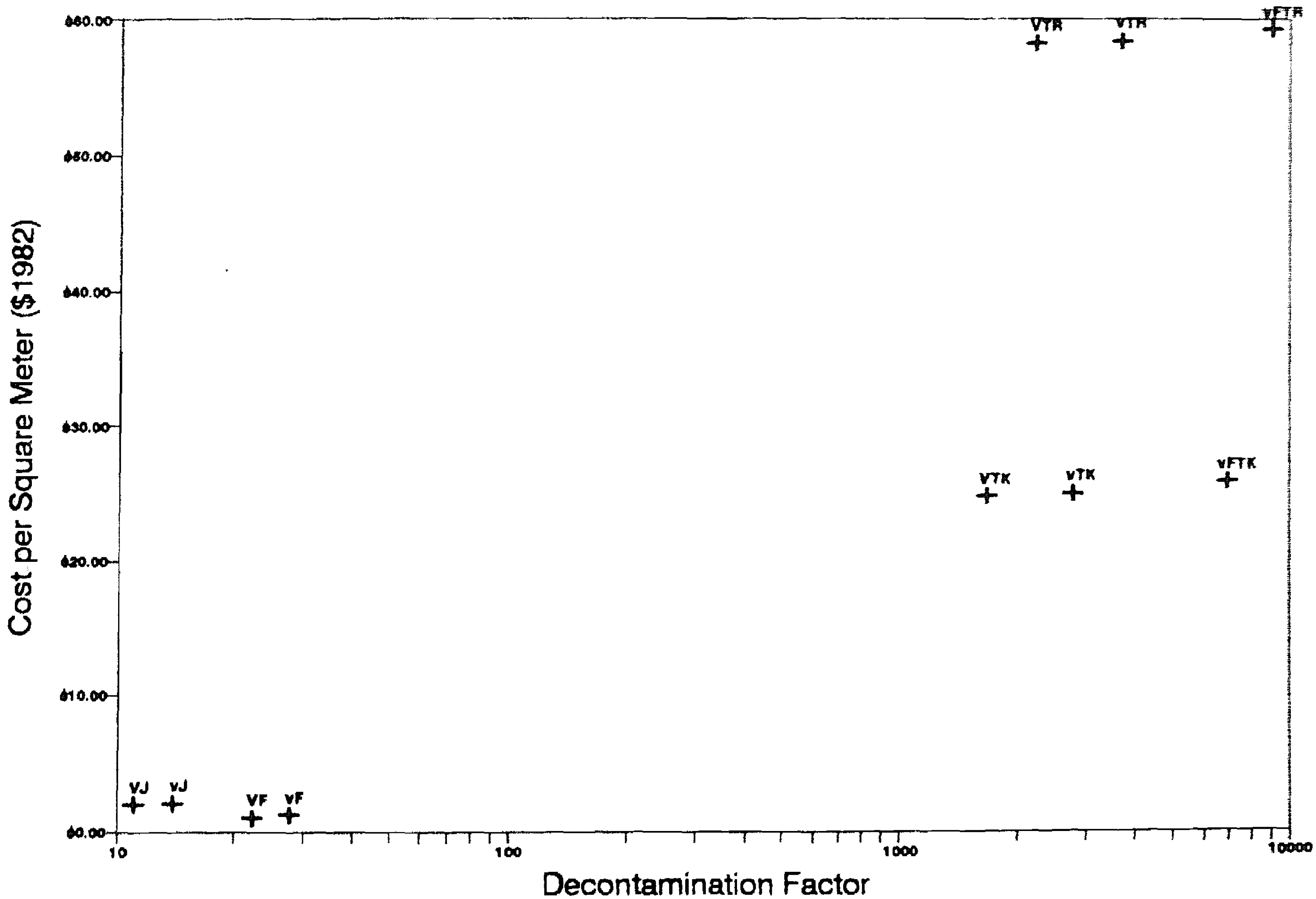

Figure 2.20. Costs and Efficiencies of Decontamination Methods: Interior Wood/Plaster Walls

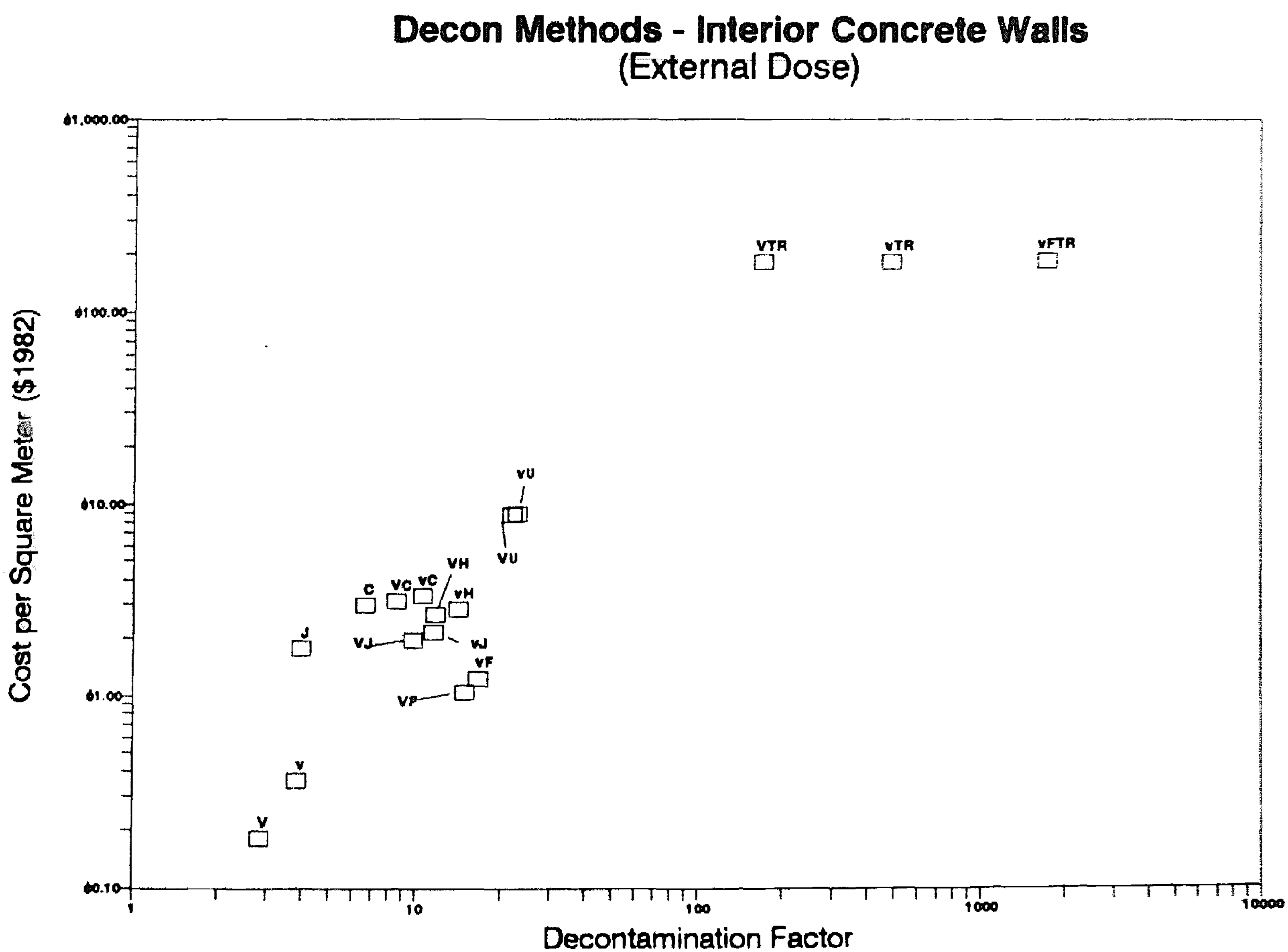

Figure 2.21. Costs and Efficiencies of Decontamination Methods: Interior Concrete Walls

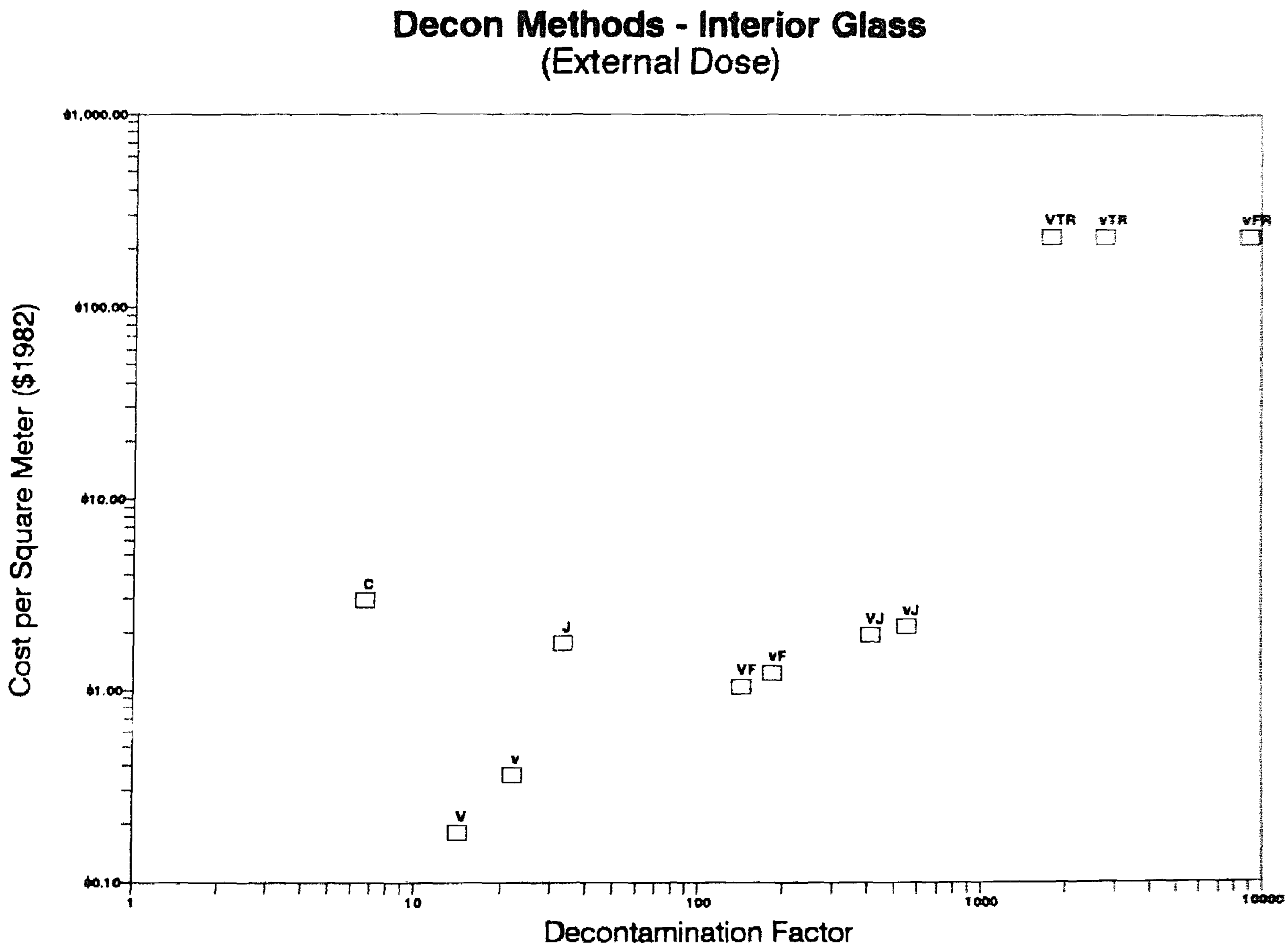

Figure 2.22. Costs and Efficiencies of Decontamination Methods: Interior Glass

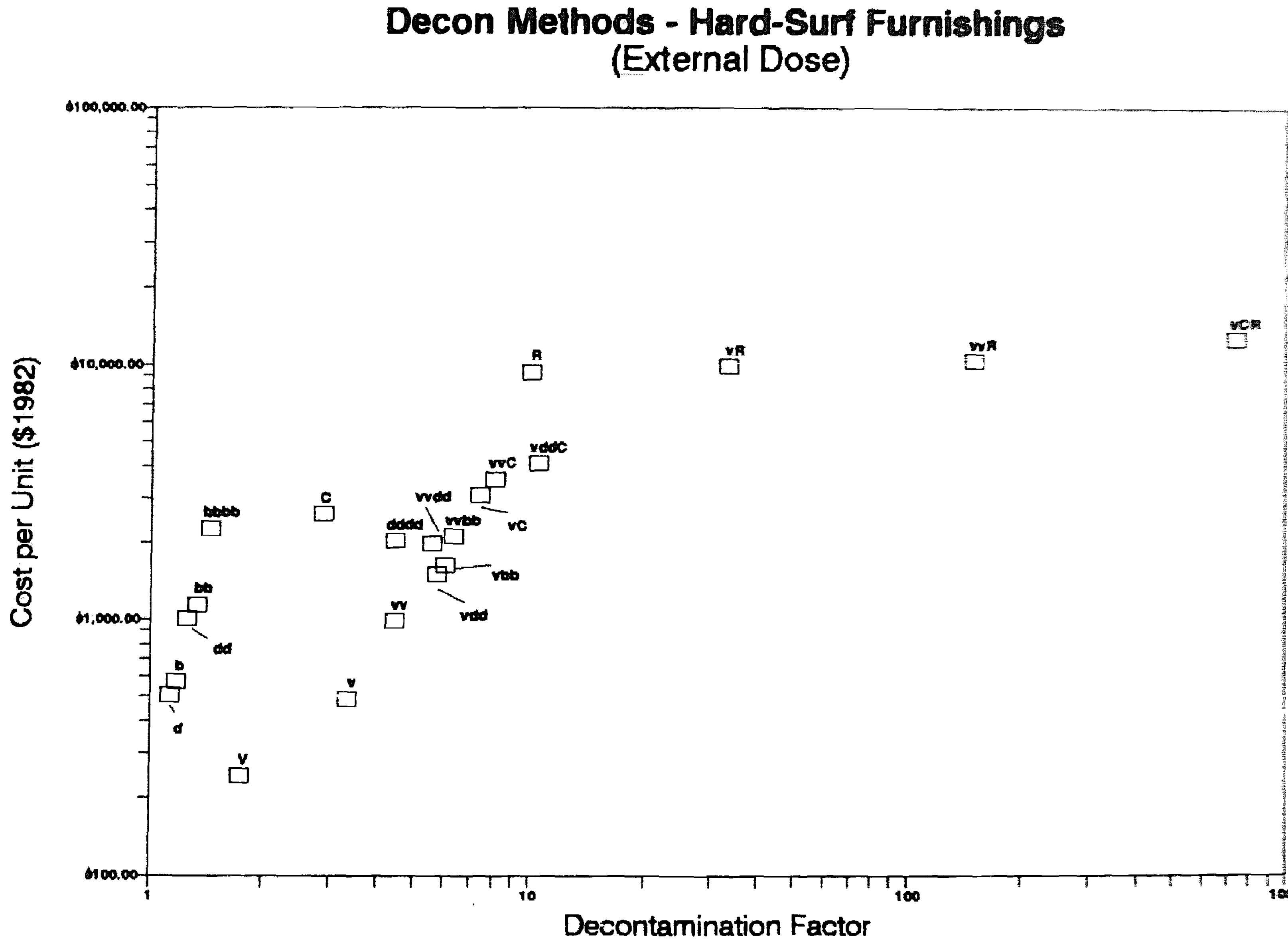

Figure 2.23. Costs and Efficiencies of Decontamination Methods: Hard-Surface Furnishings

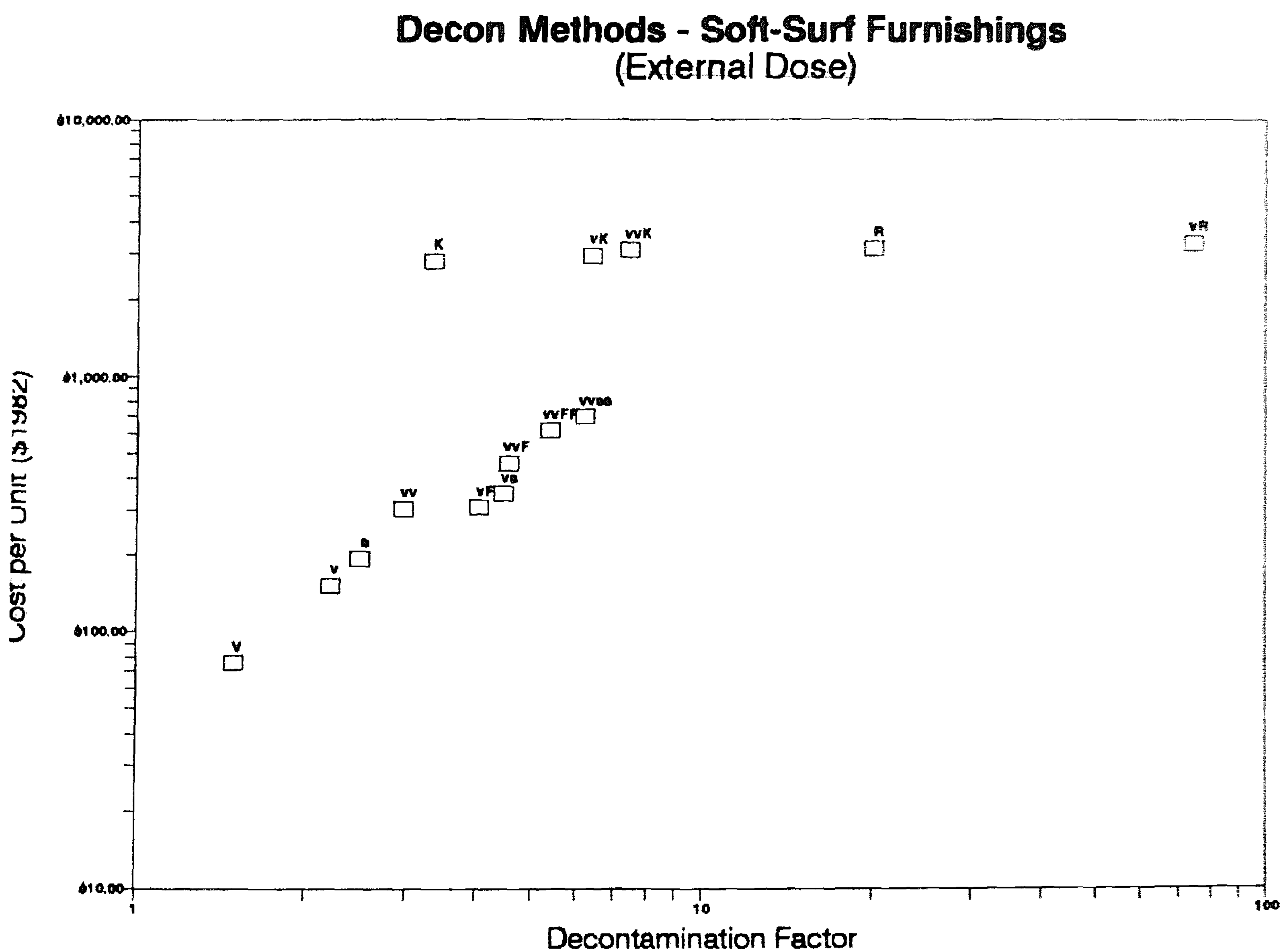

Figure 2.24. Costs and Efficiencies of Decontamination Methods: Soft-Surface Furnishings

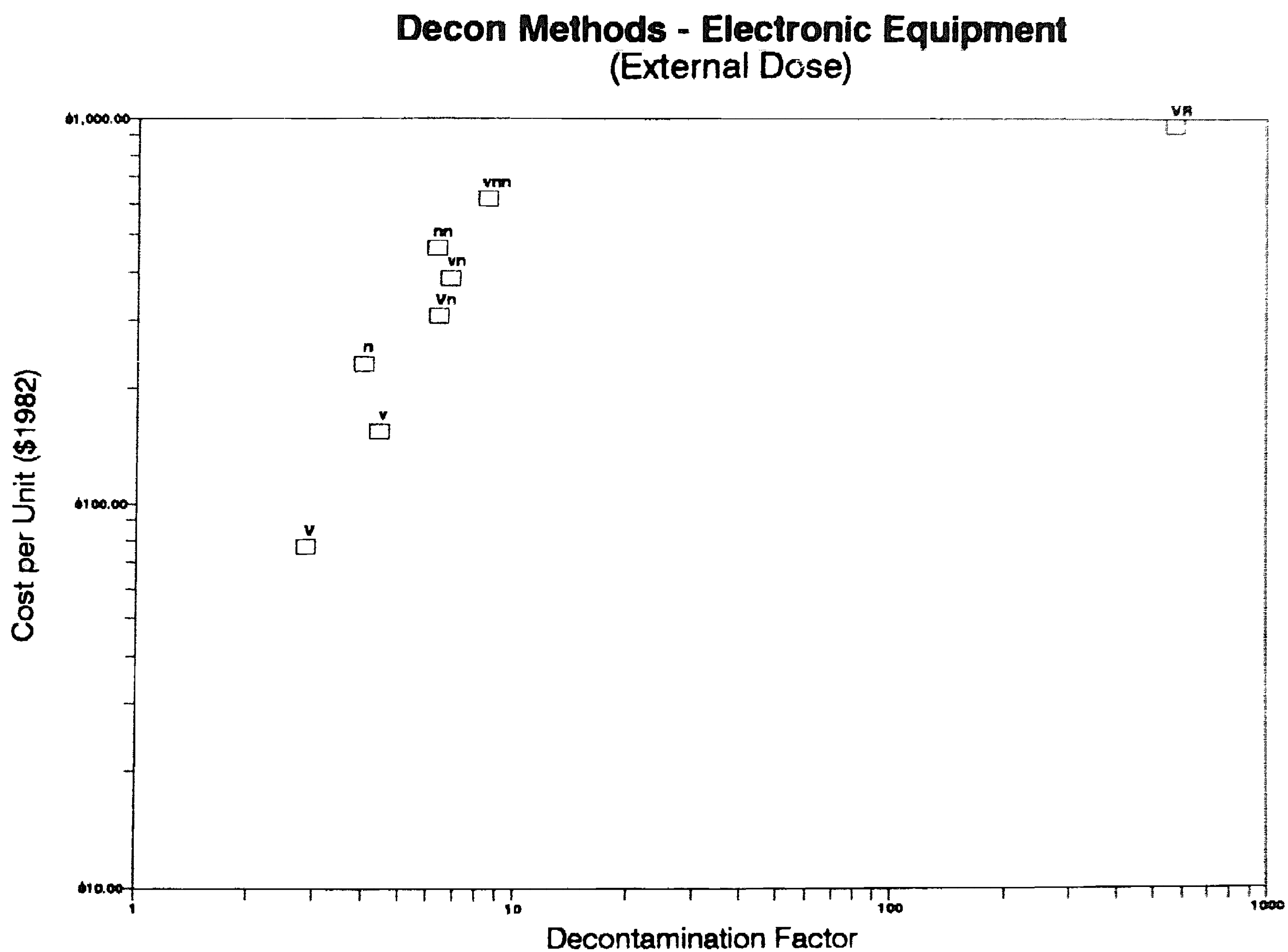

Figure 2.25. Costs and Efficiencies of Decontamination Methods: Electronic Equipment

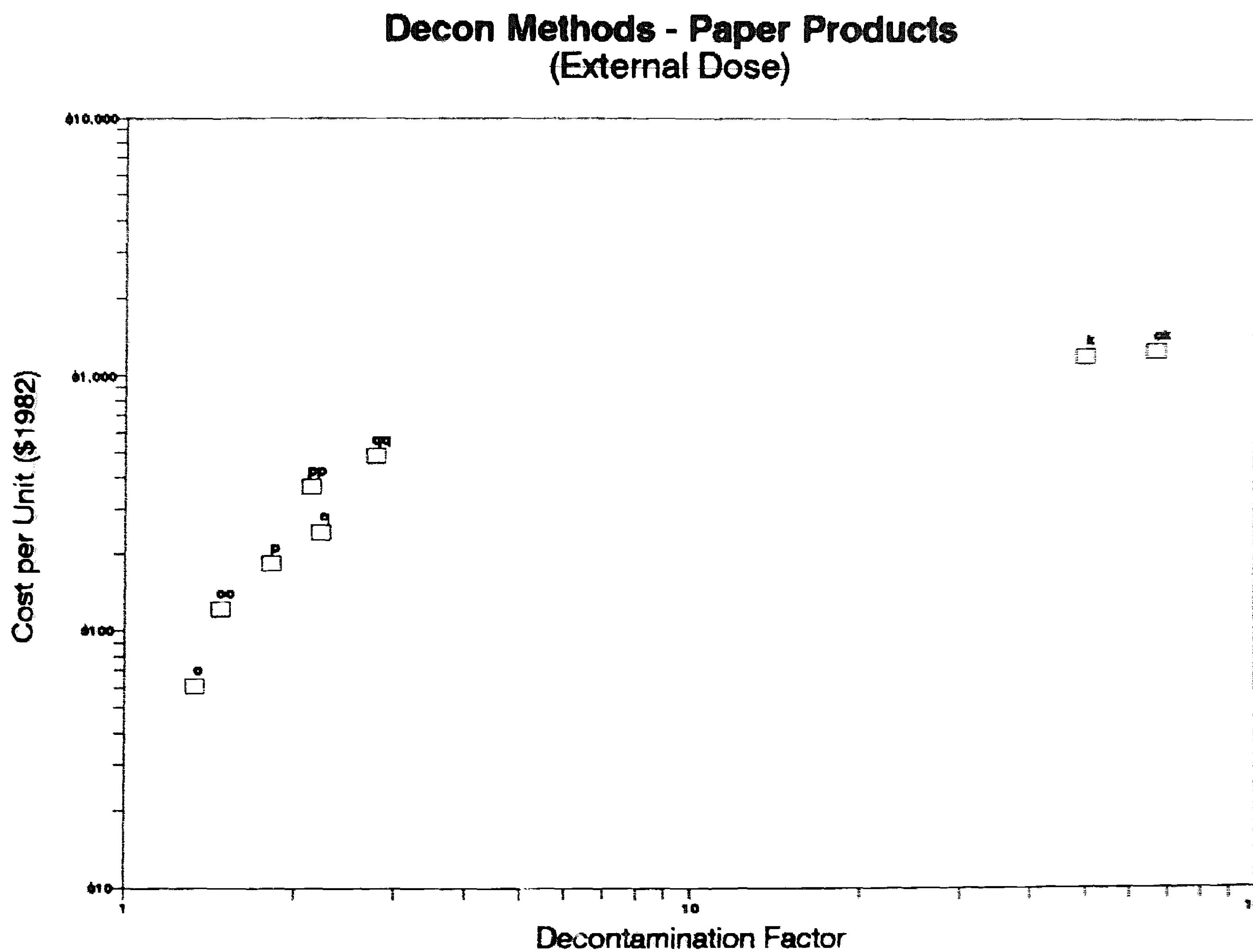

Figure 2.26. Costs and Efficiencies of Decontamination Methods: Paper Products

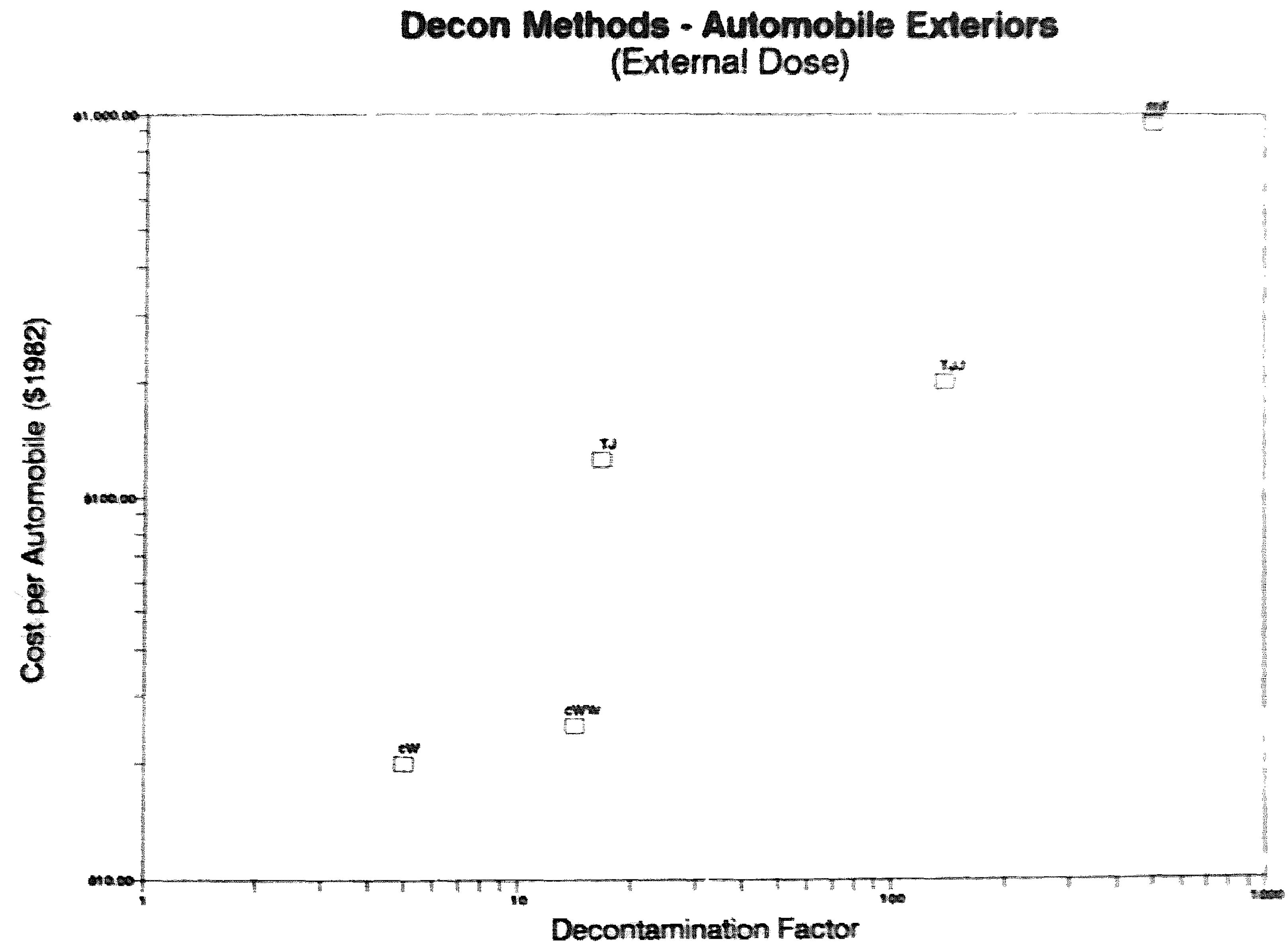

Figure 2.27. Costs and Efficiencies of Decontamination Methods: Automobile Exteriors

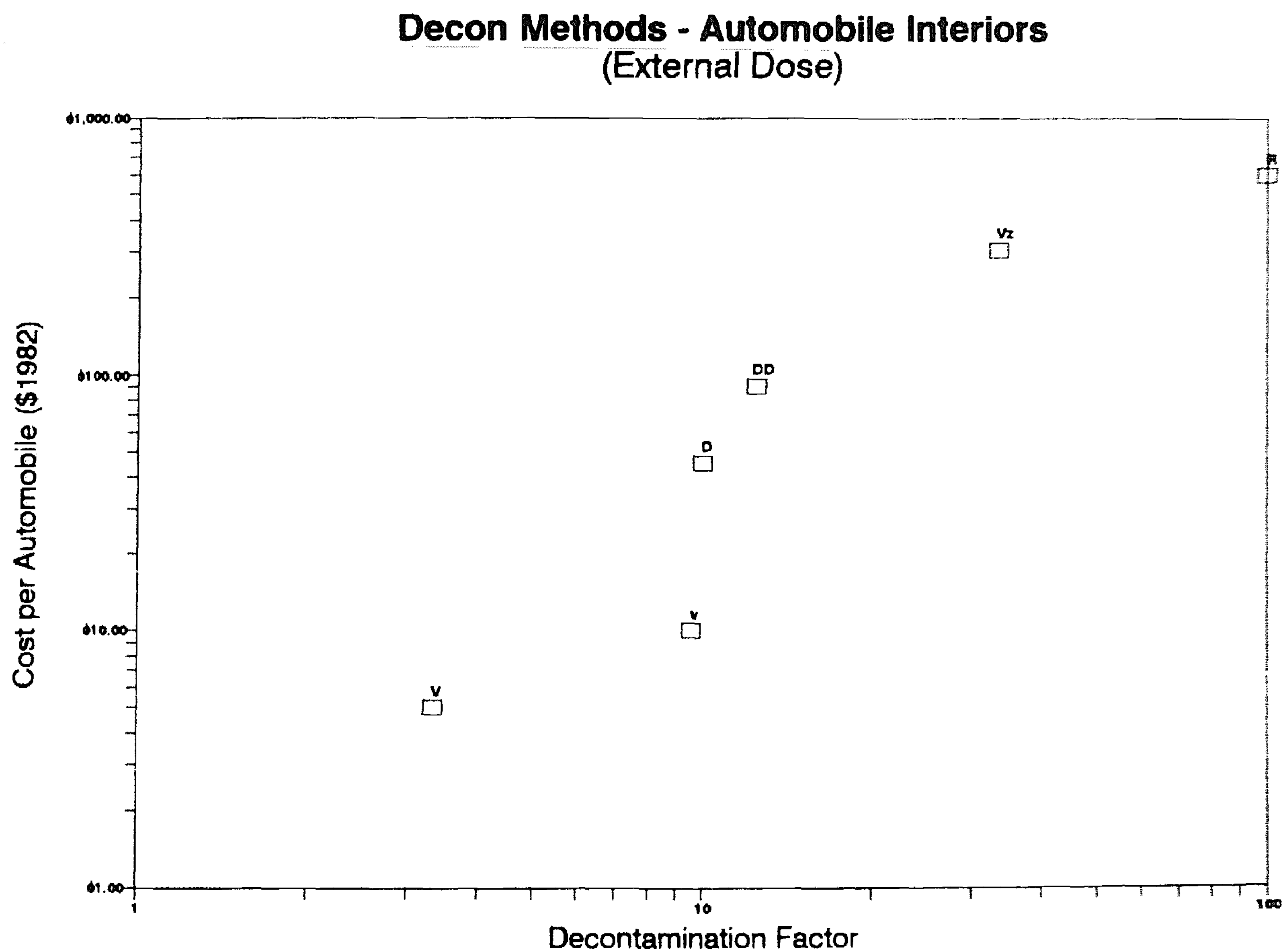

Figure 2.28. Costs and Efficiencies of Decontamination Methods: Automobile Interiors

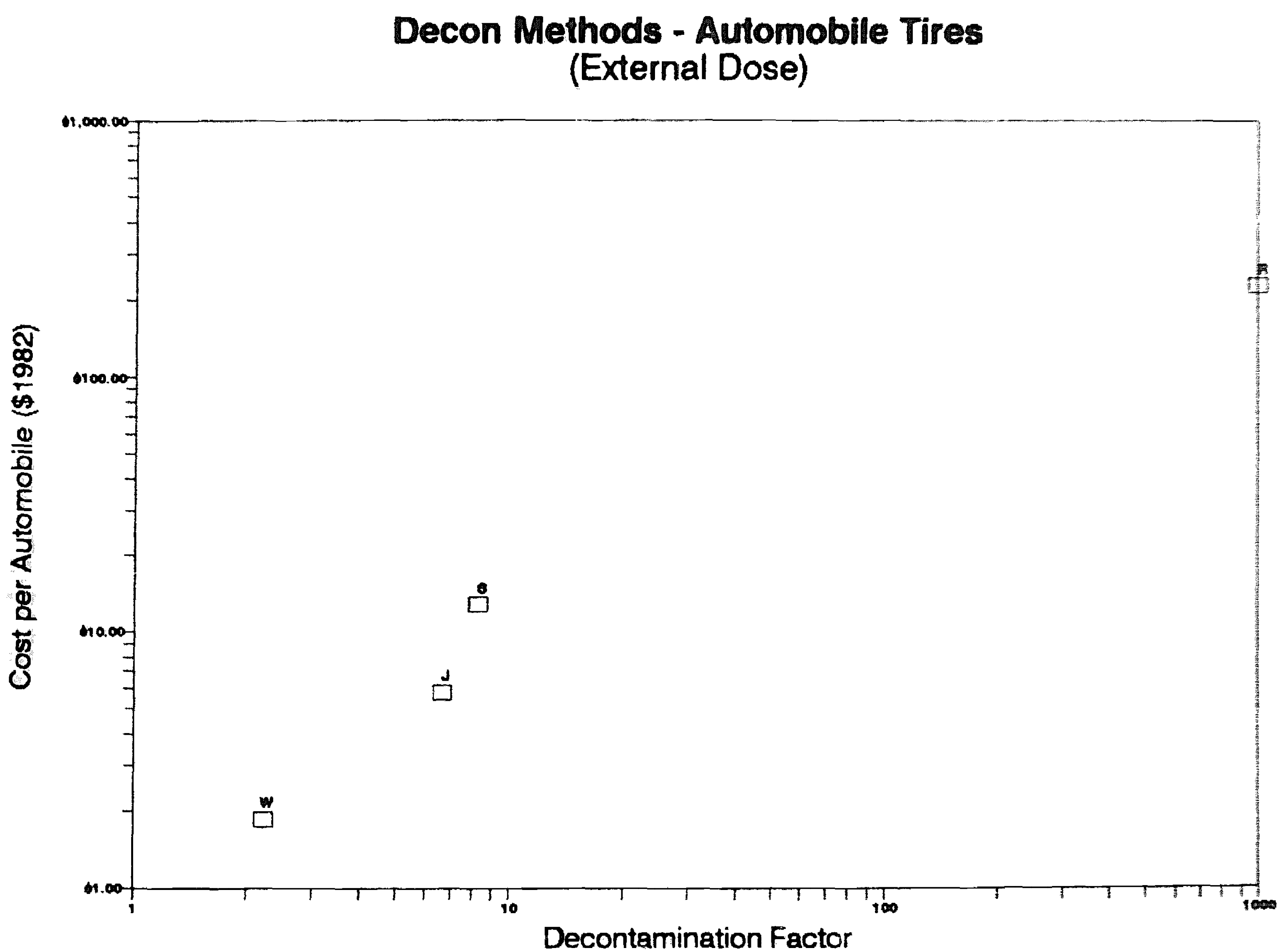

Figure 2.29. Costs and Efficiencies of Decontamination Methods: Automobile Tires

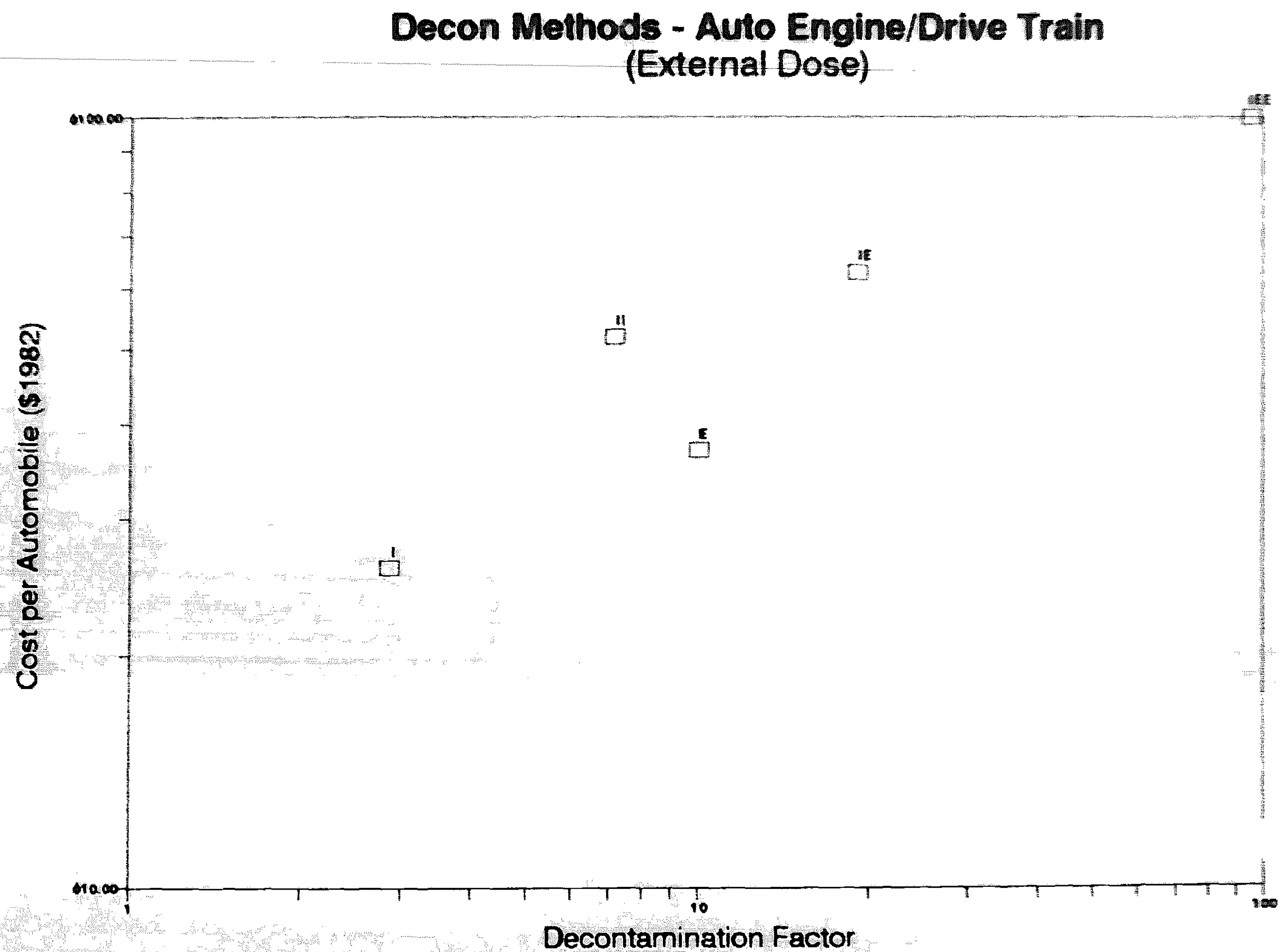

Figure 2.30. Costs and Efficiencies of Decontamination Methods: Automobile Engine/Drive Train

3.0 THE SITE DATABASE

This chapter is concerned with issues relating to the Site Database. It begins with a brief comparison of two software programs that PNL has developed to aid in Site Database preparation. Section 3.2 describes the contents of the Site Database and considers various procedures for developing the data for it. Section 3.3 addresses issues relating to partitioning the accident area into a set of grid elements. Different types of grid arrangements are considered, and the advantages and disadvantages of each are discussed.

3.1 SOFTWARE FOR PREPARING THE SITE DATABASE

Two programs, called *SD-INPUT* and *IR-GRID*, are available for preparing the Site Database. These programs are compared in Table 3.1. The main difference between the two programs is that IR-GRID relies primarily on published data, which means data based on political subdivisions. For relatively small reactor accidents, published data will not provide detailed

TABLE 3.1. A Comparison of SD-INPUT and IR-GRID

SD-INPUT	IR-GRID
Data for each grid element must be supplied directly	Imputes grid element data from political subdivision data
No employment data are required since estimates of evacuation, temporary relocation, and permanent relocation costs are not produced	Employment data are required to compute evacuation, temporary relocation, and permanent relocation costs
Particularly suited to accepting "raw" data, such as that collected in the field	Relies largely on published data for political subdivisions
Any size or shape grid element is readily accommodated	Any size or shape grid element is readily accommodated
Program for entering and/or modifying data is very user-friendly	Data need to be arranged in files according to a prespecified format.

information for the sufficiently small geographic areas needed to provide accurate results. Therefore, for relatively small accidents, SD-INPUT should be used.

SD-INPUT can also be used for larger accidents. In fact, if data can be obtained directly for all of the grid elements--i.e., data values do not have to be imputed from other geographic areas--this will produce the most accurate results. However, there is great convenience in being able to rely primarily on published data sources.

Details on how IR-GRID imputes data values to the grid elements are given in Appendix E.

3.2 CONTENTS OF THE SITE DATABASE

As noted earlier, the following information should be contained in the Site Database for each grid element:

- the population
- the degree to which the property is contaminated
- the area and type of property that is contaminated
- the value of the affected property
- employment by major sector (required by IR-GRID only).

These data requirements are described below.

3.2.1 Population

Population data are generally available from the U.S. Bureau of the Census for several types of areas, ranging from states to city blocks. For urbanized areas and other selected places, population data are compiled for city blocks. Outside of urbanized areas, enumeration districts are used; they have an average population of about 800 people. Unfortunately, neither city block data nor enumeration district data are available in printed reports, but they can usually be found in a local repository for Census Bureau data. Population data at the Census Tract level are available in printed reports; Census Tracts are defined to approximate neighborhoods.

If the defined grid elements are too small for Census Bureau data to be useful, there are at least two other possibilities. The United States Geological Survey (USGS) publishes a 7-1/2 minute series of maps that show individual houses as dots. By using a transparent overlay of the grid on the map and by counting the dots within each grid element, one can obtain an estimate

of the number of households within each element. The estimate can only be approximate, since houses are not distinguishable from other structures, such as small commercial enterprises. Another possible difficulty is that for some places these large-scale maps are seriously out of date, and, consequently, they may not provide a reliable picture of current population distributions. An alternative is to rely on local law enforcement officials, since they are likely to have first-hand knowledge of the number of people in each designated area.

Of course, population data are available for all political subdivisions. In addition, for the area around 111 U.S. nuclear power plants, the U.S. Nuclear Regulatory Commission has developed population data for 1970 out to an area of 80.47 kilometers (50 miles) (USNRC 1979). The data are based on the radial grid used by the CRAC2 program; this grid structure is discussed in the next section.

3.2.2 Contamination Level

The Site Database must also provide information relating to the severity of the property contamination. This information may consist either of radiological survey data taken directly from the field, or of predicted values produced by computer models that simulate reactor accidents and their effects. In addition, the information can be supplied in units of dose, dose commitment, ground concentration or other comparable unit, as long as the cleanup criterion is also specified in the same unit. DECON forms a ratio between the exposure level and the cleanup criterion to obtain a target decontamination factor. The target decontamination factor is the factor by which the committed dose to an individual must be reduced in order to meet the cleanup criterion. For example, if the ground concentration within a grid element gives an external 70-year dose commitment of 250 rem, a cleanup criterion of 10 rem results in a target decontamination factor of 250 / 10 = 25.

In developing a decontamination schedule that minimizes the site restoration costs and property-related losses resulting from the accident, DECON evaluates the effects of radioactive decay and weathering in reducing external dose. This information is transmitted to DECON as follows: Predicted ground concentrations, measured in curies per sq meter, are calculated using the CRAC2 computer program. The ground concentrations are then used in the DOSES program (see Section E.1 in Appendix E), which contains the weathering and decay models from the Reactor Safety Study (USNRC 1975). The DOSES model can estimate either 1) the external whole body dose rate measured at the end of each year following the accident; or 2) using CRAC2 dose conversion factors, total dose over some defined time period and measured at the end of each year following the accident. DECON makes direct use of this time series of doses or dose commitments.

3.2.3 Area and Type of Property Contaminated

Decontamination methods are typically associated with a specific type of surface, and this is how decontamination methods are characterized in this report. Unfortunately, area measurements can rarely be found for the different types of surfaces within useful geographical boundaries. However, land use information is widely available within the United States, and there are observable relationships between land uses and surface types. Therefore, an important function of the Site Database software is to transform land use information into information about different types of surfaces. For example, this software disaggregates residential property into roof areas, lawn areas, exterior wall areas, floor areas, etc. This important link enables DECON to process surfaces rather than land use categories.

The 30 types of surfaces that are currently defined were listed in Table 1.2, and the 12 land use categories are shown in Table 3.1. A comparison of these land uses with the surfaces reveals that in some cases there is a one-to-one association. Wooded areas, orchards and vacant land are examples. The category *streets and roads* divides into two surfaces: asphalt and concrete streets and roads, while grain crop and vegetable crop surfaces are treated as the single surface, *agricultural fields*.

The transformations that are complex are those involving residential, commercial and industrial land uses. These land uses consist of roofs, exterior walls, interior walls, floors, lawns, paved surfaces, windows and building contents. Exterior walls, interior walls, floors and paved surfaces are further subdivided to reflect differences in surface characteristics that may significantly affect the method, cost or efficiency of decontamination.

In addition to the land uses presented in Table 3.1, automobiles are also treated. Four "surface" types are associated with these: exteriors, interiors, tires, and engine and drive train.

Table 3.2. Land Uses Currently Implemented in DECON

Single-Family Residential	Vacant Land
Multi-Family Residential	Lawns
Commercial	Commercial Parking Areas
Industrial	Agricultural Land
Streets and Roads	Orchards
Wooded Areas	Reservoirs and Lakes

Major land use categories that are not directly implemented in the Site Database software include public and quasi-public property, recreational areas, military installations and wet areas. Public and quasi-public property can be treated as commercial property; recreational areas can be handled by expressing them as a linear combination of vacant land, lawns, and wooded areas; and military installations can be treated in a similar fashion. Wet areas present their own peculiar set of problems; the land use category *reservoirs* has been added recently.

State and local government agencies are the main source of land use information. In many areas there is an agency that can provide the distribution of land according to several usage categories for political subdivisions such as townships and counties.

Another source of land use information is the series of USGS Land Use and Cover maps. These are available for the entire U.S. and provide good detail on a large number of different land uses. To compute the area of each land use within a grid element, a transparent overlay of the grid arrangement (discussed in the next section) and a planimeter for measuring the areas will prove satisfactory. Using a random sampling method to estimate the areas rather than directly measuring all of them can be a major time saver, without significantly diminishing accuracy.

3.2.4 Value of the Contaminated Property

The database must also include information on the value of the property that is affected by the accident. Because the governing principle underlying DECON is to minimize the net present value costs of the accident through site restoration decisions, property value information is needed to determine whether, when and how a property should be decontaminated. Several factors affect this decision. First, the radioactive decay process causes the effective dose to decline over time. This suggests that deferring decontamination may make it possible to utilize less costly procedures, especially if the contaminants have a high proportion of radionuclides with short half-lives. A second factor relates to the weathering process. Precipitation, by carrying contaminants deeper into the soil or into crevices within paved surfaces, increases the shielding effect, thus lowering the effective dose. Also, effective dose is reduced when wind-borne contaminants are spread over an increasingly wider area. These effects suggest that, as with the decay process, weathering may provide benefits if decontamination is deferred.

On the other hand, delay causes potentially useful property to remain in disuse. The longer is the delay and the more valuable is the property, the greater is the social cost that results from deferred use of the property. In

addition, property that is not maintained will suffer from deterioration, and other property may lose value because of obsolescence. These three factors argue for decontamination as soon as possible after the accident. Taken together, the effects of all the factors must be weighed to determine when a property should be decontaminated if the accident losses are to be minimized.

Property value information is typically available from the local taxing authority. Another useful source is the *Census of Governments* (1978). The information that is required need not be greatly detailed. A decision rule that is applied in DECON is either to decontaminate all of the property within a grid element (except for autos and building contents, which are easy to remove from the grid element) or to decontaminate none of it. This means that at minimum a single value will suffice for the property in each grid element.

The property values should include all of the property that is evaluated for decontamination. However, the current version of the software does not evaluate automobiles. The value of public property is accounted for by multiplying the value of private property by the factor 1.95 (see *Census of Governments*, 1978).

3.2.5 Employment by Major Sector

If the IR-GRID program is used, employment data must be collected so that estimates of evacuation, temporary relocation and permanent relocation costs can be produced. Employment data are available from state labor agencies. The way these data are used in IR-GRID is described in Section E.3.1 of Appendix E.

3.3 SELECTION OF THE GRID

An accident grid facilitates the analysis by allowing the area to be divided into many manageable parts or grid elements. Generally, the greater the number of grid elements, the more accurate will be the results of the analysis. In preparing the accident site for analysis, the first step is to define the outer boundary of the accident zone. The boundary should include all areas with surfaces that have an exposure level exceeding the lowest cleanup level to be considered in the site restoration analysis[1]. The second

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[1]For the purpose of obtaining a more accurate estimate of surveying costs, an area that includes the additional land area to be surveyed should be included as a separate grid element. The only accurate information that needs to be supplied for this grid element is area and contamination level.