



Solid waste disposal site suitability evaluation in Montana
by David Wayne Bowen

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Earth Science

Montana State University

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Abstract:

Solid waste disposal site suitability studies are needed for understanding potential environmental hazards and for licensing. The Montana Solid Waste Management Bureau identified twenty-one operating sites needing evaluation for solid waste disposal suitability. The sites were evaluated by on-site reconnaissance of soil and hydrogeologic factors. The primary criteria evaluated were permeability of surficial materials, groundwater flow, connection of shallow groundwater with deeper aquifers, and proximity to surface water. In general, a suitable site should be located in materials of low permeability with a deep water table, have no connection of shallow groundwater with deeper aquifers, and should be far from surface water. Fourteen of the twenty-one sites evaluated were unsuitable. Inadequate site suitability assessments were made prior to locating many solid waste disposal sites in Montana. Suitable sites exist within a five mile radius of each of the unsuitable sites. A small amount of data coupled with soil and hydrogeologic planning would lead to better siting.

The site specific studies emphasize the need for generalized soil and hydrogeologic information. Local authorities responsible for solid waste disposal site location must be aware of the constraints which control site suitability in their area. Important soil and hydrogeologic parameters which control site suitability can be categorized on a regional basis for Montana by dividing the state into five physiographic provinces. These five provinces are the Mountains and Valleys, the Unglaciaded Plains and Mountains, the Glaciaded Plains and Mountains, the Unglaciaded Plains, and the Glaciaded Plains. In general, unsuitable sites for solid waste disposal in the unglaciaded provinces are underlain by alluvium, sandstone, limestone, igneous rocks, or metamorphic rocks; suitable sites are generally underlain by siltstone, claystone, or shale. In the glaciaded provinces, unsuitable sites are generally underlain by glacial outwash sands and suitable sites are generally underlain by glacial till.

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Date August 20, 1980

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EVALUATION IN MONTANA

by

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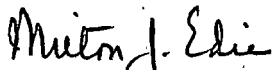
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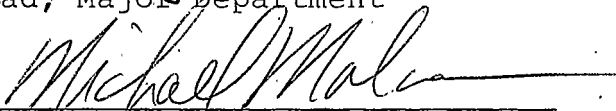
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TABLE OF CONTENTS

VITA.	ii
ACKNOWLEDGMENT.	iii
LIST OF TABLES.	vi
LIST OF FIGURES.	vii
ABSTRACT.	ix
INTRODUCTION.	1
SECTION ONE: SITE SPECIFIC STUDIES.	4
Introduction	4
Background Information	6
Methods	12
Results	14
Discussion of Results	16
Conclusions	32
SECTION TWO: RELATIONS OF SOILS AND HYDROGEOLOGIC SETTINGS TO SOLID WASTE DISPOSAL SITE SUITABILITIES IN MONTANA.	31
Introduction.	31
Mountains and Valleys Province.	37
Geographic Setting	37
General Geologic Setting	39
Hydrogeologic Units and Water Bearing Characteristics	42
Soils	44
Suitability Patterns	46
Summary	50
Unglaciaded Plains and Mountains Province.	51
Geographic Setting	51
General Geologic Setting	53
Hydrogeologic Units and Water Bearing Characteristics	56
Soils	60
Suitability Patterns	62
Summary	66
Glaciaded Plains and Mountains Province.	67
Geographic Setting	67
General Geologic Setting	69
Hydrogeologic Units and Water Bearing Characteristics	73
Soils	76
Suitability Patterns	78
Summary	80

Unglaciaded Plains Province.	82
Geographic Setting	82
General Geologic Setting	84
Hydrogeologic Units and Water Bearing Characteristics	87
Soils	89
Suitability Patterns	91
Summary	93
Glaciaded Plains Province.	94
Geographic Setting	94
General Geologic Setting	96
Hydrogeologic Units and Water Bearing Characteristics	100
Soils	103
Suitability Patterns	105
Summary	107
CONCLUSION.	108
REFERENCES CITED.	110
APPENDIX.	114

LIST OF TABLES

Table	Page
1. Summary of evaluated parameters and suitability results for site specific studies.....	15
2. Site suitability patterns.....	29
3. Hydrogeologic units and water bearing characteristics in the Mountains and Valleys Province.....	43
4. Characteristic soil properties in the Mountains and Valleys Province.....	45
5. Hydrogeologic units and water bearing characteristics in the Unglaciaded Plains and Mountains Province.....	58
6. Characteristic soil properties in the Unglaciaded Plains and Mountains Province.....	61
7. Hydrogeologic units and water bearing characteristics in the Glaciaded Plains and Mountains Province.....	74
8. Characteristic soil properties in the Glaciaded Plains and Mountains Province.....	77
9. Hydrogeologic units and water bearing characteristics in the Unglaciaded Plains Province.....	88
10. Characteristic soil properties in the Unglaciaded Plains Province.....	90
11. Hydrogeologic units and water bearing characteristics in the Glaciaded Plains Province.....	101
12. Characteristic soil properties in the Glaciaded Plains Province.....	104

LIST OF FIGURES

Figure	Page
1. Location map of the 21 site specific studies.....	5
2. Suitable landfill site.....	8
3. Unsuitable landfill site.....	10
4. Cross-section through the Augusta disposal site.....	18
5. Cross-section through the Helena disposal site.....	21
6. Cross-section through the Big Sandy disposal site.....	23
7. Cross-section through the Judith Gap disposal site.....	25
8. Cross-section through the Dupuyer disposal site.....	27
9. NW-SE cross-section in the Judith Gap area.....	30
10. Physiographic map of Montana.....	35
11. Location map of the Mountains and Valleys Province.....	38
12. Geologic map of the Mountains and Valleys Province.....	40
13. Location map of the Unglaciaded Plains and Mountains Province.....	52
14. Geologic map of the Unglaciaded Plains and Mountains Province.....	54
15. Location map of the Glaciaded Plains and Mountains Province.....	68

List of Figures continued:

Figure	Page
16. Geologic map of the Glaciated Plains and Mountains Province.....	70
17. Continental glaciation in Montana east of the Northern Rocky Mountains.....	71
18. Location map of the Unglaciated Plains Province.....	83
19. Structural features in the Unglaciated Plains Province.....	85
20. Geologic map of the Unglaciated Plains Province.....	86
21. Location map of the Glaciated Plains Province.....	95
22. Continental glaciation in Montana east of the Northern Rocky Mountains and Tertiary remnant terrace gravels.....	97
23. Geologic map of the Glaciated Plains Province.....	98

ABSTRACT

Solid waste disposal site suitability studies are needed for understanding potential environmental hazards and for licensing. The Montana Solid Waste Management Bureau identified twenty-one operating sites needing evaluation for solid waste disposal suitability. The sites were evaluated by on-site reconnaissance of soil and hydrogeologic factors. The primary criteria evaluated were permeability of surficial materials, groundwater flow, connection of shallow groundwater with deeper aquifers, and proximity to surface water. In general, a suitable site should be located in materials of low permeability with a deep water table, have no connection of shallow groundwater with deeper aquifers, and should be far from surface water. Fourteen of the twenty-one sites evaluated were unsuitable. Inadequate site suitability assessments were made prior to locating many solid waste disposal sites in Montana. Suitable sites exist within a five mile radius of each of the unsuitable sites. A small amount of data coupled with soil and hydrogeologic planning would lead to better siting.

The site specific studies emphasize the need for generalized soil and hydrogeologic information. Local authorities responsible for solid waste disposal site location must be aware of the constraints which control site suitability in their area. Important soil and hydrogeologic parameters which control site suitability can be categorized on a regional basis for Montana by dividing the state into five physiographic provinces. These five provinces are the Mountains and Valleys, the Unglaciated Plains and Mountains, the Glaciated Plains and Mountains, the Unglaciated Plains, and the Glaciated Plains. In general, unsuitable sites for solid waste disposal in the unglaciated provinces are underlain by alluvium, sandstone, limestone, igneous rocks, or metamorphic rocks; suitable sites are generally underlain by siltstone, claystone, or shale. In the glaciated provinces, unsuitable sites are generally underlain by glacial outwash sands and suitable sites are generally underlain by glacial till.

INTRODUCTION

Many solid waste disposal sites exist in the State of Montana. Relatively few have been assessed for suitability as disposal locations. Isolated site-specific studies at Butte and West Yellowstone, Montana show that contamination of ground and surface water takes place due to the location of solid waste sites in materials which are ill-suited for effective disposal (Kringler, 1979; Jones, 1979). There is a need to evaluate other sites in Montana to assess materials in which they are located for suitability as disposal mediums.

Sites evaluated in the past were evaluated on the basis of the soil at the site and the depth to the water table. These are important parameters which need to be evaluated, however, they are only a part of the integrated hydrogeologic system which controls the suitability of a site. In order to adequately evaluate the suitability for use in solid waste disposal, all parts of the soil and hydrogeologic system must be considered.

To determine a site's suitability for solid waste disposal, it is first necessary to be aware of those parameters which control suitability. With this awareness, a small amount of soil and hydrogeologic data coupled with minimal planning will lead to better siting of solid waste

disposal operations.

Often, local people responsible for siting solid waste disposal operations for their communities are not familiar with those parameters which control a site's suitability, and, are not aware of soil and hydrogeologic relationships in their areas. With this in mind, three main objectives will be met:

1. summarize those parameters which control solid waste disposal site suitability,
2. present the relationship between the soils and hydrogeology at a site and the usefulness of that site for solid waste disposal, and
3. generalize soils and hydrogeologic information pertinent to solid waste disposal for the State of Montana.

These objectives are met by discussing the relationship between soils and hydrogeologic settings and solid waste disposal site suitability. Two sections discuss this relationship. The first section deals with 21 site specific studies in Montana, and conclusions drawn from these studies. The approach to the first section is to provide background information on parameters which control solid waste disposal site suitability, to summarize the results of 21 site specific studies, and to discuss the significance of the results and the associated need for generalized information.

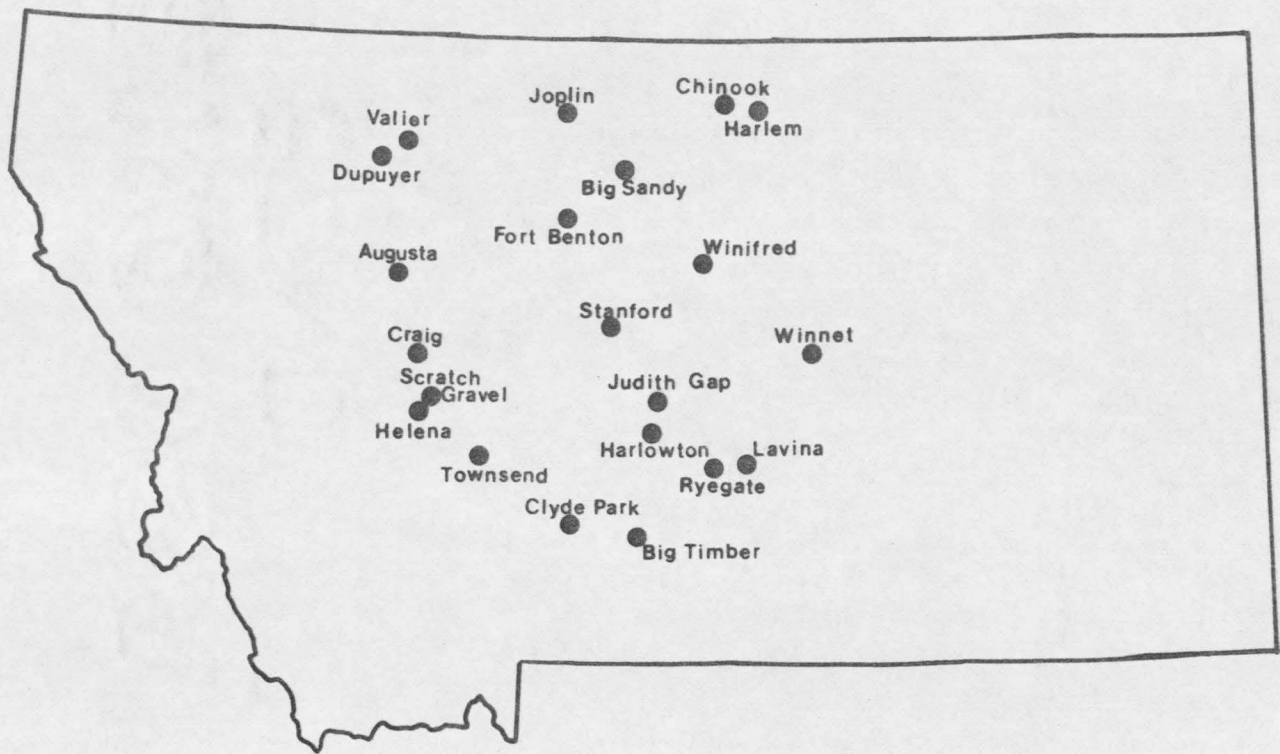
The purpose of the second section is to provide general information useful for directing future site suitability assessments in Montana. This section also generates an awareness of problems related to locating solid waste disposal sites in Montana. The approach to this section is to divide the state into five physiographic provinces and to relate soil and hydrogeologic settings with suitability for solid waste disposal in each of the provinces.

SECTION ONE: SITE SPECIFIC STUDIES

Introduction

The Montana Department of Health and the Environmental Protection Agency recognized that many small landfills exist in the State of Montana for which no site suitability studies have been done. There may be degradation of ground and surface water quality if landfills are located in materials which should not be used for solid waste disposal. Twenty-one disposal sites in Montana were chosen for site specific evaluation by the Montana Department of Health and Environmental Sciences (Figure 1) (Bowen, Custer, and Miller, 1979). The section on site specific studies demonstrates patterns of solid waste disposal site suitability.

The site specific section defines parameters that control suitability. This section uses these parameters to demonstrate the kinds of site suitability problems that exist in Montana. It then shows that hydrogeologic planning is necessary before locating a disposal site, and that only a small amount of general information can lead to much better siting.



5

Figure 1: Location map of the 21 site specific studies.

Background Information

Suitability of a site for use as a solid waste disposal site is determined by political, social, economic, climatological, workability, and environmental parameters (Bergstrom, 1968). The study of political, social, economic, and climatological factors is beyond the scope of this study. All of the 21 sites evaluated are in operation. Therefore, workability factors, which include soil texture, soil consistence, stoniness, rockiness, and depth to bedrock (U. S. Soil Conservation Service, 1971), will not be considered further in the site specific section. The evaluated parameters for the 21 chosen sites are all environmental.

The environmental suitability of a solid waste disposal site is dependent upon the ability of the materials in which a site is located to prohibit the production of leachate, or isolate any leachate which is produced at the site (Bergstrom, 1968). Since this is a reconnaissance study, no wells were drilled for monitoring the production and movement of leachate. Thus, several assumptions are necessary. These assumptions are that leachate is produced in a semi-arid climate, and that this leachate is capable of contaminating ground and surface water. Leachate is produced at the West Yellowstone, Montana, and Butte,

Montana landfill sites. This leachate is contaminating ground and surface water (Kringler, 1979; Jones, 1979). Assuming leachate production at landfill sites in Montana, and the capability for contamination of ground and surface water by this leachate, the suitability of a landfill site is controlled by the integrated soil and hydrogeologic system of that site. In general, a suitable site will have impermeable soils and surficial deposits, a deep water table, no connection of shallow groundwater with deeper aquifers, and will be far from surface water (Figure 2). Impermeable soil, when used as a cover material for waste, limits water infiltration and thus the production of leachate. Impermeable surficial deposits help contain leachate to the disposal site. A deep water table lessens the potential for shallow groundwater contamination by leachate. With no connection of shallow groundwater to deeper aquifers the potential for contamination of regional aquifers is eliminated. Finally, a large distance between a disposal site and surface water reduces the potential for contamination of surface water.

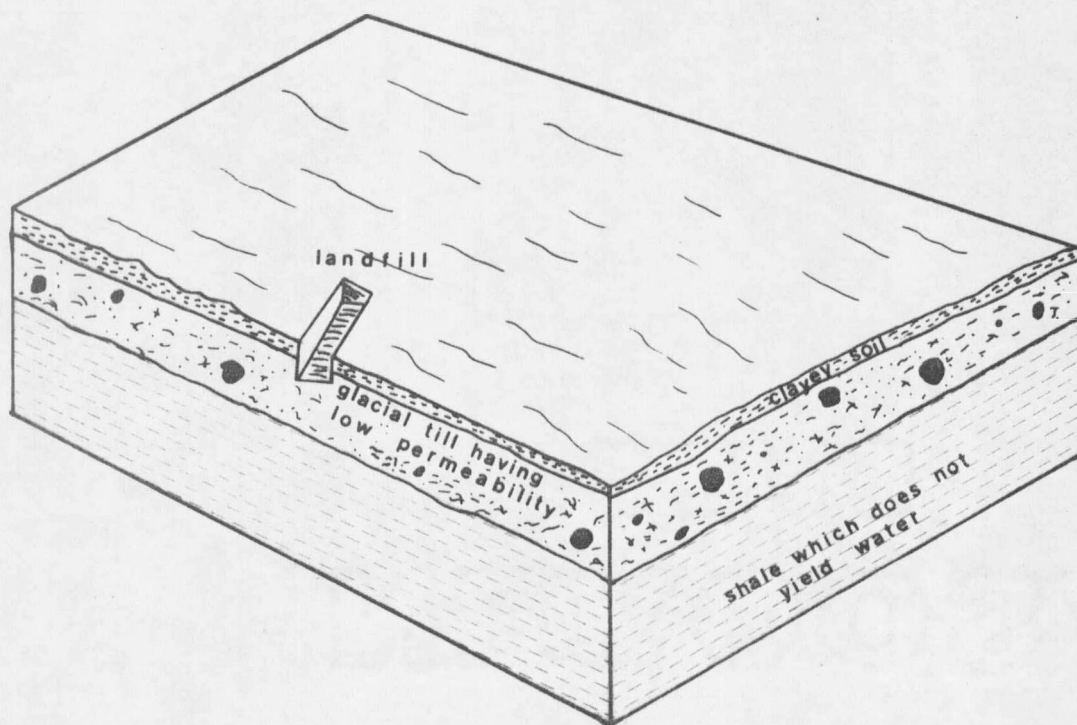


Figure 2: Soils and hydrogeology at a hypothetical suitable, landfill site.

Solid waste disposal sites may be unsuitable for a variety of reasons. A site will not be suitable if it has highly permeable soils and surficial deposits which allow water to infiltrate refuse producing a leachate, and allow this leachate which is produced to escape through the base of the site (Figure 3). A shallow water table beneath the site, which can easily be contaminated by leachate, causes the site to be unsuitable. A site will also be unsuitable if there is a connection between shallow groundwater and deeper aquifers which could lead to contamination from leachate, since, leachate contaminating shallow groundwater could then contaminate deeper aquifers. The other factor which could cause a site to be unsuitable is proximity to surface water, which could lead to contamination of that surface water by leachate.

