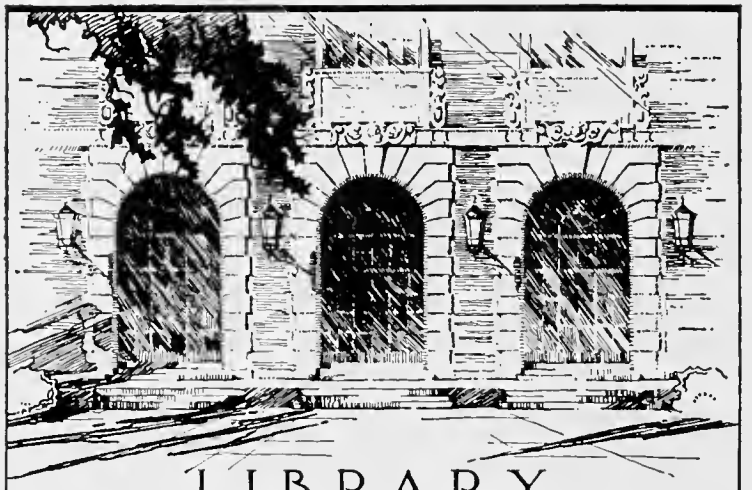

CITY PLANNING AND
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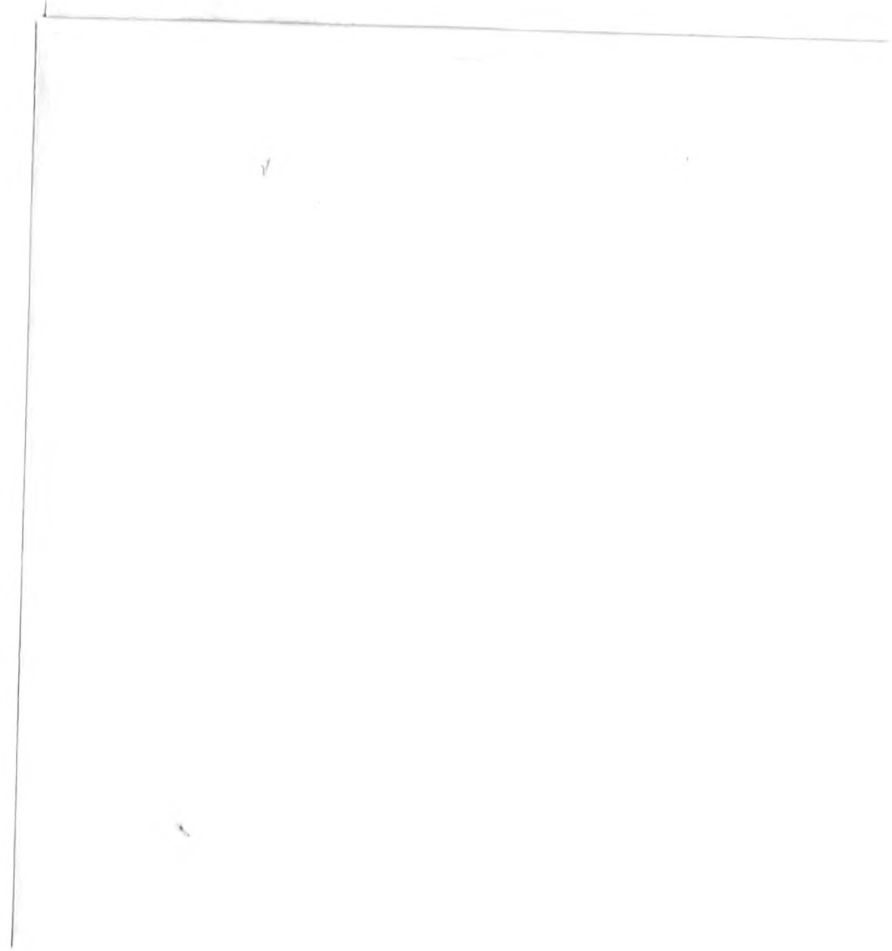

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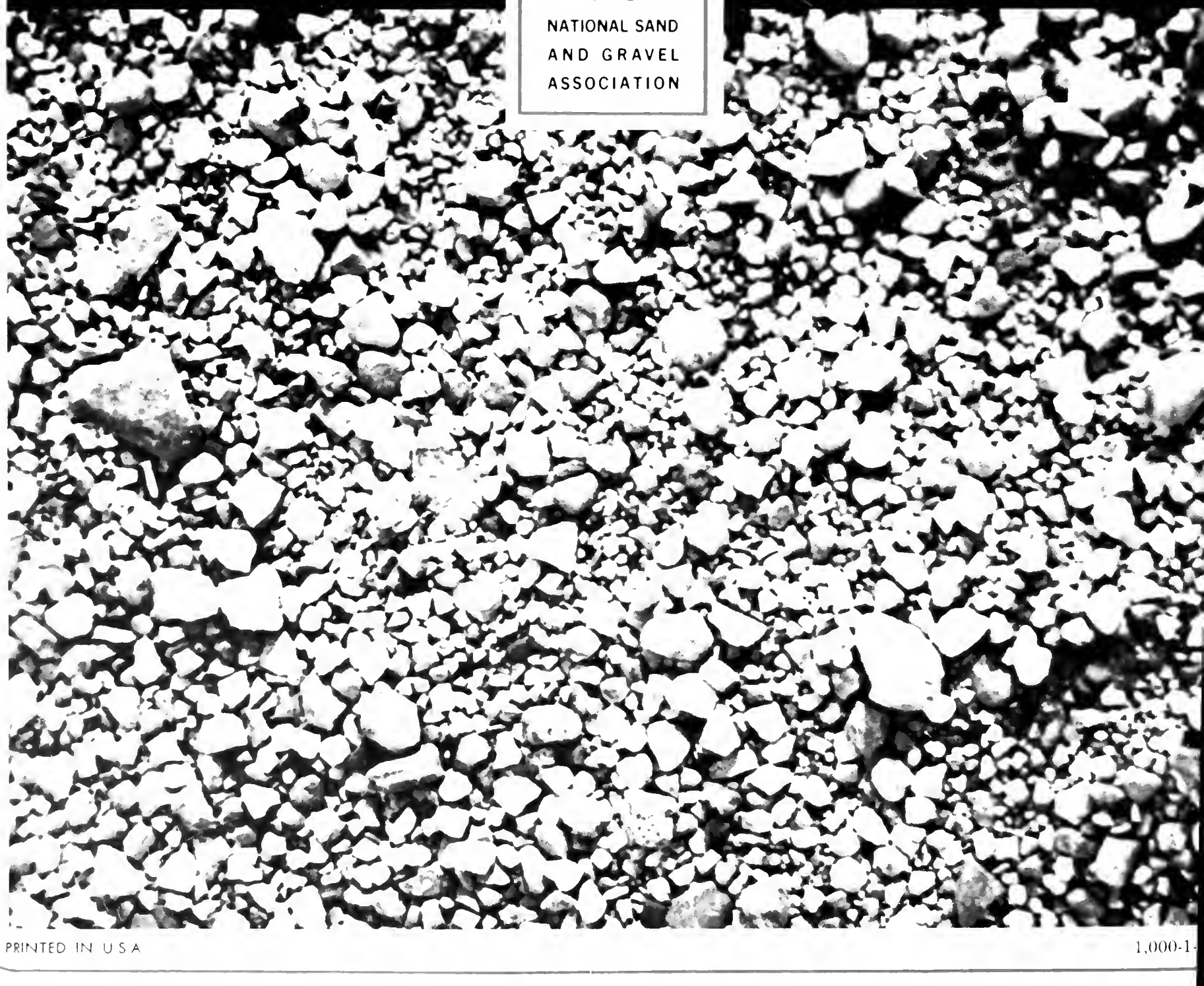

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Realizing the Recreation Potential of Sand and Gravel Sites




By George Pickels
University of Illinois

THIS RESEARCH PROJECT OF THE UNIVERSITY OF ILLINOIS WAS SPONSORED BY THE NATIONAL SAND & GRAVEL ASSOCIATION, SILVER SPRING, MARYLAND.

Foreword

This publication is the fifth research report based upon a seven-year Research Program, sponsored by the National Sand and Gravel Association at the Department of Landscape Architecture of the University of Illinois. "Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites", by Anthony M. Bauer; "Practical Operating Procedures for Progressive Rehabilitation of Sand and Gravel Sites", by Craig Johnson; "Selecting Land Use for Sand and Gravel Sites", by David R. Jensen; and "Site Planning for Sand and Gravel Operations", by John G. Baxter, were the first four published reports.

The Research Program is sponsored by the Association through its Committee on Environmental Problems (formerly called the Committee on Public Relations) and is supervised by a Research Advisory Committee whose current members are named under "Acknowledgments" in the text.

The first four research projects were exploratory in nature and were intended to acquaint members of the Association, professional landscape architects, land use planners, conservationists and others having a professional interest in the subject matter, with the fundamental techniques and problems connected with the rehabilitation of sand and gravel sites. Our fifth research report expands on these previous reports and explores a specific land-use potential for sand and gravel sites.

"Realizing the Recreation Potential of Sand and Gravel Sites", does not mean to suggest that recreation is the only land-use suited for sand and gravel sites. Rather, it is one of the many uses to be utilized at a site to a significant advantage. Future reports, one of which is now under the active consideration of the Association's new Committee on Environmental Problems, will examine in detail other potential land-uses of sand and gravel sites.

Since these future reports will be more technical in nature, and will involve other professional disciplines besides landscape architecture, it is necessary for the Association to conduct its research with a consulting organization having personnel in all the relevant disciplines, especially engineering. This report, therefore, concludes our present research program at the University of Illinois. The University of Illinois has done an outstanding job. We salute them.

We also take this opportunity to extend the sincere appreciation of this Committee and the Association to Kenneth L. Schellie, who has actively served on this Committee, without compensation, since its inception seven years ago, and to Pearsall and Schael Associates, whose design and production of the final reports have made them truly beautiful publications.

Research Advisory Committee

Realizing the Recreation Potential of Sand and Gravel Sites

By
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THIS RESEARCH PROJECT OF THE UNIVERSITY OF ILLINOIS WAS SPONSORED BY THE NATIONAL SAND & GRAVEL ASSOCIATION, 900 SPRING STREET, SILVER SPRING, MARYLAND

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This *or* *This*

Figure 1 — Outdoor recreation?

Chapter I

Introduction

Significance of Study

Because of a growing population, higher incomes, improving technology, and the increasing cost of land close to urban centers, many authorities in the field of recreation have found that the demand for outdoor recreation areas, both public and private, far exceeds existing facilities and will continue to do so in the years to come.

Millions of Americans spend not only part of their leisure, but a sizeable portion of their income on outdoor recreation. Since most people cannot afford to spend indiscriminately, the fact that a significant percentage of their income is spent on outdoor recreation is indicative of the relative importance of recreation planning. The average American not only spends a sizeable portion of his income on outdoor recreation, but it appears he is also devoting more of his time to outdoor recreation pursuits. The hours worked per week by the average worker have declined from seventy in 1850 to thirty-five in 1969. One projection shows that a 24-28 hour work week is possible by the year 2000[1]. A significant problem for the future may be the utilization of the additional leisure time thus made available.

The fact that approximately 70% of the population of the United States live in urban centers comprising 10% of all available land focuses on one of the major problems confronting recreation planners today; how to provide adequate outdoor recreation facilities for our rapidly expanding urban populations.

The four previous research projects sponsored by the National Sand and Gravel Association in conjunction with the Landscape Architecture Depart-

1. FOSTER R. DULLES, *A History of Recreation*, Appleton-Century-Crofts, New York, 1965, p. 390.

ment at the University of Illinois were exploratory projects dealing with general problems that the industry has faced for a number of years. This project focuses on a specific land use that has direct application potential to many sites in all areas of this country.

It is noteworthy that this study dealing with recreation occurs at a time when the demand for recreation in this country is the highest it has ever been and at a time when there is great public interest and concern over environmental quality. This environmental concern, coupled with the increasing demand for construction aggregates in our rapidly growing metropolitan areas, has indeed placed the sand and gravel producer in a very sensitive position. Perhaps the most significant challenge now facing the sand and gravel producer, as well as other mining industries, is how to extract mineral deposits while minimizing environmental and ecological problems.

Because of the diversified nature of any urban environment, outdoor recreation encompasses many different use types and effects for many types of people. It is assured that a report of this nature will interest a number of professions, and not just those directly associated with the sand and gravel industry. Those most immediately concerned are the professions that effect and shape urban environments, the architects, engineers, planners and landscape architects. It is hoped that this report will be as valuable to these professions as it will be to the sand and gravel industry.

Objectives

The title of this report contains a key word "Realizing," which sums up the objective of this study. It is important that sand and gravel producers, as well as other environmental planners, appreciate the potential that sand and gravel sites have in relation to recreation. It is quite obvious, as witnessed by previous recreation developments, that a number of professionals, while appreciating the recreational potential of these sites, may not "recognize" the degree of potential that exists and/or may not know how to transform the sites into actual physical recreation features.

The attempt to *recognize* as well as *accomplish* recreation potential sums up the manner in which this project will be approached. If producers and planners can first comprehend the recreational value of sand and gravel sites they will be better equipped to consider those features that best suggest how the sites could be developed.

The purpose of this report is not to suggest that recreation is the only land use suited for sand and gravel sites. It is one of many uses that could utilize a site to significant advantage. It is hoped that through a general understanding of recreation and the physical features that are responsible for the existence of certain recreation uses, the sand and gravel producer with his knowledgeable background in mining will be better able to correlate the two functions into a desirable ultimate facility. Therefore, this report will survey various types of recreational characteristics and relate these to those exhibited in typical sand and gravel sites.

Knowing that a particular sand and gravel site is best suited for a certain type of recreational use is a step in the right direction. It is equally important to understand how to bridge the gap between a potential recreation area and a developed recreation area. It is for this reason that two case study sites are included in this study.

Summary of Findings

The final transition of a sand and gravel site into a desirable recreation feature depends upon an accurate analysis of the potential for recreation, recognizing the physical features that would affect the type of facility it can be, and the ability to implement ideas and proposals into physical realities on the site.

Following are some pertinent factors that strongly suggest sand and gravel sites can be successful recreation areas. The realization and appreciation of these factors are prerequisite to any significant recreation benefit the sand and gravel industry or the public will enjoy.

1. Optimum Location

Sand and gravel operations are generally located in close proximity to urban areas where the greatest demand exists for recreational sites and activities.

2. Desirable Site Features

The nature of sand and gravel sites and operations are conducive to the production of terminal physical site characteristics considered ideal for recreational purposes; namely, topographic relief and water areas useful for a variety of recreational activities.

3. Alternative Use Sequence

In accordance with wise land management and progressive rehabilitation practices, recreational uses can occur on sand and gravel sites prior to, concurrent with, or subsequent to site excavations over the extended periods of operation which are characteristic of the industry.

4. Multiple Benefits

In consideration of conforming with typical zoning regulations and requirements, creating a positive

public relations image, and realizing mutually advantageous economic returns, the development of sand and gravel sites for recreational uses should be of significant benefit to both the industry and local public agencies.

5. Effectuation Procedures

The successful transformation of a sand and gravel site into a potentially valuable recreational resource is achieved through the application of a comprehensive and systematic planning process based on a thorough understanding of the characteristics of the area and requirements of the people, including basic resource inventories and identification of alternative development possibilities.

Subsequent to realizing a particular sand and gravel site has recreational potential, and prior to any proposals being formulated, the producer as well as the recreation administrator will have to be convinced that recreation is the best use for that particular site. Following are a number of reasons why the producer may decide in favor of recreation reclamation:

1. Recreational development may offer the producer the greatest economic return for the expense involved.
2. A plan to provide for recreational use may create a favorable impression on local authorities and secure necessary zoning for site operations.
3. Recreational rehabilitation is good publicity for the producer and such good will may be beneficial for subsequent operations.
4. Recreation may be the only practical afteruse for the site at that particular time.

If the producer sees potential in developing his site for recreation, he might contact the local municipality to see if some arrangement could be worked out whereby both parties would benefit. Since the producer should not be expected to develop a site and turn it over to the public without due compensation, the local park administrators would want to be assured that acquisition of such a site would be to their benefit also. Following are a few reasons why recreation planners may look to sand and gravel sites as potential recreation areas.

1. In many cases it is possible to acquire a very unique recreation feature at considerably less cost than if one had to construct a similar facility elsewhere.
2. Sand and gravel sites may be the only available potential recreation sites in the vicinity. Due to zoning ordinances, other land may be committed to other uses.
3. The long term duration of sand and gravel operations may allow for long-term purchase agreements by public or private concerns.
4. Sand and gravel sites are a valuable asset as open space in a community, before, during, and after excavation.

Thus, the recreation potential of sand and gravel sites is favorable. It appears that with an adequate rehabilitation plan most sites could be converted into valuable recreation features that are beneficial to both the producer and the recreation planner. Actually, it is the implementation stage that is most critical. This is where ideas are transformed into physical features and where the imaginations of the planner and the operator will be adequately tested.

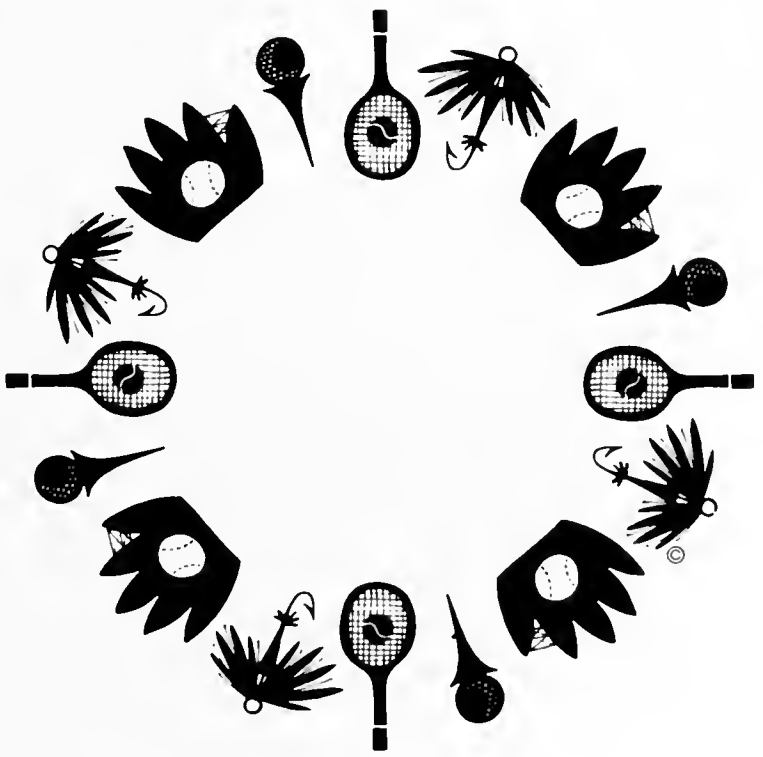


Figure 2 — Outdoor recreational activities

U.S. Bureau of Outdoor Recreation Photos

Chapter II

Recognizing Recreation Possibilities

To people not associated with the sand and gravel industry and not directly connected with park planning, it might appear that the similarities of both are rather limited. The average individual has probably seldom seen a sand and gravel operation. Since most people are familiar with various types of parks (city, community, state, etc.) they have experienced or are familiar with various recreation activities (skiing, swimming, boating, horseback riding) and are conscious of the various physical features of a site and how these relate to recreation uses. (Figure 2)

The correlation of mining and recreation uses will be explored in detail to see what factors are common to both. In the case of recreation areas, one can determine the desirable features and compare these to characteristics of typical sand and gravel sites. Similarities between each can then be exploited to transform the sand and gravel site into a recreation area.

There are a number of factors that need to be better understood concerning both sand and gravel mining and recreation. Of major significance and having direct bearing upon this study are those factors dealing with the classification of recreation areas, the site selection considerations of both sand and gravel sites and recreation areas, characteristic physical features of both mining and recreation, and the operational considerations of mining. Each of these factors will be looked at individually, in an attempt to correlate mining and recreation. (Figure 3)

Classification of Recreation Types

One of the most common methods of classifying recreation areas used by recreation planners is that which designates recreation land as resource-oriented, user-oriented, or intermediate (composite resource-user oriented.)[2] (Figure 4)

RESOURCE ORIENTED: The nature of the physical resource may be of scenic, scientific, or historic significance. The scarcity of the resource and degree of interest it generates, dictates whether or not the area will be deemed a recreation area.

Scenic areas are characterized by picturesque vistas, overlooks, drives, and unusual natural features such as waterfalls, mountains, or rivers.

Scientific sites are those that exhibit unique geologic or biological features of significant educational value, such as fossil beds, unique rock formations, and volcanoes, where natural phenomena can be studied.

Historic sites are those that reflect significant previous use, character, or individuality, either of the site or of some specific feature upon it, such as important battle sites, archaeologic features, and unique historic structures.

2. Marion Clawson, *Land for Americans*, Rand McNally and Company, Chicago, 1963, p. 37.

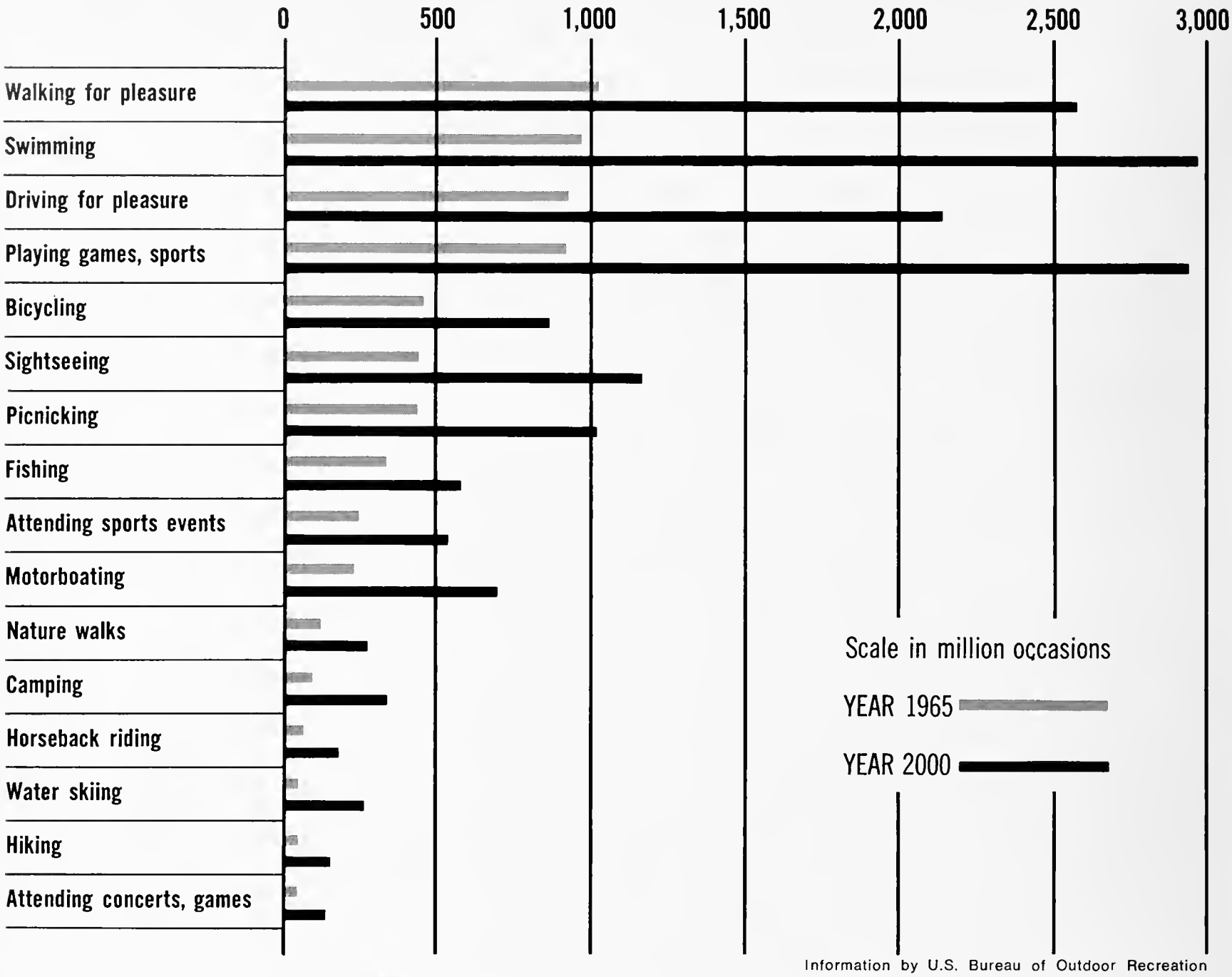


Figure 3 — Most popular summertime outdoor recreation activities

Although generally not the case, there could be instances where reclaimed sites would be classified as resource-oriented. In many instances sites prior to excavation do exhibit physical features such as trees and vegetation, which would suggest a resource theme, but due to operational processes, much of this cover has to be removed and the terminal landscape is considerably altered.

It is quite possible, through the practice of selective mining to preserve certain areas of the site, either adjacent to or overlying deposits. In this way the character of the site, although considerably altered, could be preserved to some extent.

Due to the nature of the substrata and the particular area that is being mined, some sites exhibit steep cut banks that may lay open to view various layers of geologic material that would have scientific value, both to the professional and to the amateur geologist. These cut banks could be utilized for the education and enjoyment of park visitors.

USER-ORIENTED: This refers to a recreation area that is primarily oriented towards providing activities for a large number of people. Such areas are usually characterized by numerous and varied recreation use areas. An important consideration here is that of accessibility since the success of such an area depends upon the extent of the use received from visitors. Urban parks (neighborhood, community, district) are prime examples of user-oriented facilities. They are generally situated in close proximity to potential users and serve a specific area. They are considerably smaller than resource-oriented parks and are generally not noted for their resource value. All user-oriented parks are not entirely devoted to the game-type pursuits of children. Recreation use areas are basically divided into two types, *active* and *passive*. This provides a varied recreation program which is necessary in a highly populated area where interests are as varied as the type of people.

Sand and gravel sites are generally larger than the average user-oriented park, but could provide the same types of recreation use areas, either on a larger scale or in conjunction with other desirable site features such as stands of trees and vegetation or water features.

INTERMEDIATE: (Composite Resource-User Oriented Area) These are recreation areas that are usually smaller than the large resource-oriented features, but larger than the user-oriented areas. They are exemplified by some state parks and Corps of Engineers' Reservoir projects which are generally within two hours driving time of their users. They exhibit features that attract both the resource-oriented and the user-oriented recreationist. Few sand and gravel sites are large enough to fall within this category and almost none could function at any great distance from their market areas.

It would appear that the majority of sand and gravel operations could be classified between the user-oriented and composite resource-user oriented park categories. They are generally not small enough to be bona fide urban play areas and are not in the same category as the composite parks. Sand and gravel operations have been known to exist as part of a composite recreation area, displaying features that strongly suggest mining can have a definite effect upon the types of recreation sought. Such is the case in Kickapoo State Park west of Danville, Illinois, where a strip mining operation was developed into a park. Facilities for camping, picnicking, and fishing were provided along side the cut banks and ponds. Motorcyclists have found the eroded hills and slopes to be ideal for scramble courses and hill climbs.

Another method by which recreation facilities can be classified is according to ownership and jurisdiction; private or public, depending upon the character of the facilities and the nature of the user group. Outdoor recreation is provided by a large and varying number of private groups. A few are relatively large, with national memberships, but most have a more limited range of activity, and many are strictly local. A relative few are interested in passive pursuits while the majority of such groups are primarily interested in active forms of recreation. Private groups tend to be more interested in activities than in resources.

A number of sand and gravel sites have previously been exploited by private recreation groups. In England such sites are highly sought by private fishing and sailing clubs for their exclusive use. Similar situations have occurred in this country where depleted sites have been developed for specific use or left in their natural state to be utilized as fishing or hunting preserves.

Resource oriented

U.S. Bureau of Outdoor Recreation Photo

Intermediate

User-oriented

Figure 4 — Recreational area classifications

Site Selection Determinants

There are three factors that individually or collectively influence the functioning of a sand and gravel operation and determine the success a recreation area can experience. These are location and access, size and configuration of the site, and the type of resources available.

LOCATION AND ACCESS: The location of a recreation area can greatly affect the potential success of the facility. (Figure 5) Urban recreation facilities that are relevant to the needs and desires of a community will generally be heavily utilized if located within convenient access of potential users. Since highly developed urban areas are bisected at regular intervals by streets, park facilities are likely to be easily accessible. One problem that does exist in urban areas concerns the safety hazard that results from heavy traffic flowing around park areas. Care should be taken to assure the safe passage of children and adults to and from park facilities. Traffic lights and crosswalks are extensively used, but tunnels and pedestrian overpasses also have great promise. For recreationists commuting from greater distances, parking should be provided.

The classification of a recreation area often has a direct bearing upon its location. The larger recreation areas such as the resource-oriented and composite resource-user oriented areas are generally not within walking distance and usually lie beyond the limits of public transportation lines. In order to adequately serve large urban centers these recreation facilities have to be located along or adjacent to major traffic routes or reasonably close by. Since the location of access routes do not alone dictate where a park is to be sited, provisions may have to be made for the construction of adequate connector routes that link the park with major access routes.

Some recreation areas are beginning to provide not only automobile access but also landing facilities for small planes. These areas are usually resource-oriented and generally feature some specific type of recreation attraction such as skiing, hunting, or fishing. Boat access is also provided at numerous recreation areas. Islands, remote peninsulas, and coves sometimes offer unique recreation experiences that can only be reached via water access.

Sand and gravel sites likewise depend upon location and access as a vital consideration for their operation. (Figure 6) Haul distances from the excavation area to the processing plant or from the processing plant to the market area directly affect the location of many operations. Because of the high cost of transporting material, sites have to be situated as close to their market as possible. Since nature created sand and gravel deposits only in certain locations, the producer is greatly affected by location. Public reaction, land use regulations, and already developed land have forced the producer to move further and further into suburban areas, thus increasing his haul distance.

Generally, the producer is not faced with access problems. Because sites are usually situated in an urban-suburban locality, existing streets and highways can be utilized for the transporting of sand and gravel. In more remote locations roads may have to be constructed.

SIZE AND CONFIGURATION: The size and configuration of recreation areas are dependent upon many different factors. (Figure 7) Within designated recreation areas certain specific uses can be programmed depending upon the physical requirements of the specific use. Length and width dimensions determine the siting and subsequent occurrence of a particular use. Although most active recreation use areas (court and field games) are rectangular in design, irregular shaped parcels of land should not be considered as lost space. Parking lots, passive recreation areas, and buffer zones make good use of such areas.

Size may directly affect the classification and the manner in which a recreation area is to be utilized. Following is a table listing some common recreation areas and their sizes.[3]

FACILITY	SIZE
PLAY AREAS	
Playlot (Totlot)	2500-10,000 sq. ft.
Playgrounds	1 acre/800 people. Minimum size 3-5 acres.
Playfields	1 acre/800 people. One playfield 10-20 acres per 15,000-25,000 population.
PARK LAND AND RECREATION AREAS	
Large Urban Recreation Areas	Minimum size of 100 acres. 15 acres/1000 people.
Municipal Parks	1 acre/250 people or one 20 acre municipal park for each 5000 people.
Regional Reservation Area	10 acres/1000 people. Minimum size of 500 acres.
Statewide Recreation Area	30 acres/1000 people. Minimum size of 800 acres.
Local & Regional Recreation Area	20 acres/1000 people. Minimum of 50 acres/5000 people.

3. U.S. Department of the Interior, Bureau of Outdoor Recreation, *Outdoor Recreation Space Standards*, United States Government Printing Office, Washington D.C., Passim, 1967.

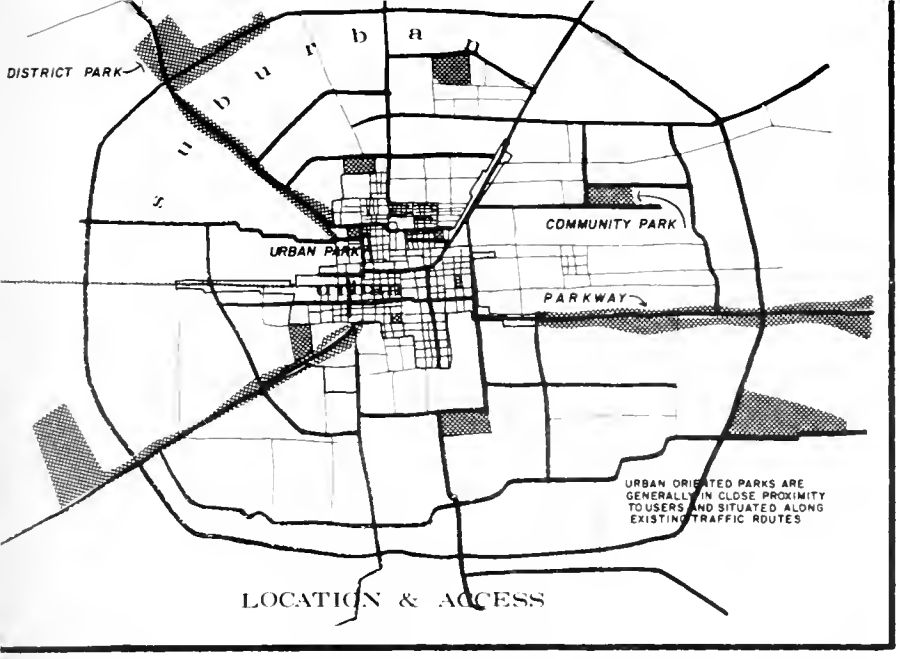


Figure 5 — General siting of recreation areas

Sand and gravel sites also vary in size and configuration. (Figure 8) A recent survey showed that the size of sand and gravel sites ranged from 10 to 3,000 acres with 13% consisting of less than 100 acres, 60% between 100-500 acres, and 27% over 500 acres.[4]

The factor most responsible for the size and configuration of a sand and gravel site is the nature of the deposit. Other factors that affect the size and configuration of a site are stockpiles of overburden, segmented bodies of water, islands of nonminable material, and resource amenities on the site. The configuration of the deposit gives a rather exact indication of how the site will appear as a result of excavation.

RESOURCE POTENTIAL: All recreation areas exhibit various physical resource features that suggest how the site could be best utilized. These features may be topographic, vegetative, or aquatic in nature. Small urban playlots or certain playgrounds may not appear to be conducive to recreation because of their lack of trees or water, but it is this lack of resources that suggest the site is best suited for activities which might eventually destroy any trees and vegetation.

Although not an on-site consideration, adjacent land uses may ultimately determine the success or failure a particular recreation area will experience. Annoyance factors such as noise, dust, water, and air pollution, and unsightly views may not only influence siting of various uses, but may also eliminate a portion of the site from recreational use. Such problems may be partially or totally eliminated through the use of screening elements (earthen mounds and planting), and in the manner use areas are oriented.

4. ANTHONY M. BAUER, *Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites*, National Sand and Gravel Association, Silver Spring, Maryland, 1965, p. 14.

Figure 6 — General siting of sand and gravel operations

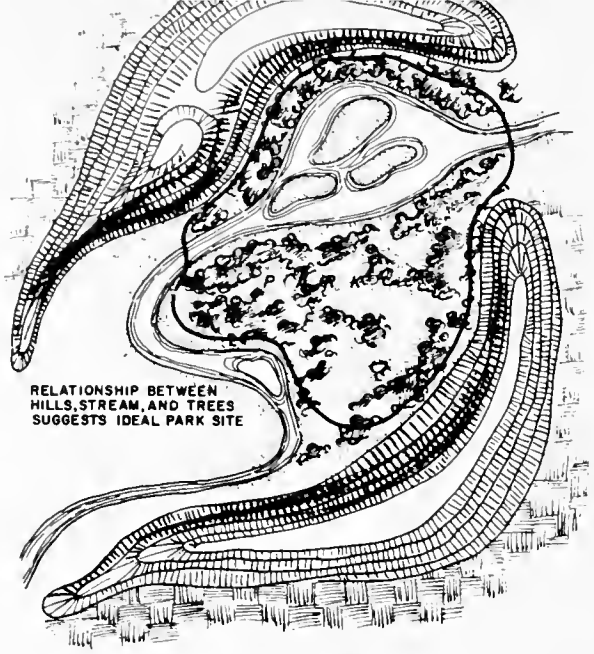
Characteristic Physical Features

Additional factors that indicate a site's potential for recreation include certain physical site characteristics. If sand and gravel sites exhibit physical features similar to those inherent in desirable recreation areas it would be easier to correlate mining and recreation.

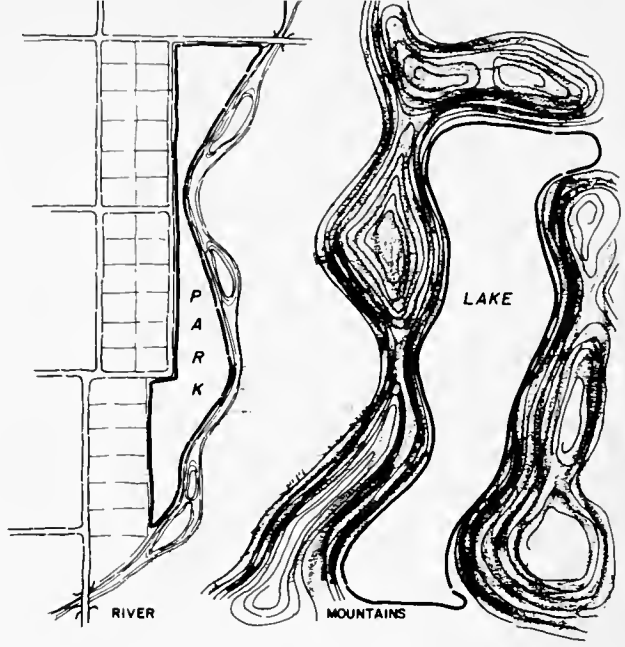
Recreation planners have singled out three physical characteristics that are desirable for recreation; trees, topographic variations, and water features, which would offer a diversified populace the varied recreational uses that they so often demand.[5] (Figure 9) These physical characteristics could have application either from a functional or an aesthetic standpoint. Aesthetic factors cannot be precisely measured due to the personal nature by which they are viewed or experienced. Functional factors are those physical features of a site that best facilitate certain uses.

TREES AND VEGETATION: From a functional standpoint trees and vegetation serve as wildlife habitats, control erosion, and act as dust in-

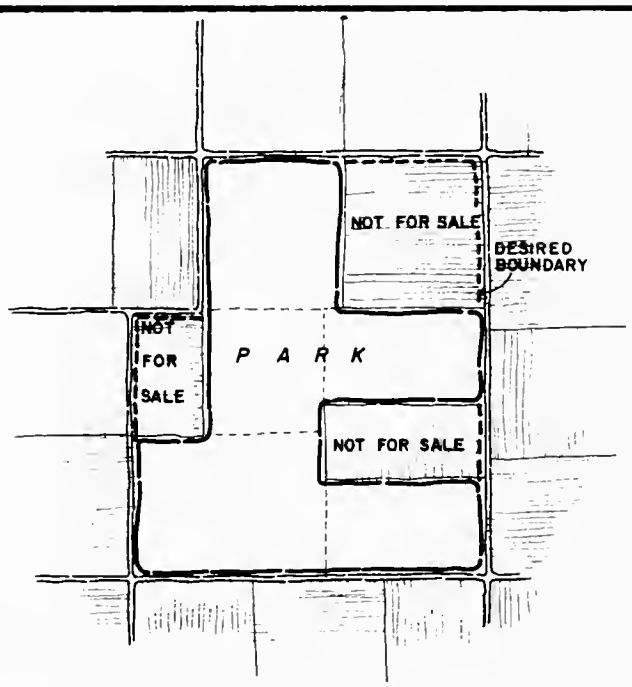
5. HOWARD G. DANFORD, *Recreation In the American Community*, Harper and Brothers, New York, 1953, p. 14.



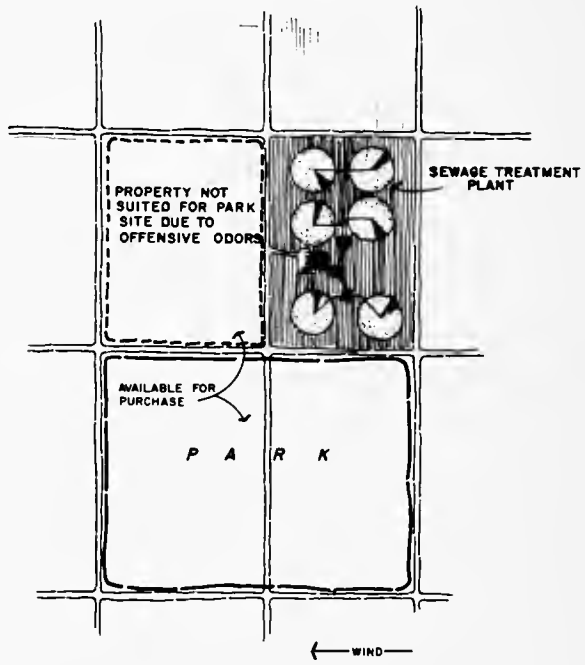
desired natural features



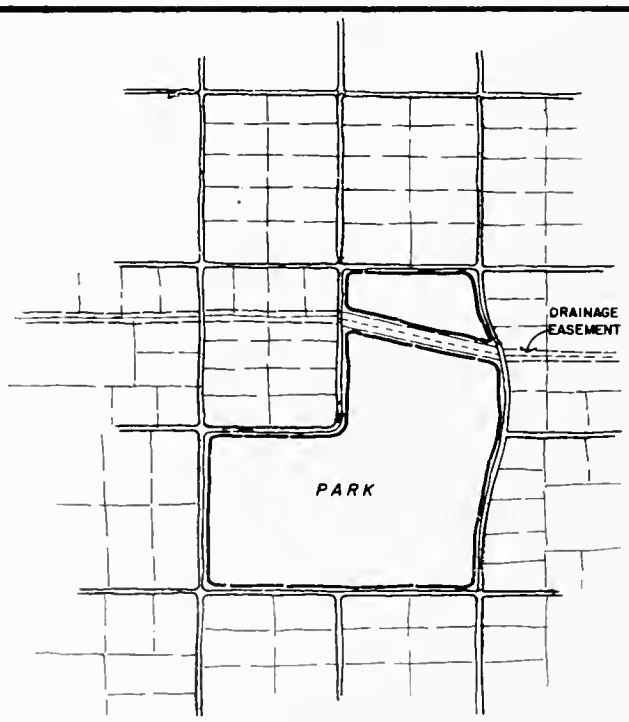
intensive use areas



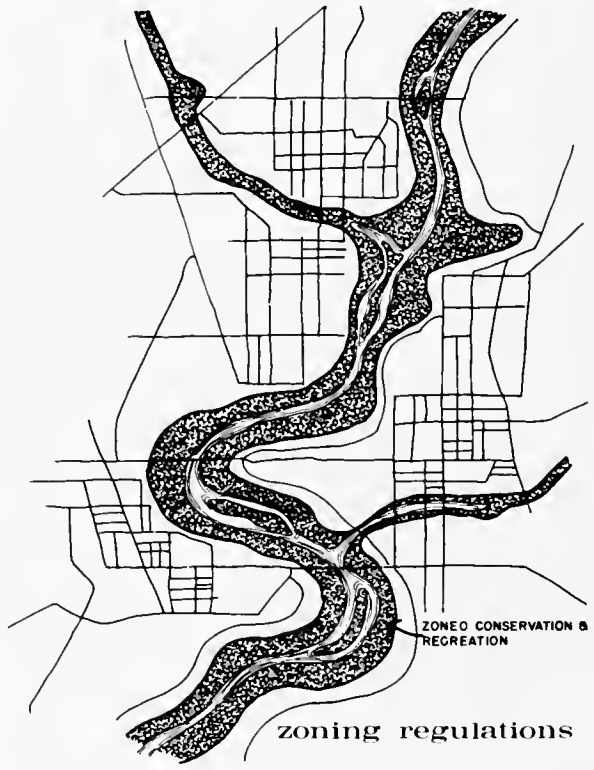
property lines, available land & cost



noneonforming land use

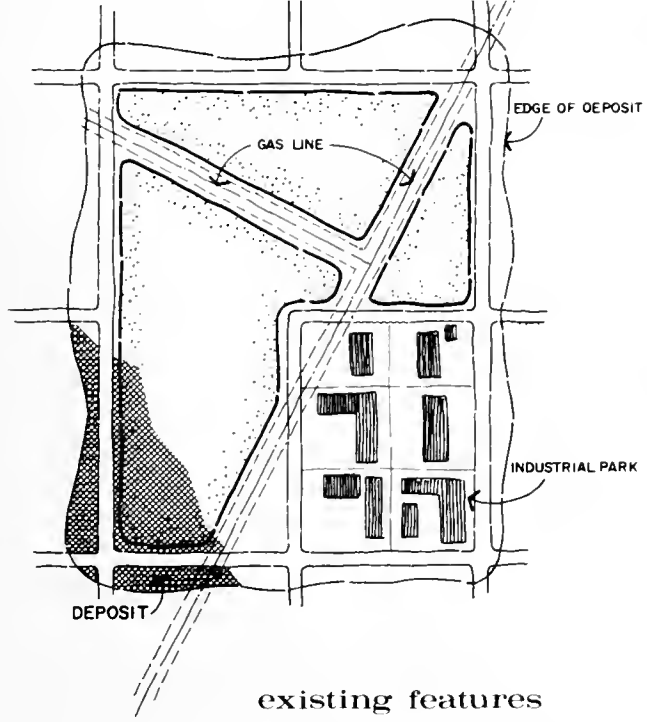


street grids & easements

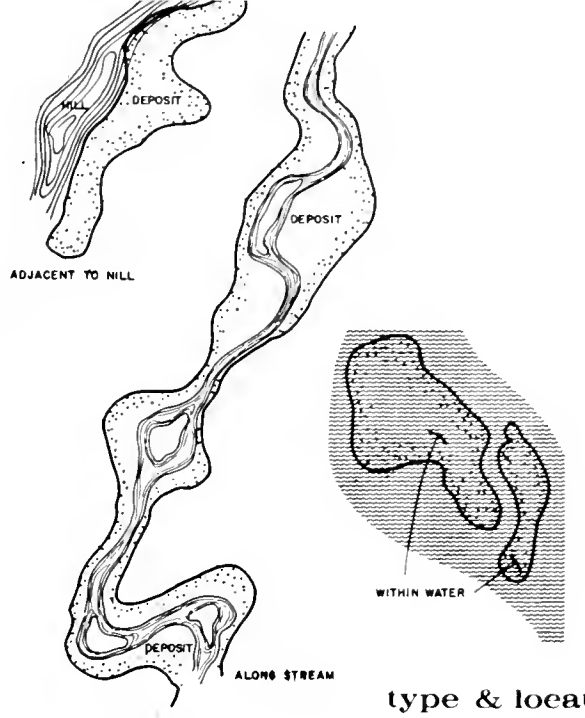


zoning regulations

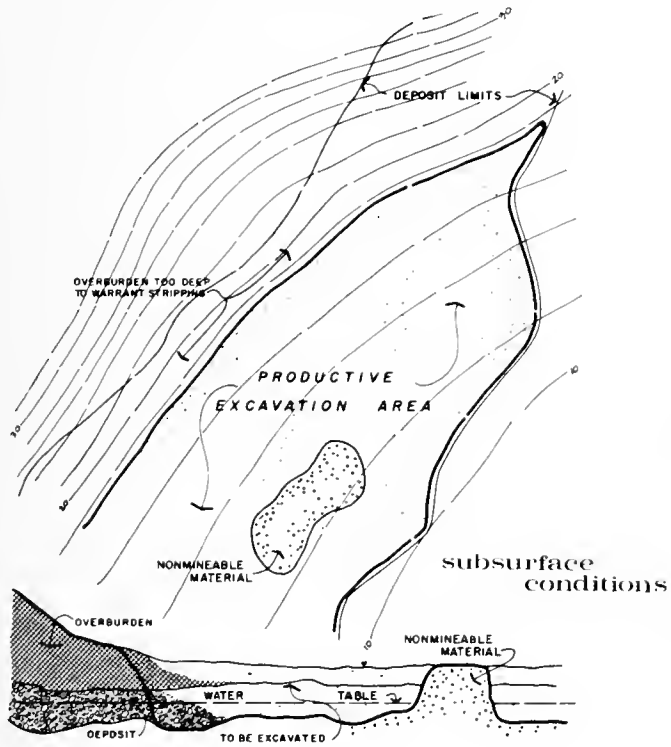
Figure 7 — Size and configuration determinants of recreation areas



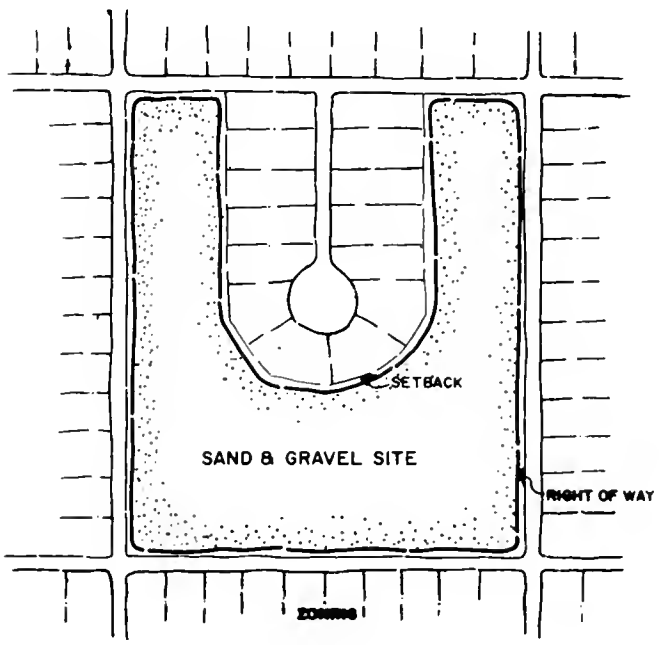
existing features



type & location



subsurface conditions



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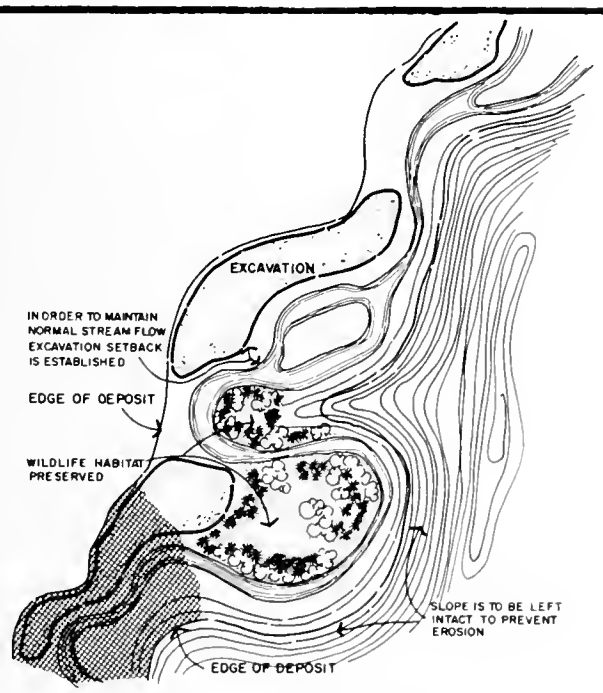
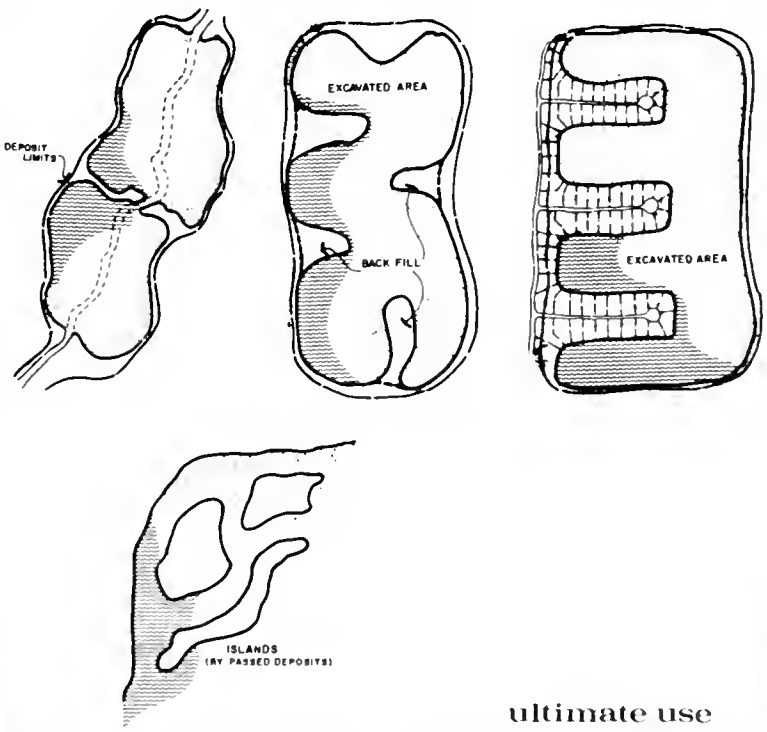


surface conditions



ultimate use

Figure 8 — Size and configuration determinants for sand and gravel sites

Figure 9

hibiters. Stands of trees also create micro-climates that are of great importance to recreationists; acting as windbreaks and providing shade for various activities. Aesthetically, trees and vegetation can provide areas of visual contrast. The various textural qualities of leaves and branches characteristic of different species of plants offer visual contrast that can be pleasing in relation to recreational activities. Contrast is also provided between dense and sparse areas and between species varying in height, mass, and color.

Considering the fact that sand and gravel operations are moving increasingly further from the urban core areas, there is a good chance that trees and vegetation may be present. These could be major landscape features and dictate the development plans for a site.

TOPOGRAPHY: Aesthetically land forms of varying height and configuration can define space, reduce scale, provide privacy and solitude, suggest natural circulation of walkways, paths, and roads, channel or restrict views, and define use areas. (Figure 10) Topographic features are probably the most functional aspect of a recreation landscape. They not only have strong aesthetic qualities, but the type of feature can have a direct affect upon the type of recreational uses incorporated onto a particular site. Hills suggest hiking, climbing, and winter activities. Northeast and northwest slopes provide shelter from sun and wind while flat areas may be easily utilized for camping facilities or building sites.

Topographic variations that result from sand and gravel operations are the strongest indications that such sites have potential recreational value. (Figure 11) A most desirable feature of a sand and gravel site is the land forming potential of that site. This potential is usually realized in the formation of mounds and shallow depressions.

The initial indication of a sand and gravel site's land forming potential will result from test borings that reflect the composition of the substrata. The actual physical location of the site can also give some indication as to what the composition, or percentage of sand to gravel in the deposit is. Deposits that are closest to their source or origin (glaciers or parent rock) are generally not characterized by great quantities of sand relative to gravel.[6] The further the mining operation is from the source, the greater chance there is of finding large percentages of sand which is considered valuable land forming material.

Test borings may further indicate that there are areas within deposits that do not warrant excavation due to the poor quality of sand and gravel. Such areas are often designated as non-minable and are often left intact while excavation proceeds around them.

Most sand and gravel deposits are covered by overburden of varying thickness. The depth of the overburden can be a factor when considering the possibility of excavating an area, due to the cost of removing the overburden and stockpiling it elsewhere. Most producers would not object to removing from 2′ - 10′ of overburden to get the sand and gravel deposit beneath. Overburden can be very valuable for recreation in the formation of fills and mounds that can have many applications in a recreation setting.

Land forms characteristic of sand and gravel mining can probably best be viewed at most dry sites that have been depleted. Such sites are usually characterized by steep and irregular slopes, and pits of varying depth and configuration. (Figure 12) In some instances these depleted sites remain unchanged, until encroaching development surrounds them and land values rise to such proportions that it soon becomes economically feasible to develop the sites. (Figure 13) This suggests that depleted sites also have recreation value and could be converted into valuable recreation areas. In a number of cases this has been the normal sequence with the resulting recreation area being quite successful. (Figure 14) In the majority of cases such recreation features have been those that could be adapted to the existing site without too much site alteration. Examples are fishing, swimming, hunting, and boating.

WATER FEATURES: Traditionally, water features of various types have captured the imagination of people in all walks of life. Water can be made to flow, gurgle, gush, seep, slide and stand depending upon the effect one desires to achieve. Aesthetically, water in various degrees of motion and confinement can portray moods of serenity, strife, anticipation or anger. Functionally, water can provide a place to swim, fish, or boat, and can also

6. BAUER, *Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites*, p. 9.

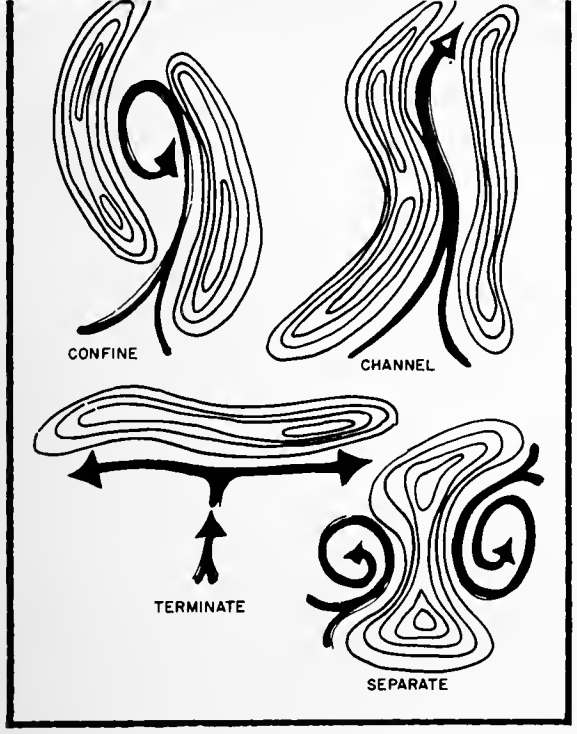


Figure 10 — Functional aspects of land forms

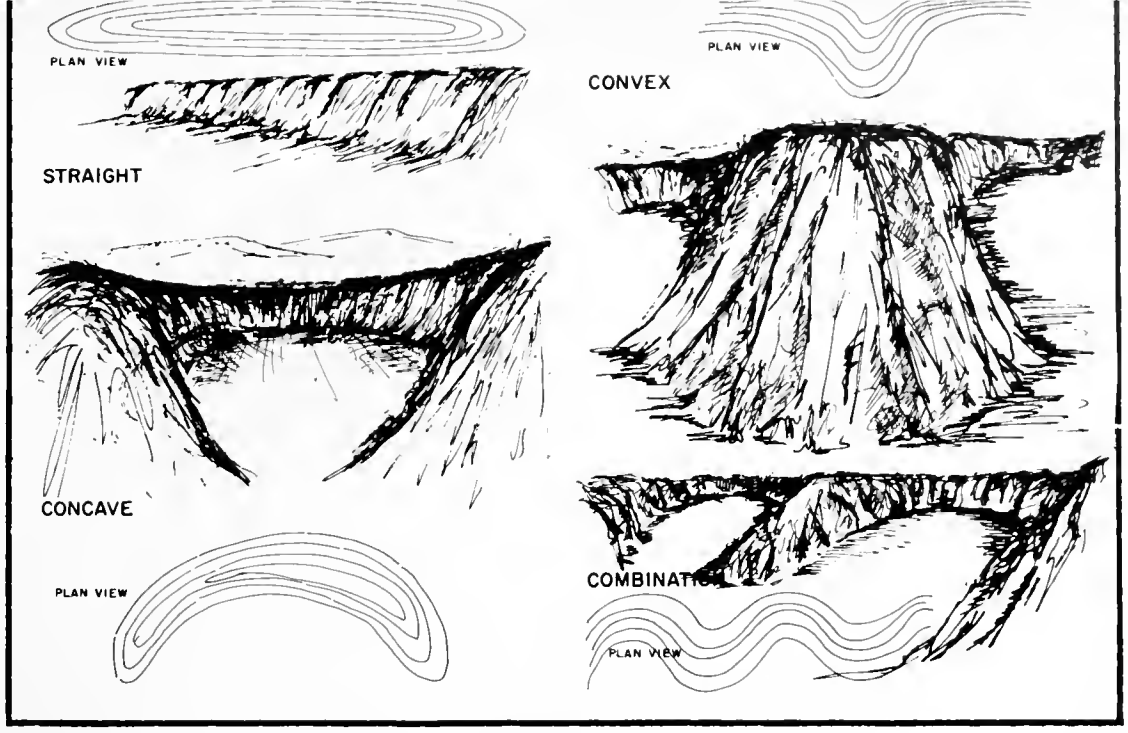


Figure 11 — Land form configurations

be used to push or pull. Recreational use of water areas depends primarily upon the depth of the water, amount of shore frontage, clarity and cleanliness, and nature of the shore area. In situations where it is possible to alter shorelines and create various land configurations, the type of recreation uses to be incorporated onto the site should strongly suggest how this is to be accomplished.

Water features that result from sand and gravel operations are of varying sizes and configurations. (Figure 15) Generally, they are of two types: (1) shallow and segmented, and (2) extensive and open. (Figure 16) Without land reclamation, such water features may be unsafe for recreational use except for fishing and water fowl hunting. The shallow segmented bodies of water are generally isolated and protected from view by adjacent overburden mounds and encroaching vegetation. Aesthetically, the water features are generally quite attractive. Water in sand and gravel operations occurs when excavation takes place below the ground water table. Since sand and gravel mining operations do not produce polluting or toxic substances the water features are not health hazards and can be utilized in their natural state.

Operational Considerations

When analyzing the recreational potential of a sand and gravel site the site planner should develop projections and recommendations based on mining processes. It is these various processes that will determine the final physical character of the site, thereby dictating to a large degree the nature of possible recreation features. (Figure 17)

There are normally four basic steps involved in the mining of sand and gravel, (1) clearing and stripping, (2) excavation, (3) processing, and (4) transporting. Each of these could advantageously affect the immediate and future recreation potential of any site.

CLEARING AND STRIPPING: Clearing involves the removal of trees and vegetation from above deposit locations. Usually a sizeable portion of the site is cleared to make way for stripping operations. Stripping refers to the removal of topsoil and overburden from above the deposit. Of particular concern should be preservation of topsoil for future re-use. Since most vegetation is cleared from the site prior to excavation, any terminal site features will accordingly be void of vegetative growth. In order to preserve the terminal site features for recreation use vegetative cover is desirable. Since topsoil contains the necessary minerals for plant growth, its redistribution can assure the proper medium for plant sustenance.

Overburden can represent valuable mounding material if a sufficient amount is available. Such mounds are often integral parts of many recreation features and also serve as screening devices segregating recreation from mining operations. Overburden is recognized as land forming material in both wet and dry operations.

EXCAVATION: Probably most representative of the operations phase is the manner in which excavation dictates site configuration. Although governed by deposit characteristics, the excavation stage often defines the site and can suggest various recreational uses of that site. In wet sites excavation determines water feature configuration and depth. In dry sites excavation is evidenced by cutbanks of varying degree and/or isolated land forms of non-minable material. These resulting features dictate best recreation use of the site.

Figure 12 — Topographic variations on sand and gravel sites

Figure 13 — Typical land form characteristics of sand and gravel sites

PROCESSING: The actual location of the processing plant will understandably affect the excavation pattern and consequently any recreational use of the site. Processing plants are generally situated in such a location that will not require their having to be moved and must be easily accessible to transportation routes.

TRANSPORTING: This is the procedure whereby the raw deposit is delivered to the processing plant; which may not be located on the site, or moved from the on-site processing plant to market areas. On-site transportation routes for truck, rail, or barge shipment provide circulation potential for recreationists.

Recreation Potential

A recent outdoor recreation study conducted for the megalopolis area of New York — New Jersey — Philadelphia for the Outdoor Recreation Resources Review Commission (ORRRC) cited a

number of recommendations that would correct the present imbalance in the existing outdoor recreation programs.[7] Although this study applies to an eastern populace, there is every reason to believe that the recommendations would apply to large urban areas elsewhere. These recommendations were designed to improve facilities for: (1) People who live in areas where outdoor recreation facilities are most lacking, and who prefer developed facilities over wilderness areas; (2) people who do not own automobiles and therefore should be within walking distance of recreation facilities or can take advantage of a common carrier; (3) children who have little opportunity to experience outdoor recreation; and (4) residents of densely populated areas that are beset by traffic congestion.

In deciding how to remedy the situation of inadequate or nonexistent outdoor recreation facilities, the above report suggested that primary attention be focused on those resources that are most lacking in relation to demand, such as water areas and related facilities.

The recommendations are as follows:

1. Develop more facilities on underused public land within reach of the population centers where there are fewest recreation opportunities.
2. Provide important new outdoor recreation areas to be serviced primarily by common carrier transportation.
3. Develop more outdoor recreation facilities for children, particularly day camp facilities on publicly owned land close to dense population concentrations.
4. Ameliorate the automobile access problem.
5. Conserve and rehabilitate beach areas.
6. Step up pollution abatement programs.
7. Use water supply reservoirs for recreation.
8. Aid in redeveloping lakes.
9. Create artificial lakes in cooperation with private enterprise.
10. Preserve and develop historic sites.
11. Encourage the development of second or vacation homes.
12. Stimulate contributions by private sector.

It appears that sand and gravel producers may be able to play a significant role in realizing the full potential of the preceding recommendations. The comparative analysis of recreation areas and sand and gravel sites noted the great similarities between the two.

In summarizing this chapter a number of factors should be emphasized. First is the producer's need to be as close to his market as possible to minimize transportation costs. Since he is generally unable to acquire urban real estate, the producer is forced to locate his operations in suburban localities where land is cheaper, more accessible, and where dissent from adjacent land owners is minimal. This suburban site is gradually surrounded by urban development that has a normal tendency to expand outward from the central core area. Soon, the once suburban site becomes rather urban in character and as resources are depleted producers are forced

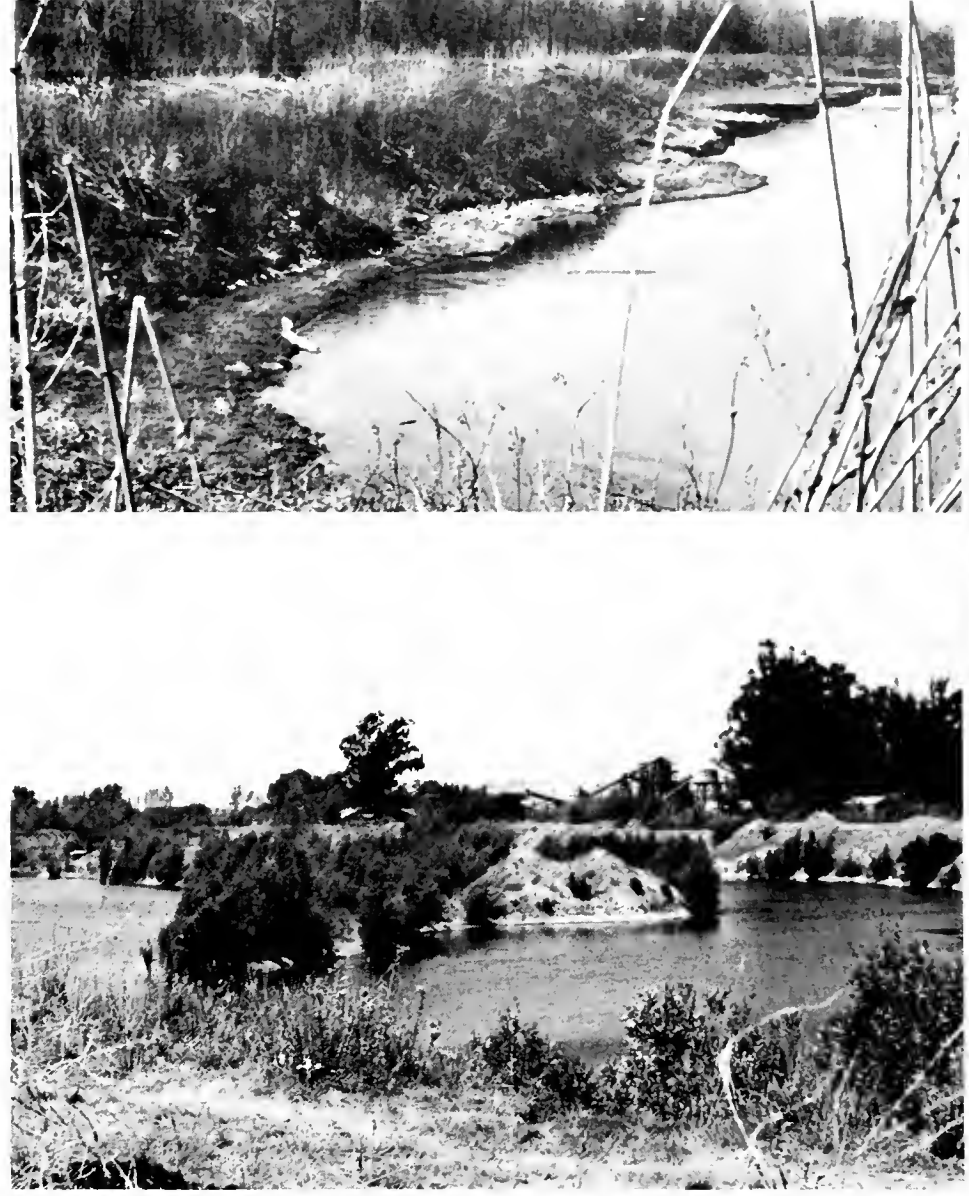


Figure 14 — Evident recreational potential on now-rehabilitated sites

7. CLAWSON, *Land for Americans*, p. 3.

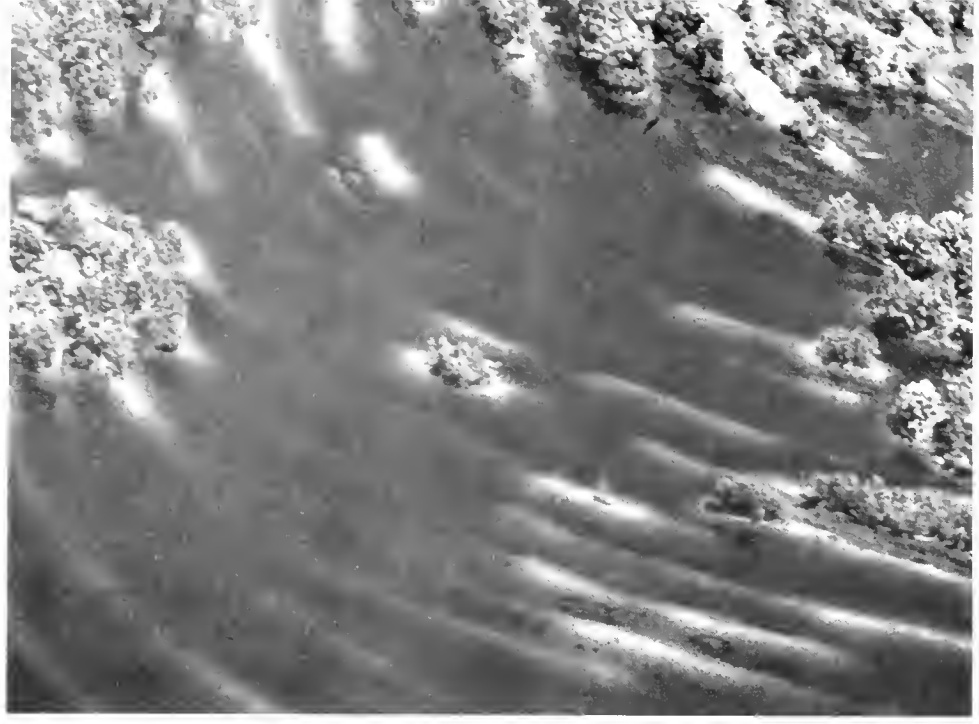


Figure 15—Shallow and segmented water features

Figure 16 — Extensive and open water features

to locate further out in less developed areas. To a producer or recreation planner the situation could not be better for recreation potential. In a number of years these sand and gravel sites will be exhausted of resources and being in such close proximity to potential users could make ideal recreation areas.

It should also be noted that sand and gravel sites are comparable in size and configuration to suburban oriented parks. This means that a municipality may have sizable potential recreation areas scattered throughout its suburban fringe areas.

Trees and vegetation, variances in topography and water features not only represent ideal recreation features, but frequently exist on sand and gravel sites or are the consequence of various mining operations. Since sand and gravel sites are relatively large, these features are often quite extensive and represent a significant contribution to potential recreation use. Since the actual deposit does not underlie the whole of a particular site, such resource features as trees and vegetation that exist off the deposit areas have a good chance of being left intact and may form the basis for various planning schemes. Different types of excavation equipment produce distinct terminal site features as a result of unique operating patterns. The four basic phases of mining, clearing and stripping, excavation, processing, and transporting are responsible for all on-site physical topographic variations. Mounds, depressions, cutbanks, islands of nonminable material and any land forming potential the site will exhibit are direct consequences of various grading and operational requirements.

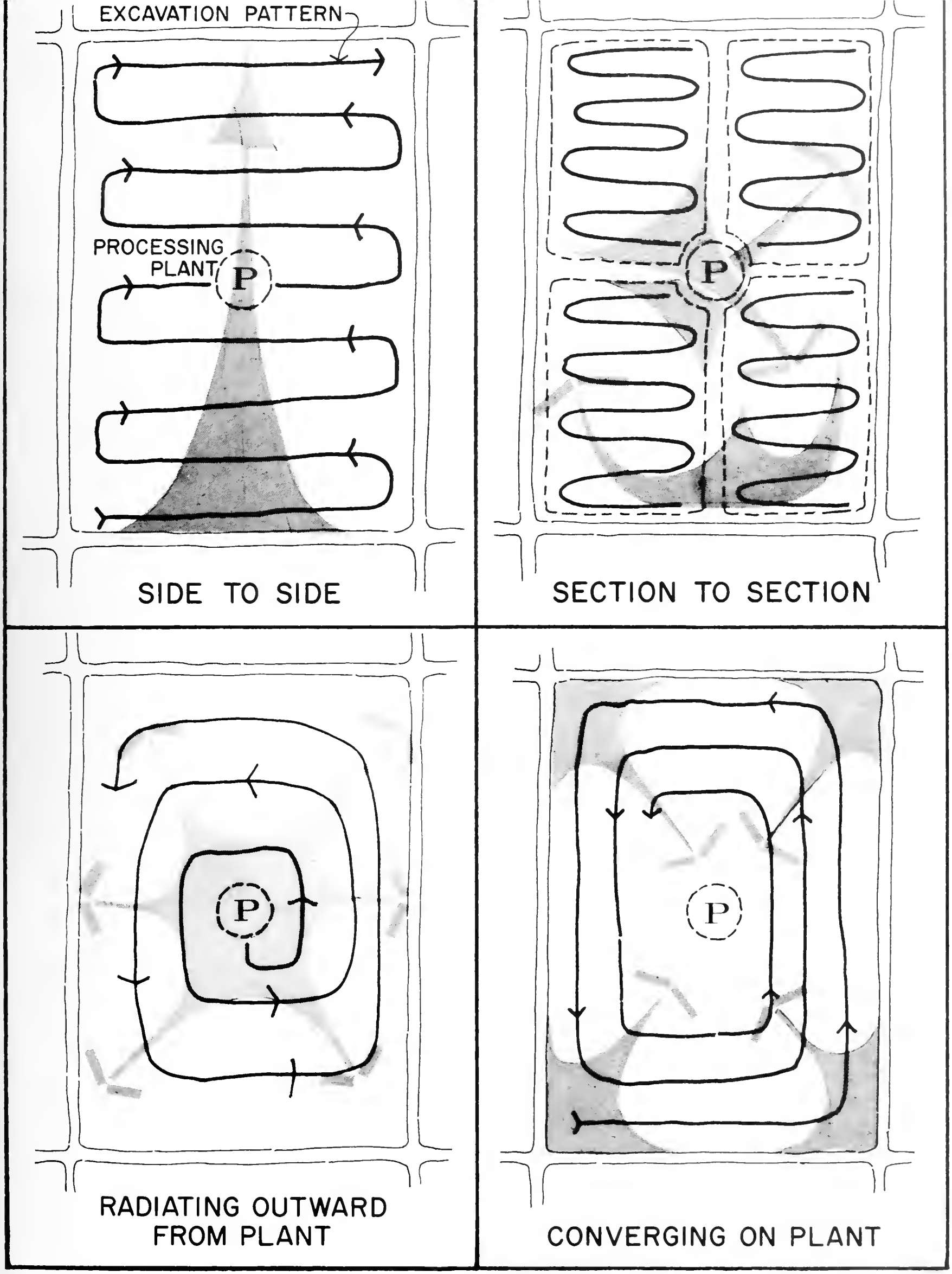


Figure 17 — Alternative approaches to site operations

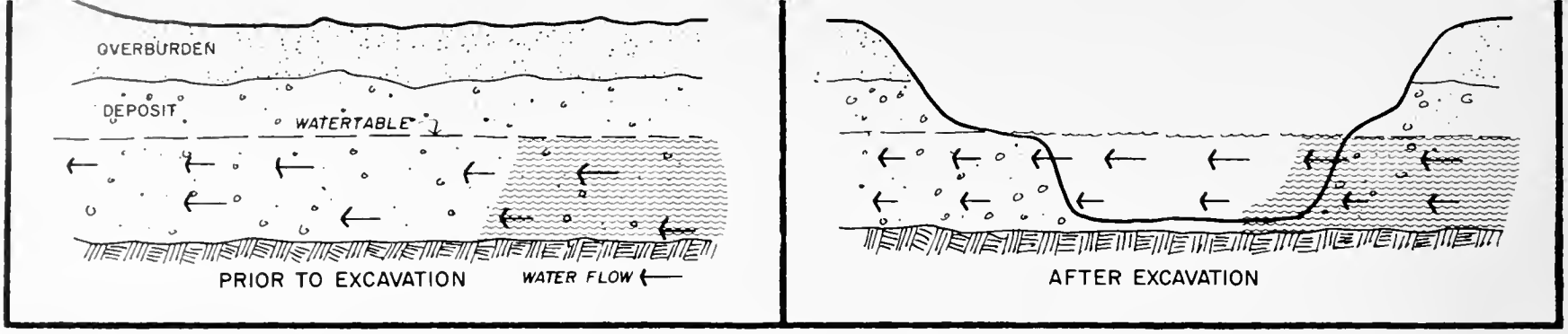


Figure 18 — Water in excavated sand and gravel sites is continually rejuvenated

Chapter III

Determining Recreation Objectives

An understanding of how sand and gravel sites and recreation areas relate to each other will not in itself suffice when attempting to physically develop sand and gravel sites for recreation. If one recognizes the fact that no two sand and gravel sites are alike and that outdoor recreation activities are just as varied, it can easily be seen that there are no standard solutions that could be applied to all sites.

Variables to be Considered

There are a number of factors that need to be considered when attempting to correlate mining and recreation. These variables affect all rehabilitation operations and while they vary in degree of significance on particular sites, they should nevertheless be integral parts of the rehabilitation process. A thorough understanding of these variables will assist the operator and planner in deciding how to best develop a particular sand and gravel site for recreation.

TYPE OF SITE: Of particular significance is the nature of the site, whether it will be a wet or a dry operation, which may indicate subsequent recreational development.

Water-oriented recreation is probably highly sought near almost all urban areas. Some natural streams, rivers, and lakes are so polluted that swimming and many other forms of water recreation are restricted, crowded, or too far from most users for desired regular use. Assuming that the water table has not been polluted, the water in sand and gravel excavations is highly desirable for almost all forms of water recreation. Since the water table is constantly in motion, large bodies of water within excavation areas are constantly being rejuvenated. (Figure 18) In order to facilitate swimmers and boaters, water areas should be of safe depth so that normal activities are not hampered. Standards should also be considered for other aquatic activities such as fishing, skin diving, and wading. (Figure 19)

The fact that a site will be dry necessitates further consideration as to how the area is to be utilized for recreation. Since water-oriented recreation is out of the question, the imagination of the planner and the terminal site features of the site will be determining factors in how the site is developed. Any provisions for recreational activity should be in harmony with terminal features of the site and since large scale earth moving is costly, the site itself should suggest what recreational activities will be provided.

The rough, harsh appearance of newly excavated areas possess the characteristic features that interest and attract many people. It is these types of features, repeated throughout the site at varying intervals, that will also determine the actual size and configuration of the various recreational use areas, consequently being directly responsible for how the site is developed. Their forms and sizes may

be altered to conform to desired uses and to render them safe for recreational use.

Wet operations generally are singled out as being most representative of how a site's configuration can be altered to conform to the particular desires of the operator and planner. Although configuration alterations are most evident in wet sites, the dry site probably offers more potential for imaginative reshaping and final utilization of various terminal site features. The dry site is exposed in its entirety while the major portion of the wet site is covered with water.

NATURE OF FACILITIES: When considering recreational development in conjunction with sand and gravel sites, one usually thinks in terms of how the site is to be utilized. The physical attributes of the site subsequent to excavation, in many cases, are very dominant and reasonably adaptable to recreation. It is impossible to foresee the actual terminal physical character of a site prior to excavation. Any preconceived notions of recreation will probably be based upon past experience with other excavated sand and gravel sites and recreational uses that would most likely adapt to such sites. Recreation features most adaptable to sand and gravel sites will almost always include uses that necessitate significant variances in topography. Wet sites naturally suggest water-oriented recreation.

There are factors other than physical terrain features that also affect the nature of facilities that are to be programmed for a site. These are:

1. **Needs and Desires of Potential Users**—Those that are going to be most affected by any recreational development should be considered concerning their desires and recreation needs. This can be done by interviewing or by mailing questionnaires to households in the surrounding communities. A survey of recreational facilities in the area will give an idea of what is lacking as well as what is most heavily utilized. For example, certain ethnic or age groups may predominate in the vicinity of operations, and may affect the type of activities programmed for the site.
2. **Climatic Factors** — The annual precipitation, average temperature, average velocity and direction of prevailing winds, and seasonal variations all affect any recreation area and subsequently any proposed development of that area.
3. **Adjacent Land Uses** — Non-compatible adjacent land uses may affect any recreational development, although screening methods may serve to eliminate many undesirable features.
4. **Development Costs** — This is a very practical consideration when planning for recreational facilities. If funds are not available for certain facilities, they will not be provided.

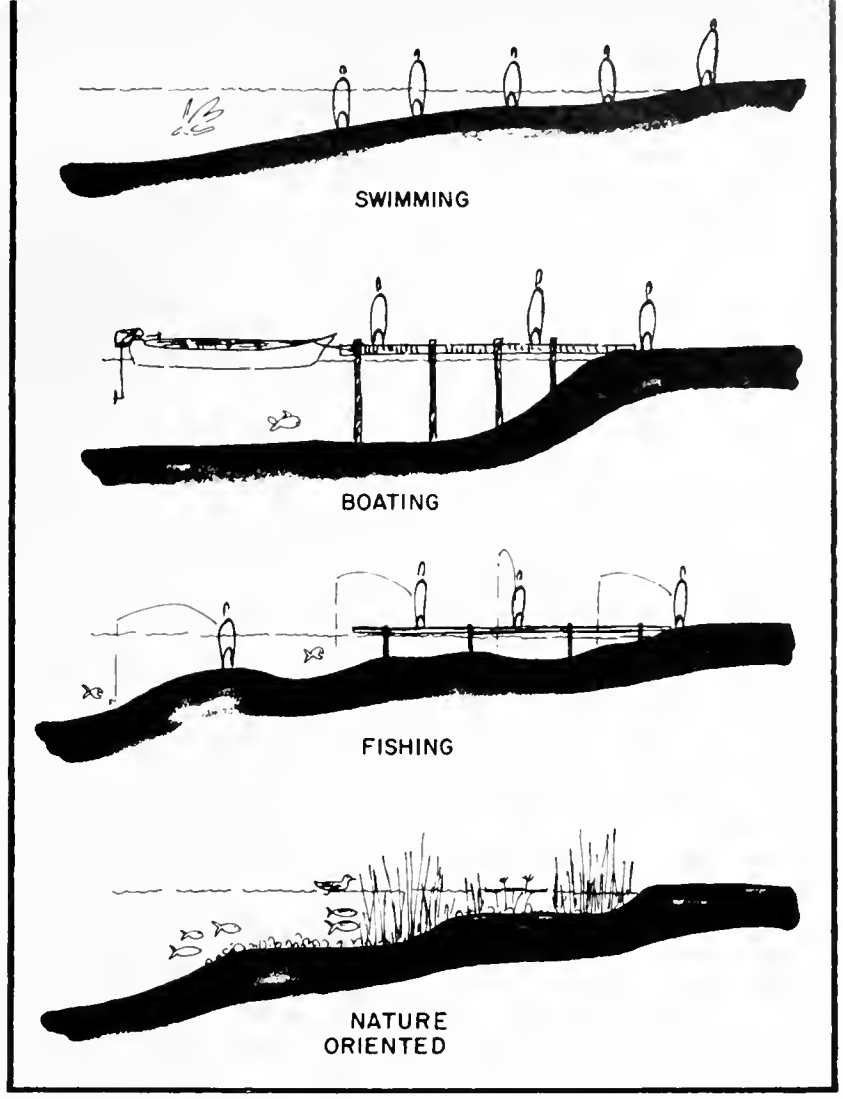


Figure 19 — Bottom treatment varies with desired use

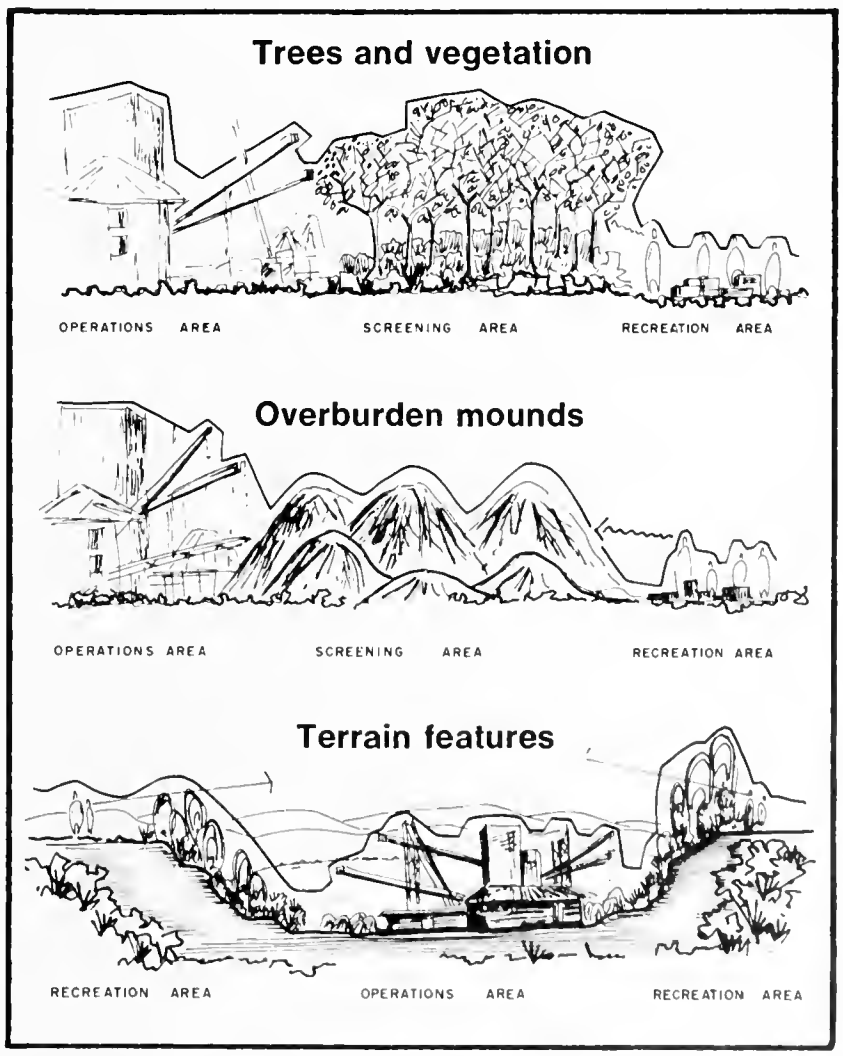


Figure 20 — Methods of separating mining and recreation

Figure 21 — Overburden mounds and vegetation utilized as screening devices

EXTENT OF OPERATIONS: To believe that the normal effectuation of site preparation, excavation, processing, and transporting are the only factors that affect recreational planning on a site is erroneous. Since these are the only factors upon which production need depend, assuming they can function, they are also the very factors that affect any recreation potential of a site. Unfortunately, the site is affected to a much greater extent than is evidenced by observing the various operational phases. There are probably numerous ways in which these side effects of the various mining processes affect any recreation potential of the site. The three major considerations that are of immediate concern to a recreation planner are potential annoyance factors produced by the normal functioning of the mining operation, safety hazards that would deter any recreational activity, and the problems evolving about. the ecological alterations of the site. Each of these warrant a closer analysis.

1. ANNOYANCE FACTORS — The various potential annoyance factors of dust, noise, and unsightly views, and how they can be dealt with, affect recreational use of sand and gravel sites. The degree to which these factors and the recreationist are separated will most likely be the margin of success the site will experience.

Following are several ways to minimize potential annoyance factors. These factors not only directly affect the on-site recreationist, but greatly affect the attitude and opinions of adjacent property owners.

1. Smaller processing plants and more strategically located stockpiles are most acceptable to adjacent communities.
2. Time is a factor in public opinion. It is more favorable for an operation to be in progress prior to adjacent development. Generally, the shorter the operation, the more favorable public opinion.
3. Care should be taken to see that trucks do not speed or deposit mud and dirt on public roads.
4. Vegetative and earth mound screening should be a recognized necessity where annoyance factors are encountered.
5. Normal plant operations should correspond with the work schedule of the adjacent community

In general, recreational activities should not be located immediately adjacent to sources of dust or noise, and views into the site that reveal unsightly areas should be screened when practical. (Figure 20) In attempting to minimize potential annoyance factors that are inherent to all sand and gravel operations, careful consideration should be given to

environmental factors such as wind direction, orientation of site, location of major access routes, direction of flow of any stream or river on the site, seasonal variations, topography changes on the site, existing and proposed adjacent development, and existing uses on the site.

Sites situated in areas adversely affected by cold and severe weather experience a period in which production has to cease. This could be prime time, if weather conditions permit and the personnel and equipment are available, to make necessary site improvements.

Another method by which nuisance effects can be minimized is by physical separation of the conflicting activities. This has one obvious disadvantage in that a certain percentage of the site would have to be maintained as a buffer zone, thereby not being utilized for mining or recreation. The zone could have incorporated within it various methods of screening that would supplement the effect already achieved by the physical separation of the two use areas. (Figure 21) Of particular concern here would be the width of such an area and the amount of trees or vegetation that would serve as screening material. Not unrelated to the physical separation of the two interests of mining and recreation would be a careful evaluation of existing site features that may offer possibilities as to how the two areas could be segregated from each other. Physical characteristics such as water features, tree masses, and a variance in elevation may already serve to divide the site into sections. The elimination of annoyance factors and the degree to which an operation blends into the fabric of neighboring communities greatly affects any potential recreational development that may be planned for the site or any part of it.

2. SAFETY FEATURES — A certain degree of risk is desirable in children's play areas to offer the challenge and adventure children seek. What is not desired are safety hazards that may not be recognizable as such to children or adults. (Figure 22)

Sand and gravel sites may contain a combination of interesting terrain features and water areas with potentially dangerous steep banks, and pot holes.

Generally speaking, slopes up to 25% will support vegetation and for this reason offer reasonably stable footing, whereas unprotected slopes are more subject to slides and cave-ins that may not be obvious to many users. Ways in which slopes can be stabilized and made safer for recreation are: (Figure 23)

1. Rounding off the tops.
2. Use of overburden to fill out slopes.
3. Use of vegetation to stabilize slopes.
4. Use of drainage structures to eliminate erosion.
5. Terracing.

Since most sand and gravel operations are relatively large and extensive and generally continue over a period of 5-30 years, old equipment, old buildings, and debris may accumulate. Normally these items are removed when the site is depleted and operations cease, but in some instances, they have been left behind to rust, deteriorate, and become overgrown by vegetation. These features normally have great appeal to children and represent a safety hazard that should be eliminated.

3. ECOLOGY—Ecology is the biological science that deals with the relationships of plants and animals to their environment. In conjunction with sand and gravel operations, there are no instances where sites can be worked without altering ecological conditions. Therefore, there must be a compromise between conservation and utilization of natural resources. It is in this context of proper management, that we may minimize problems while emphasizing potential.

Site clearing, resulting in micro-climate alteration both on and off the site, is a cause of ecological change in the sand and gravel operation.[8] The greatest change is evidenced on or adjacent to areas that have been subjected to extensive clearing. Wind and temperature extremes produce adverse effects upon any vegetation that one may attempt to introduce or any that are adjacent to such cleared areas. Surface temperatures on spoil banks have exceeded 130°F.[9] These high temperatures can be critical, especially when accompanied by wind. Both are responsible for loss of soil moisture, increased plant transpiration and rapid surface drying.

Prior to any work on the site, a preliminary survey should be conducted of the deposit, site, and equipment characteristics that will affect the physical character of the site and subsequently the ecology. Such things as deposit location, deposit depth, exact location of non-productive areas, existing vegetation and wildlife, extraction capability of equipment, water table characteristics, and extent of clearing operations are a few of the numerous items of ecological significance that should be considered in order to recognize ecological implications of site operations.

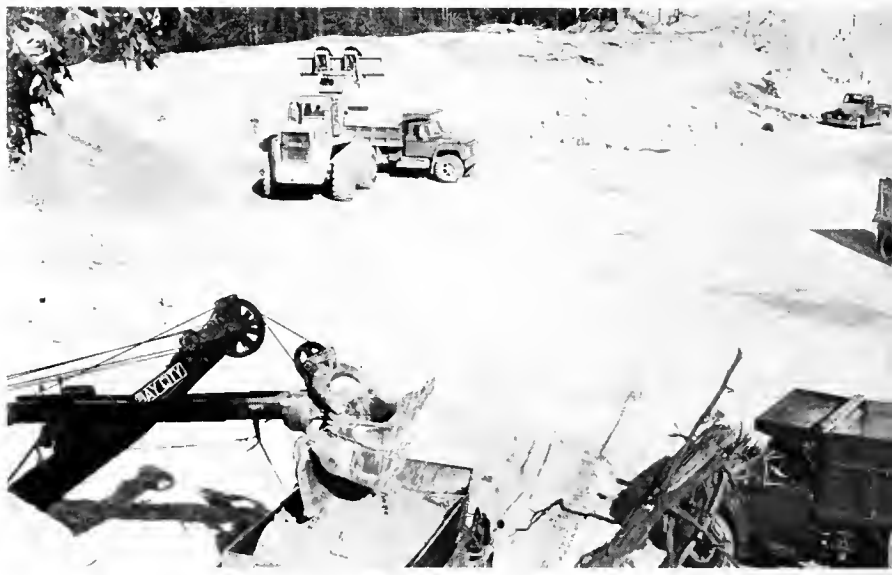
The ecology of a site should not only be considered prior to operations but also during and after the extraction procedure. The utilization of vegetative screens, planting on steep slopes, and the landscape treatment of the site depends upon correct application of ecological principles. Since any recreational use will affect the site in various ways,

8. U.S. Department of the Interior, *Surface Mining and Our Environment*, United States Government Printing Office, 1967, p. 30.
9. *Ibid.*, p. 30.

Steep slopes

Abandoned equipment

Water features



Operating Equipment

Figure 22—Safety hazards associated with mining operations

the selection of facilities must be carefully considered in areas of high ecological significance. It should not be overlooked that some areas may be of greatest value if left undisturbed.

Of particular interest in the recreational development of sand and gravel sites are the problems associated with planting on slopes and the effect that slopes and aspect have on plants. In this particular setting plants are affected by soil moisture, soil depth, temperature, light, erosion, and wind. Generally, upper slopes are poor locations for survival and growth, moisture conditions being significantly better on lower slopes.[10] For this reason more drought resistant species should be planted on higher slopes and ridgetops.

Alternative Approaches:

There are three factors that determine the approach the operator and the recreation planner may take in programming a site for recreation. These are progressive rehabilitation, sequence of recreational use, and ownership and management. Each factor plays an important role in the site development program for recreation on the site.

1. PROGRESSIVE REHABILITATION—Progressive rehabilitation is the process whereby a predevelopment plan becomes an integral part of the various stages of sand and gravel mining. The desired objective is to ready the site for recreational use by performing rehabilitation procedures concurrent with the various mining processes. This could probably be best illustrated in the excavation process where terminal site features have been graded and situated according to some prearranged plan so that subsequent alteration of the site is not necessary once mining has ceased. In order for progressive rehabilitation to accomplish its desired objective, all phases of the mining operation must be geared to the ultimate outcome — a successful and desirable recreation area.

Although depleted sand and gravel sites have been converted into attractive recreational features without pre-operation plans, the nature of facilities have been very simple — boating, fishing, hiking trails, and generally rather passive types of recreation. In instances where more active facilities have

10. *Ibid.*, p. 34.

been provided for development, cost has been a major consideration due to the amount of earth work involved. Since most recreation plans have to appeal to a diversified population, the necessity for multiple-use recreation becomes a significant development factor.

Progressive rehabilitation is a very logical manner in which to approach mining and recreation. Rather than having to commit extra man-hours and capital to subsequent rehabilitation, the same basic operations can be accomplished concurrent with the four basic phases of operation mentioned previously. General site planning would indicate areas for the planting of trees and vegetation, the construction of various recreation facilities and necessary supporting elements such as parking, service areas, access routes, and pedestrian circulation. In reality progressive rehabilitation minimizes safety hazards, permits ease of circulation, assures that site features conform to the proposed recreation intent of the site, and permits recreational utilization of the site sooner than could be realized otherwise.

2. SEQUENCE OF ACTIVITIES — There are three conditions whereby recreation can function on land bearing sand and gravel: 1) prior to clearing, 2) concurrent with excavation, and 3) subsequent to operations. In order to facilitate all three, a site will have to be of sufficient size to warrant both mining and recreational uses. Following is an evaluation of each sequence and how it might affect the overall recreation potential of a site.

1. Previous Use: In many cases real estate is purchased by sand and gravel producers who have no intention of mining the site for a number of years. This assures the operator of having at his disposal a readily available source of sand and gravel upon which his business depends.

Considering deposit characteristics, proposed plant location, transportation routes, and size of site, any previous recreational uses on the site should not interfere with later operations. The actual on-site location of a highly desirable and successful recreation area that exists prior to excavation could dictate the initial starting point of excavation. Of major significance would be the size and shape of such an area which might serve as a guide in determining how the total site will be developed. It may be that the existing use is of such value that it should be retained as long as possible. This would have the effect of postponing all mining phases in the area, allowing excavation to proceed in such a manner as not to interfere with this area until the remainder of the site has been depleted of sand and gravel. There also remains the possibility that if the existing recreation feature is of significant value, it should not be given up to excavation. If there exists on the site, but not over the deposit, a particular recreational use area that would be advantageous to expand, it may be best to incorporate this into a development proposal. This could be done by either expanding the existing use as to create a larger use area or by incorporating the existing use into a proposed complex.

Depending upon the expected time of initial excavation and site characteristics, certain types of recreational uses can be programmed to the site. Recreational uses that require high construction costs relative to the short duration of time they may be utilized, could not be justified due to the fact that excavation will progress into the use area. In low cost, short term situations, advancing excavation would destroy any temporary recreation areas, with little loss of construction capital. A few examples of the types of recreational uses that could be made available to the public on sand and gravel sites prior to excavation are the following:

1. Nature Trails
2. Bicycle Paths
3. Hiking and Riding Trails
4. Skeet Shooting
5. Hunting and Fishing
6. Golf Driving Range
7. Dirt Track Auto Racing
8. Open Space
9. Primitive Camping
10. Archery Range
11. Rifle Range
12. Field Games
13. All water sports if there already exists sufficient water
14. Picnicking

2. Concurrent Use: Both excavation operations and recreational uses can co-exist adjacent to each other. Since a major portion of any site may remain untouched by excavation for a lengthy period of time, its continuous use can be appropriately programmed. Let us assume that a site of 80 acres is divided into four equal sections of 20 acres each and that the rate of excavation is four acres per year. This means that each section will support excavation for five years and that the last section will not be depleted until twenty years after the initial excavation. Let us assume that a predetermined recreation proposal calls for the entire site to be developed as a community recreation area. In order to utilize the 60 acres of the site not in active operation, some type of recreational activity could be planned for. This would mean that 75% of the site would always be open to public or private recreational use, assuming that as each section is depleted it would become available for recreational use via progressive rehabilitation. This would give neighboring communities a current account of mining and reclamation progress, and would assure local interests that recreational development would be the terminal result of the mining process. Such a

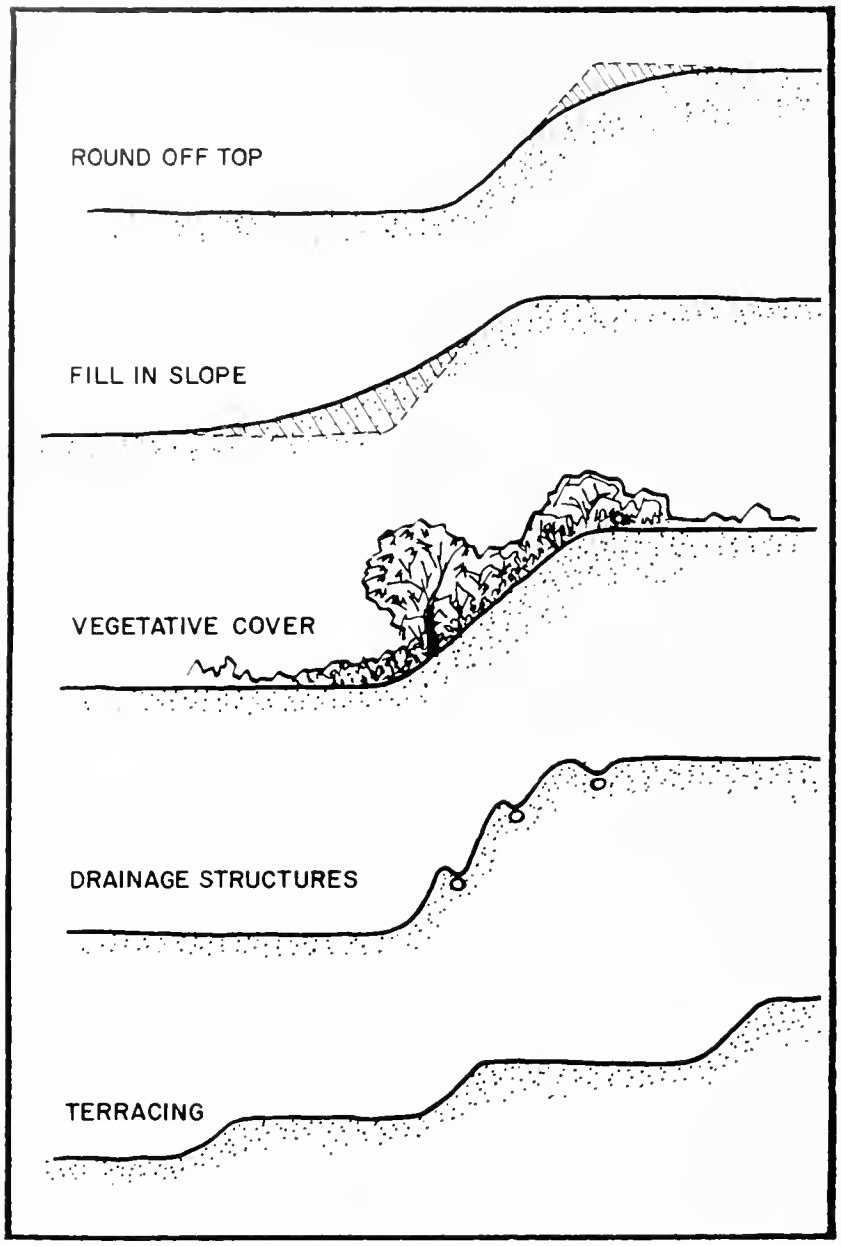


Figure 23 — Slope treatment

site could be the source of additional income if a fee were charged for the use of recreational facilities on that property during the period of operations.

Each successive use area could be in recreational use 5, 10, and 15 years after excavation first started. Since certain recreational facilities and equipment have a higher degree of permanency than others, this could determine where their placement should be in relation to the duration of operations. Area II will be available for recreation five years before it is initially excavated and should contain the least permanent features and equipment. This area could conceivably be maintained in turf and support such field sports as football and baseball. Area IV which is the last area to be excavated, 15 years from initial excavation, would contain more permanent facilities. (Figure 24)

When considering concurrent recreational use of his site a producer should be assured that local citizen groups or municipal agencies will not attempt to halt excavation to maintain temporary recreational areas. This problem is being encountered by some producers.

In the situation where a site is divided into sections based upon duration of operation, there can always be concurrent and subsequent recreational activities if progressive rehabilitation is practiced. All uses that are applicable under prior excavation are also applicable for concurrent usage.

Following is a list of uses that can co-exist on a site concurrent with excavation, and because of progressive rehabilitation can also be developed subsequent to excavation. Also applicable for concurrent use is the list previously given for prior usage.

1. Court Games
2. Creative Play Areas
3. Putting Greens
4. Miniature Golf Course
5. Boating
6. Swimming
7. Go-Kart Track
8. Motorcycle Scramble Course

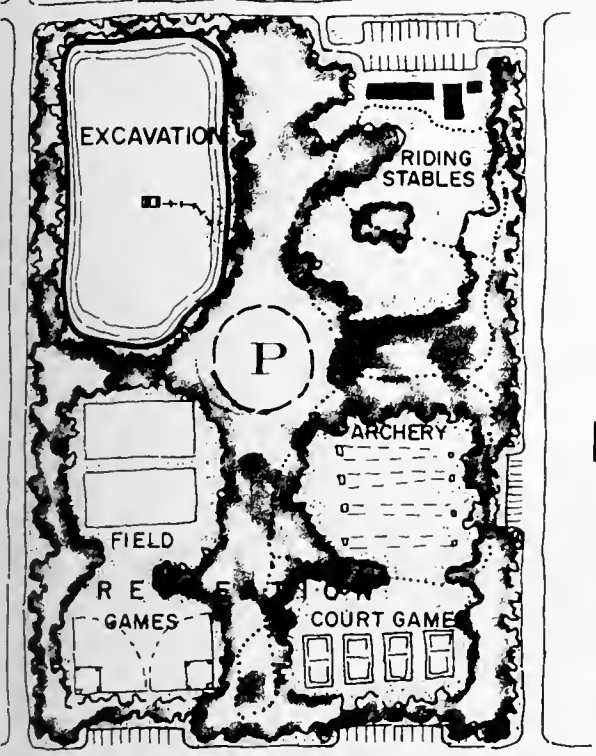
For concurrent use of a sand and gravel site, the recreationist must accept potential annoyance factors sometimes associated with mining.

3. Subsequent Use: In a sand and gravel operation that does not practice progressive rehabilitation or permit any recreational use of the land prior to mining, any recreational use must be developed subsequent to operations. In an operation where prior recreational uses are permitted and progressive rehabilitation is practiced, concurrent uses could also be considered as subsequent. If the operator sees any benefit in allowing prior recreational use of his site, and the land permits such, then the site could be developed in stages. Each stage would hopefully relate to the next and the terminal recreation feature should function as a complete unit.

There are some instances where a newly developed section of a site cannot be utilized by the public because of a particular use that functions best in total. In such cases there could only exist on the site prior and concurrent uses. Any subsequent uses that may be possible through progressive rehabilitation would have to be delayed in favor of the proper development of this major feature. Following are some recreational uses that would adapt to sand and gravel sites, but could only be utilized in total, subsequent to all mining.

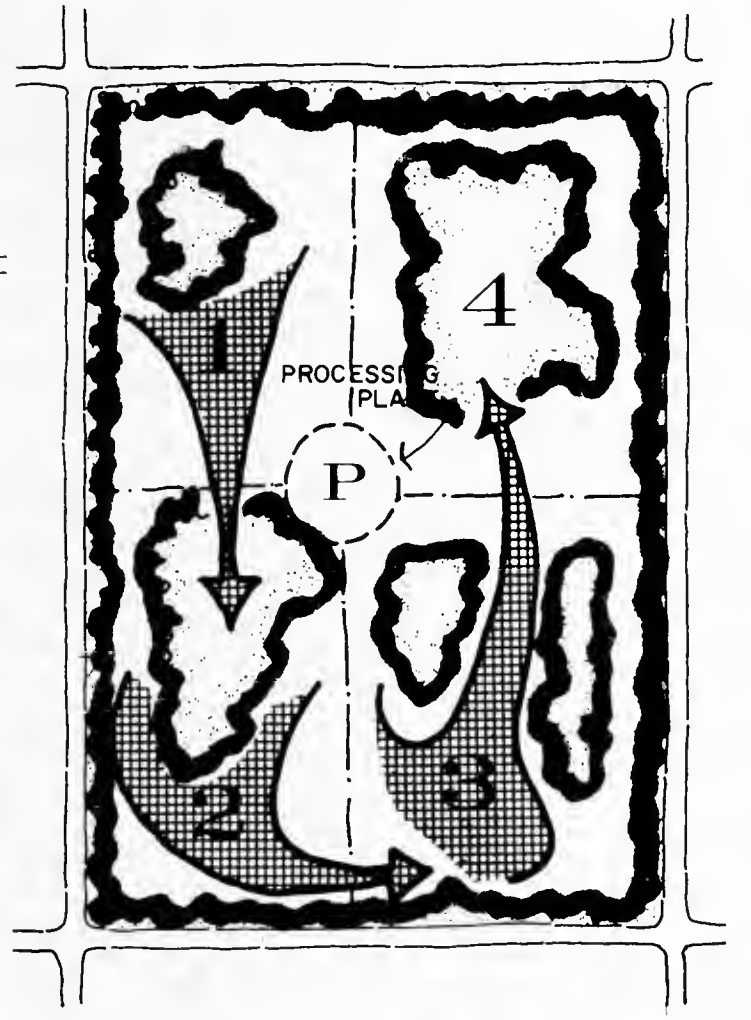
1. Zoo
2. Amusement Park
3. Aquarium
4. Civic Center
5. Botanical Garden
6. Golf Course (18 hole)
7. Auto Racing Course

Subsequent to all excavation, the total reclamation of sand and gravel sites could also include the following:

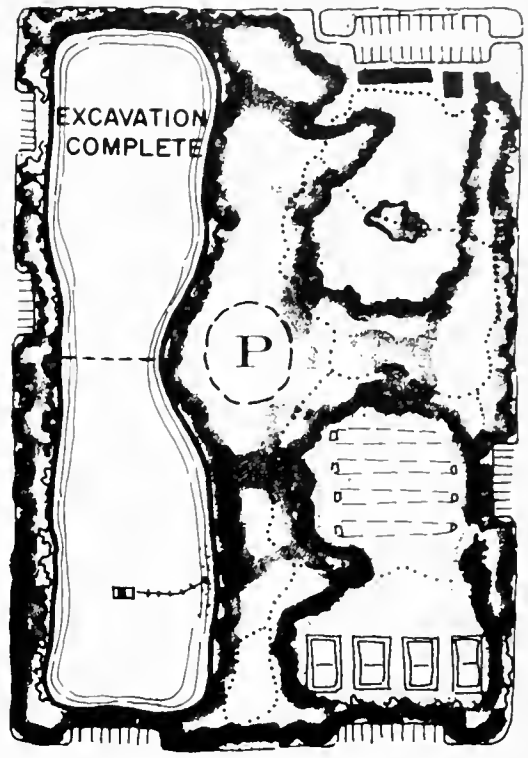


FIRST PHASE

RECREATIONAL USES ARE SITUATED ON THE SITE ACCORDING TO PATTERN & DURATION OF EXCAVATION. LEAST PERMANENT AND LESS COSTLY USE AREAS WILL BE EXCAVATED FIRST.

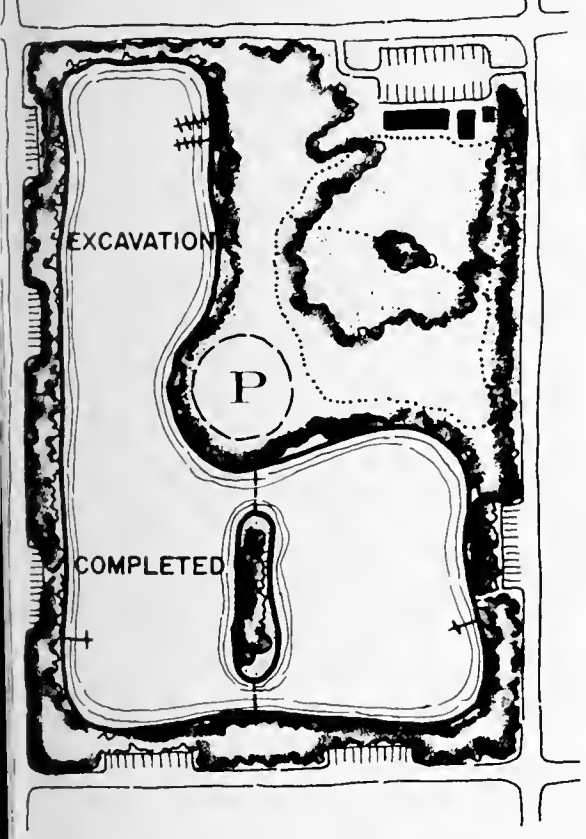


4-PHASE OPERATION



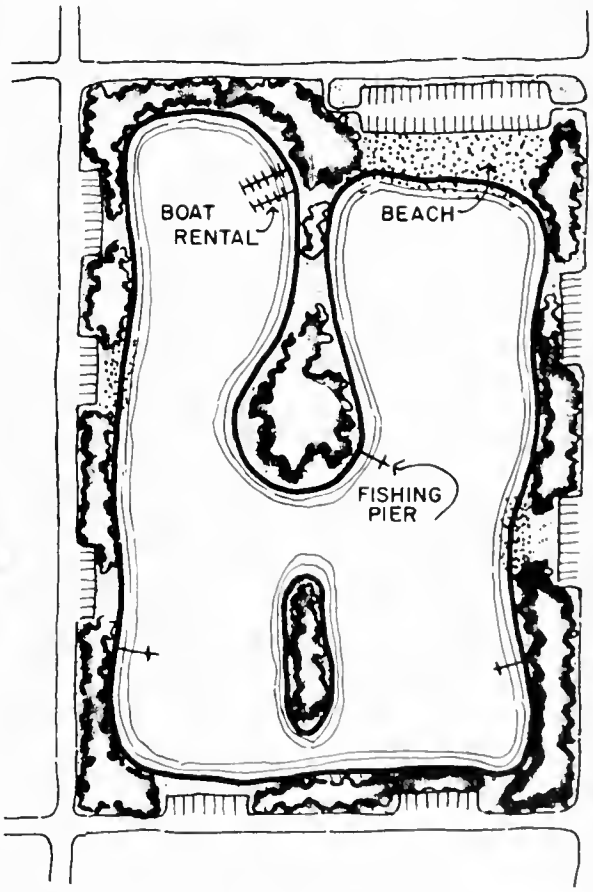
SECOND PHASE

EXCAVATION COMMENCES ON AREA 2. LEAST PERMANENT AND LESS COSTLY USE AREA IS PHASED OUT AREA I CAN NOW BE UTILIZED FOR RECREATION.



HIRD PHASE

XCAVATION MOVES INTO AREA 3 EAVING THE MOST PERMANENT AND OSTLY FEATURES OF AREA 4 TO BE XCAVATED LAST.



FOURTH PHASE

AREA 4 IS EXCAVATED LEAVING THE SITE VOID OF ALL PREVIOUSLY EXISTING RECREATION AREAS. SITE IS NOW PROGRAMMED FOR WATER ORIENTED RECREATION.

Figure 24 — Progressive mining and how it could effect recreational use areas

1. State or Regional Park (with or without water features)
2. Municipal Park
3. Open Space Land
4. Creative Playground for Urban Environment
5. Wildlife Preserve
6. Hunting and Fishing Area
7. Speed Boat Course
8. Sailing Basin
9. Drag Strip

Any of the previously mentioned uses that were adaptable to prior or concurrent recreation usage could also be developed subsequent to all excavation. In a situation where a predevelopment plan has been formulated and progressive rehabilitation is the approach to realizing this objective, the producer is faced with the task of making sure the terminal site features correspond with the nature of activities programmed for the site.

Ownership and Financing:

Ownership of a particular piece of real estate and its sand and gravel resources has great implications on how the tract may be developed. Title to the land permits the owner to mine and to use his land as he so desires so long as he does not infringe upon the rights of others.

There are three ownership options by which sand and gravel sites can be developed for recreation.

1. Private
2. Public
3. Joint-private and public

Of particular interest are various methods by which recreational development can be financed so as to be satisfactory to both public and private interests.

1. Assessment Lien Procedure — The actual development responsibility falls on the owner who should have a predetermined plan of rehabilitation. If for any reason the plan is not executed by the operator, the local municipality or county, following due notice to the operator, can have the plan completed and the costs assessed against the owner.

2. Performance Bond Procedure — Typically, a sand and gravel operator is required to post bond with the local governmental body prior to excavation. If the predetermined rehabilitation fails to materialize, the performance bond is forfeited and the money used to complete reclamation.

3. Purchase and Leaseback — This calls for the local governmental body to purchase sand and gravel land and lease the property to the operator. The public body then assumes any responsibility for rehabilitation.

4. Public Development — Property already owned by municipalities often contain sand and gravel resources but are also destined to be parks or recreation areas because of projected land use plans. The sand and gravel operator may lease this land from the municipality with the understanding that once excavation has been accomplished, the municipality will develop the property after rehabilitation.

Whether sand and gravel sites should be managed on a local or state level would probably depend upon the size and location of the site. Developed sites in close proximity to urban centers would be most valuable to inhabitants of such centers, and would experience relatively little use from outside sources. Sites situated outside municipal boundaries may best be managed by the county or even regional governmental bodies. It is assumed that since the great majority of sand and gravel sites have no national significance and exhibit no rare resource features, they would not be considered for national management.

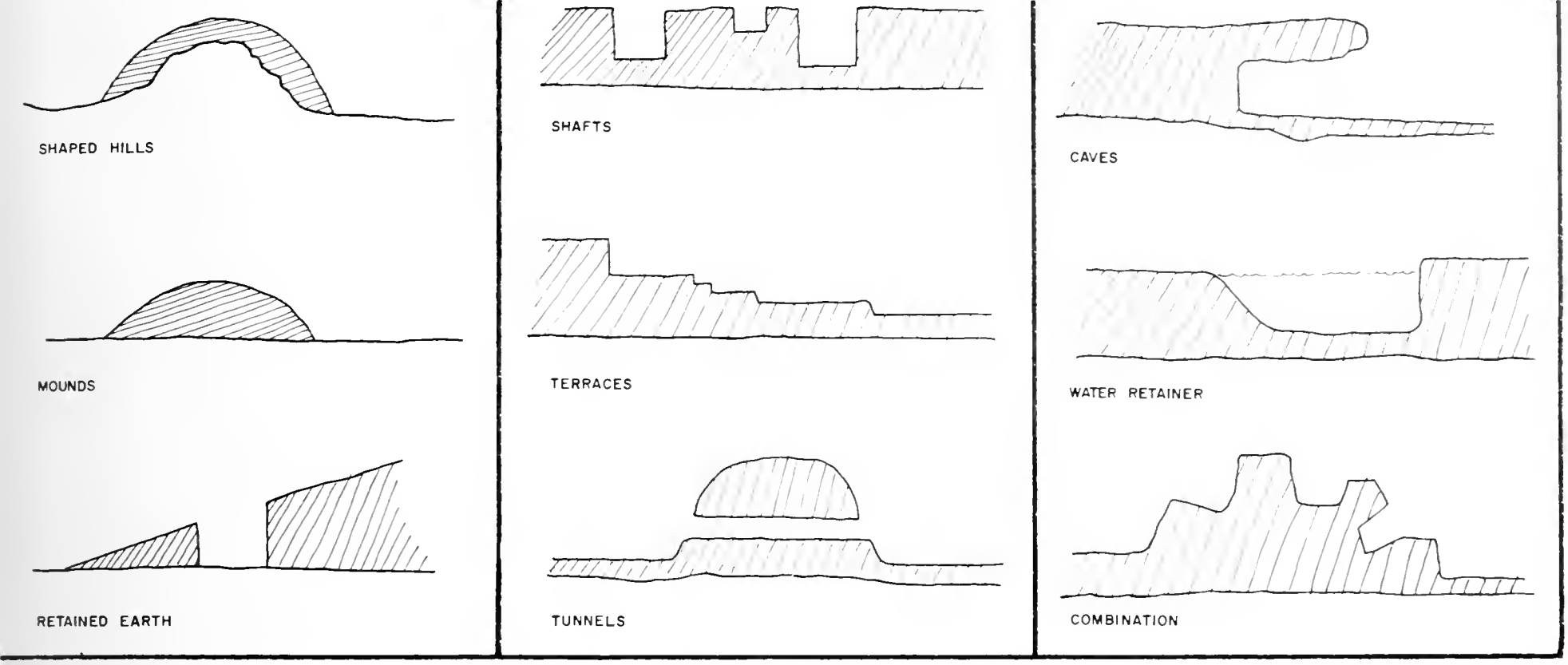
Conclusions

There are a number of factors that govern how a particular sand and gravel site will be developed for recreational use. Of most significance are the type of site, the nature of facilities that will be offered to recreationists, and the type and extent of operations.

Recreation can occur upon sand and gravel sites: 1) prior to the mining operation, 2) concurrent with mining, and 3) subsequent to mining. If possible, sites that are large enough should be utilized in all three instances. The actual site development, therefore, should be by progressive rehabilitation if possible, so that recreation can occur in all three instances. This is also the most practical method in many instances since it utilizes available personnel and equipment, and opens the site for recreational use sooner than any other method.

Ownership of sand and gravel sites affects how a particular site will be developed and whether it will be private or public. There are various ways in which the producer and local citizenry can cooperate so that both benefit from a recreational development.

The transformation of a sand and gravel site into a recreation area is going to have to be the undertaking of a number of professional disciplines. The producer alone cannot accomplish the required results, but must have the cooperation of the landscape architect, recreation administrator, planner, and the horticulturist.



William Morgan's Earthform Categories
Progressive Architecture, APR., 1967

Figure 25 — Sculptural qualities of earth forms

Chapter IV

Techniques For Effectuation

How does the producer accomplish the transition from a typical sand and gravel site to a desirable recreation area? The producer should be responsible for the development of terminal site features, their form and placement according to a predetermined recreational use plan. Grading and the formation and utilization of land forms are primary considerations in transforming a sand and gravel site into a recreation area. (Figure 25) Of secondary importance to the producer are associated problems dealing with planting and the correlation between use areas and physical site features. These considerations will be the particular interest of the landscape architect, planner, and horticulturist.

Grading

If a sand and gravel site is to be progressively rehabilitated to offer prior, concurrent, and subsequent recreation uses, each mining phase has to be approached with this in mind. Other than the imagination and ideas of the planner who prepares the pre-development plan, it is the operator who will most affect any terminal physical site features. The whole idea behind progressive rehabilitation focuses on the ability of the operator to adequately transform physical site features into usable elements for recreation use.

Following is a phase by phase explanation of how the producer can conduct his operations while complying with progressive rehabilitation. Since site features are a direct result of the manipulation of earth and various grading considerations, it will be these factors that the operator should be most concerned with.

STRIPPING: Stripping should occur only over the area that is to be excavated for a specified

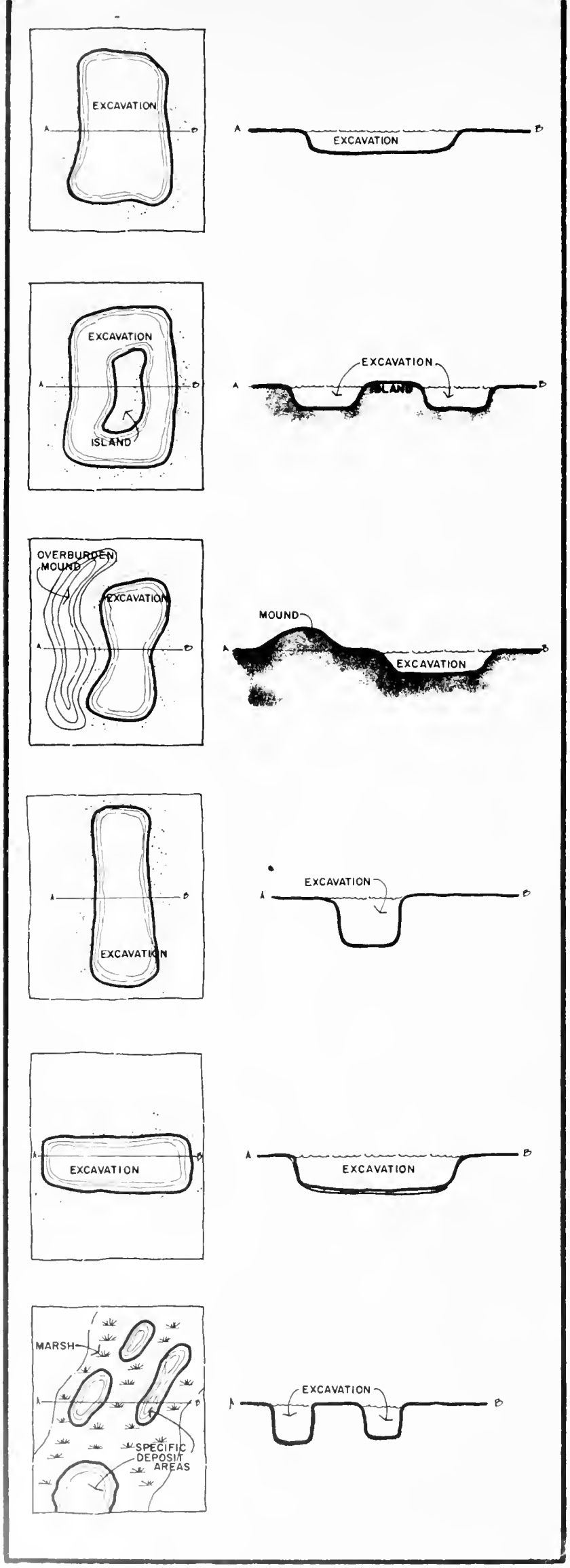


Figure 26 — Potential wet site configurations that may effect recreational use of the site

period of time. This implies that the site should be divided into sections to facilitate planning and programming of recreation areas. Sufficient area should be stripped on the periphery of the anticipated excavation in order to accommodate stockpiling of topsoil and overburden. The size of this area will depend upon the amount of overburden available and the dimensions of any planned mounds. The placement of topsoil and overburden should be in locations where they will be ultimately utilized. No stockpiling should occur in the area that will subsequently be excavated. Topsoil should probably be strategically stockpiled in several areas since mounds and subsequent features that are to support vegetation may require it.

As soon as one section of the site nears completion, the next section should be cleared and stripped. This process should continue until the total site has been excavated.

On wet sites where the deposit is covered by a lake, stream, or river, stripping of overburden also occurs. The overburden material is usually returned to the excavation. It can also be accumulated in one area, eventually creating an island. This would depend greatly upon the depth of the water, the composition of the overburden, and the amount of overburden. Mud and other material of low compactability would not be desirable island building material, and it would probably be best to return such material to the excavation.

The depth of topsoil and overburden varies with each site. Generally 1″-4″ of topsoil is average. Most producers would consider stripping up to 10 feet of overburden if the deposit size and quality were favorable.

STOCKPILING: Overburden stockpiles are usually the first terminal site features that result from mining. They can serve as both functional and aesthetic components of the landscape. The size and form of these earthen mounds will depend upon the functional or aesthetic qualities desired. Stockpile mounds properly situated can screen certain interior site features that may be annoying to recreationists or outsiders. They can also act as channeling, segregating and terminating elements and also emphasize certain physical features.

Three types of equipment are most frequently utilized for stripping purposes. These are the bulldozer, scraper and tractor-shovel rig. Each has its own peculiar operating characteristics that are evidenced in the manner it forms overburden mounds. Bulldozers are most commonly utilized and create mounds by pushing material into piles. If sufficient overburden is available the dozer can create gradual, sloping mounds since the dozer compacts the overburden as it crawls over previously deposited material.

Scrapers are utilized in large-scale stripping operations since they are large and require sufficient area to operate. A scraper scoops up the overburden into a bowl by making a single pass over an area. The depth of cut can be regulated so that a uniform layer is taken off each time. The scraper then deposits the overburden in the reverse manner and in layers that are subsequently compacted by repeated runs over the area. Resulting mounds are generally long and gently sloping. They are generally 15 to 25 feet wide.

Crawler-shovel rigs or clamshells deposit overburden in conical-shaped piles that can grow in height and breadth by depositing additional material on top of existing piles. These piles are poorly compacted and more susceptible to erosion than the other types. Such mounds usually have to be leveled off and compacted prior to being utilized for recreation. A definite limitation encountered when working with any shovel or clamshell rig is that of its extension capabilities. It has to excavate and stockpile within the same area unless the material is dumped into trucks to be transported elsewhere. This is expensive and time-consuming and should be utilized only as a last alternative.

Mounds can be seeded and planted with turf, trees, and shrubs shortly after they are laid down. This suggests that established and stabilized mounds can be planned to precede excavation so that annoyance factors and undesirable views will be contained within the confines of the excavation area. These mounds can subsequently be utilized by recreationists for various purposes.

EXCAVATION: The excavation stage is probably the most significant in terms of site alteration. The extraction of sand and gravel first creates a depression that varies in size, configuration and depth depending upon deposit characteristics. (Figure 26) Basically, this is the skeleton upon which to build. With the exception of overburden mounds which were created prior to excavation all terminal site features will be either a direct result of excavation slopes, cut banks or an indirect result as land forms of waste sand.

The only manner in which an operator can alter an excavated site which has a rough appearance is by grading and manipulating earth forms. Wet and dry sites can both be altered in this manner, but only wet sites can utilize the land forming potential that waste sand offers.

Dry sites probably present a greater challenge to the recreation planner and landscape architect due to the fact that all terminal site features will be visible and will affect any recreational use of the site.

Following are a number of ways that physical site features can be altered in order for them to re-

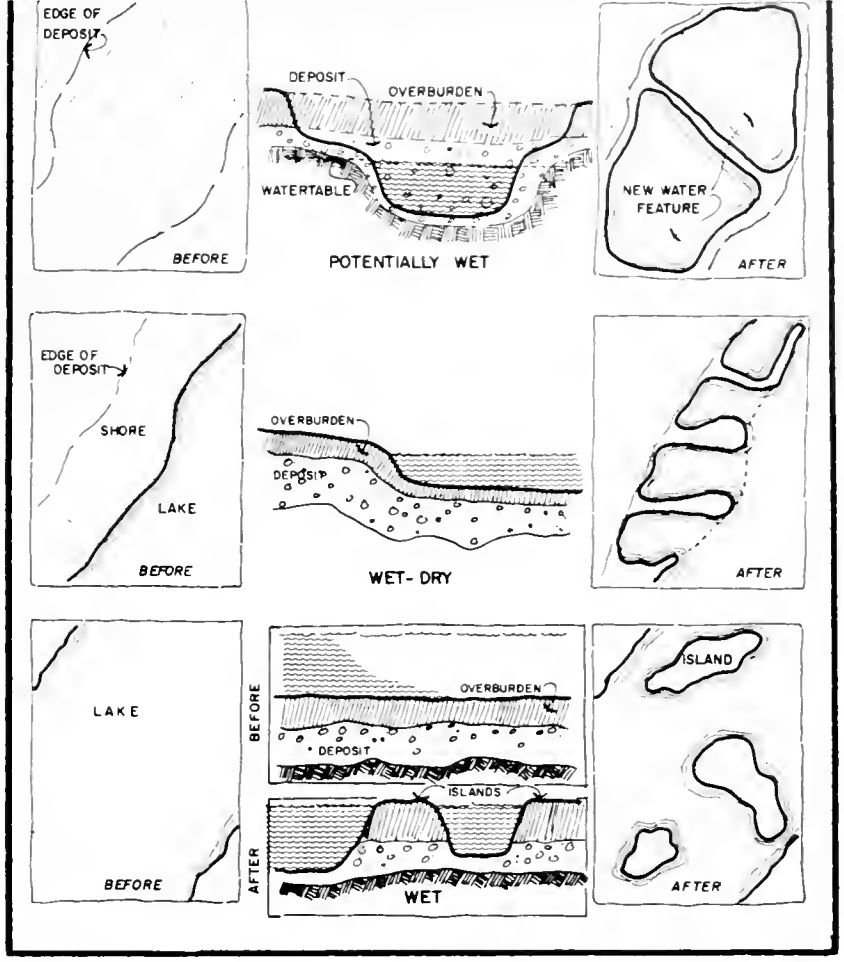


Figure 27 — Water feature potential in three distinct instances

late both functionally and aesthetically to potential recreational use of the site.

1. Slopes can be pushed in from the top or filled in at the bottom in order to achieve a desired slope gradient. Certain recreational uses require specific slope standards. Height of slopes vary from 5′-300′ with the average being about 50′. Non-stabilized slopes can be serious erosion problems if not graded and planted. Slopes can also be terraced to accommodate various activities while also reducing erosion and minimizing the safety hazard.
2. Islands of non-minable materials that cannot be economically removed can be incorporated into a design proposal. Such features may serve to segregate or define various use-areas, and in conjunction with cut banks can serve as channeling elements when planning for pedestrian circulation on the site. They can also be utilized for recreational use if they can be made to comply with certain size and slope standards. These islands of non-minable material will also have to be graded to slope and safety standards.
3. Although the deposit configuration normally defines the excavation area the possibility of not excavating an area should be considered when appropriate. This could occur within peripheral areas of the deposit or within the central core area. Such latitude can be extremely valuable to the planner who would not have to restrict his design to the actual excavation configuration. Such a practice

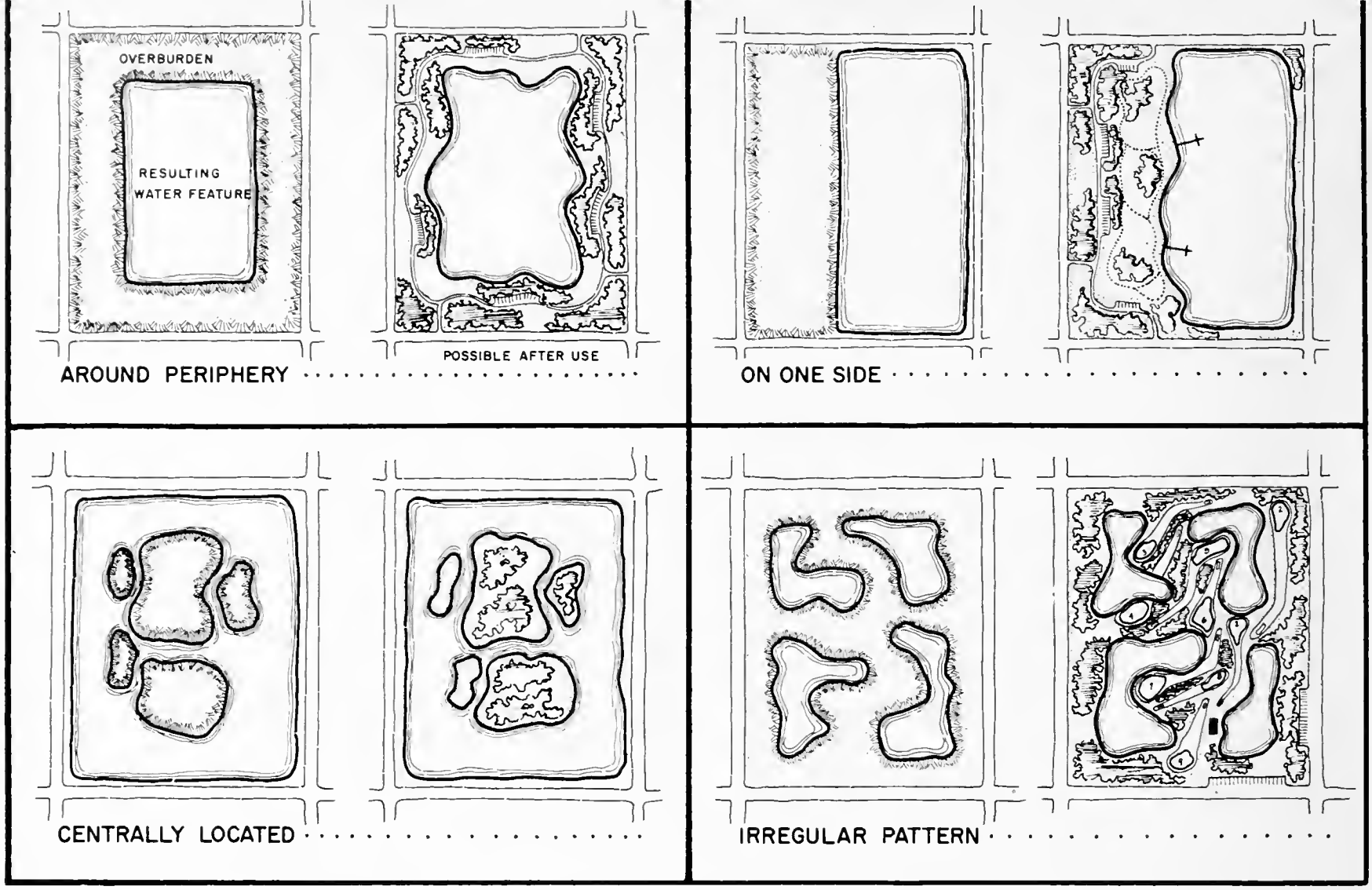


Figure 28 — Overburden placement — general patterns

can be quite effective when attempting to provide specific slope gradients and alignments. Certain areas of the site can be physically separated from other areas and large-scale terracing can be accomplished by not excavating a certain area to its maximum potential.

4. Valuable pre-excavation on-site features such as trees and vegetation may be preserved where possible, even though they exist over deposit areas. From a recreational standpoint these may be too valuable to be eliminated and excavation should proceed around such areas.

The operator, landscape architect, and recreational planner need to coordinate their efforts in attempting to mold physical site features into desired recreational features. The operator cannot do this alone, since he may be unaware of the relationships that exist between various site features and how these relationships contribute to the overall success of a recreational development. Once the operator is confident of his ability to manipulate land forms he can follow a predevelopment plan while matching certain site features to desired recreational areas.

The excavation of wet sites can be approached in a slightly different manner. The type of recreational facilities will obviously be water-oriented and since the major portion of the site will most likely be underwater, bottom features will not have to be dealt with in the same manner they were in dry sites.

From the standpoint of land forming potential and recreational value there exists three distinct instances whereby wet operations can contribute to the overall recreational development of a site. These are: (Figure 27)

1. Where mining progresses from an existing lake or river location into dry land (or vice-versa).
2. Where the ground water table lies within the deposit but the surface is dry.
3. Where deposits are already covered by water.

Generally the operator is concerned with the same problems he encountered in dry sites, the utilization of overburden and the slope, height, and configuration of earth mounds and cut banks, whether they be above or below water level. The type of treatment would depend upon the anticipated nature of the recreation area. (Figure 28) Swimming and wading areas would have very gradual bottom gradients out to a specified distance with the accompanying beach area being equally level. Aquatic environments that are to support fish and water fowl have distinct requirements also. Most aquatic plants that attract water fowl and provide nesting cover grow in shallow areas.

Certain fish depend upon temperature variants to trigger necessary life and breeding cycles. This

usually calls for depth variations within the lake or pond if a specific species of fish is desired. Bottom treatment is also important. Certain species of fish depend upon a sandy and pebbly bottom to feed and spawn while other fish prefer decaying matter such as old trees and brush for cover and concealment. Some fish prefer irregular bottoms while others may require even gradients.

Shoreline treatment is particularly important when the water area is to be used by motor boats and where the lake is of substantial size. Boats and wind on large lakes create waves that can have a devastating effect on unprotected shoreline. This is most evident where the shore and bottom gradients are steep and where there is no aquatic vegetation. To prevent such erosion, gradients should be gentle. Where this is not possible rip-rap, stones and concrete pieces have often been used to protect the shoreline. Sand bars could be created a few yards from shore that would intercept the brunt of wave action created by wind and boats. (Figure 29)

A number of wet sand and gravel deposits contain excess amounts of sand. Such sand can be separated from the rest of the deposit by a desander and pumped via a floating hose assembly to the periphery of the excavation. Here the waste sand can be deposited to create new land forms, fill in depressions or create beach areas. (Figure 30) The occurrence and amount of this waste sand can be predetermined and its utilization programmed into a development proposal.

It should also be realized that waste sand and overburden need not be deposited away from the excavation, but could be returned to the excavation. Such a situation may occur when mining in an area of lush vegetation that grows to the waters edge. On-shore deposition of overburden or waste sand would greatly affect the ecology of the shoreline and could eliminate a great percentage of flora and fauna. If overburden is returned to the excavation, the site shows little evidence of having been mined and helps preserve the habitat essential to shore birds, fish and minute organisms. Waste sand and overburden can also fill in bottom depressions that are detrimental to certain species of fish.

A problem that may be encountered when mining in existing water bodies (lakes, rivers, estuaries) is that of siltation. Potential siltation problems may be numerous,[11] and may be difficult to minimize and almost impossible to eliminate. In the marine mining of sand and gravel, some sedimentation or siltation is produced in the initial excavation and again when silts or fines are returned to the water area. To detect a potential sedimentation problem, a suspended-solids sampling test could be taken after excavation has commenced.

11. Gordon M. Wolman, *Problems Posed by Sediment Derived from Construction Activities in Maryland*, Report to the Maryland Water Pollution Control Commission, Annapolis, Maryland, 1964, p. 22.

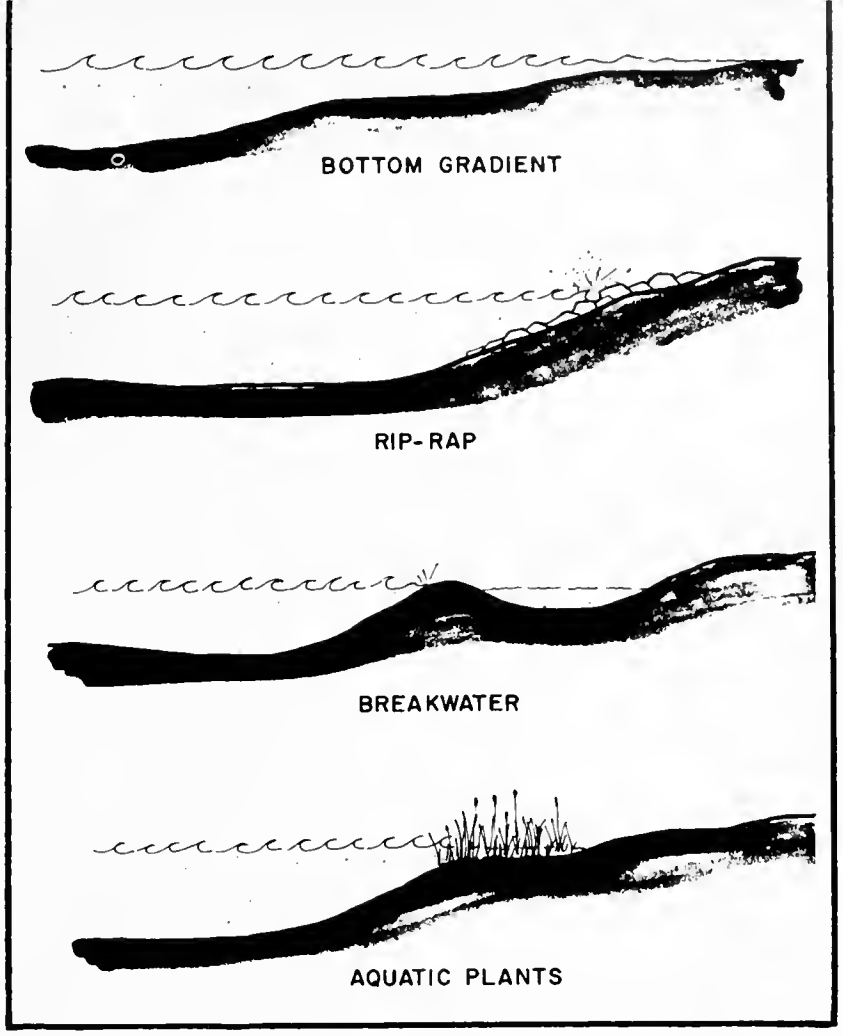


Figure 29 — Ways to prevent shore line erosion

Erosion of cut banks and overburden mounds may also cause siltation. If a site is being progressively rehabilitated for recreation, such banks and mounds should be immediately seeded and planted to prevent such problems.

Where deposits exist within marshy areas and when excavation has to proceed inland, areas could be sectioned off so that silt is reasonably confined. Back-filling is one method of segregating different excavation areas. The barrier can be removed once excavation is completed or it can be left intact so it does not restrict normal stream flow. When deposits occur at varying intervals along a main channel or stream, it would be best to work upstream so that resulting siltation settles out in previously excavated areas. (Figure 31)

When sand and overburden are utilized as land forming material, dikes or earth mound barriers adjacent to the water can be created by bulldozers on shore with the overburden of sand being deposited behind or within the confines of such an area. Land forming potential is probably most evidenced in situations where existing shore areas can be altered by adding extensions of waste sand and overburden or by controlling excavation in such a manner so as to conform with design requirements.

Excavations that occur in open water not immediately adjacent to shorelines and where the distance is too great to warrant pumping of waste sand, represent no land forming potential other than the creation of islands. This itself is greatly dependent upon the depth of water above the de-

Figure 30—Desander being utilized in land forming

posit, the depth of overburden, and the amount of waste sand available. If islands are to be part of a recreation development, it would appear that they could only be created by building upon areas not already excavated. This could occur on adjacent non-deposit areas, on islands of non-minable material or certain areas of the deposit could be excluded from excavation and built upon. In any case, the water would have to be extremely shallow and the overburden and waste sand quite plentiful.

Basically, wet sites can be made to conform to five (5) different general configurations: (Figure 32)

1. Sections
2. Islands
3. Tree Form
4. Open water
5. Combination of Above

The site configuration would depend most upon the type of recreation desired and the corresponding character of the area.

Recommended Procedures

The developer, having an understanding of the problems that will be encountered in recreational rehabilitation, and knowing how these problems can be minimized or eliminated needs a guide which he can systematically follow in effectuating his recreational rehabilitation program. Following is a five phase procedure which, if followed, can guide the operator through development from conception to implementation. A brief explanation of each phase follows so that the operator may see the reasons behind such a procedure.

1. Program Determination:
Define the recreational objectives that may be sought so that development will be suited to a particular site and establish design criteria which will govern the character and nature of the development. A program will do the following:

a. Determine particular recreation needs.
b. Recognize existing recreation features on the site.
c. Utilize features resulting from excavation.
d. Provide for seasonal activities where appropriate.
e. Attempt to separate conflicting use areas.
f. Consider guidelines proposed by local, state or Federal agencies.

2. Conditions of Site and Environment:
Identify the physical, cultural and perceptual characteristics of the site and surrounding environment that will affect any recreation proposals. These factors will determine the size, character, and use of recreation facilities and should consider the following:

a. Proximity to population.
b. Set-back regulations.
c. Existing utility easements and connections.
d. Adjacent land uses.

3. Design Alternatives:
Emphasize the flexibility of operations as far as land forming capability is concerned and focus on the various opportunities that exist for different types of use areas depending upon the size and configuration of the site.
Considering the following:

a. Type of recreation (active or passive).
b. Service to all age groups or specific interests.
c. Private vs. public facilities.
d. Land-forming potential of overburden.

4. Proposals:
A series of recommendations in the nature of plans and presentations that graphically and verbally portray the conclusions that have precipitated out of the previous steps, expressing the ideas and desires of the operator, the site planner, and potential users. The final proposal should represent the optimum recreational development and indicate how it is to be operationally achieved.

5. Details:
These are the explanatory tools without which any recreation plan cannot be implemented. These show the **how**, **where**, and **what** that, if properly executed, result in a desirable recreation area.

Following is a procedural checklist which could be utilized in the step by step solution of any recreation development attempt. Although many of the factors listed may be arrived at and satisfied during normal operations, hopefully, this step by step procedure will bring to light many other factors that are not otherwise considered in the planning and design of a recreation facility.

Procedural Checklist

1. Program Definition — Parameters

A. Scope and Limitation
1. Mining Operation
2. Recreation Development
3. Optimum Resource Utilization

B. Objectives and Purpose
1. Need — supply and demand
2. Value — benefits
3. Opportunity — potential

C. Criteria for Operations and Development
1. Scheduling
   - *a. Initiation*
   - *b. Sequence*
   - *c. Duration*
2. Compatibility
   - *a. Nuisance*
   - *b. Safety*
   - *c. Ecology*
3. Administration
   - *a. Organization*
   - *b. Financing*
   - *c. Management*

2. Inventory of Conditions— Existing Record

A. Regional Context — Geography
1. Site location and access
2. Population distribution
3. Land use pattern
4. Political jurisdictions
5. Master plans

B. Site Characteristics — Physical Surveys
1. Natural Conditions
   - *a. Topography — relief and slope*
   - *b. Hydrology — water features*
   - c. *Geology — sand and gravel deposit*
   - *d. Soils — types and uses*
   - *e. Biology — vegetation and wildlife*
   - *f. Climate — sun, wind, temperature, precipitation*
2. Cultural Controls
   - *a. Adjacent uses and structures*
   - *b. Circulation and utilities*
   - c. *Legal restrictions — Zoning*
3. Perceptual Effects
   - *a. Views*
   - *b. Sounds*
   - c. *Odors*
   - *d. Pollution*
   - *e. Movement*

C. Operational Considerations
1. Activity Patterns
   - *a. Stripping, stockpiling, excavation, processing, transportation*
2. Type of Equipment
   - *a. Excavation, processing, transportation*
3. Terminal Site Features
   - *a. Land forms, water areas*

3. Determination of Alternatives — Choices

A. Site Form Possibilities
1. Land and Water Relationships
   - *a. Undisturbed areas*
   - *b. Excavated areas*
   - *c. Waste fill areas*
2. Practical Configurations
   - *a. Variations*

B. Recreation Use Potential
1. Types of activities
   - *a. Standards*
2. Location and Distribution
   - *a. Opportunities*

C. Composite Concepts
1. Form — use relationships

4. General Proposals — Recommendations

A. Master Recreation Development Plan
1. Use areas and facilities
2. Circulation and utilities
3. General grading and planting

B. Master Operational Plan
1. Excavation pattern and sequence
2. Processing and Storage
3. Public Relations

C. Implementation Schedule
1. Excavation and operations
2. Site rehabilitation and development
3. Recreational uses and activities

5. Site Development Details — Standards

A. Grading
1. Berms and slopes

B. Planting
1. Screens and masses

C. Typical Structures
1. Recreation facilities

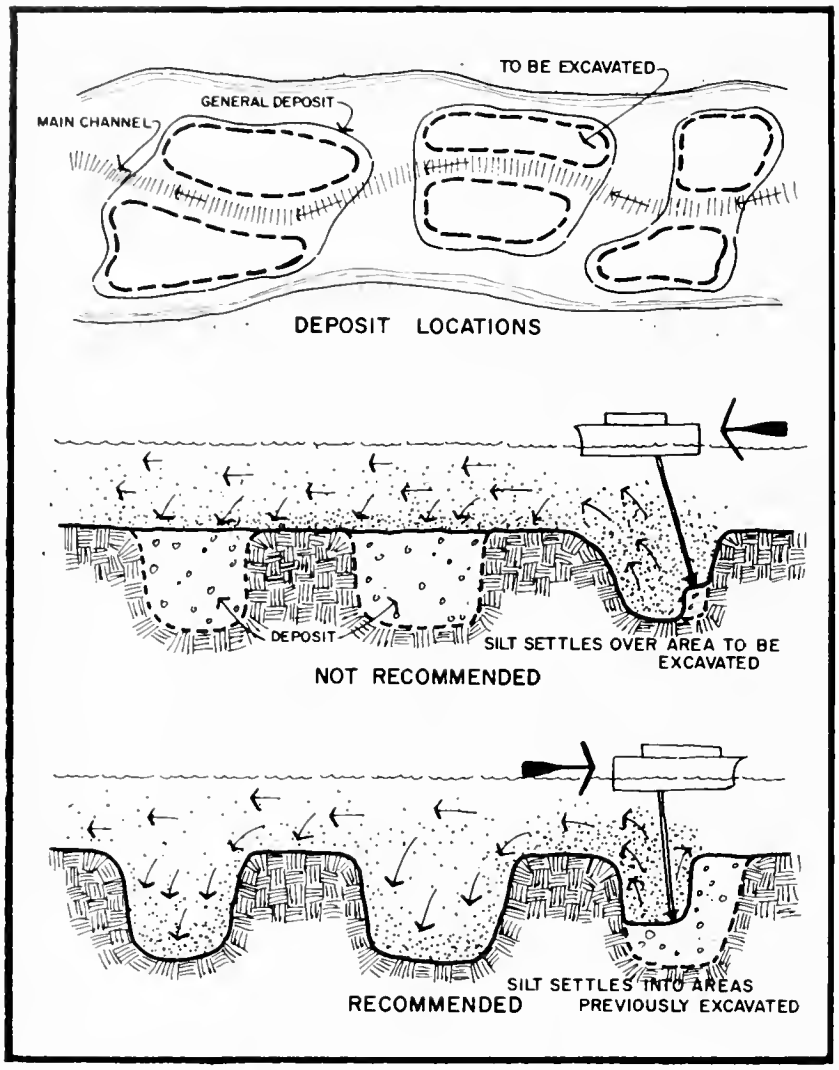


Figure 31 — Minimizing siltation when dredging in rivers, streams, or creeks

SUMMARY

The reader should now have a definite understanding of how sand and gravel sites relate to recreation areas, and the problems that must be overcome. It should be recognized that no two sites will be developed in the same manner, but that general procedures can be applied to almost all sites. In light of this, the two case study site solutions that follow in the next chapter may illustrate how the problem of recreation development can be approached.

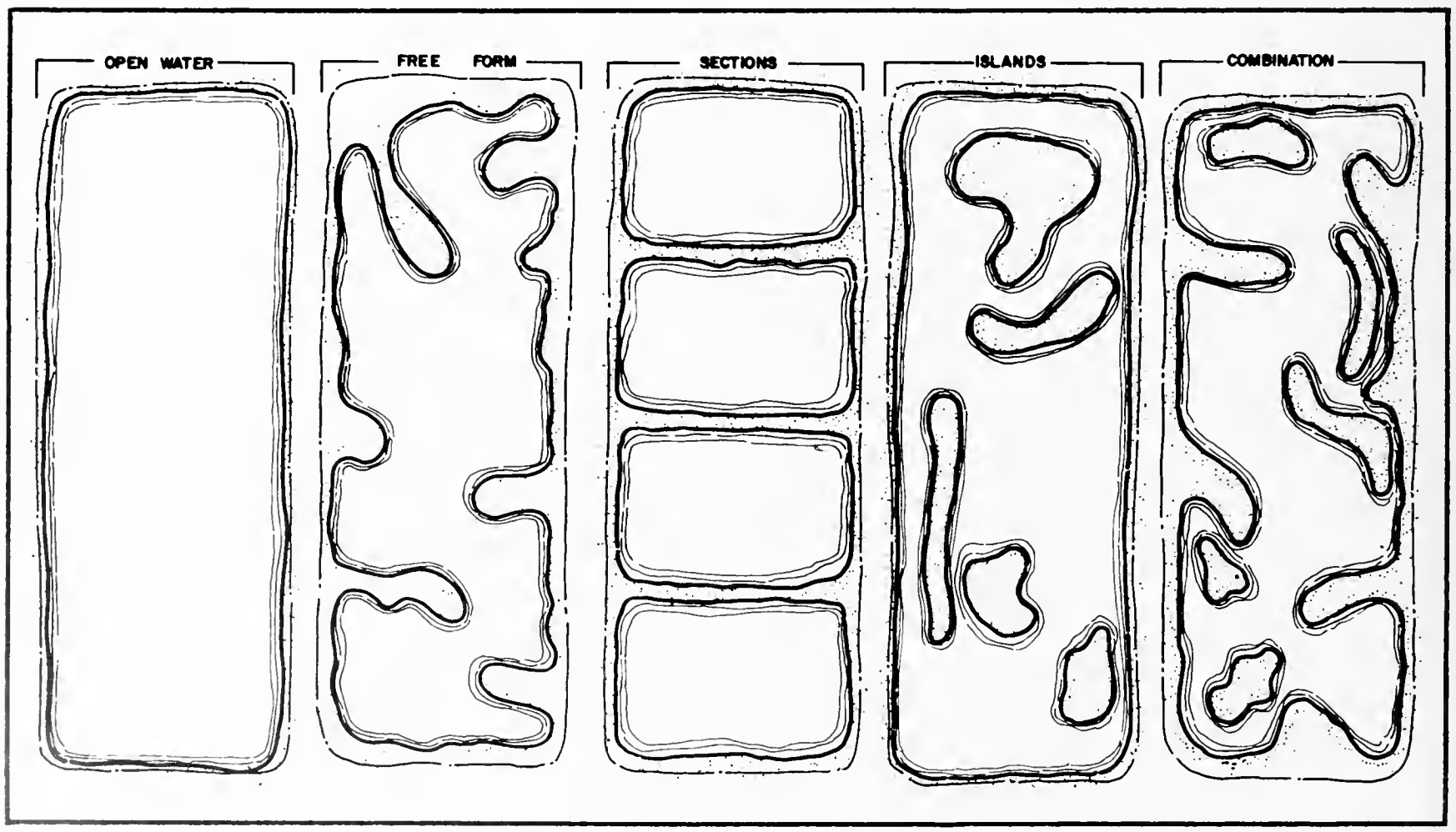


Figure 32 — Possible wet site configurations

Chapter V

Case Study Demonstrations

Mason Springs Farm and Chatfield Recreation Area are two case study sites included as a part of this research project in an attempt to apply some of the procedures, principles, and ideas expressed in the earlier chapters.

The sites were selected as part of this study by the National Sand and Gravel Association. The Potomac Sand and Gravel Company of Washington, D.C., owns the Mason Springs Farm site and will operate any excavation of the site. The Colorado Sand and Gravel Producers Association has primary interest in the Chatfield Recreation Area site. Both organizations have acted as information gathering agencies and have been very cooperative with this author throughout the study.

The solutions of both case studies have been developed over a period of two years, during which time two trips to each site were made. The sites were surveyed and accompanying data gathered from various local and governmental agencies. Pertinent information obtained from these visitations formed the basis upon which the general proposals were formulated.

In order that the case study proposals be of significance to producers everywhere, the individual solutions had to be schematic and relatively general in scope, focusing on broad principles and featuring concepts that could be implemented in similar situations elsewhere. Each represents, in this author's opinion, the best solution for that site, relevant to the problems associated with recreational development on the basis of available information.

Each study was based on the assumption that mining was to occur on each site, and that recreation was the desired after use for the site. The Colorado Sand and Gravel Producers Association and the Potomac Sand and Gravel Company were both aware of the intended after use of each site and offered suggestions that were incorporated into the development proposals.

□ □ □ □ □

Following is a general description of each site and the graphic sequence of considerations and recommendations.

Mason Springs Farm

Located approximately 40 miles south of Washington, D.C., this 1300 acre site forms the upper reaches of Mattawoman Creek, a tidal estuary of the Potomac River. The site is divided into two sections by Maryland Route 224 which runs east and west through the center of the tract. It is the north portion of the tract that will be considered as the case study project. Including Mattawoman Creek, the northern sector consists of 900 acres of woodland and tidal marsh, the latter comprising 35% of the total acreage.

With the exception of two small areas on the east

side of the property, the entire area is uncultivated. Timber growth is extensive over that portion of the site that is not marshy. Oak, sweetgum, and pine trees predominate with a dense undercover of small to medium shrubs. The area has been logged and there remain few trees over 16 inches in diameter.

The area on either side of Mattawoman Creek is low and marshy. At low tide the character of the lowlands changes from wet marsh to mud flats, exposing considerable bottomland. The only major drainage way is on the north portion of the property, which is spring fed and remains active even in dry weather, running south-north from the highway to Mattawoman Creek.

Of particular interest to the Potomac Sand and Gravel Company, owners of the site, is the navigability of Mattawoman Creek in its upper reaches. The channel is narrow and winding from its mouth to the site; minimum channel width being approximately 150′ while the minimum depth at low tide is 7′. The channel is unmarked upstream from Sweden Point, and near the vicinity of Thoroughfare Island becomes obscure and difficult to follow. The Potomac Sand and Gravel Company feels that barge traffic is feasible on Mattawoman Creek for transporting sand and gravel.

Overland access into the site can be facilitated over the logging roads into the area. The main logging road that runs from Route 224 to Nelson Point could easily be utilized by personnel operating equipment on the site.

Because of the dense growth of vegetation on the site, the interior portion of the property is not visible to motorists from Maryland Routes 425 and 224. These routes form the eastern and southern boundaries of the case study area. The site cannot be entered from the west except by boat up Mattawoman Creek. A government owned rail spur parallels the north edge of the property serving the U.S. Naval Propellant Plant at Indian Head and originating at Waldorf, Maryland. North of the rail spur the land rises abruptly and affords those inhabitants who live on this hill the only unobstructed view into the site.

At present the site is occasionally utilized by fishermen and hunters. There is no evidence that any attempt has been made to introduce any other form of recreation on the site. The Charles County Park and Recreation Department has indicated that the strip of property adjacent to Route 225 along the eastern edge of the site has been considered for park usage. At present no plans are available that will convert this strip into park land.

The area of the site, 40 miles south of Washington, D.C., is rural in character, and possesses great potential for growth. Adjacent communities are Glymont, immediately to the north; Marbury, about one mile west; and Mason Springs, on the east. All are rural with low population densities. Glymont has a high school and a small shopping district. The major employer in the area is the U.S. Naval Propellant Plant located at Indian Head, west of Glymont.

Sub-surface information used in analyzing the productivity of the sand and gravel deposits on the site were supplied from three sources:

1. Records of core drillings made by Smoot Sand and Gravel Company.
2. Records of core drillings made by Columbia Sand and Gravel Company.
3. A soil-resistivity survey.

Interpretation of the preceding information indicates that there are three areas which contain sand and gravel in sufficient quantities to warrant excavation. These are areas 1, 3, & 4. In addition, two smaller areas (5 & 6) possess substantial deposits, but of questionable economic value. There was no information available in the test borings to indicate gravel percentages in these areas. Area 2 is also questionable as to quantity and quality of gravel. (See Figure 44)

The following criteria were used by the Potomac Sand and Gravel Company in determining the productive deposit areas:

1. Minimum thickness of sand and gravel bed — 10′.
2. Minimum percentage of gravel to sand — 25%.
3. Maximum thickness of overburden — 17 feet, but not to exceed 75% of the thickness of the sand and gravel bed.

The results of interpretation of all available deposit data are shown in the following table:

AREA	OVER-BURDEN	SAND & GRAVEL TONNAGE	% GRAVEL
1	10.3 feet	1.98 million	35
2	12.2 feet*	.87*	?
3	5.8 feet	2.31	32
4	2.9 feet	4.84	40
5	4.0 feet	.36	?
6	6.0 feet	.22	?

TOTAL: 10.58 million tons

*Insufficient data available in this area to make an accurate estimate of material.

Several problems become apparent when the area is analyzed from a production standpoint. Of primary concern is the depth and width of the channel into the dredging sites. The channel as it presently exists is inadequate to handle large tonnages directly from the dredge sites. Also, areas 5, 6 and portions of area 3 are marginal for production by existing ladder-type dredges because the deposit does not extend to a sufficient depth below water level to permit normal operations by the dredge.

This would necessitate frequent shifting of the dredging point with a ladder-type dredge, which is not practical.

Following are operating procedures suggested by the Potomac Sand and Gravel Company:

1. Dredging should commence on the west side of area 3, working in an easterly direction with the possibility of dredging through to area 4, which seems to contain the richest deposit on the site.
2. A small tug should be provided which could tow 2 or 3 loaded barges per trip from the dredge to a mooring site in the mouth of Mattawoman Creek, where a full tow load could be made up for towing to the company's Georgetown plant. Empty barges could be supplied to the dredge by the reverse procedure.

Conclusions drawn by the Potomac Sand and Gravel Company suggest that the protected site offers an excellent opportunity for winter dredging. The company's normal Potomac River operations have to be suspended occasionally in the winter because of exposure to wind and ice.

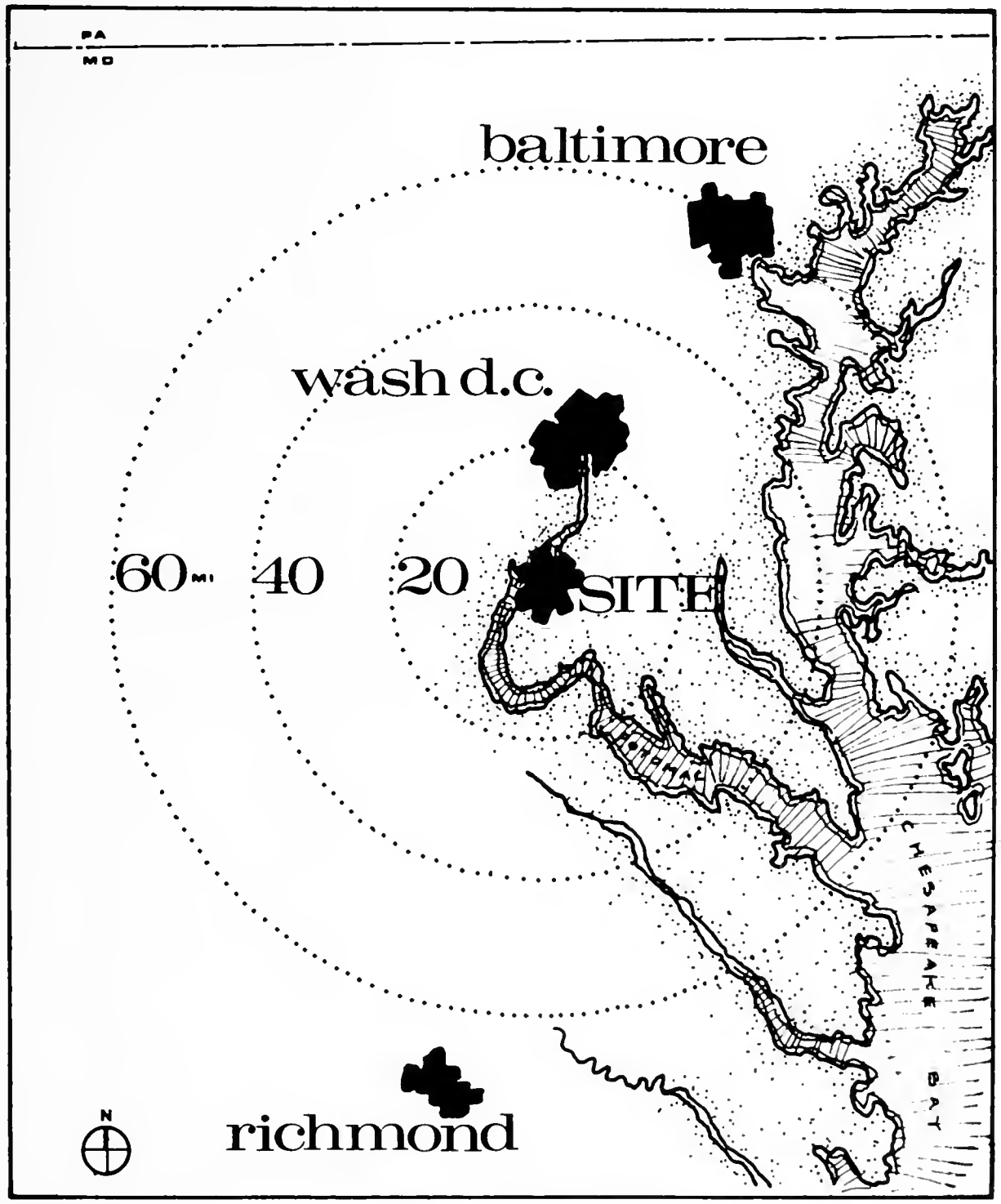


Figure 33 Location-Regional

Significance: Shows the site's relationship to major centers of urban concentration and the origin of the majority of potential users.

Source: Author.

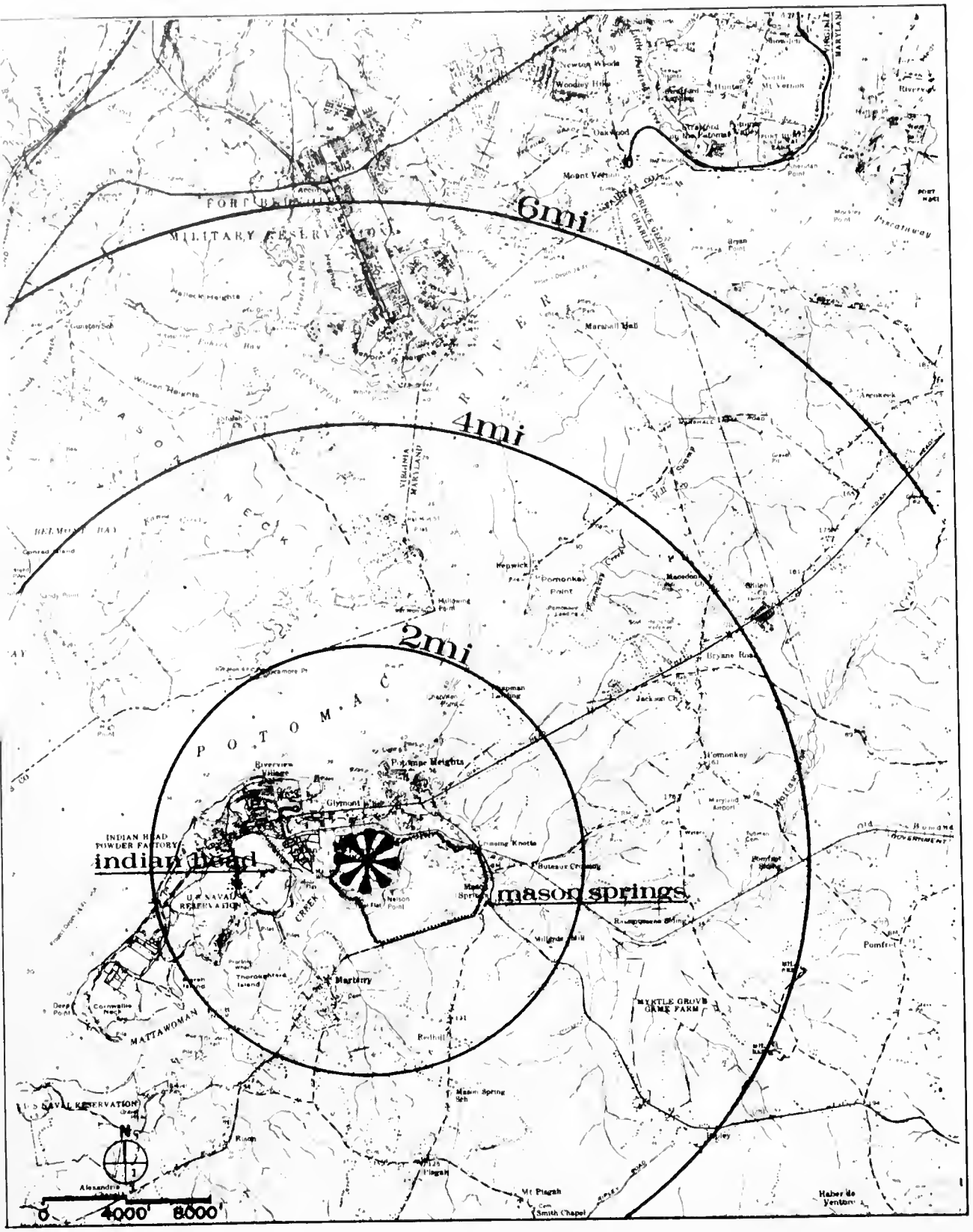


Figure 34 Location-Area

Significance:
Relates site to local surroundings and indicates water-oriented recreation resources.

Source:

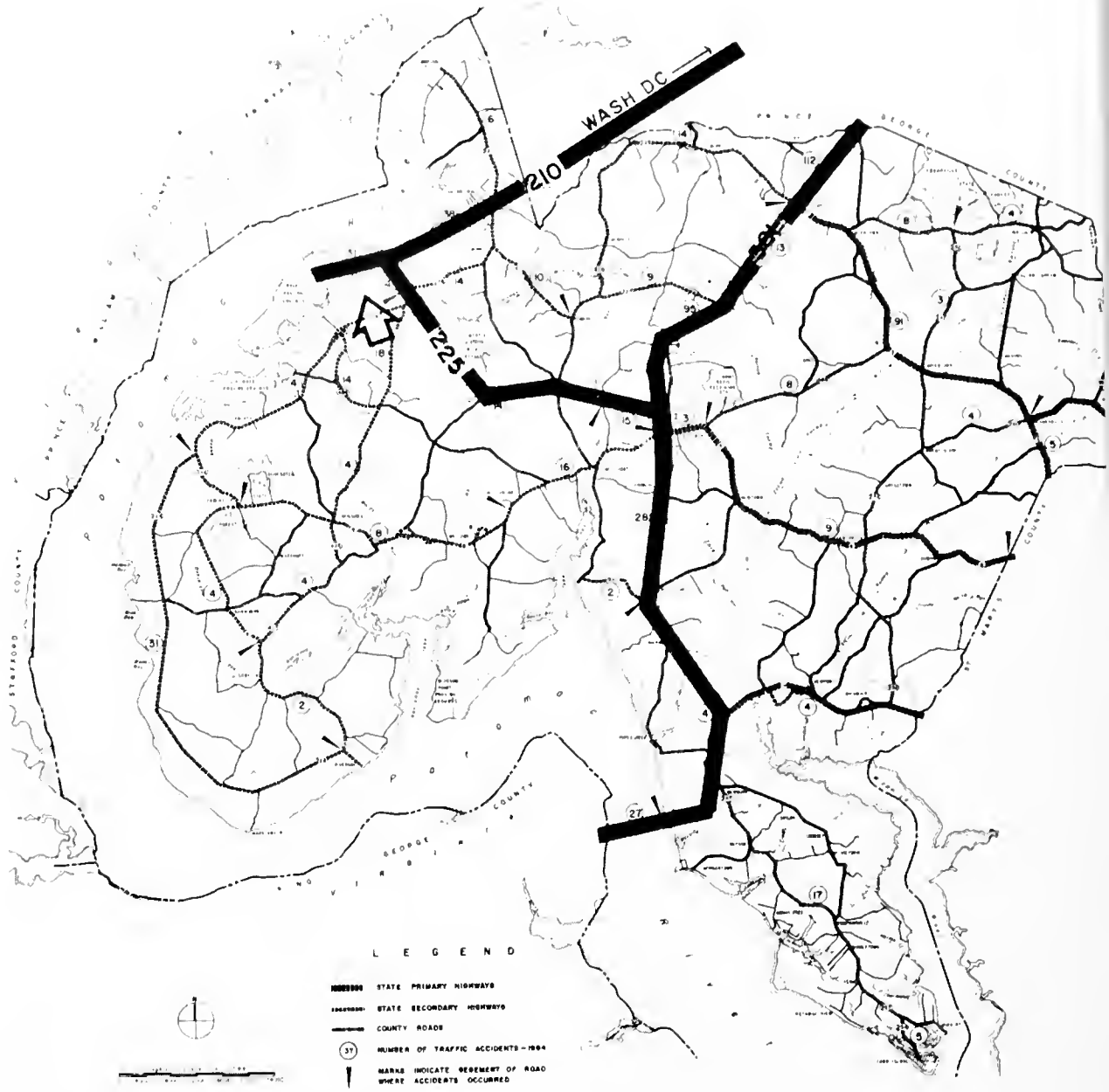


Figure 35 Access

Significance:
The site is easily accessible for recreation from Washington, D.C., and other large urban concentrations by road or by boat.

Source:
Charles County Comprehensive Plan

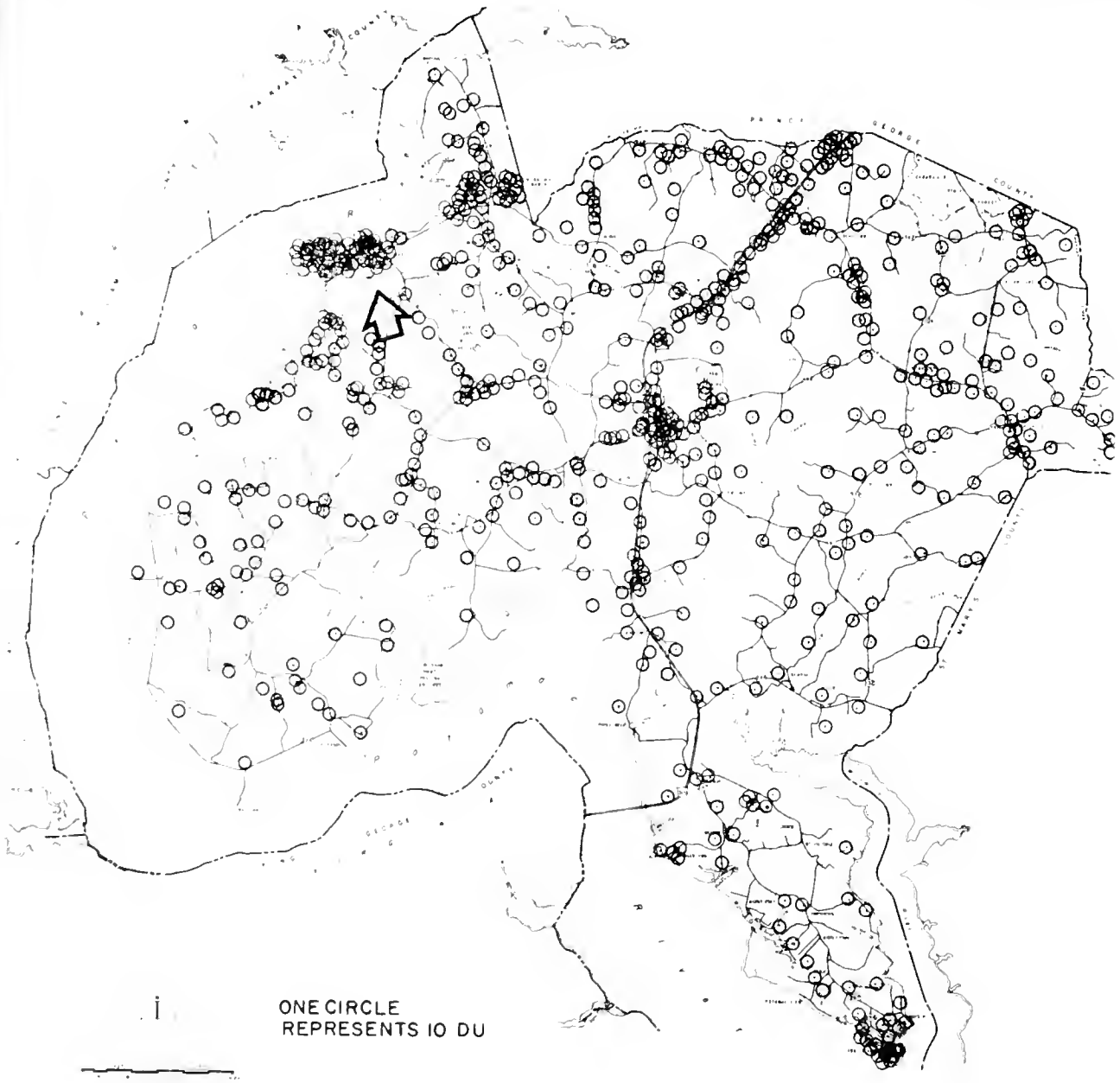


Figure 36 Population Distribution

Significance:
Denotes the population distribution in Charles County as of 1968 and indicates areas of highest density. Shows that the high density around Indian Head could possibly support a recreational development.

Source:
Charles County Comprehensive Plan, Harland Bartholomew and Associates, 1967.

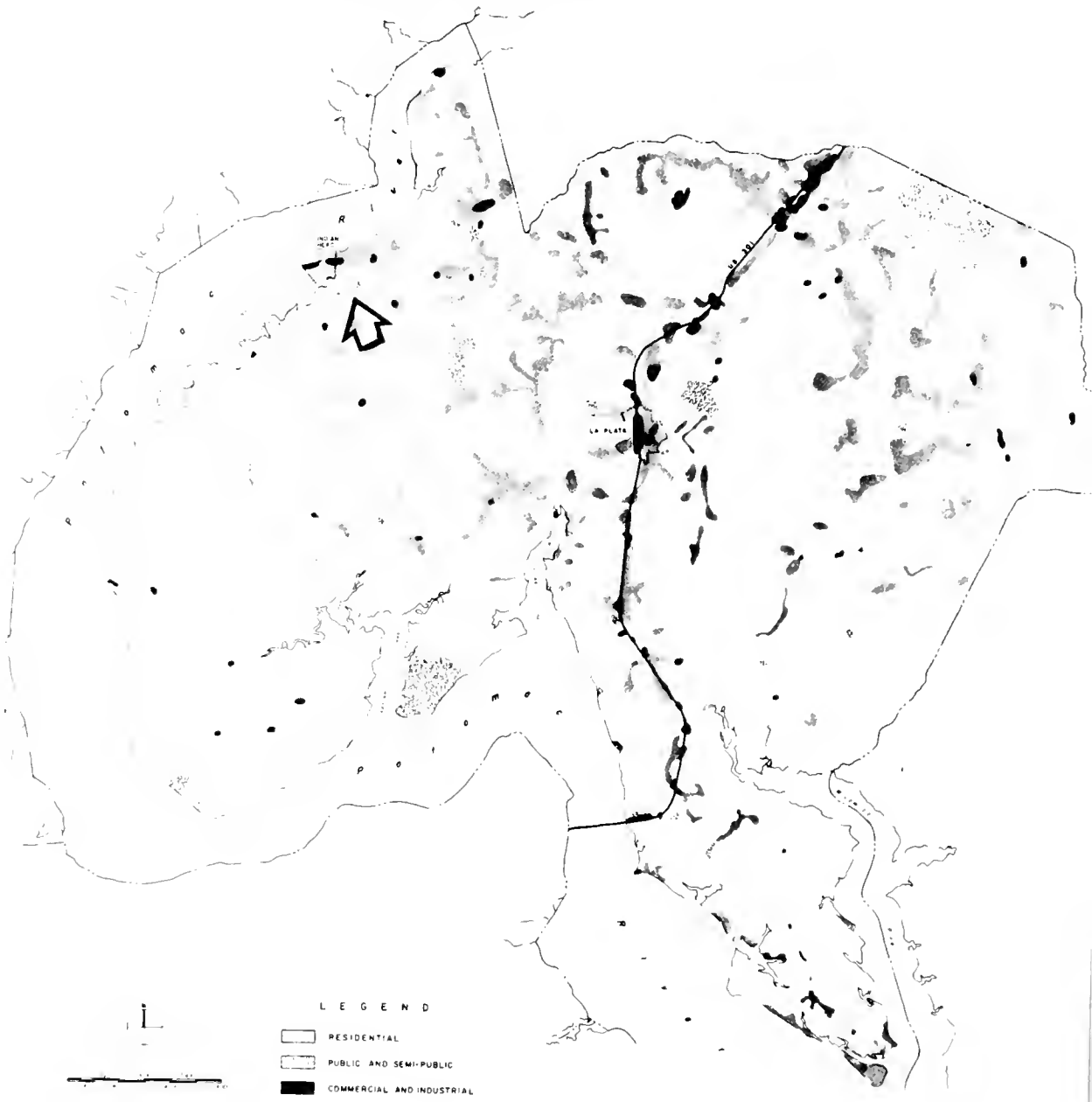


Figure 37 General Land Use — 1969

Significance:
Recreational development on site would agree with the existing land use plan of the area.

Source:
Charles County Comprehensive Plan.

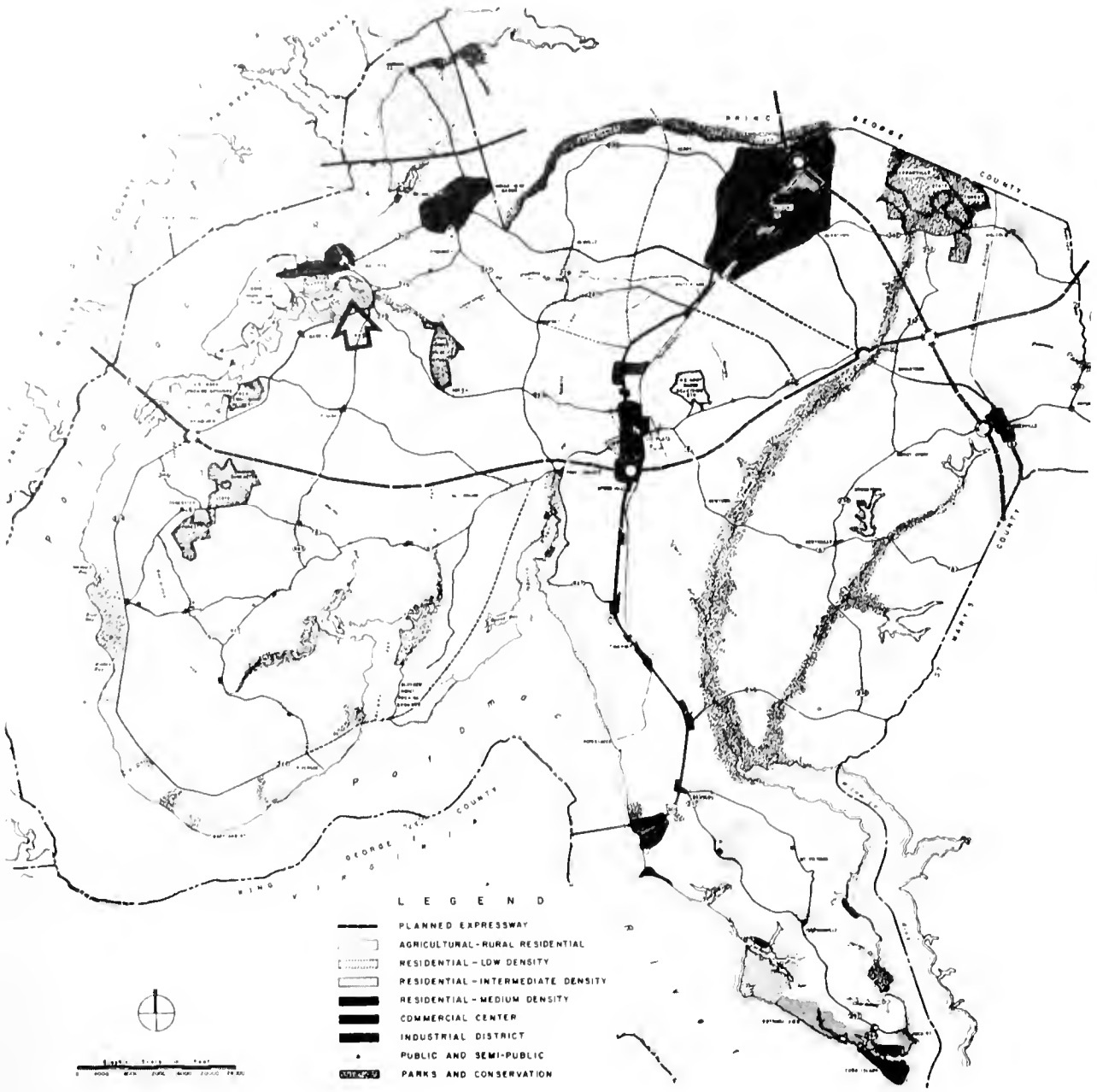


Figure 38 Land Use — 1985

Significance:
Planned recreation development of the site would not conflict with future land use of the area.

Source:
Charles County Comprehensive Plan.

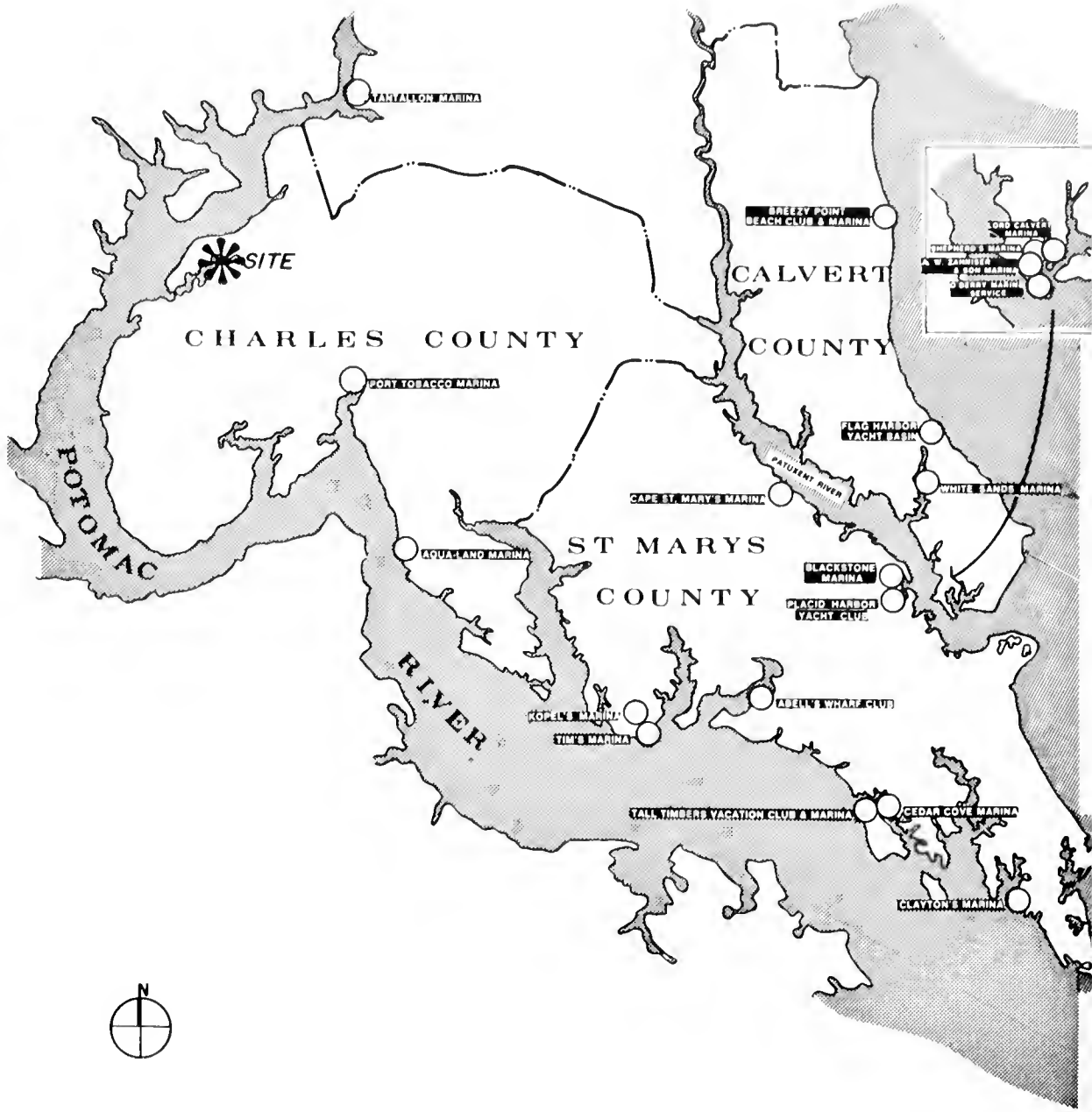


Figure 39 Marinas — 1968

Significance:
Site could probably support a marina relative to the number of marinas further south and considering population density of Indian Head Area.

Source:
Survey of Southern Maryland Marine Facilities, University of Maryland Co-operative Extension Service, 1965.

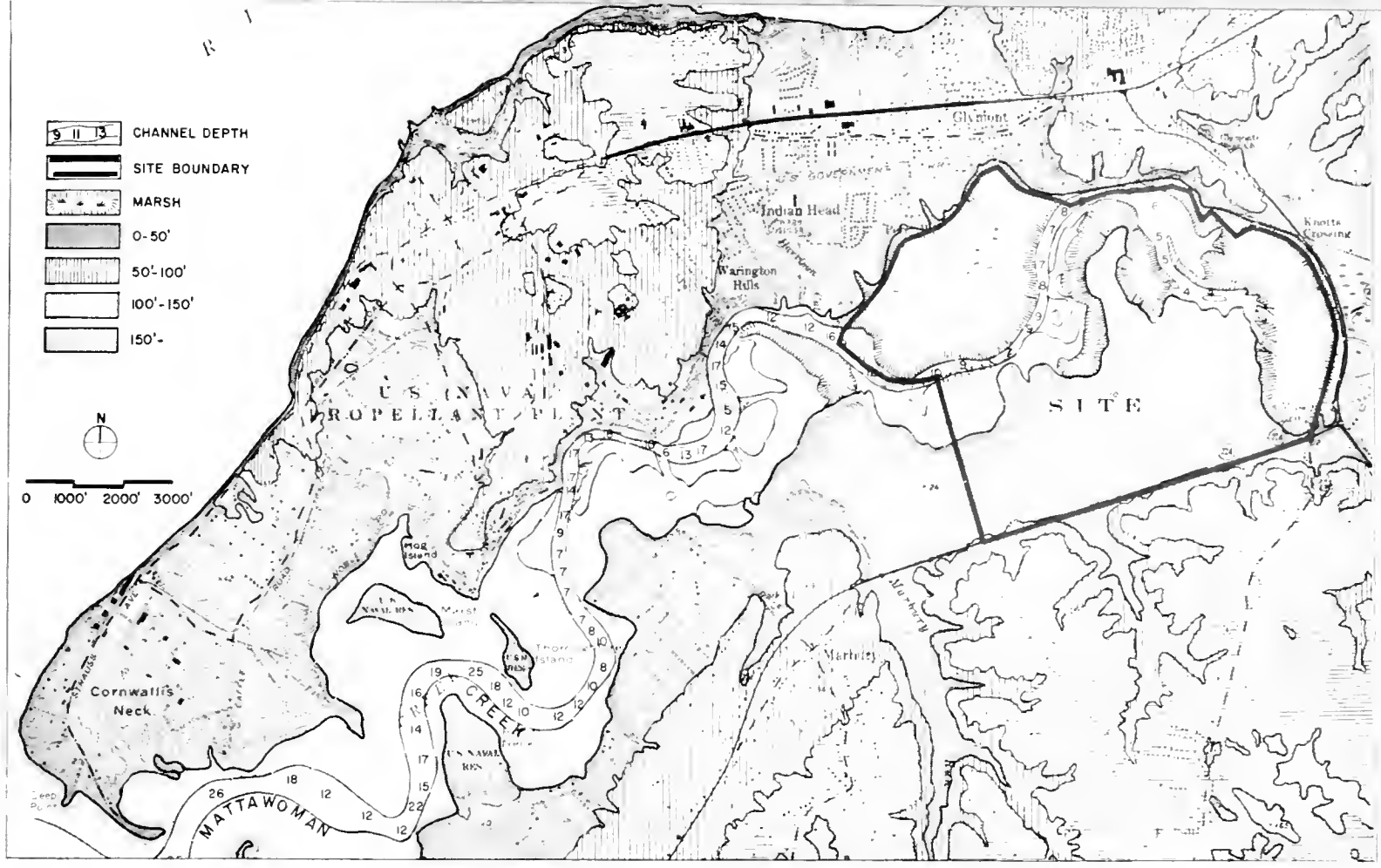


Figure 40 Physiography

Significance: Indicates topographic variations of the site and surrounding area and illustrates the predominantly wet, marshy environment of the area.

Source: U.S.G.S. map.

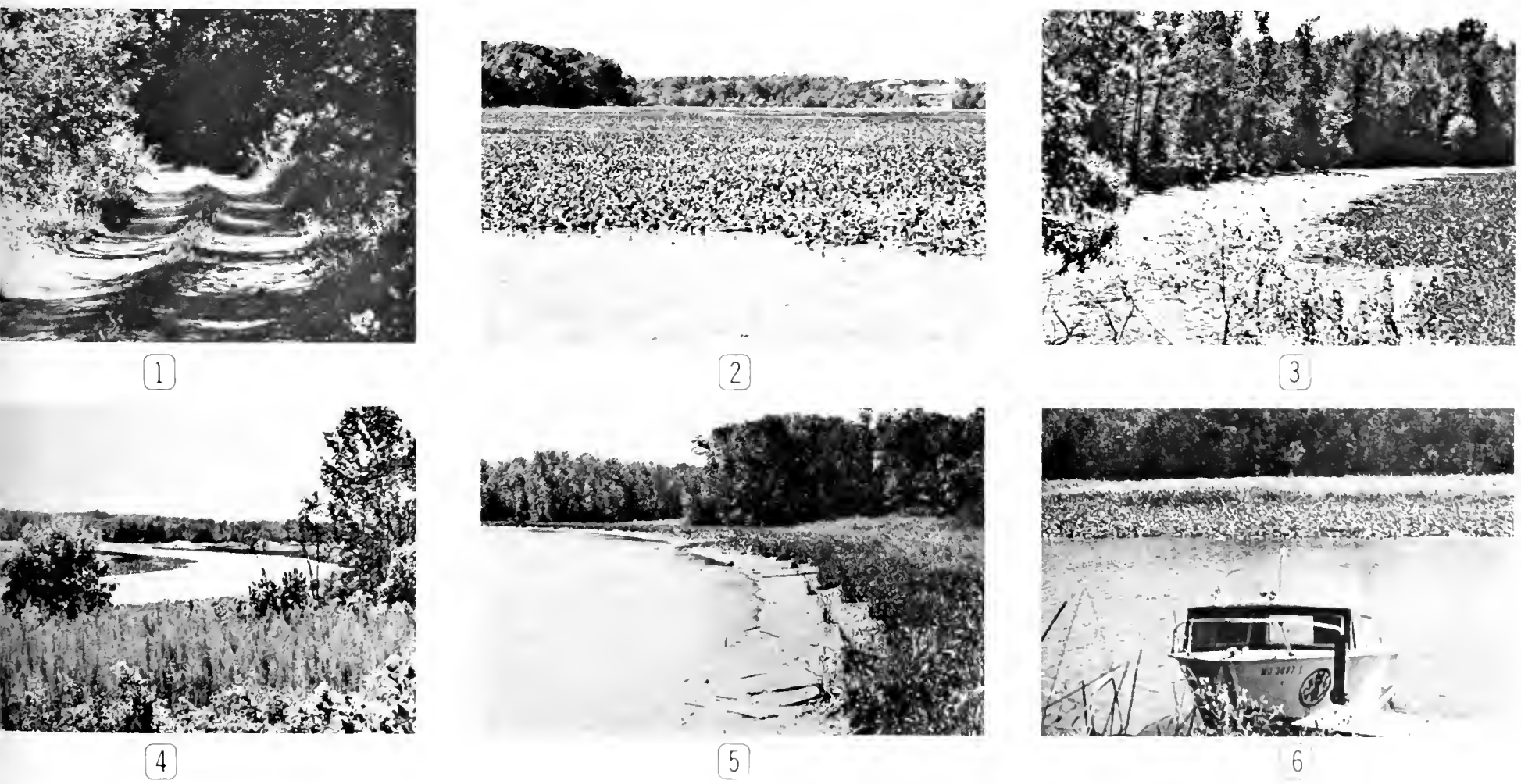


Figure 41 Detail Shots

Significance: Defines existing site character and suggests the type of recreation facilities that may be provided.

Source: Author.

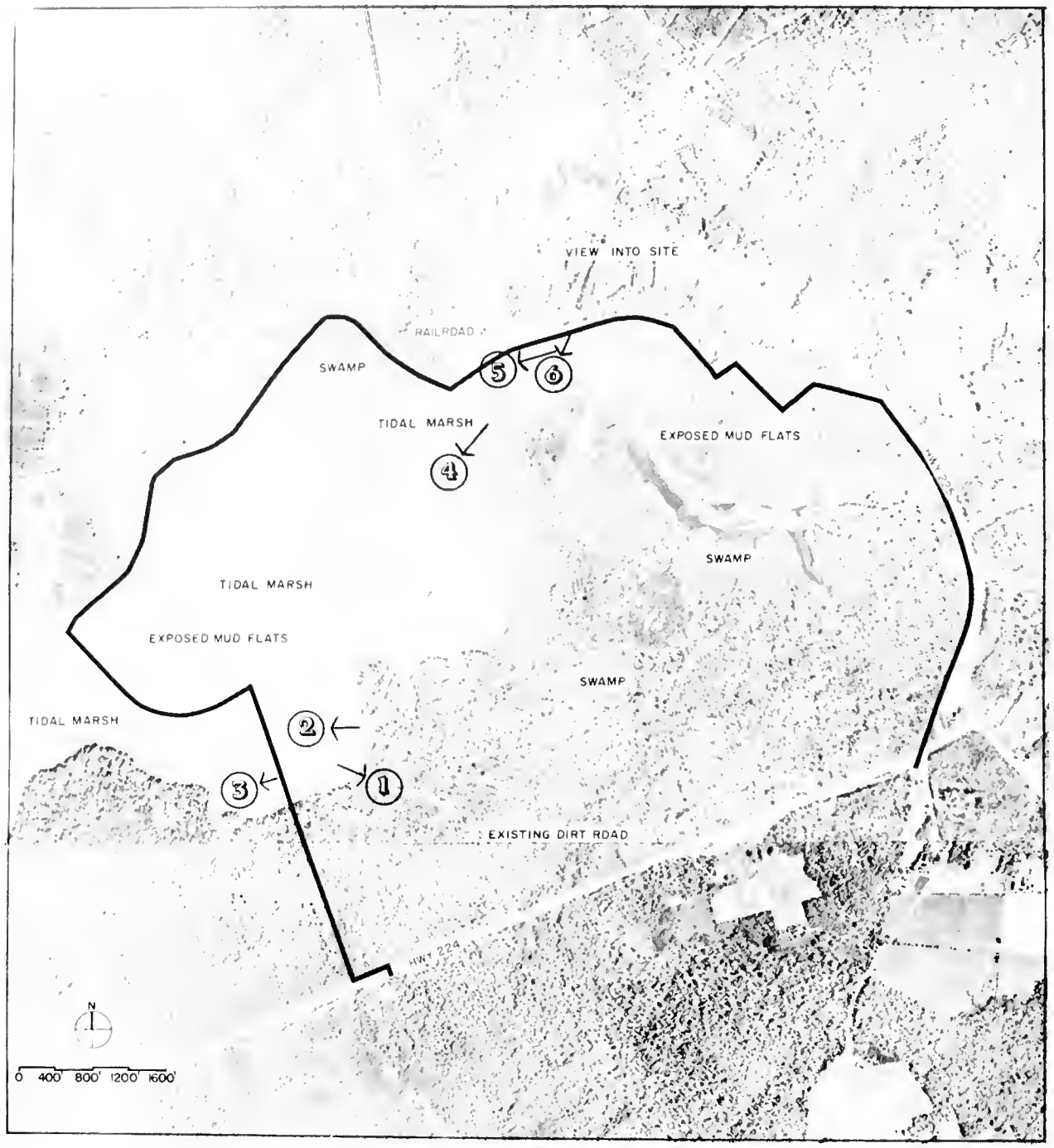


Figure 42 Aerial Photograph

Significance:
An overall view of site and adjacent property defining various topographic and vegetative features.

Source:
Potomac Sand and Gravel Company.

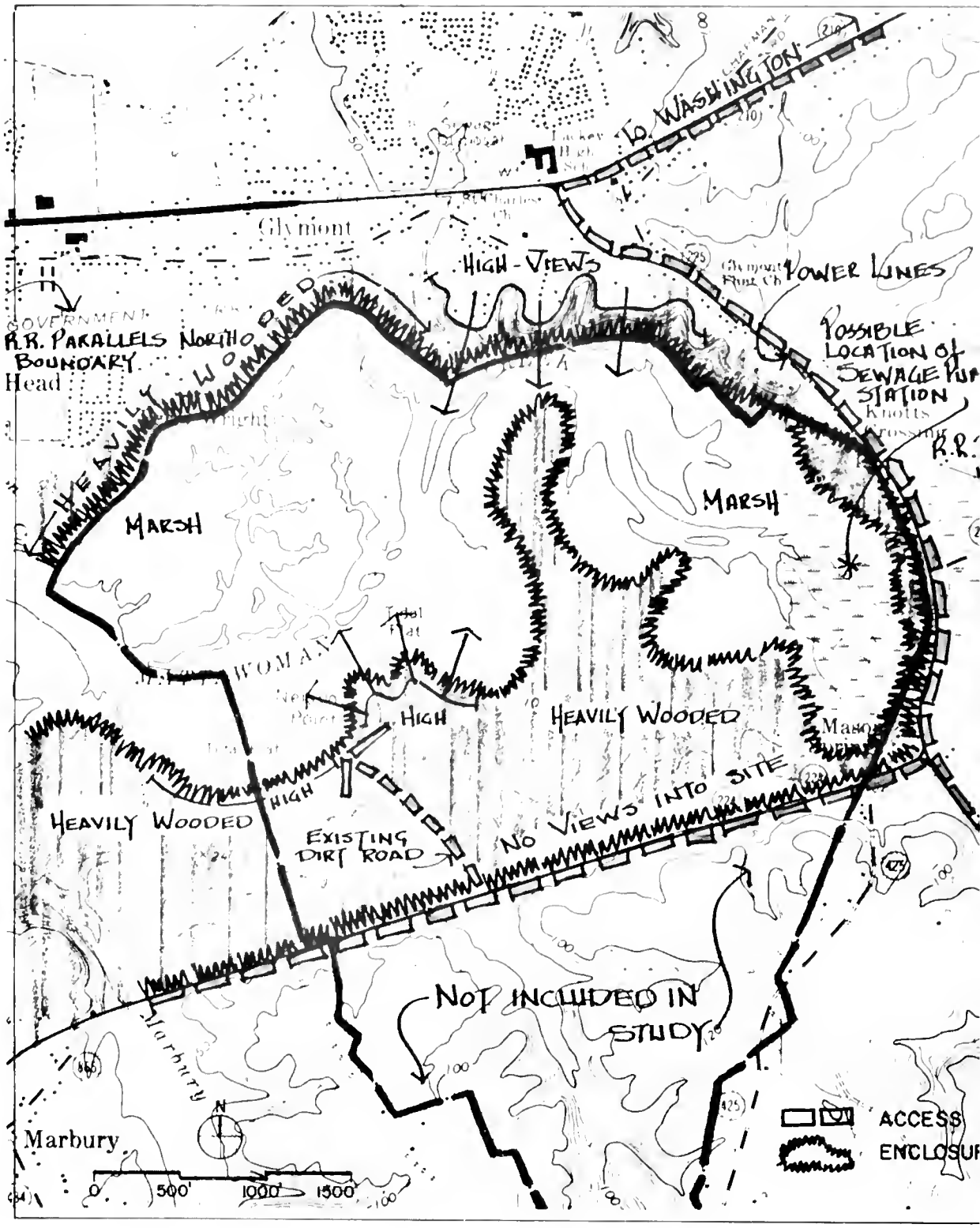


Figure 43 Site Analysis

Significance:
Graphically illustrates major physical, cultural, and perceptual considerations that may affect recreational development of the site.

Source:
Author.

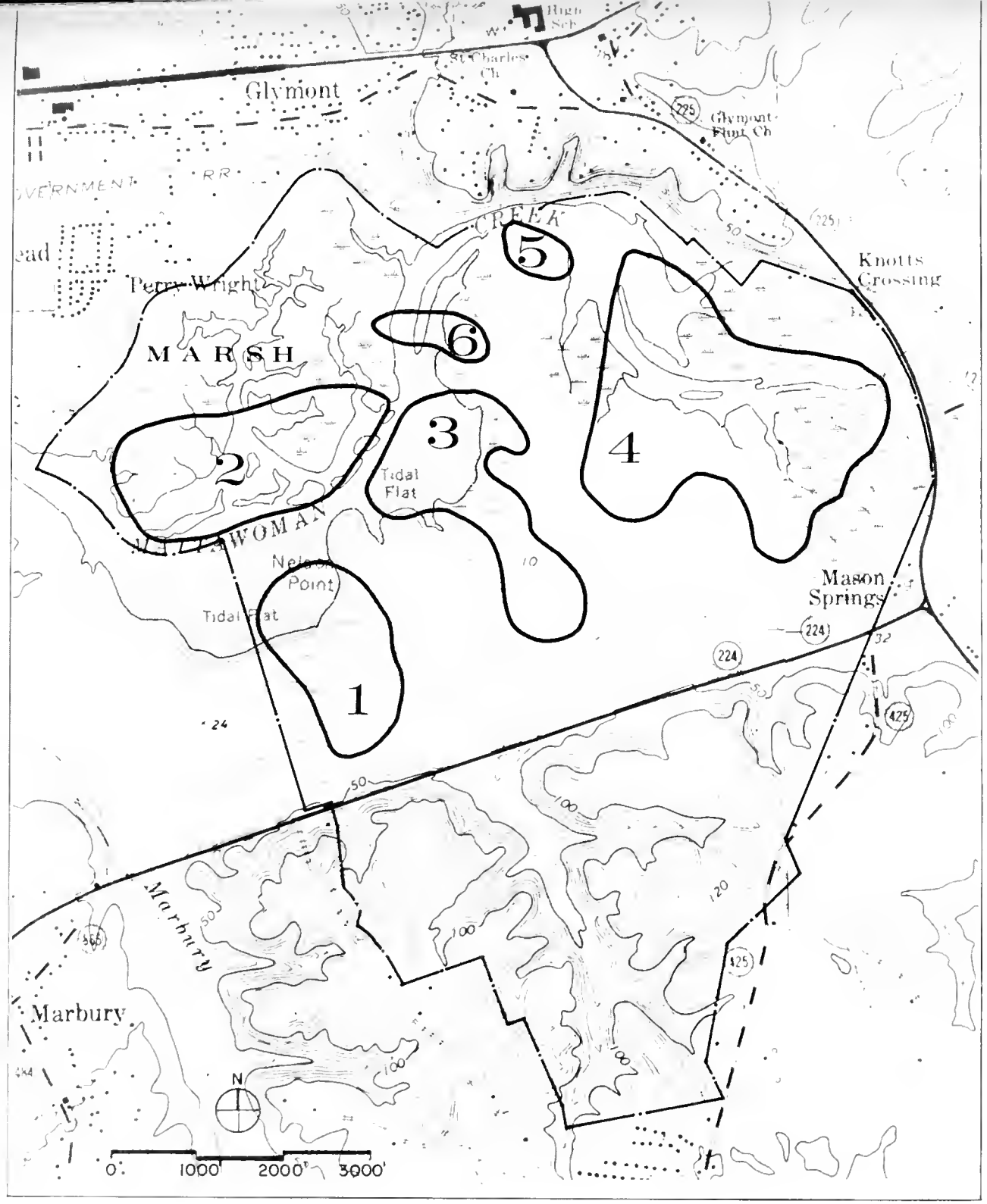
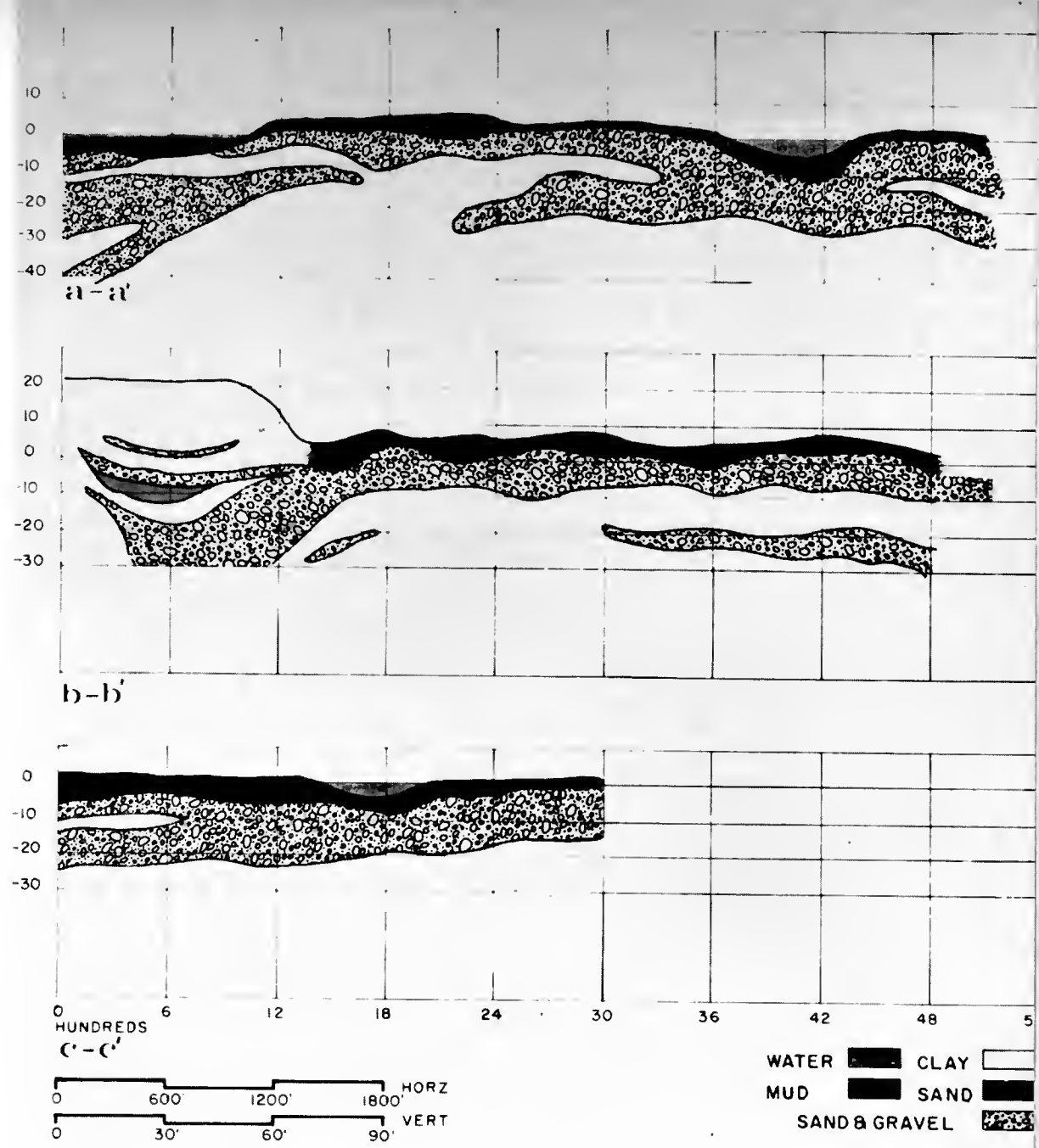


Figure 44 Deposit Location

Significance:
Defines the location and configuration of probable excavation areas and substrata data.
Source:
Potomac Sand and Gravel Company.



SECTIONS

Figure 45 Substrata

Significance:
Graphically illustrates the depth and extent of the deposit and related material.
Source:
Potomac Sand and Gravel Company.

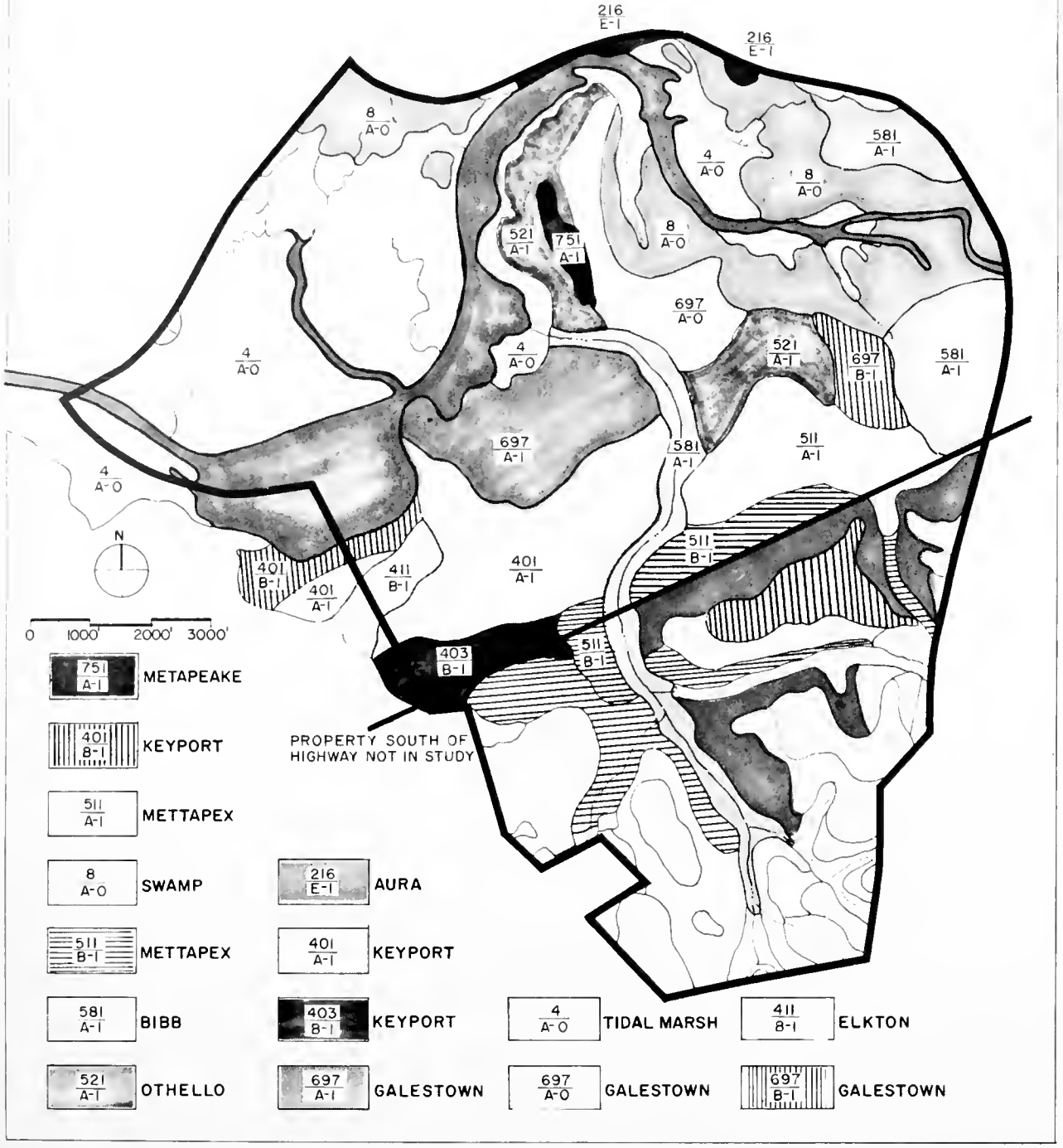


Figure 46 Soil Survey

Significance:
Shows the types of soils on the site as a basis for subsequent analysis.
Source:
Maryland Soil Conservation Service.

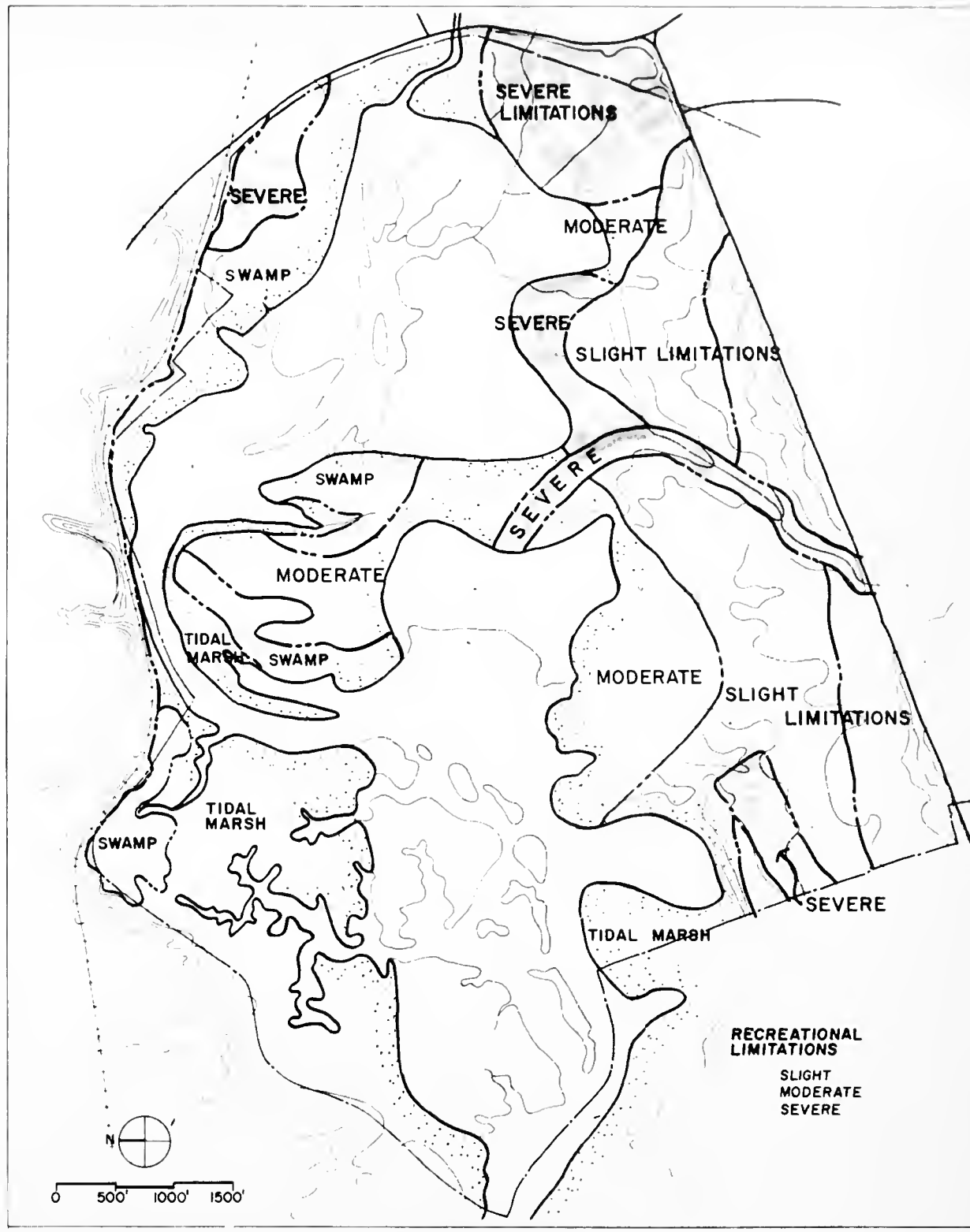


Figure 47 Soil Analysis

Significance:
Suggests where recreational development is best suited for play and picnic areas, paths and trails.
Source:
Maryland Soil Conservation Service.

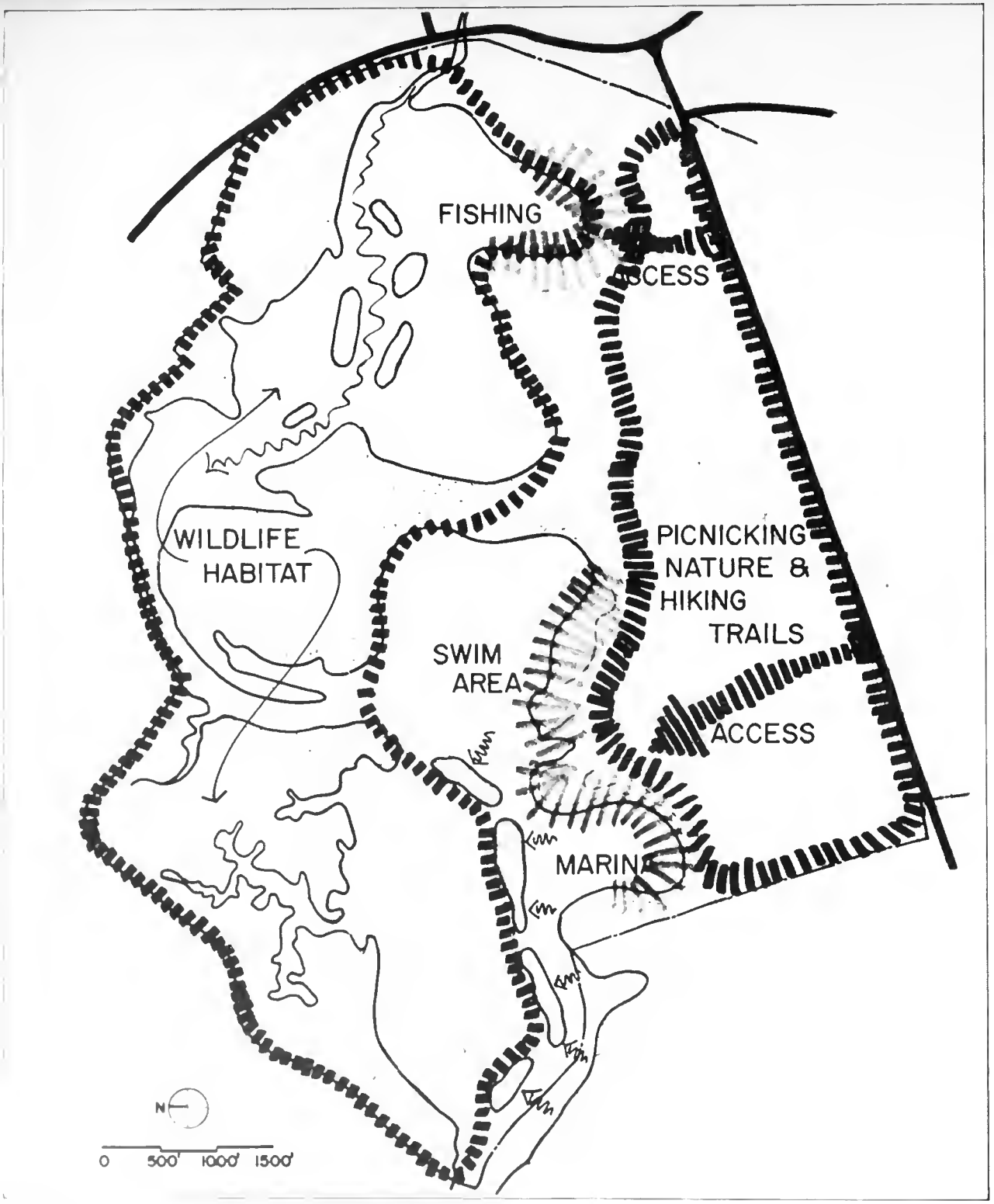


Figure 48 Design Concept

Significance:
Outlines major use areas and shows how they relate to each other on the site.
Source:
Author.

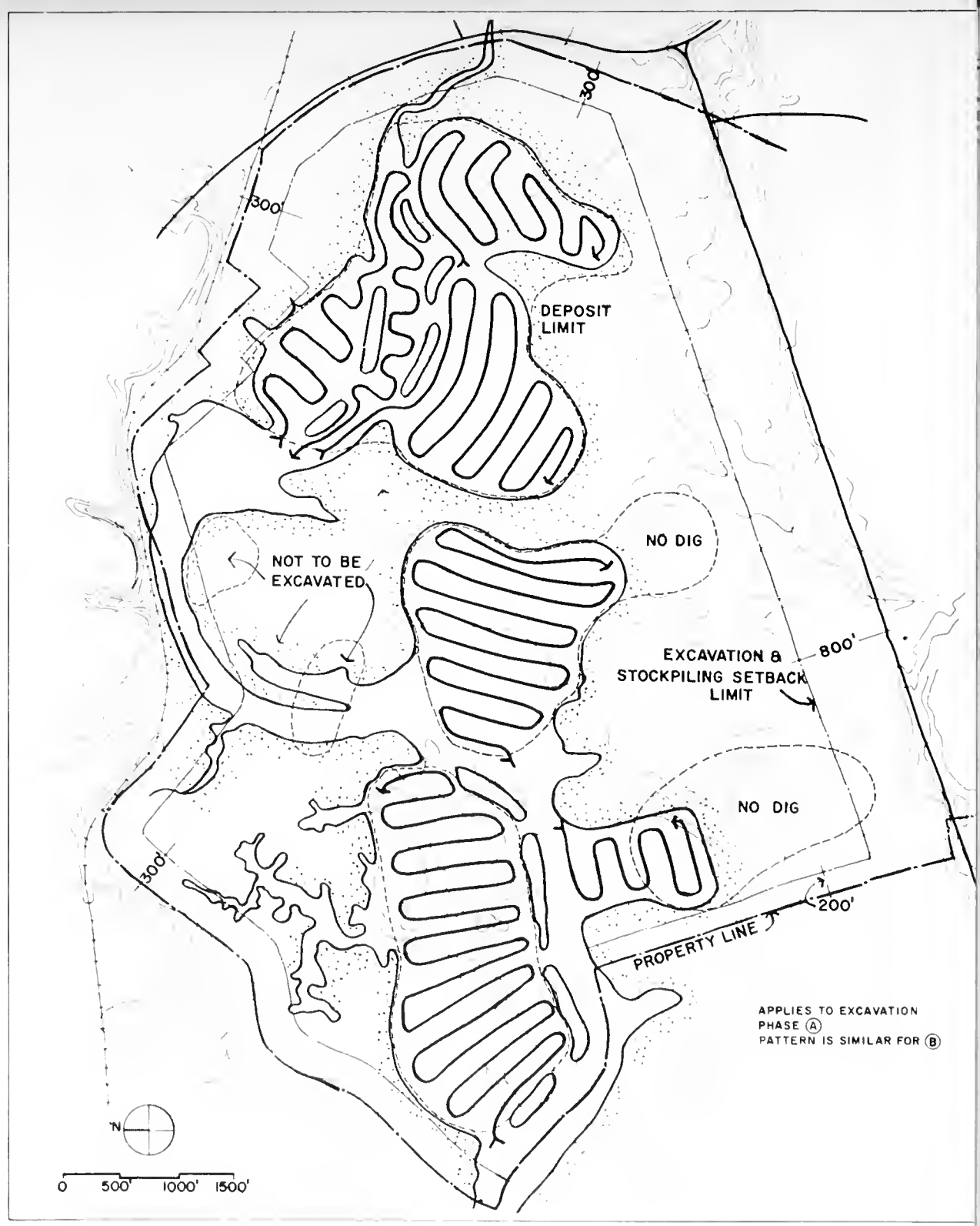
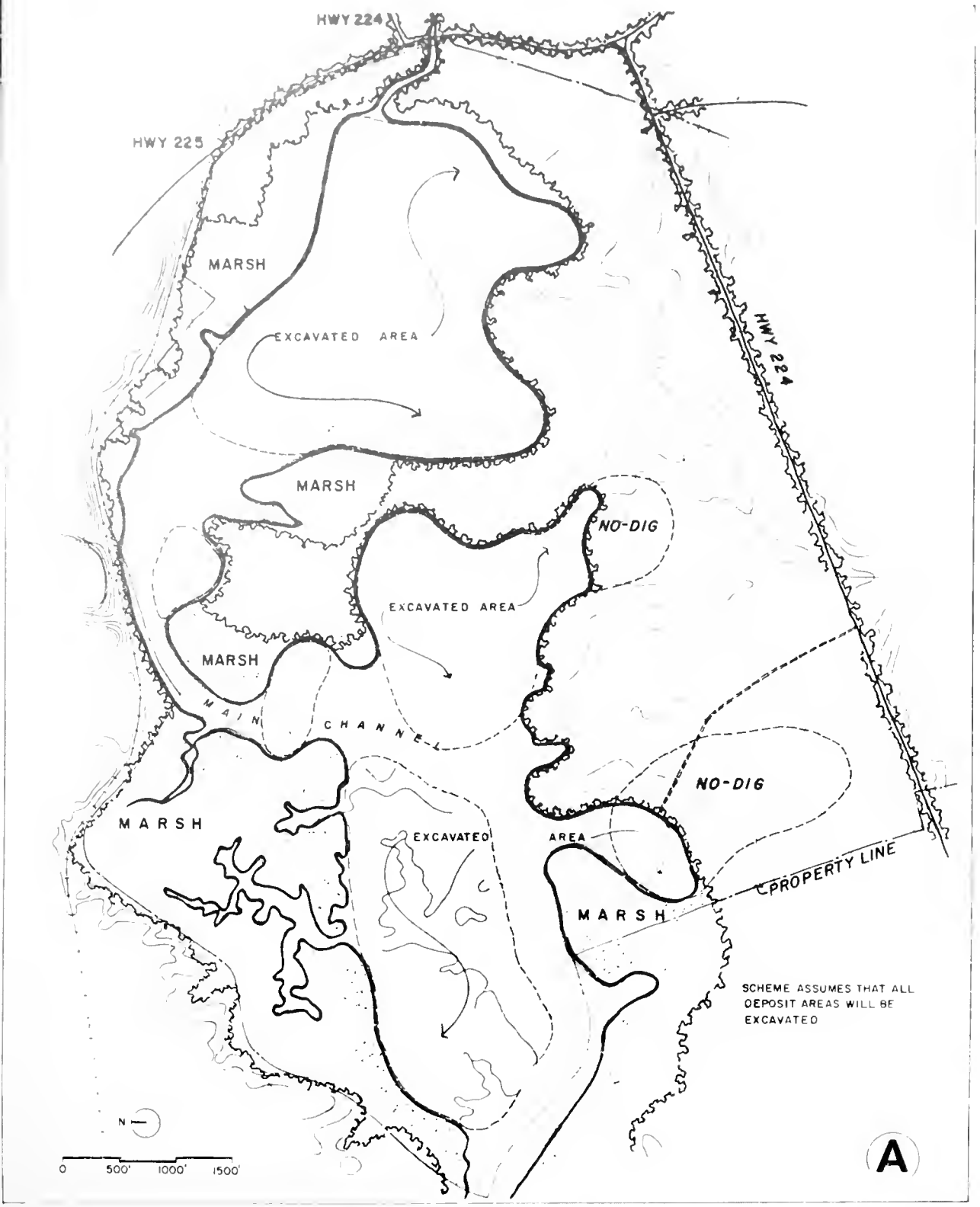


Figure 49 Excavation Pattern

Significance:
Shows how dredge can operate. Method is schematic and can easily be modified.
Source:
Author.



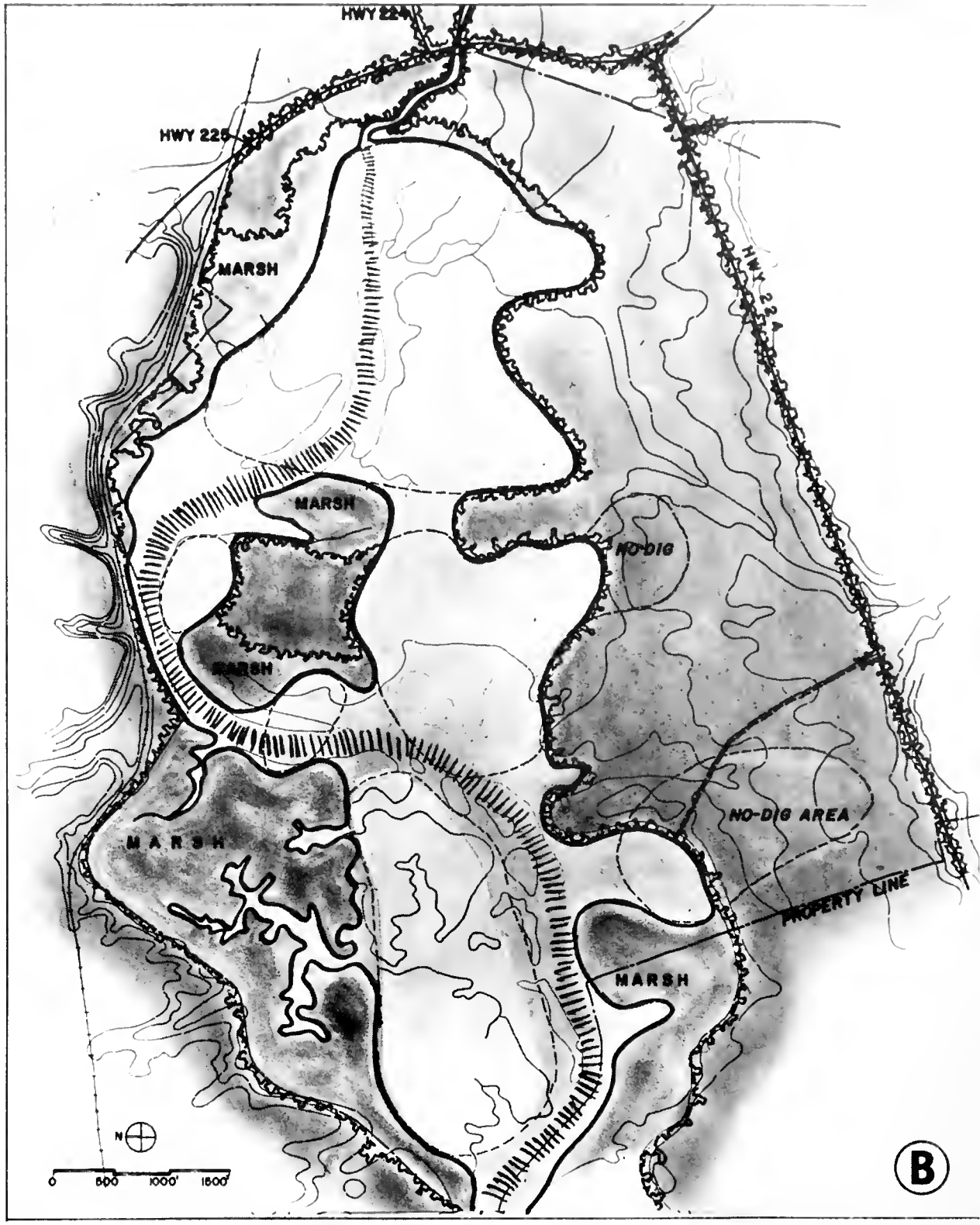
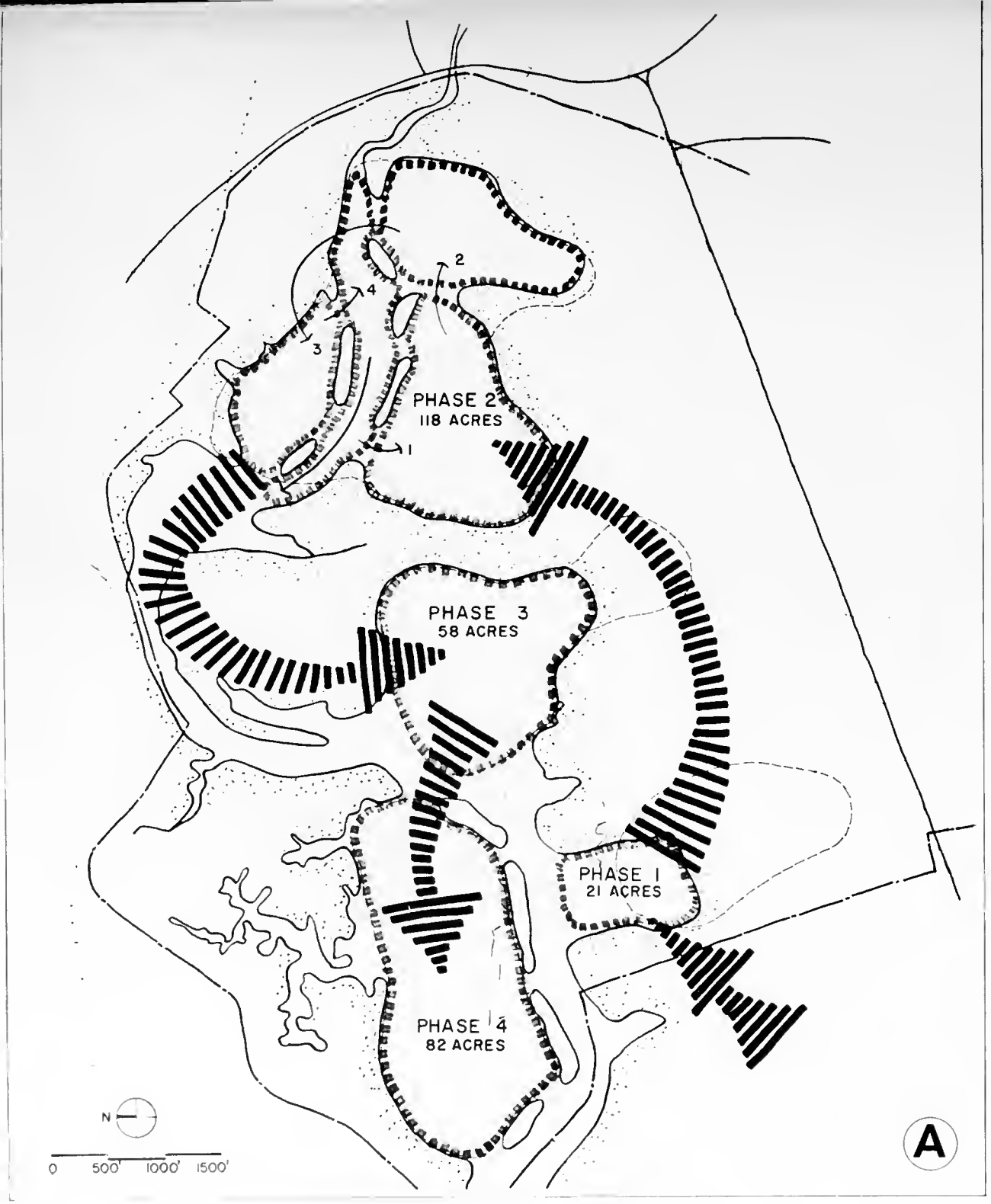


Figure 50 Site Configurations

Significance: Portrays the site after excavation and shows how the water area configuration can vary.

Source: Author.



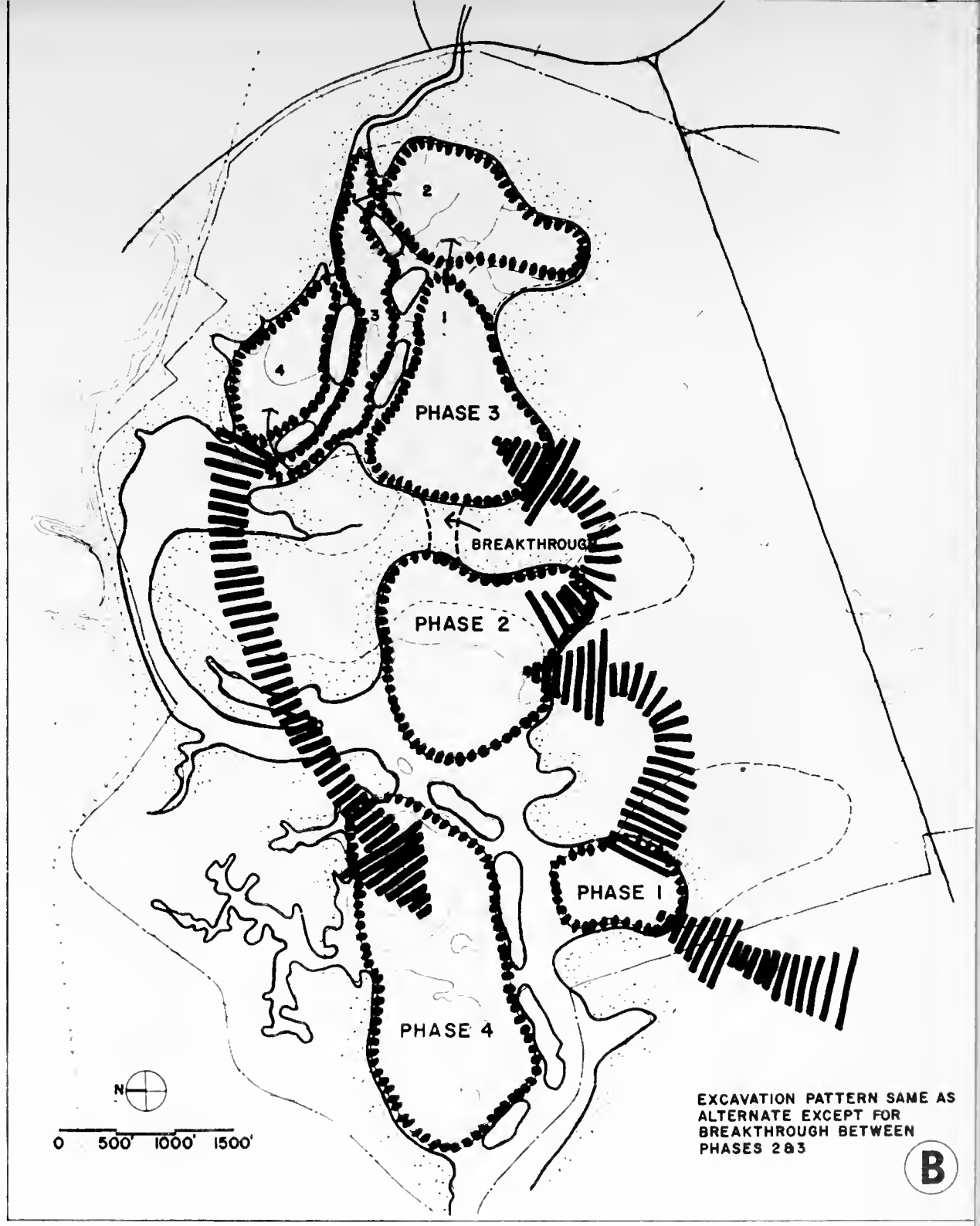


Figure 51 Excavation Phases

Significance: Suggests how excavation will progress so the site can be ready for recreational use at the earliest date.

Source: Author.

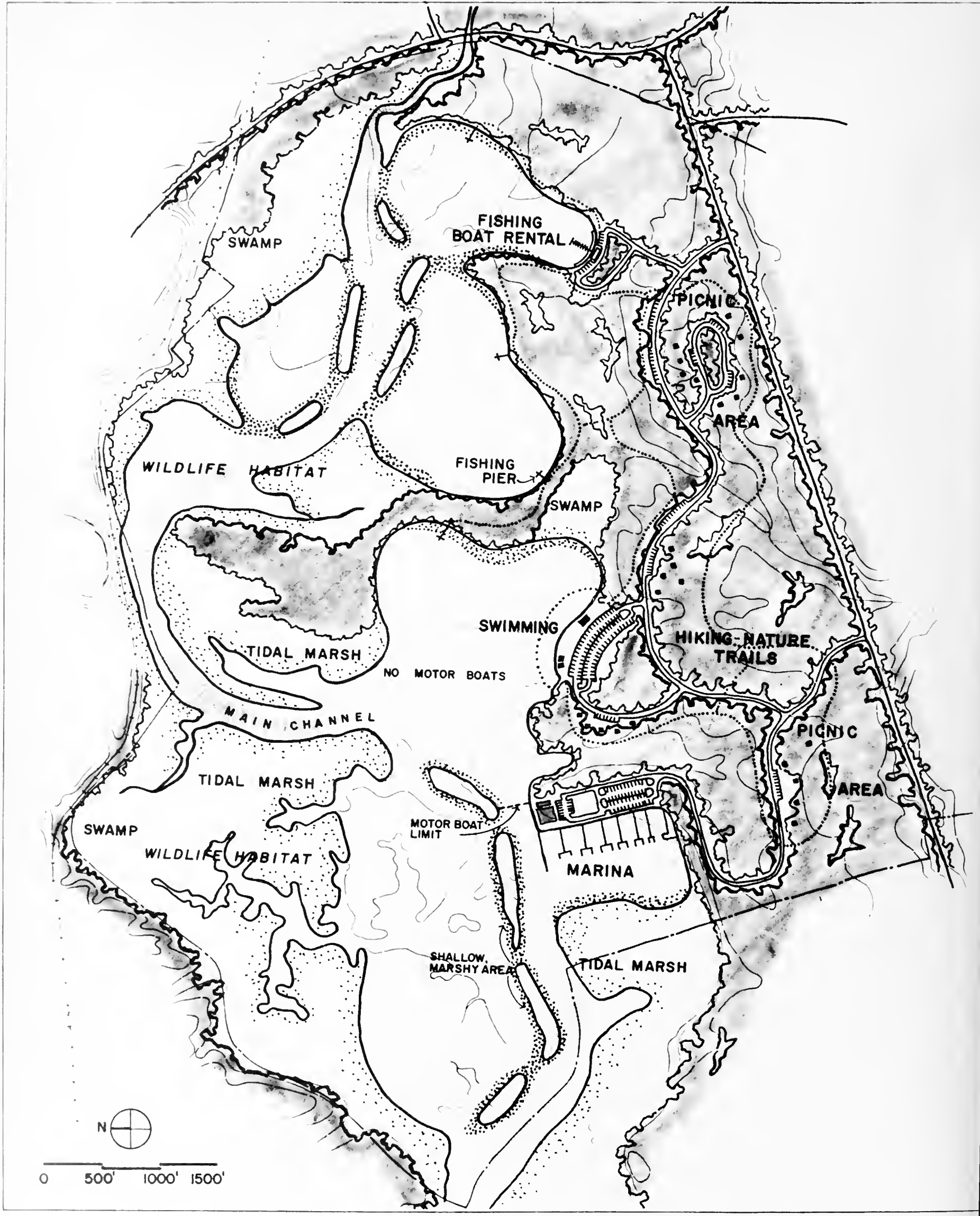


Figure 52 Master Plan

Significance: Depicts the proposed recreational development based on previous data, featuring actual recreational use areas.

Source: Author.

Summary:

Mason Springs Farm is a site that focuses on a major problem the sand and gravel industry will face in the future: how to properly approach excavation on a site that is endowed with ecological value. An ecological study of the area could have been invaluable as a planning aid. Since the site is owned by a sand and gravel company and since there will be excavation, the solution attempts to assure that operations on the site will respect the existing conditions and protect the ecology to the extent possible.

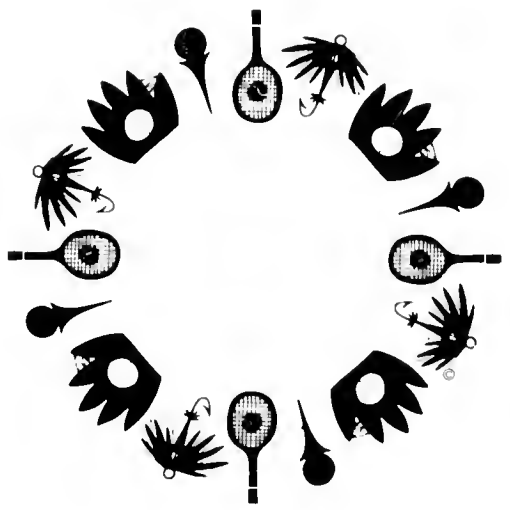
The soils analysis was an important basis for planning and suggested placement of recreational use areas. Since a thorough on-the-site survey was not possible, aerial photographs proved to be very useful. In many cases such information is more revealing than actual on-site surveys since they do portray overall relationships, and show how various vegetation and topographic features relate to each other.

Since the site is wet, and recognizing the fact that excavation will expand existing bodies of water, the proposal suggests the possibility of incorporating a marina into any recreational development. However, boats are noisy, produce oily residues, and cause wakes, all of which are destructive to wildlife, especially in delicate esturine environments such as Mason Springs Farm. The best location for a marina is in the vicinity of Nelson's Point. This location is on the west boundary of the site which is also the farthest down stream location. In situating the marina at Nelson's Point the site is penetrated to the least extent possible. By restricting boat traffic to that portion of the Creek below Nelson's Point, the problems of noise pollution, wake damage, and oily residue, are restricted to the lower portion of the site.

To further guard the wildlife habitats from damage induced by boat wakes, existing mud flats across from Nelson's Point, adjacent to the main channel of Mattawoman Creek, have been left intact, and increased in size and height by the addition of overburden. A similar practice is suggested for the eastern end of the site where the main channel runs between exposed mud flats. In this location islands would act as isolating elements and tend to segregate the areas behind them from the remainder of the site. These smaller isolated pockets would be more conducive to wildlife habitat establishment and would tend to hasten the site's return to a natural state. The backfilling at the breakthrough between Phases 2 and 3 is proposed for the same reasons. The resulting peninsula would separate the more active western sector of the site from the more naturalistic eastern sector. It would also act as a natural barrier guarding against the possibility of the main channel shifting.

The recreational development of the dry portion of the site is relatively passive in nature. This is not a site that would best be utilized for active court and field games.

Access is best afforded to the marina area via the existing logging road leading from Highway 224 to Nelson's Point. Another access point would be located at the east end to service the row-boat rental, fishing area, and the picnic area.



Chatfield Dam and Recreation Area

The Chatfield Dam and Recreation Area is a Corps of Engineers flood control and water retention project. Devastating floods which occured in 1965 along the South Platte River pointed out the need for additional flood protection for Denver and surrounding communities.

The dam is now under construction and is located approximately 13 miles south of metropolitan Denver, and four miles South and West of the corporate limits of Littleton. The total size of the site encompasses approximately 5,000 acres. The dam is situated at the confluence of the South Platte River and Plum Creek. Resulting water impoundments and potential pool areas are as follows:

Normal Recreation Pool	1,150 acres
Fifty Year Flood Frequency Pool	1,280 acres
Flood Control Pool	4,500 acres

Since the South Platte River is the boundary line between Douglas and Jefferson Counties, the recreation area is equally located in both counties. At present the land is primarily agricultural grazing land with sparse single family residential development, but it has the potential of becoming a major source of supply of sand and gravel for the Denver metropolitan area. There are a few small subdivisions on the northwest side of the dam. Of greatest significance is Columbine Heights, containing approximately five hundred homes, a school, a church, and a public playground. Further to the west is a development known as Meadow Brook Heights, containing approximately thirty single family residential units and several hundred vacant lots zoned for residential use.

Access to the Chatfield site is excellent. The existing major highway that connects Littleton with Denver proper (U.S. 85) intersects state highway 75 at the dam site. Highway 75, known as the Platte Canyon Road, crosses the South Platte River and continues to Waterton and the Glenn L. Martin Plant each situated at the southern end of the site. State highway 121 traverses a route along the western boundary of Denver, penetrates the Meadow Brook Heights subdivision west of the dam and intersects highway 75 near the dam.

Sand and gravel resources are most evident south of the dam along the South Platte River. The land immediately south of the dam contains rich deposits of sand and gravel that will not be available for extraction because operations will utilize the material in the construction of the dam.

The land lying between highway 75 and the South Platte River is presently level grazing land and contains rich deposits of sand and gravel. Test borings supplied by the Martin Marietta Company, owner of the land, indicate the existence of marketable deposits. Overburden averages 4′ to 6′ in depth and consists of unconsolidated granites and sandy clay loams.

The area is not new to sand and gravel mining. The Hall Sand and Gravel Company is presently working in an area north of highway 75 where the highway crosses the river. The Douglas County Gravel Company operates a site near the south end of the South Platte River portion of the flood reservoir area. There are other sites, both active and abandoned, that offer testimony to the existence of sand and gravel resources along the South Platte River, although the Plum Creek extension of the site appears lacking in sand and gravel resources.

The actual recreational development of the entire area, as well as the construction of the dam and its associated features, is a project of the U.S. Corps of Engineers. Their recreation proposals have not been altered and do not conflict with proposals set down in this study.

At the time this study was initiated, the Corps had developed a recreational development proposal for the area. Upon locating and plotting the productive sand and gravel deposits, it was found that the recreational plans of the Corps of Engineers did not overlap or conflict with any mining operations that could occur on the site, since much of the sand and gravel deposits will be underwater once the dam is completed and the recreation pool filled. The area south of the recreation pool and along the South Platte River has not been designated as an active recreation area. The rich deposits in this area can be extracted without alteration of existing recreational plans.

It was determined that there are three (3) distinct situations where sand and gravel could be mined that would have significance from a recreation standpoint.

1. Where lake meets shore and both overlie the deposit. Excavation could proceed from the lake towards the land, introducing the possibility of creating a varying shoreline. (Site 1 north).
2. Where deposits exist in the floodplain, but not adjacent to the lake. (Site 2 south).
3. Where sand and gravel deposits have been covered by the recreation pool, introducing the possibility of creating islands where the water is shallow enough. (Site 3 north).

To further emphasize the recreational potential that each of the above situations offer, three different sites were selected within the Chatfield Recreation Area to be developed for recreation use.

Following are illustrations that comprise this case study.

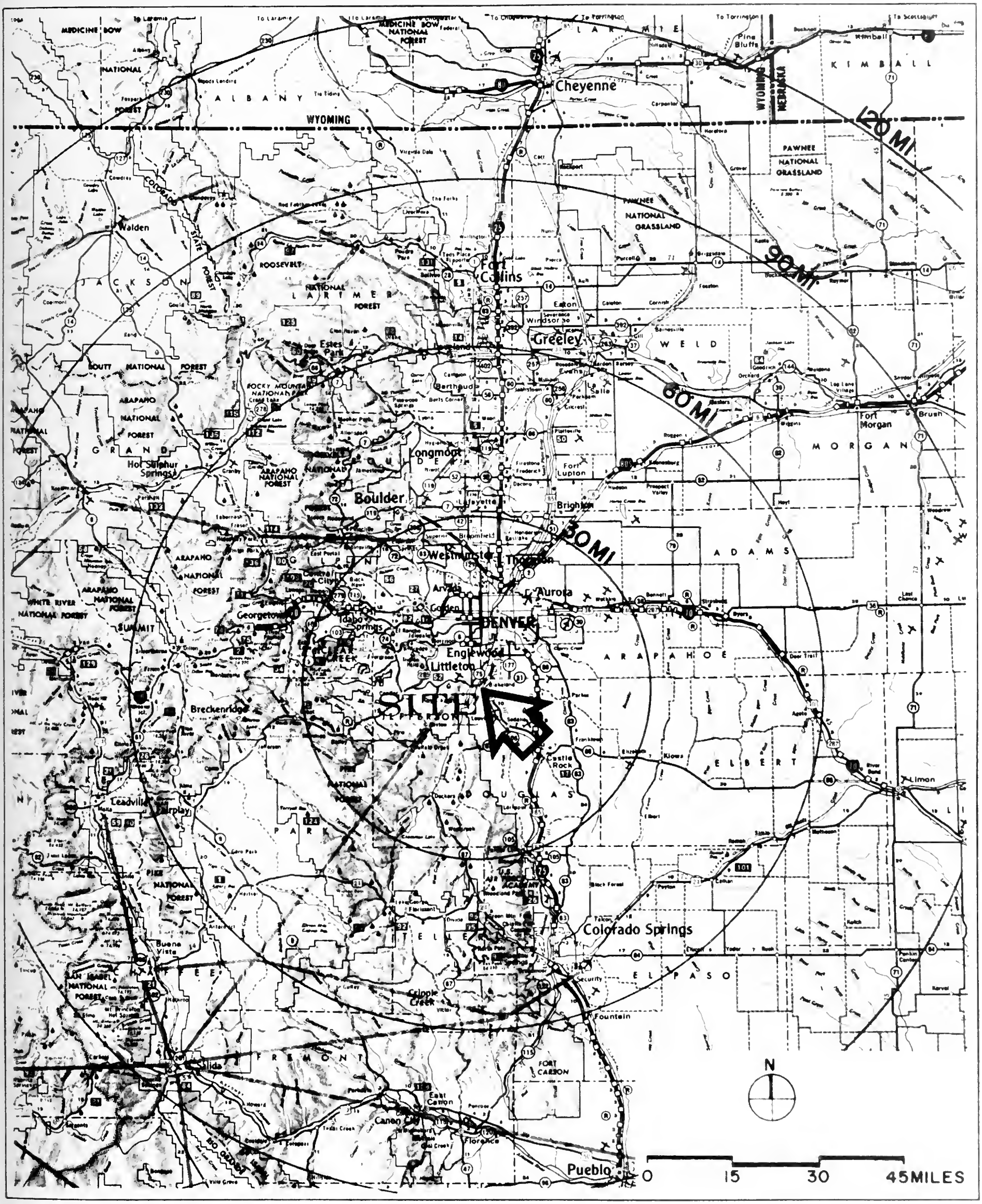


Figure 53 Location-Regional

Significance: Suggests that recreational use of the site could be a regional attraction.

Source: Highway map — Colorado.

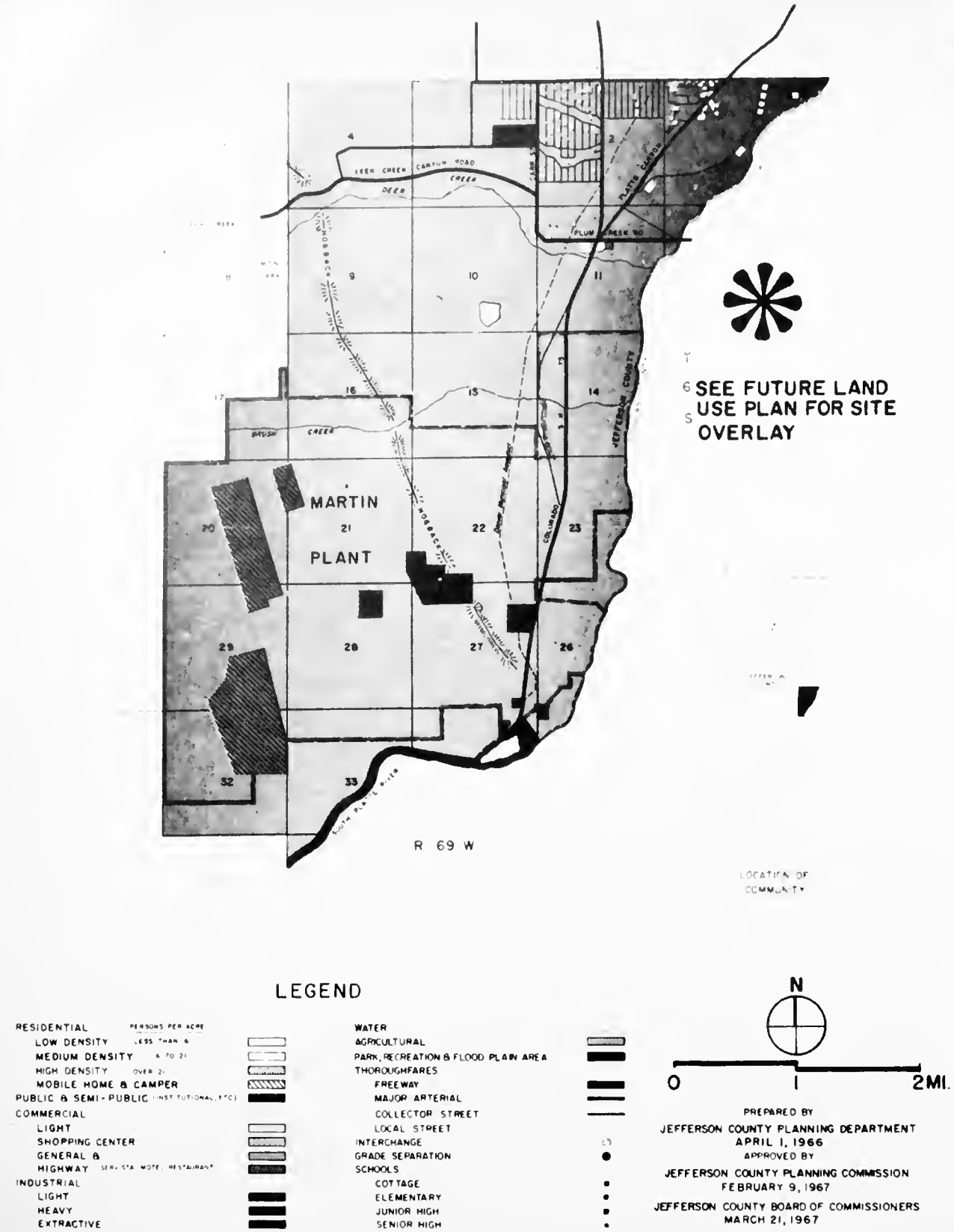


Figure 58 Existing Land Use

Significance:
Suggests that recreational development of the site will not conflict with adjacent land uses.
Source:
Jefferson County Planning Department.

Figure 59 Future Land Use

Significance:
It appears that all development centers around the site, recognize recreation as the dominant theme.
Source:
Jefferson County Planning Department.

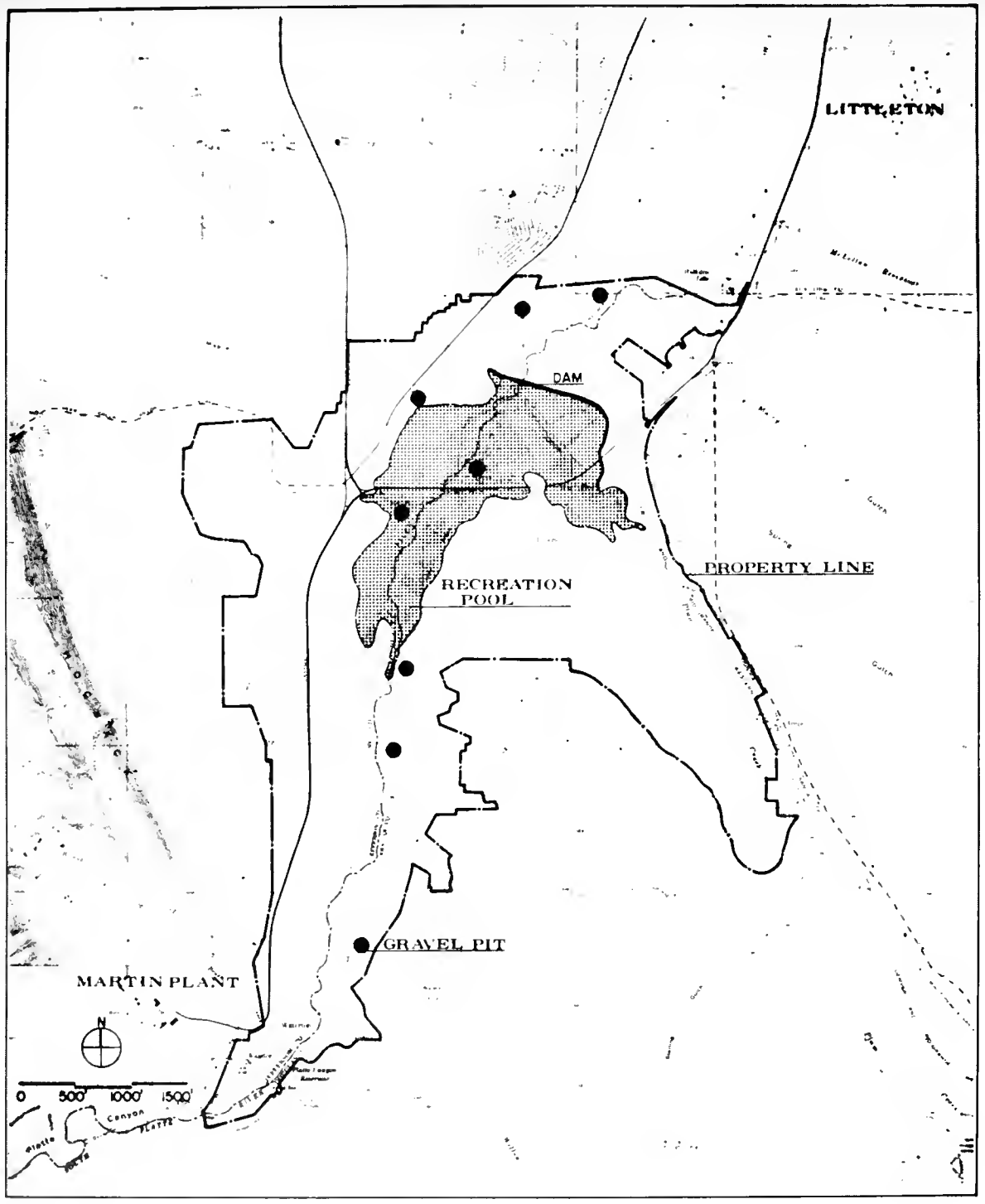


Figure 60 Physical Features

Significance:
Locates the features that affect development of the site and also recognizes features that should be preserved for recreation.
Source:
U.S.G.S. map.

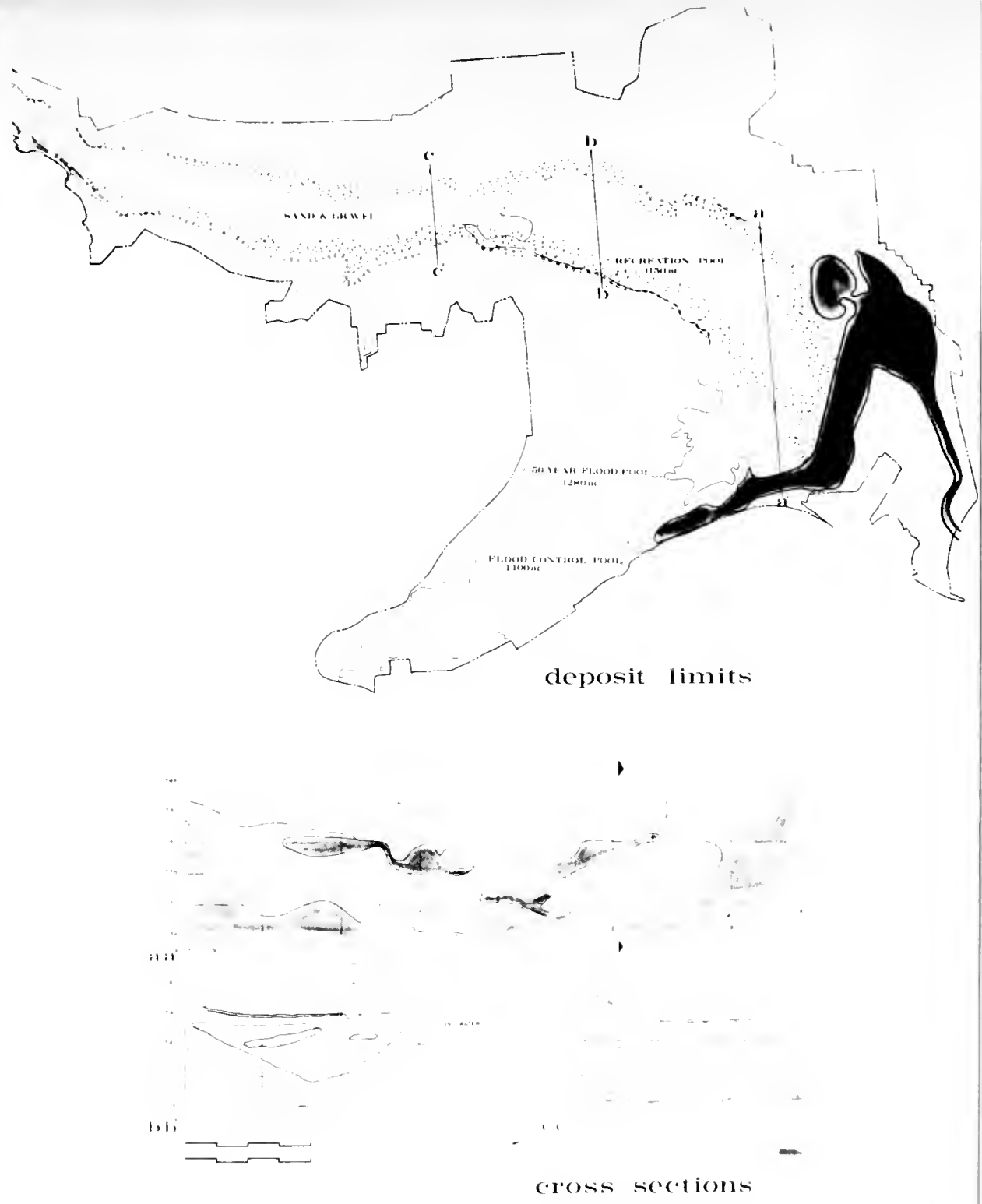


Figure 61 Sand and Gravel Resources

Significance:
Identifies the areas that may be affected by excavation and indicates the extent and configuration of deposit.
Source:
U.S. Army Corps of Engineers.

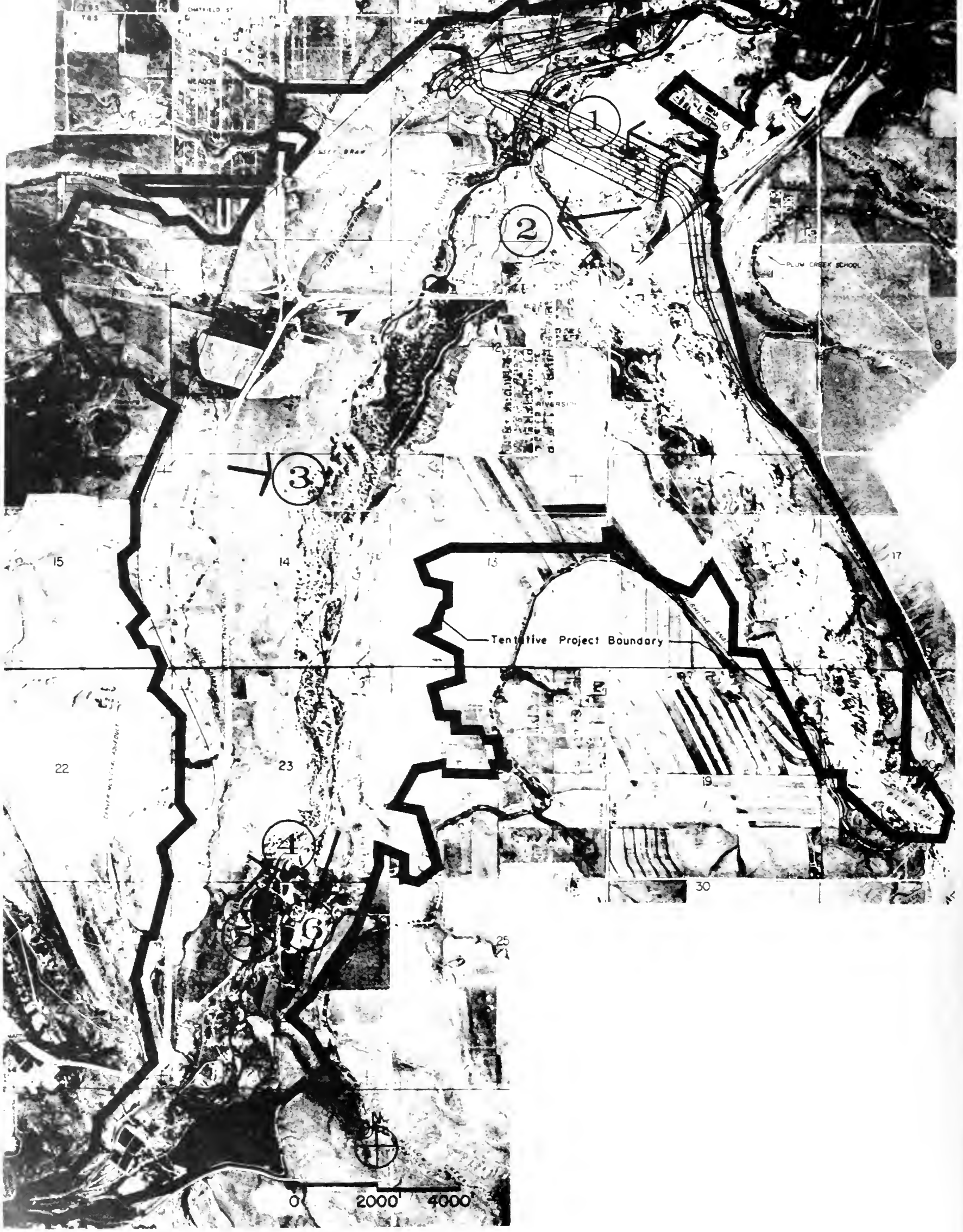


Figure 62 Aerial Photograph

Significance: Shows current locations and relationships of various features of the landscape, such as trees, hills, and streams.

Source: Colorado Sand and Gravel Producers Association.

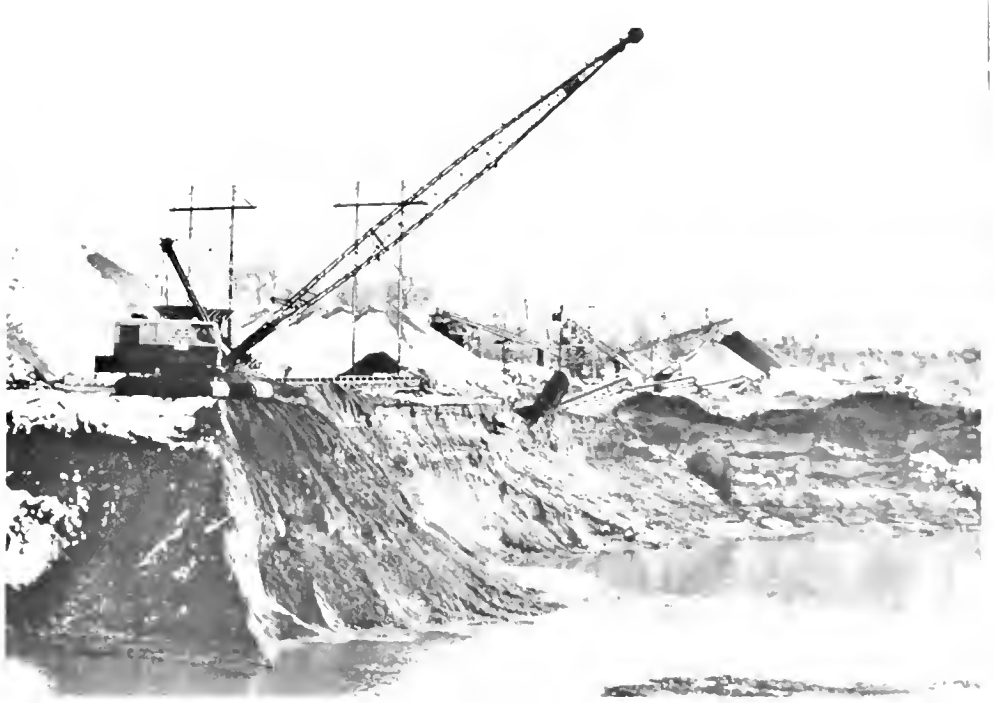
1

2

3

4

5



6

Figure 63 Detail Shots

Significance: Focuses on the character of the site and significant physical factors that may offer a suggestion as to the nature of proposed recreational development.

Source: U.S.G.S. map.

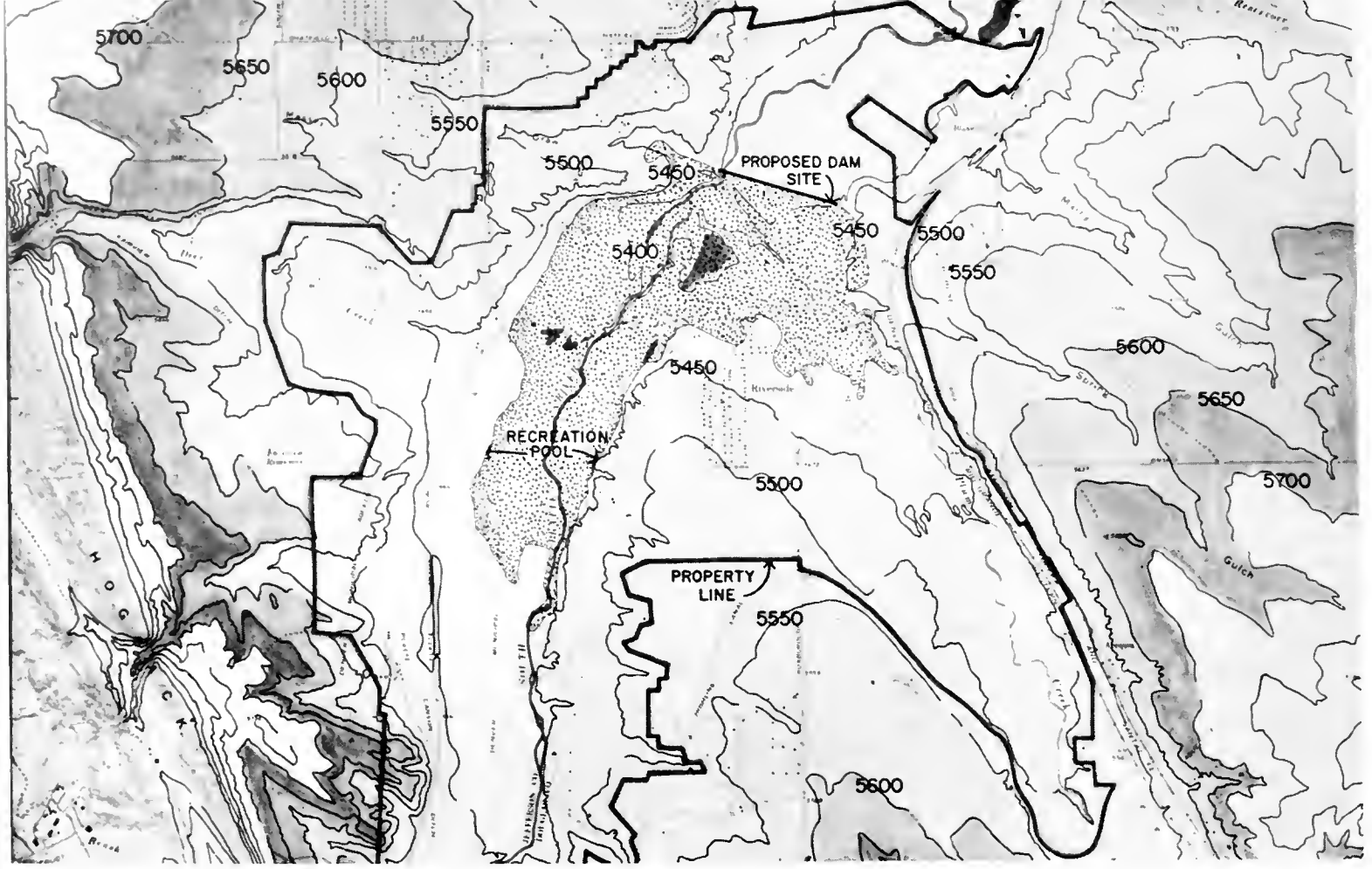


Figure 64 Physiography

Significance: Shows the dam location and how existing topography variations may affect development.

Source: U.S.G.S. map.

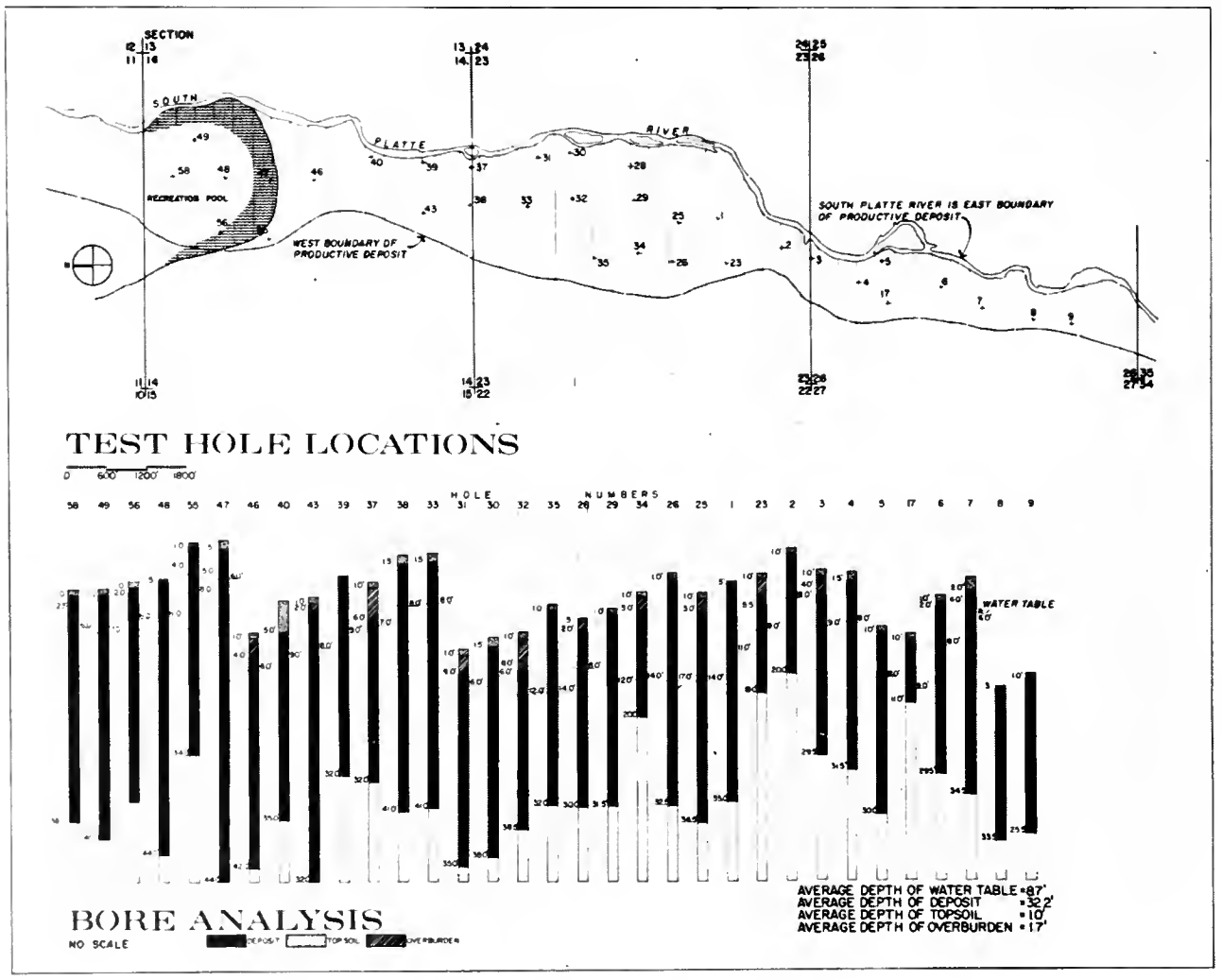


Figure 65 Deposit Data

Significance: Gives a more detailed account of deposit location, configuration, and composition.

Source: Martin Marietta Company.

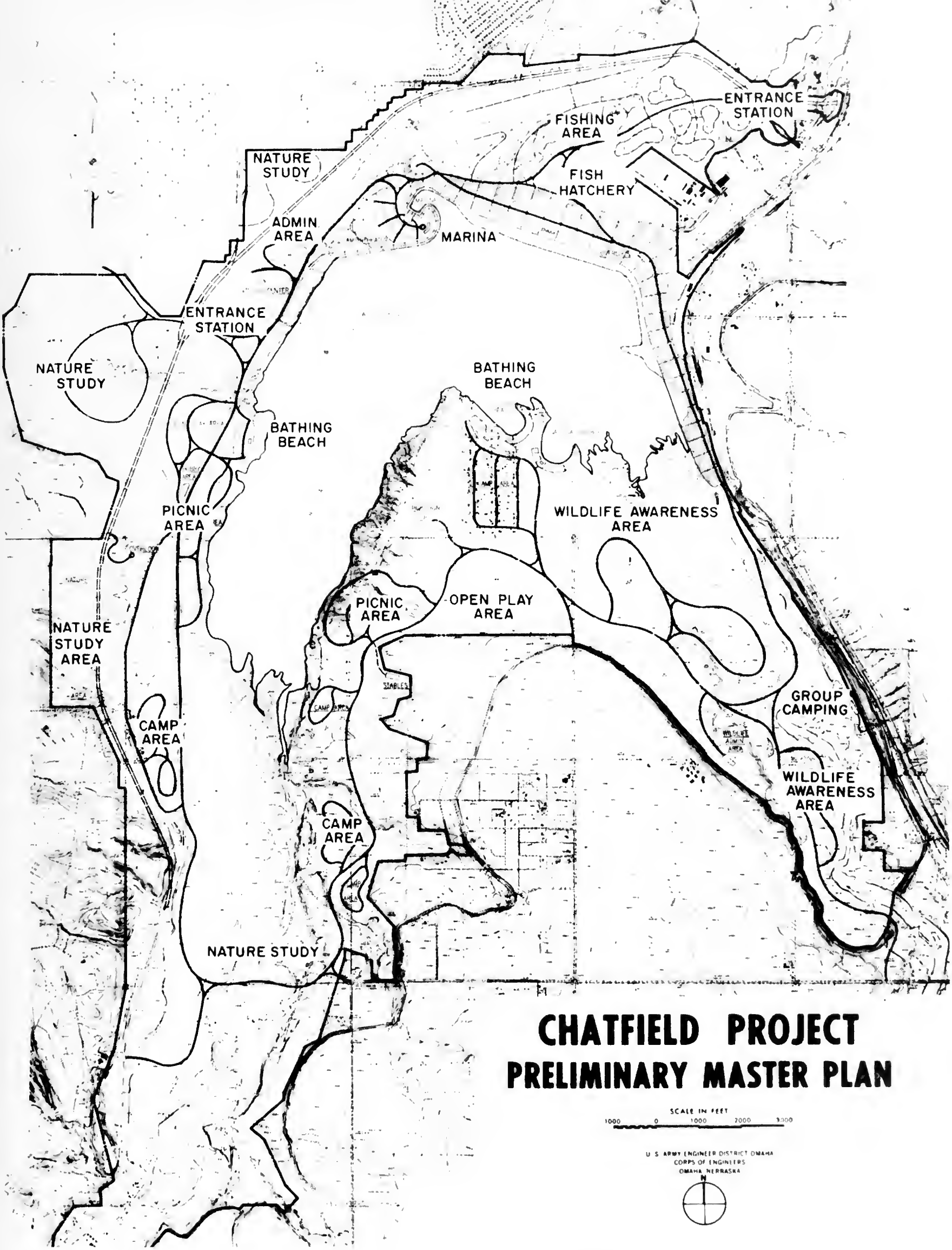


Figure 66 Recreational Use Areas

Significance: Illustrates the recreational development proposals of the Corps of Engineers for Chatfield.

Source: U.S. Army Corps of Engineers.

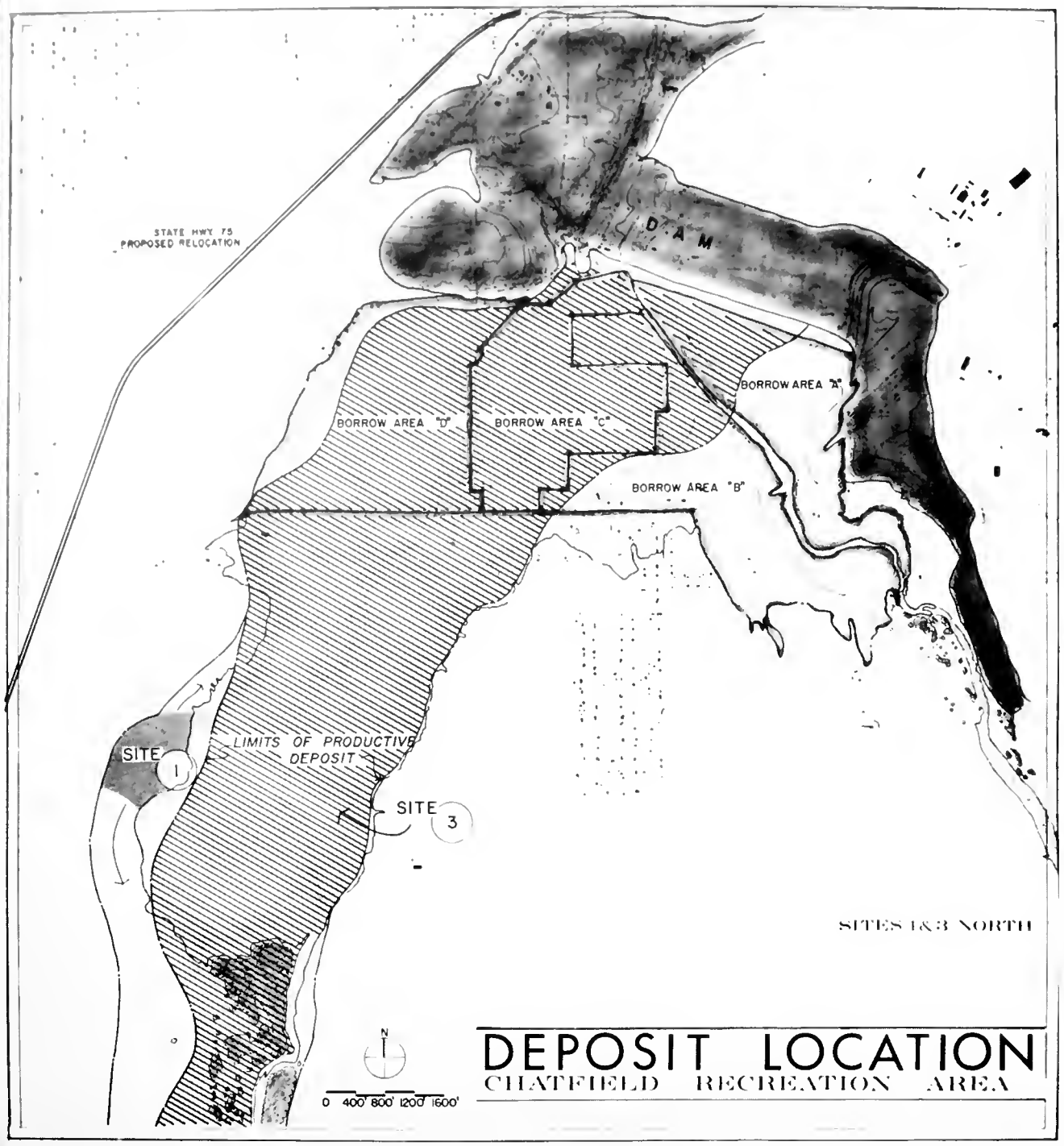
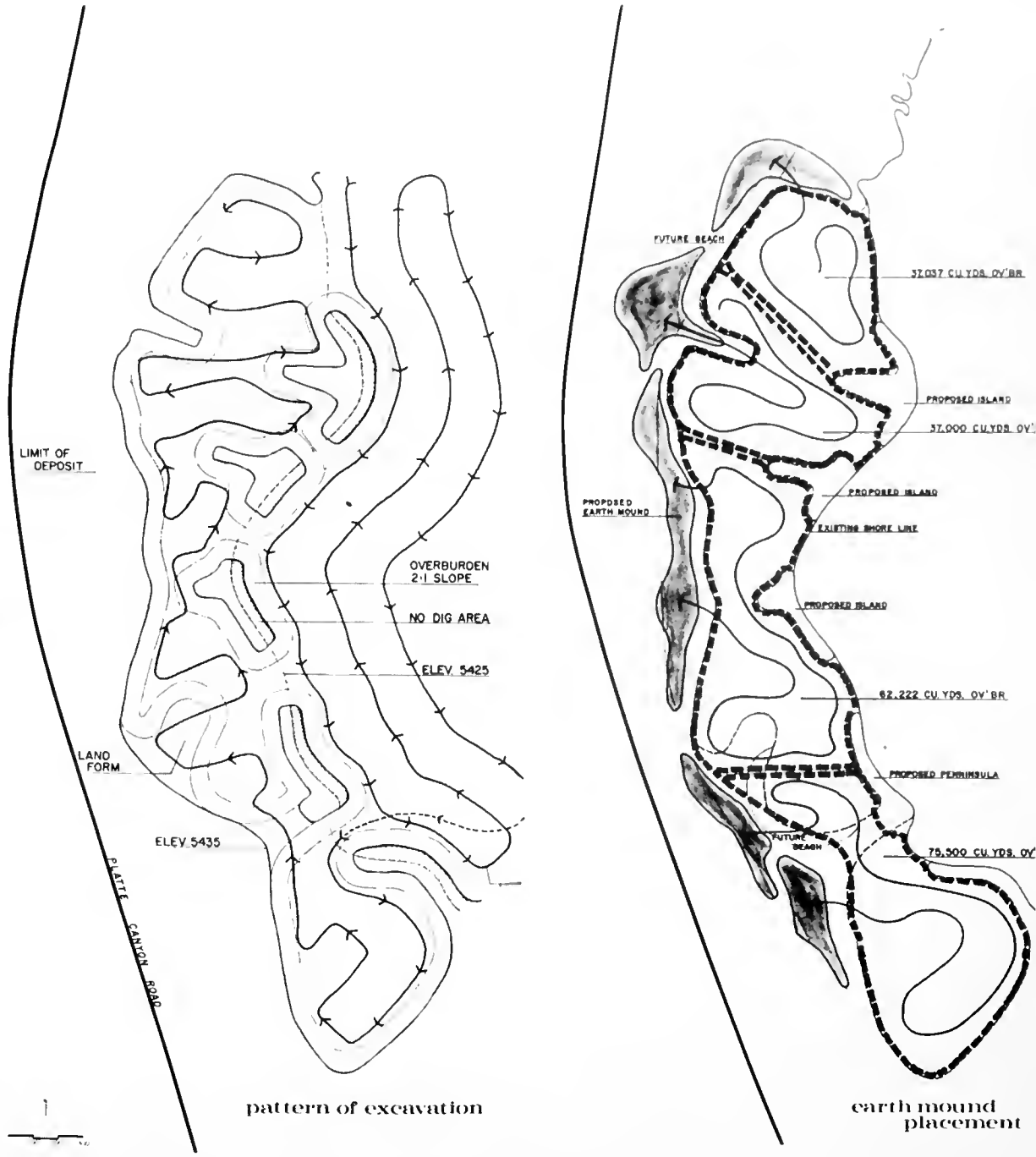


Figure 67 Deposit Location — Sites 1 and 3 North

Significance:
Pinpoints the general locations of two of the three areas that display particular features significant to recreational planning in wet sites.

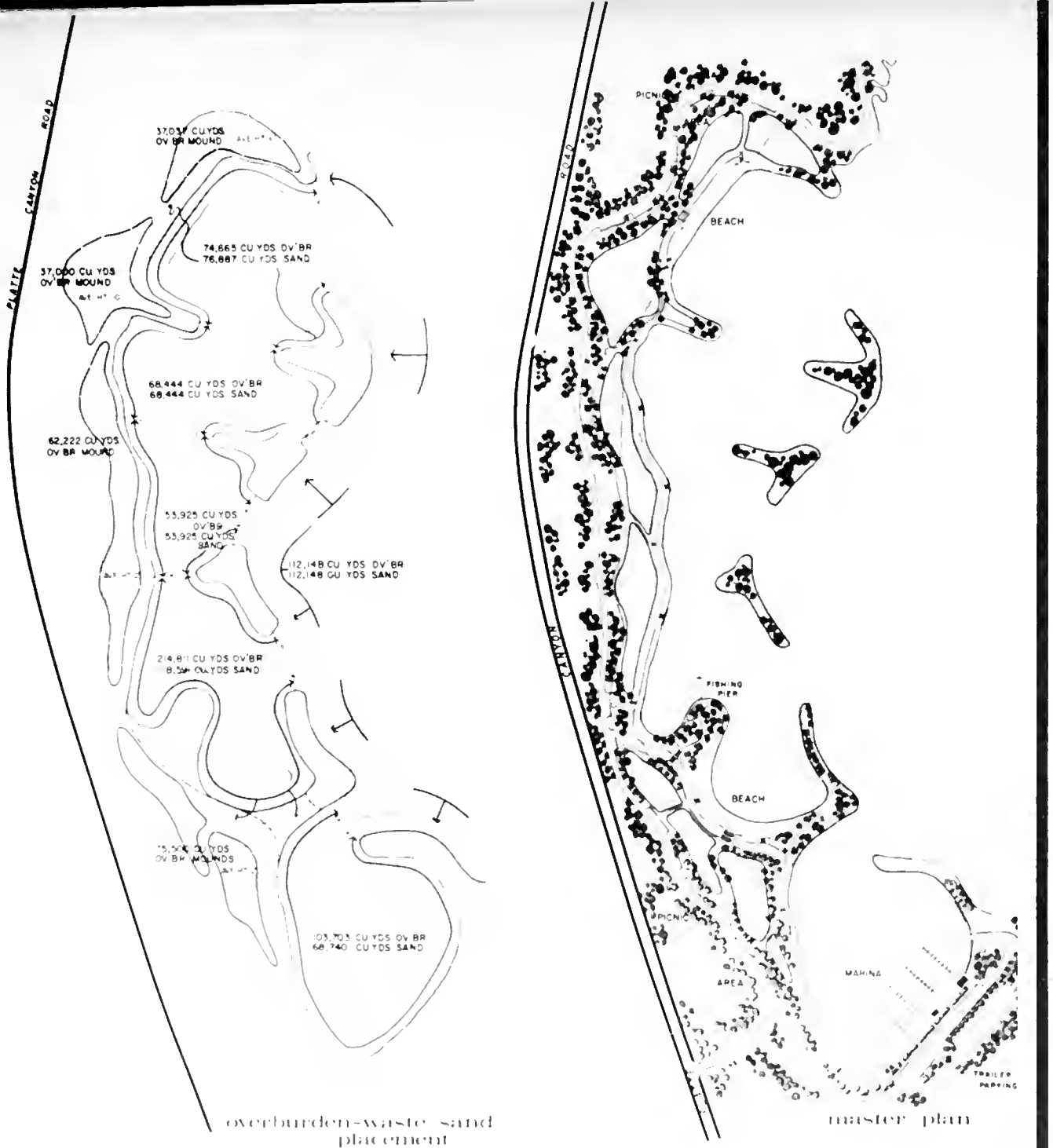
Source:
Martin Marietta and Colorado Sand and Gravel Producers Association.



Figures 68 Site Reclamation

Significance:
Shows how various operational phases can contribute to a development proposal.

Source:
Author.



overburden-waste sand placement

master plan

Figure 69 Site Reclamation

Significance:
Shows how various operational phases can contribute to a development proposal.

Source:
Author.

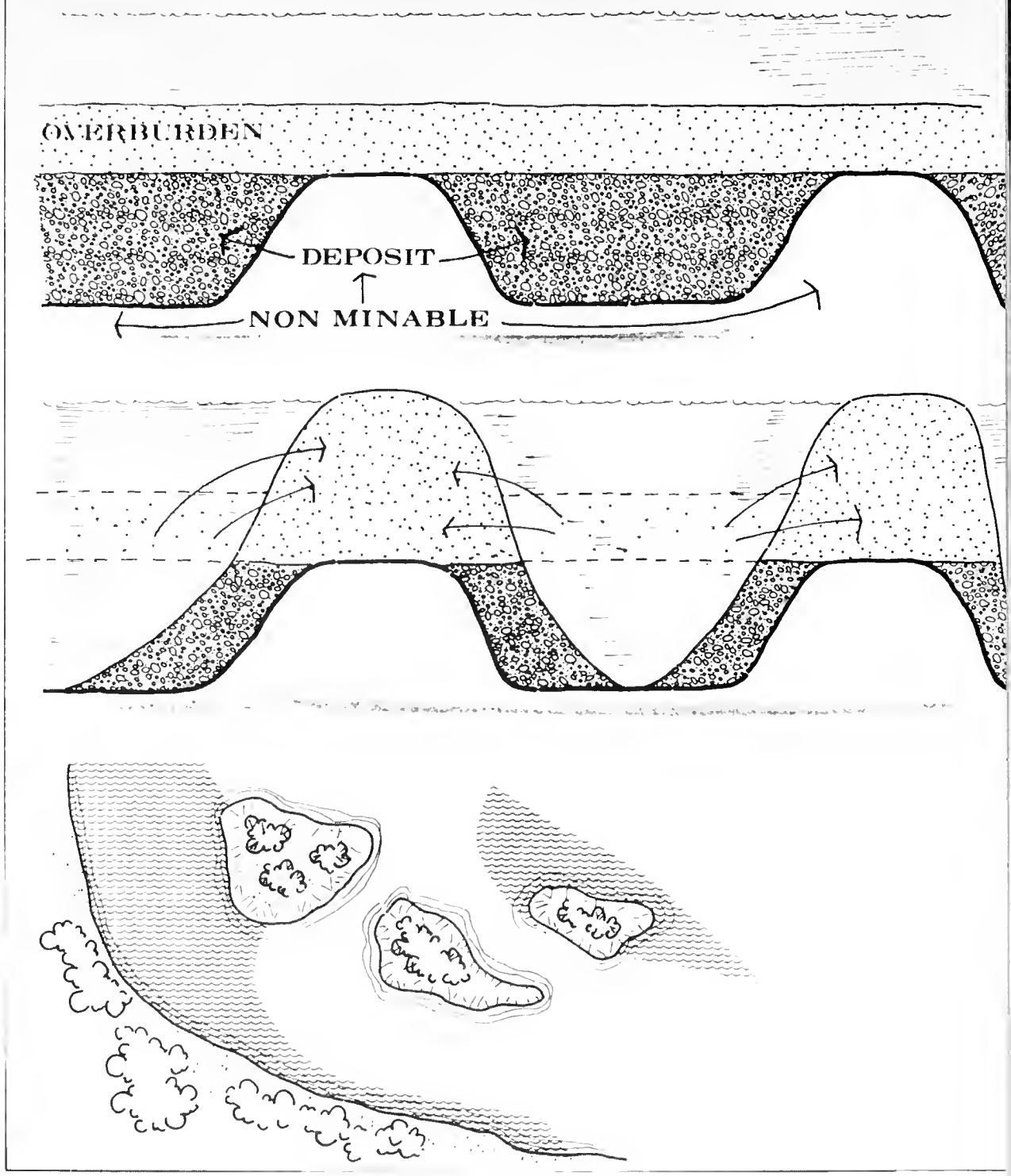


Figure 70 Development Proposal (Site 3)

Significance:
Illustrates how islands may be formed from overburden. They could be valuable recreation features in like situations elsewhere.

Source:
Author.

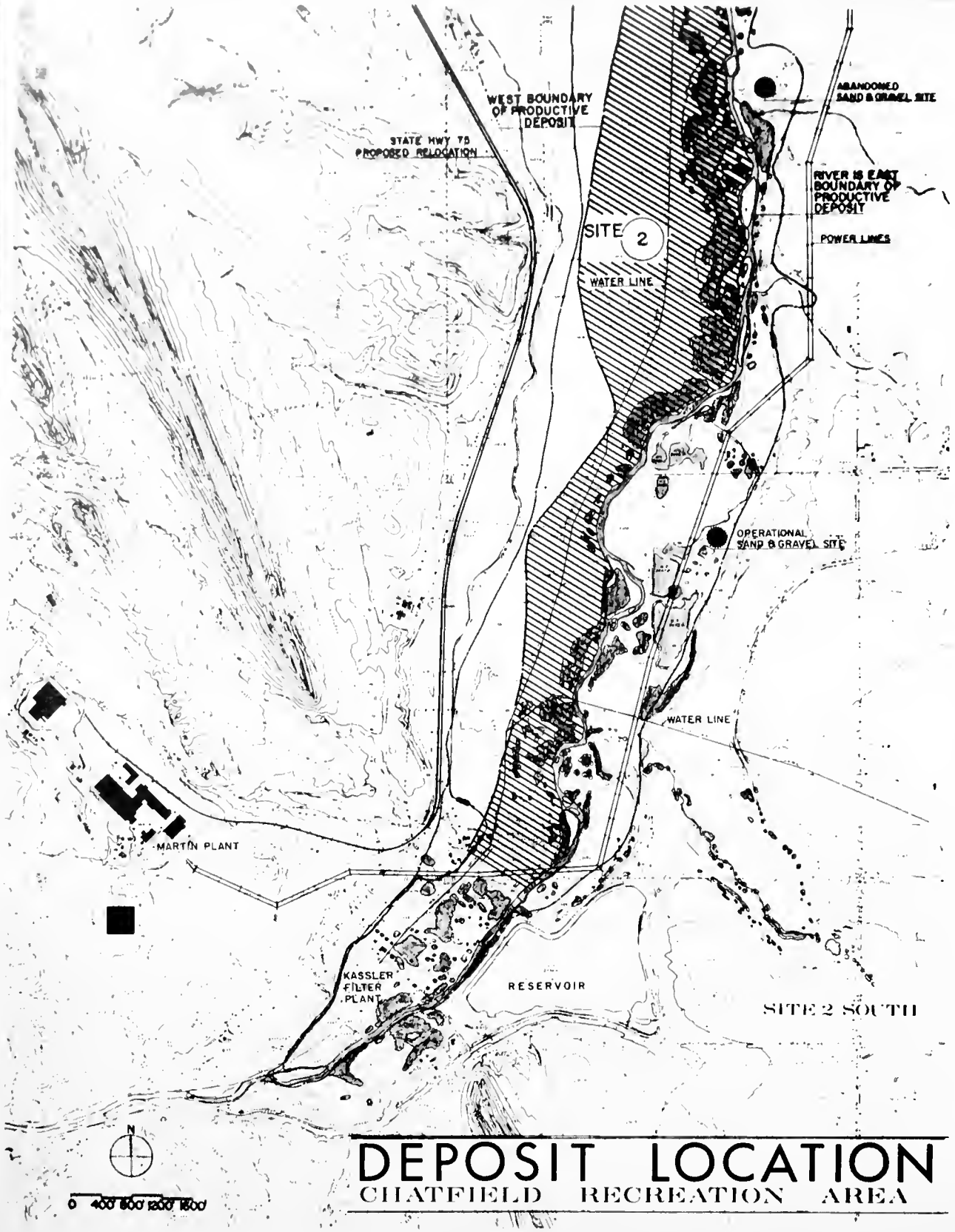


Figure 71 Deposit Location (Site 2 South)

Significance:
Locates and shows the site characteristics of test site 2.
Source:
Author.

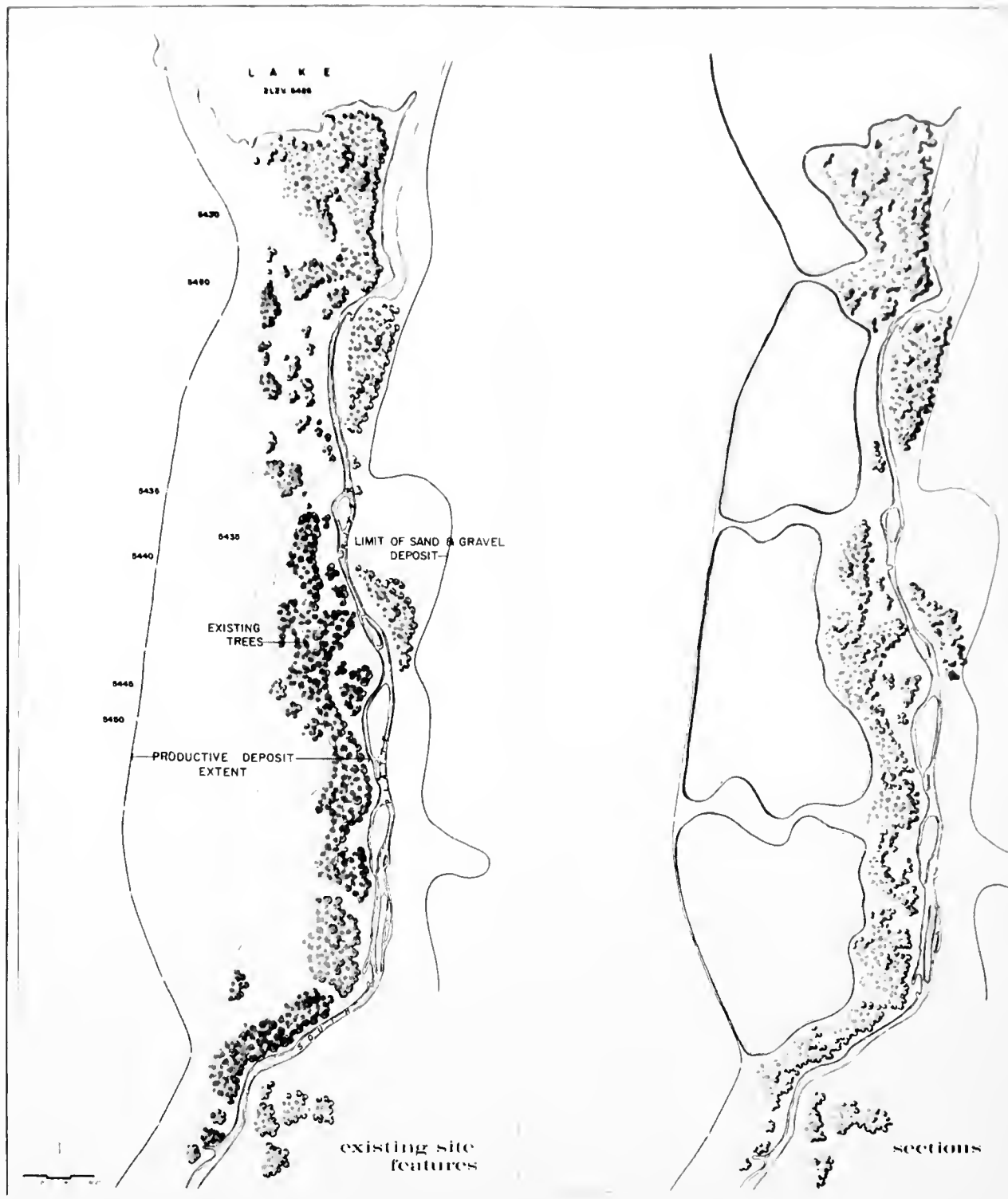


Figure 72 Site Configurations Possible

Significance:
Illustrates how a particular design proposal may alter the shape of the shoreline. Master plan shows ultimate site development.
Source:
Author.

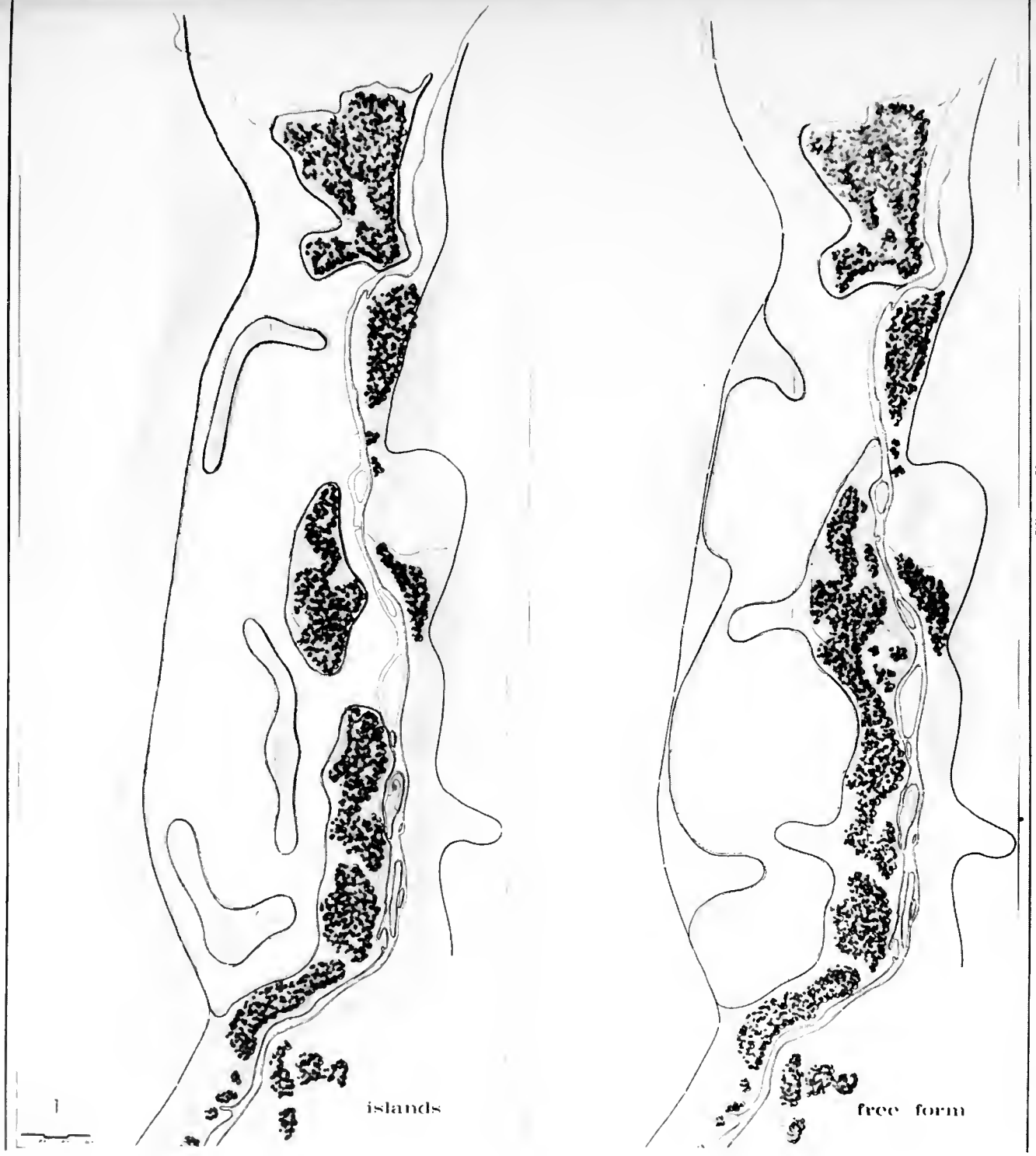


Figure 73 Site Configurations Possible

Significance:
Illustrates how a particular design proposal may alter the shape of the shoreline. Master plan shows ultimate site development.

Source:
Author.

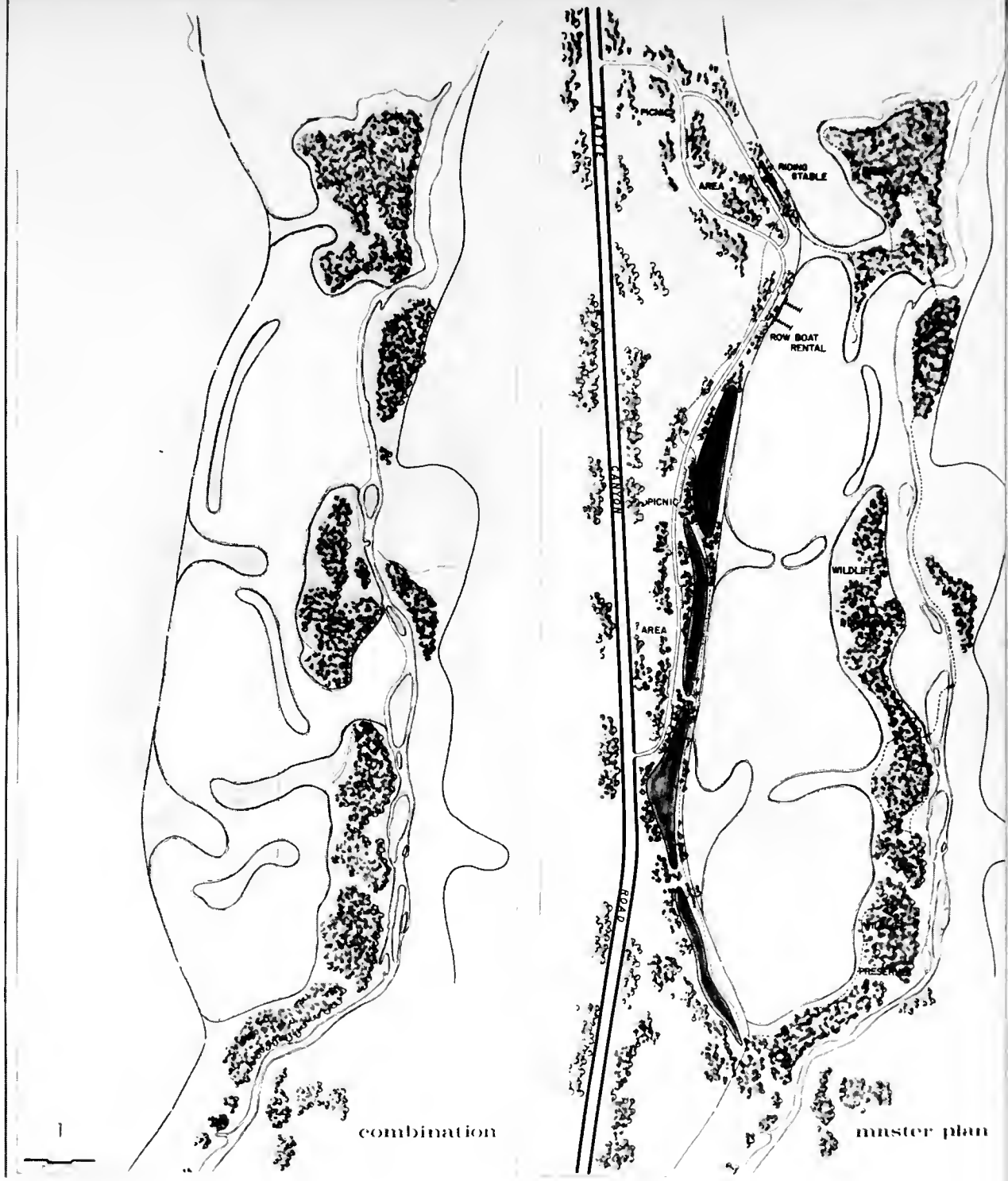


Figure 74 Site Configurations Possible

Significance:
Illustrates how a particular design proposal may alter the shape of the shoreline. Master plan shows ultimate site development.

Source:
Author.

Figure 75 Walk and Bicycle Path Adjacent to Lake

Significance: Shows character of proposed development.

Source: Author.

Summary:

A trip to Cherry Creek Reservoir, a similar type of recreation project development by the Corps of Engineers southeast of Denver gave some insight into how Chatfield Recreation Area might be developed by the Corps. Since Denver is a semi-arid region, trees are sparse except near water or in the mountains. For this reason a number of trees have been planted at Cherry Creek and appear to be the major features around which picnic areas and other use areas have been planned. Chatfield also needs a substantial number of trees, since the topography is presently flat or gently rolling adjacent to the lake.

Existing trees on the southern end of the South Platte River leg will be the only significant stands on the entire site once the recreation pool is filled. Because they are valuable wildlife habitats and add great interest to that area, they should be saved in order to contribute to the character of the area and dictate the type of recreation that should be programmed for that area.

Each mining area focuses on a specific approach to recreational development. It is suggested that similar development schemes be formulated for similar areas that contain sand and gravel deposits. Certain portions of the Corps of Engineers recreation master plan could be altered to permit mining and progressive recreational development. Such an arrangement whereby the Corps would allow mining and subsequent recreational development of the site would benefit both the Corps and the Colorado Sand and Gravel Producers.

Because of the openness of the land around the lake, specifically in the vicinity of Site 1 and Site 2, it was concluded that any recreational development of these areas should be relatively passive in nature. It is felt that a number of individual beach areas of the type suggested at Site 1 could better reflect the character of the area than one or two large facilities that would require sizable parking and service areas. It is hoped that the solution of the Site 1 area can be applied to similar situations that exist on the site further north and would be relevant in like situations elsewhere.

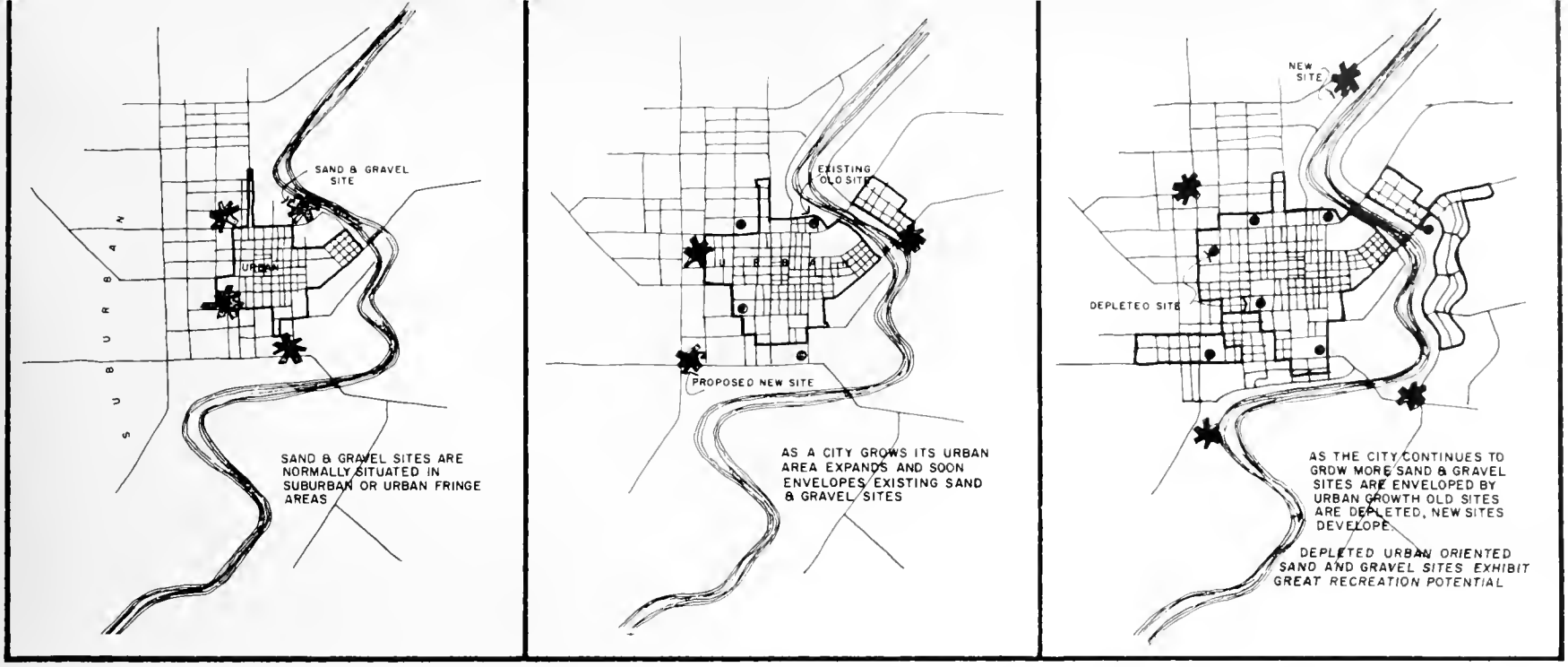


Figure 76 — The effect of urban growth on sand and gravel operations

CHAPTER VI

Conclusions

The demand for outdoor recreation, coupled with the equally important need for construction aggregates has focused attention on the possibility of developing sand and gravel sites for recreational use. Such a situation is favorably strengthened when considered in the context of an urban environment. Present outdoor recreation facilities in many large cities are generally too crowded, too small, and many do not provide the uses that a diversified urban populace demands.

Sand and gravel sites are looked upon as potential recreational areas for a number of reasons. Their terminal site characteristics are probably most suggestive of recreation, while their size and location alone are reasons enough for them to be considered. If urban areas continued to grow as rapidly as they are now, the construction aggregate industry is going to have to meet this demand by establishing operations as close to their potential markets as possible due to the low cost-high bulk characteristics of the material and its relatively high transporting cost.

Since urban core areas are already intensely developed, any underlying sand and gravel deposits are probably not extractable. Consequently, the producer is forced to acquire sites in increasingly suburbanized localities. (Figure 76) These sites occur in areas that are less developed than urban core areas and therefore do not represent immediate annoyances to adjacent land owners. As these sites are slowly depleted, the surrounding area is rapidly growing. Soon all adjacent property is developed and in many cases the only significant open space in the area is the almost depleted sand and gravel site. Soon the site is depleted, and abandoned until property costs rise to such proportions that it becomes economically feasible to develop the site in the form of subdivisions, sanitary land fill operations and/or other uses. Little thought has gone into the prior and concurrent uses of these sizable tracts of lands. Steps must be taken before such valuable recreation areas are lost forever to the bulldozer, asphalt paver, steamroller or the many other manifestations of man's need to develop. One ob-

Speedboat course

Beach

Childrens' Amusement Park and Zoo

Private lake

Figure 77 — Examples of recreational rehabilitation

vious step in this direction would be to zone gravel bearing land for future extraction. This property would not be totally lost if it were not immediately utilized by the producers. Such land could be a significant contribution to a city's open space program. Sites could be rehabilitated to conform with the particular recreational desires of the local communities or they could be developed in such a manner so as to duplicate the existing character of non-mined adjacent open space.

It was pointed out quite early in this report that sand and gravel sites closely resemble urban-suburban recreation areas. Basically, the lengthy period of operations, often 15-30 years, and the potential annoyance factors associated with mining are reasons enough for many people to object to any mining. However, it is this stage of mining, excavation, that will generally transform a site into a highly desirable recreational area. Annoyance factors cannot be totally eliminated, but they can be adequately minimized. This can be done in many ways, the more common being the utilization of earth mound and/or vegetative screens situated in such a manner that recreation and mining interests are not only physically separated, but noise, unsightly views into the operations area, and dust, are strategically controlled.

If a producer does desire to rehabilitate his site for recreational use he should, in most cases, approach development via progressive rehabilitation. This does necessitate a predevelopment plan, which could allow the site to be utilized for recreation

Park

Golf course

Recreational housing development

Skeet range

Figure 78 — Examples of recreational rehabilitation

prior to, concurrent with, and subsequent to excavation. Progressive rehabilitation is recommended because:

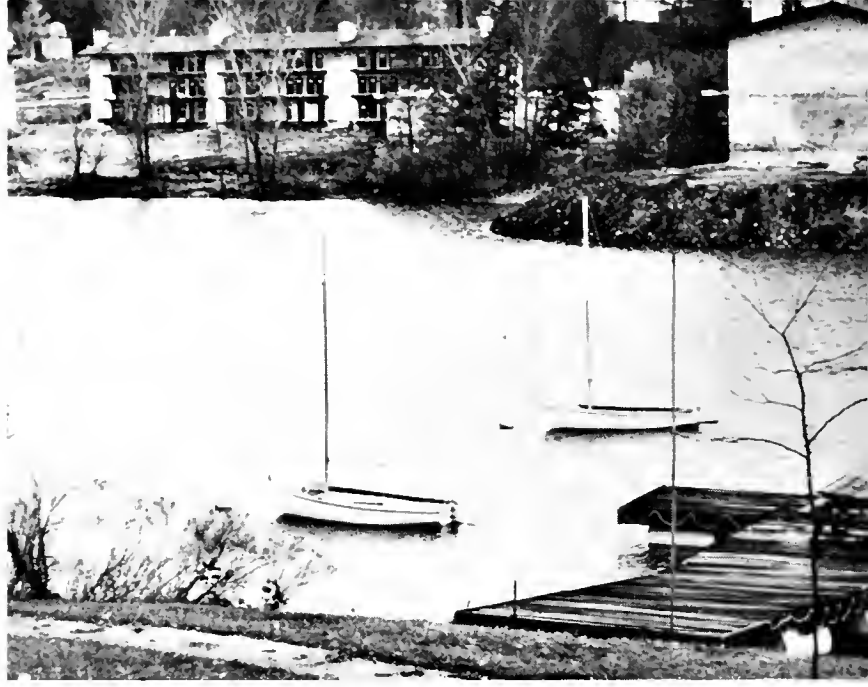
1. It utilizes already available personnel and equipment. Rehabilitation work could occur during slack periods or during winter slowdowns.
2. It opens the site to recreational use sooner than other methods.
3. It assures the concerned public that recreational development will be the terminal site use.
4. It could be the most economical method of development.

It should be emphasized that non-rehabilitated sites have contributed favorably to outdoor recreation and may be considered superior to developed sites by many naturalists, boaters, hunters and fishermen.

The final success of any proposed rehabilitation project is necessarily dependent upon the implementation stage, or grading and earthmoving phases of operation. Certain site features must be made to conform to desired recreational use requirements. Basically the major site features to work with are slopes, cut banks, overburden mounds, and impressions or depressions. In each of the previous situations the size, height, location, stability and slope gradient are factors to be considered.

It is obvious that such a complex undertaking as transforming a sand and gravel site into a recreational feature demands the expertise of various pro-

Horse racing — park complex



Lake oriented apartment complex

Lake oriented condominium complex

Private lake

Figure 79 — Examples of recreational rehabilitation

fessionals. Although the producer possesses an adequate understanding of the various mining phases, he could employ the services of a site planner, recreational specialist and ecologist to assist him in his development of the site. There may also be many others that could be of some service to the operator.

The recreational potential that sand and gravel sites possess is virtually unlimited if considered within the context of the individual site. The character of physical terrain features can be altered in numerous ways to conform to desired recreational use requirements. The imagination of the planner and the ability of the producer to recognize recreational potential on a site are probably foremost considerations to any successful development. (Figures 77, 78, 79)

The evident lack of imagination that most present day rehabilitated sites exhibit is probably based on assumption that imaginative development costs more than a lesser imaginative scheme. This does not seem to be a justifiable reason for not considering the best possible solution to any rehabilitation proposal.

With so much justifiable concern being generated about our environment, pre-operations planning and long term rehabilitation solutions will probably become prerequisite to mining in the near future. It is only through such practices that the sand and gravel producer will be able to convince the public

Figure 80 — Slope stabilization

that his operations are in the public interest.

It should be realized that recreational rehabilitation need not be the sole re-use potential that a particular site may exhibit. There may be reasons why a depleted site could be utilized as a sanitary land fill operation, and subsequently transformed into a desirable recreational feature. Problems originating from the land fill operation would obviously have to be eliminated prior to any recreational use of the site.

Within the past five to ten years the rising popularity of recreation-oriented apartments, subdivisions, and condominium complexes has been phenomenal. Such are generally featured in conjunction with golf courses, lake complexes and generous open space. There is every reason to believe that depleted sand and gravel sites can be transformed into desirable recreation-oriented living habitats. Slopes could easily be stabilized (Figure 80) and made to support dwelling units, depressions could be converted into underground parking facilities or indoor recreational areas, and existing water features could serve to tie the total complex together.

This author believes that there is a great need for imaginative planning coupled with the realization by the producer and the public that there is unlimited potential waiting to be recognized and channeled in the desirable direction.

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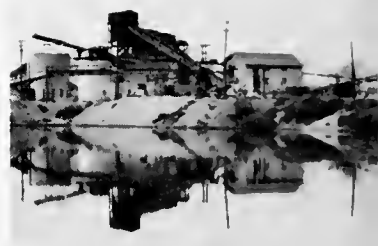

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