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EVALUATION OF COAL DEPOSITS IN THE NARRAGANSETT BASIN, MASSACHUSETTS AND RHODE ISLAND

Prepared for
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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CONTRACT NO. J0188022 –
EVALUATION OF COAL DEPOSITS IN THE NARRAGANSETT BASIN, MASSACHUSETTS AND RHODE ISLAND

FEBRUARY 1979

EVALUATION OF COAL DEPOSITS IN THE NARRAGANSETT BASIN, MASSACHUSETTS AND RHODE ISLAND

Edited by

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1979

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The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily the official policies or recommendations of the Interior Department's Bureau of Mines or of the U.S. Government.

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16. Abstract (Limit: 200 words)

Since 1976 28 drillholes have yielded 20,000 ft. of core, 4 of which produced 2,100 ft. of core in this BOM Phase 1 program, transitional from the initial NSF Phase. Results to date show that the Basin is complexly folded and faulted and variably metamorphosed.

The northern two-thirds of the Basin is less deformed and metamorphosed than the southern third. The deformational model which explains the data and which will guide future drilling, holds that coal has been mobilized during deformation and concentrated in the crests and troughs of folds as greatly thickened pods and lenses. About 60 percent of the 28 holes have encountered coal over 10 ft.thick and seams up to 30 ft. have been mined in this century. The coal is low sulfur, high ash anthracite. Mapping o surficial geological and societal factors important to potential mining has been done and a computerized mapping capability of the Basin of 1 sq mi grid developed based on weighting values of geological and non-geological factors. We recommend that a substantial drilling and geophysics program comprise BOM Phase 2.

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ACKNOWLEDGEMENTS

We express our profound gratitude to the multitude of persons whose efforts have made the completion of this volume a reality, and to those who have helped us to better understand the coal-bearing Narragansett Basin. It is not possible to name them here. This is, and continues to be, a project whose growing momentum is a product of the interest and concern of the people of the region and their elected representatives. Special thanks goes to the Oversight Committee of this Project for their interest and constructive guidance.

When the Narragansett Basin Project was about to pass beyond the NSF Phase, it became clear that there was no federal agency which considered this exploration effort as a high national priority and at the same time also had the resources to fund it. As a result of interest in seeing the promising results of our 1976 and 1977 studies continue, the Narragansett Basin Project was extended by means of a congressional appropriation. A number of elected officials played prominent roles in this bipartisan effort to make this possible, notably Honorables Thomas P. O'Neill, III, Lieutenant Governor of Massachusetts; Thomas P. ("Tip") O"Neill, Jr., Speaker of the House (D-MA); Edward M. ("Ted") Kennedy (D-MA); Edward Brooke (R-MA). Special recognition is due to Representative Margaret Heckler (R-MA) for her extraordinary concern and untiring efforts to insure the continuation of this Project. We are grateful also to the entire New England Congressional Caucus. We extend our gratitude as well to the Congressional Staff members.

In addition to the scientific staff who are authors of various parts of this report, we are grateful to others who assisted in other activities: George Cutter, Jay Jones, Daniel Logue, Dennis Place, Donald W. Podsen, Lesley Manent, Margaret Hanley and Sally Sargent. We wish to acknowledge the dedicated efforts of Patricia C. Tassia, Jean M. McElvery, Dorothy M. Sheehan, Janet M. Reach, and Joan Miller in the preparation of this report, and to Bruce H. Withey who prepared the artwork and illustrations.

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A. Masslite Quarry, Mass.

B. Norton, Mass.

C. Seekonk, Mass.

D. Portsmouth, R.I.

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Graphic logs of the drillcores obtained under the National Science Foundation Grant No. AER76-02147.

ABSTRACT

This report summarizes the results of the Narragansett Basin Project's activities during the U.S. Bureau of Mines (BOM) Phase 1, which was transitional from and which followed the National Science Foundation (NSF) Phase which initiated the investigation of New England's potential coal resource. The 960 sq. mile basin is a structural and topographic lowland containing 12,000 to 20,000 ft. of terrigenous clastic sediments of late Pennsylvanian age, and which rests on an upper Precambrian and Cambrian basement. The Rhode Island Formation, which is the coal-bearing unit, comprising the bulk of the Pennsylvanian rocks consists, in order of decreasing abundance, of sandstone, conglomerate, siltstone, shale, and coal. In the NSF Phase, 24 drillholes yielded 17,900 ft. of core; in the BOM Phase 1 study, 4 drillholes yielded 2,100 ft. of core. Anthracite and semi-anthracite was encountered in beds up to 30 ft. thick in widely spaced parts of the Basin. The coal, typically very low in sulfur, and a high ash anthracite, was mined in substantial volumes from 1808 to 1959 from shaft and open pit in Portsmouth and Cranston, R.I., and in lesser volumes in Mansfield, Mass. Currently coal is now being mined in Plainville, Mass. as a fuel in the manufacturing of lightweight aggregate from the same quarry that serves as the source of rock being processed.

The structurally complex Narragansett Basin is now known to have a greater extent than earlier since recent drilling by others (Chapter 2) has confirmed our interpretation that the Basin extended offshore south of Boston. The Basin also extends into Rhode Island Sound to the south.

The geological structure is more complex in the southern part of the Basin than in the northern part. Three episodes of folding have been documented on Aquidneck Island and four episodes of faulting have been demonstrated for the Basin as a whole. Relatively less well exposed rock in the northern part of the Basin, increases the difficulty of recognizing and correlating structural episodes in the northern part of the Basin. The Basin has been subdivided into six structural domains which appear to have distinctive structural, metamorphic, paleontological and sedimentological differences that may assist in isolating important events in the evolution of the Basin and its component parts.

The tentative structural model recently developed in BOM Phase 1 has important implications for exploration and mining. In the first and second folding stages the coal is mobilized and thickened in the crests and troughs of folds whose axes are horizontal to subhorizontal. While conventional coal exploration and mining methods are not applicable, great thickening in the crests and troughs of large scale structures, which can be defined by geology, geophysics and drilling, may provide compensating advantages. Bedrock over most of the Basin is 0-50 ft., but thicknesses of glacial deposits up to 150 ft. are present locally. Pre-Pleistocene topographic trends are controlled by structure and rock hardness; Pleistocene deposits aligned to the S.E. are superimposed on earlier trends.

The southern part of the Basin is mainly dominated by high grade Barrovian metamorphism and plutonism of Permian age, related to the Alleghanian Orogeny. About 300 sq. miles of the 960 sq. mile Basin has been affected. The remaining 660 sq. miles, in the chlorite and subchlorite zones of metamorphism are compatible with the presence of high quality anthracite and semi-anthracite. Illite crystallinity studies begun in the NSF Phase, have been carried out in the BOM Phase 1 with important results. About half of the northern Basin is now known to be in the diagenetic (unmetamorphosed) or subchlorite zone and the remainder in the chlorite zone of metamorphism. Illite studies, probably best recording temperature effects, show a generally progressive increase from the NW corner of the Basin near Plainville, Mass. toward the south and southeast. Reflectivity and coal petrography studies, probably best recording pressure and effects related to shearing, indicate a generally opposite pattern. Thus these methods provide powerful tools for the ultimate solution of problems important to coal exploration for coals of higher combustible volatile content and exploitation of these.

Due to the complex nature of the coal, chemical data may not be easily used to determine rank. The coals have been tectonically deformed and mineralized. This deformation plus thermal metamorphism have altered the coals, in some cases by producing natural coke. Brecciated coal is often coated with a secondary depositional carbon. The coals' hydroscopic nature and high ash contents are due to the deformed nature of the coal and the presence of this secondary carbon. The stratigraphy and sedimentology of the coal-bearing Rhode Island Formation is similar to described alluvial fan deposits.

The non-geological studies allow three conclusions to be made:

1. A substantial number of areas have been identified in the Narragansett Basin in which mining could be carried out without undue difficulty from a land use point of view.

2. Substantially more than two hundred instances of past or current mining activities have been identified in the Basin. Many of these are in areas defined as geologically interesting, and may be advantageous from the point of view of future exploration.

3. The map systhesis technique developed for this contract is successful and may easily be adapted to future exploration in its current form and also in its expandable form dealing with unit measurements of one-tenth mile.

We recommend that BOM Phase 2 exploration should accomplish the intent of the Congressional language in House Report No. 95-1251, to continue a substantial drilling and geophysics program:

> "The Committee expects the Bureau to continue studies involved in ascertaining the extent and quality of low sulfur coal reserves in the Narragansett Basin in New England including necessary drilling and geophysical studies. The knowledge of the extent of such deposits is of great importance to this 'energy poor' area".

Chapter 1

INTRODUCTION AND GEOLOGIC SETTING OF THE NARRAGANSETT BASIN

by

James W. Skehan, S.J. and Daniel P. Murray

Introduction

The Narragansett Basin supported intermittent and limited coal mining mainly during the nineteenth and early twentieth century. Because of the "energy shortage" of 1973, renewed interest in the potential coal resources of the Basin was generated. This interest resulted in the Narragansett Basin Project, a program at Boston College that was initially (February, 1976 to February, 1978) funded by the National Science Foundation and other organizations, and more recently (November, 1977 to February, 1979), the U.S. Bureau of Mines (BOM) funded a program which was phased in to continue activities begun in the NSF phase and to carry on new approaches.

During the NSF phase, 24 core holes were drilled in several different parts of the Basin, producing 17,900 feet of core. During the BOM Phase 1, 4 core holes were drilled in widely spaced parts of the Basin, resulting in 2,100 feet of core. Both phases consisted also of related geological and demographic studies.

The results of the National Science Foundation phase and the closely related transitional activities of the first part of the U.S. Bureau of Mines phase are detailed in a two volume report previously submitted to both agencies (Skehan and Murray, eds., 1978). The results contained in volume 1 are oriented toward a reconnaissance evaluation of the coal resource through geologic studies and drilling; those in volume 2 are oriented toward identifying in a preliminary fashion Legal, Economic, Environmental, and Societal (LEES) constraints to possible future mining activities in the Basin. These volumes also contain a more complete hisotry of the Narragansett Basin Project, a comprehensive bibliography of the geology of the region, and preprints of several papers that pertain to the regional geologic setting of the Basin.

This report, which in general follows the format of the U.S. Bureau of Mines Work Statement, consists of discussions on the following topics:

1. Regional Geologic Studies
2. LEES Studies
3. Drillsite Selection
4. Drilling Results
5. Recommendations

The present volume, prepared as the final report of BOM Phase 1 for the U.S. Bureau of Mines, summarizes salient points of that work which was carried out jointly under NSF and BOM funding but which was previously reported on in the two aforementioned volumes. To that extent, then there is some necessary repetition in the present volume, chiefly in the section on core logging as the methodology was developed during the NSF and the application done during BOM phases respectively. Additionally this volume covers in detail the results of the Bureau of Mines funded effort during the period February through October 1978.

Geologic Setting

The 960 sq. mile Narragansett Basin is a structural and topographic depression that contains terrigenous clastic sediments of Late Pennsylvanian age (Figure 1-1). These rocks, at least in part, rest unconformably upon Avalonian basement (Figure 1-2) and are comprised primarily of 600-650 million year old (m.y.) granitic rocks and subordinate amounts of Upper Precambrian to Cambrian and possibly Ordovician sediments, volcanics, and volcaniclastics. The Basin/basement contact is exposed in several widely separated localities. It appears that the western margin is mainly a fault contact, while the northern margin is known to be, at least in several places, an unconformity and at least locally is cut by faults which affect the Basin margin. Recent geophysical studies (McMaster and Collins, 1978), mapping and drilling (Skehan and others,1978b) indicate that the Narragansett Basin extends beneath the Atlantic Ocean north of Cape Cod and south of Narragansett Bay respectively. Several horsts of granitic basement also occur within the Basin. Gravity traverses across the Basin (Sherman, 1978) indicate an irregular Basin/basement surface, probably developed by a combination of folding, involving basement, and faulting. In certain parts of the Basin the thickness of Pennsylvanian sediments may be as great as 12,000 or even 22,000 feet.

Five formations, now referred to collectively as the Narragansett Bay "Group" (Skehan and others, 1978a) are recognized in the Narragansett Basin: The Pondville Formation, the Wamsutta Formation, the Rhode Island Formation, the Dighton Conglomerate, and the Purgatory Conglomerate (Table 1-1 and Chapter 4 of this volume). All of these consist of clastic terrigenous sediments. Lack of outcrop, due to extensive glacial overburden, coupled with rapid facies changes and structural complexities render the construction of a detailed stratigraphy for the Narragansett Basin a slow and painstaking process which can only be accomplished by an intensive drilling and geophysical program. The stratigraphic relationships of the above mentioned formations are basically the same as presented by Mutch (1968, Figure 2), except for the Conemaughian (Stephanian A) age which we have tentatively assigned to the Purgatory Conglomerate, which may be the correlative of the Dighton Conglomerate. A previously estimated total thickness (Shaler and others, 1899) of 12,000 ft for the five formations was highly speculative; however, it is consistent with stratigraphic sections determined recently from gravity observations of depth to basement under the Narragansett Basin (Sherman, Peter, pers. comm., 1978). Lyons (1977) indicates a total thickness of almost 20,000 ft for the Rhode Island Formation alone.

The five formations are comprised of clastic sediments consisting (in order of decreasing abundance) of sandstone, conglomerate, siltstone, shale, coal

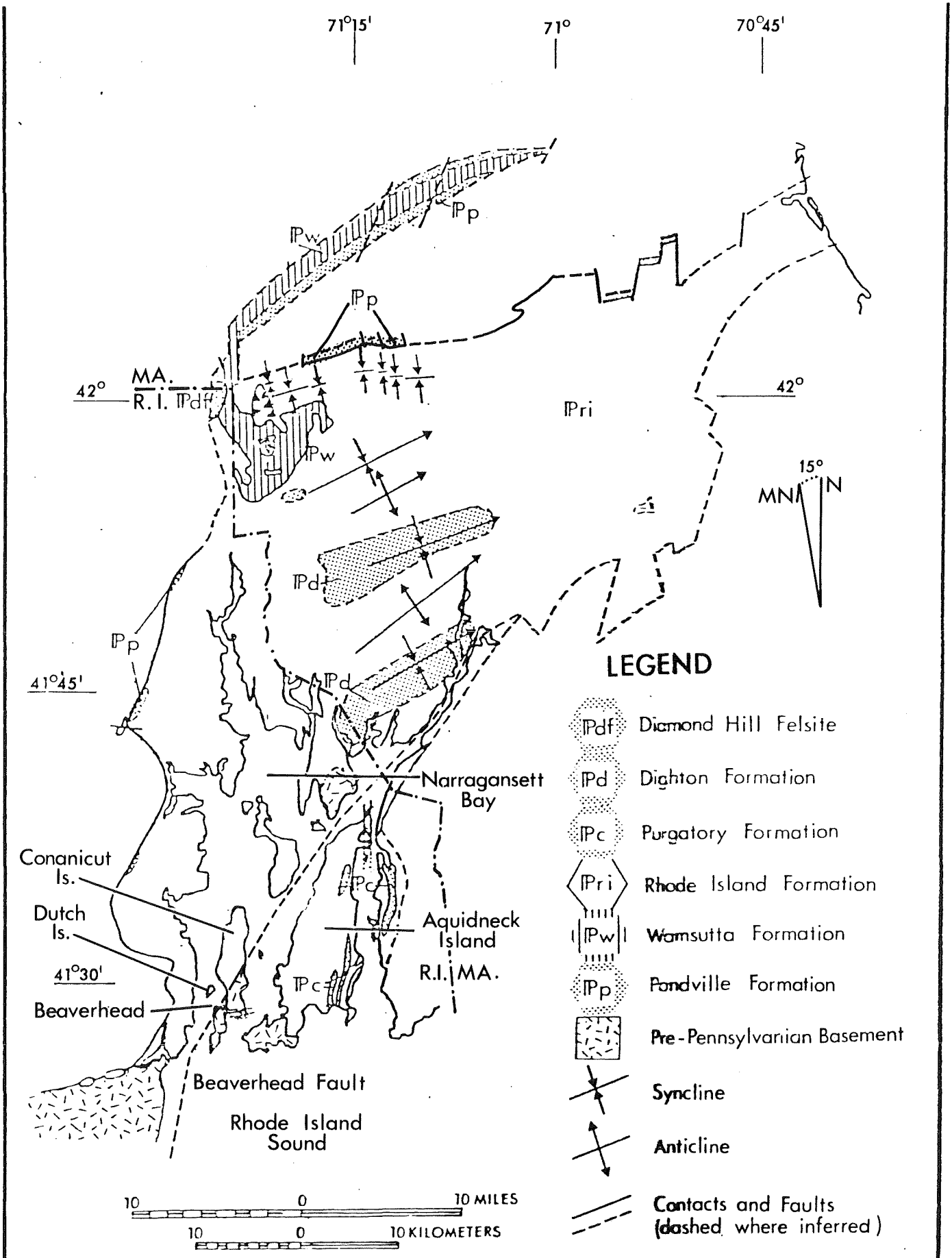
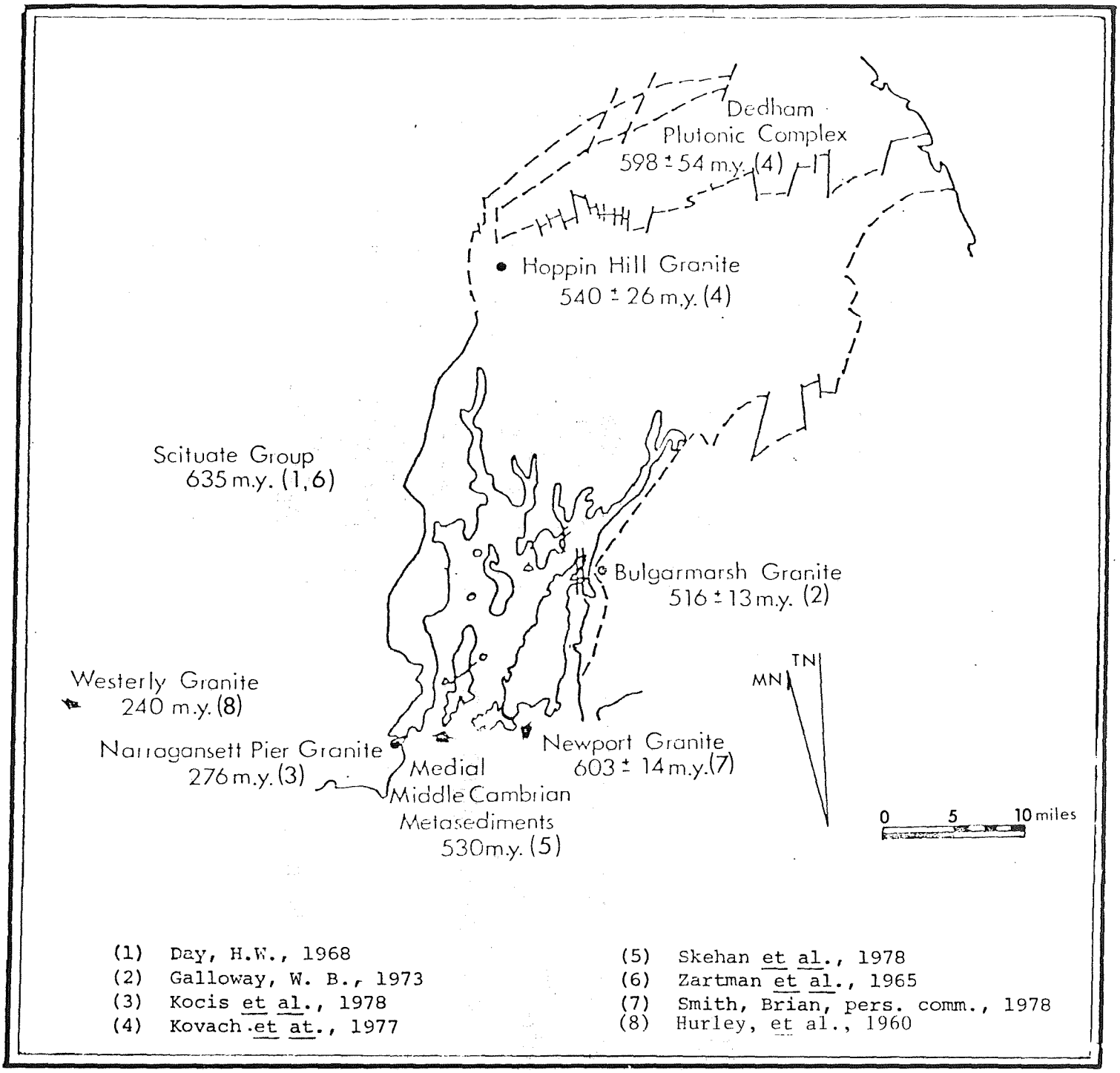


FIGURE 1-1 GEOLOGIC MAP OF THE NARRAGANSETT BASIN



(1) Day, H.W., 1968
(2) Galloway, W. B., 1973
(3) Kocis et al., 1978
(4) Kovach et at., 1977
(5) Skehan et al., 1978
(6) Zartman et al., 1965
(7) Smith, Brian, pers. comm., 1978
(8) Hurley, et al., 1960

FIGURE 1-2 REPRESENTATIVE AGE DATES OF THE BASEMENT COMPLEX AROUND AND WITHIN THE NARRAGANSETT BASIN. AGES ARE IN MILLIONS OF YEARS BEFORE PRESENT. (SKEHAN AND MURRAY, EDS., 1978)

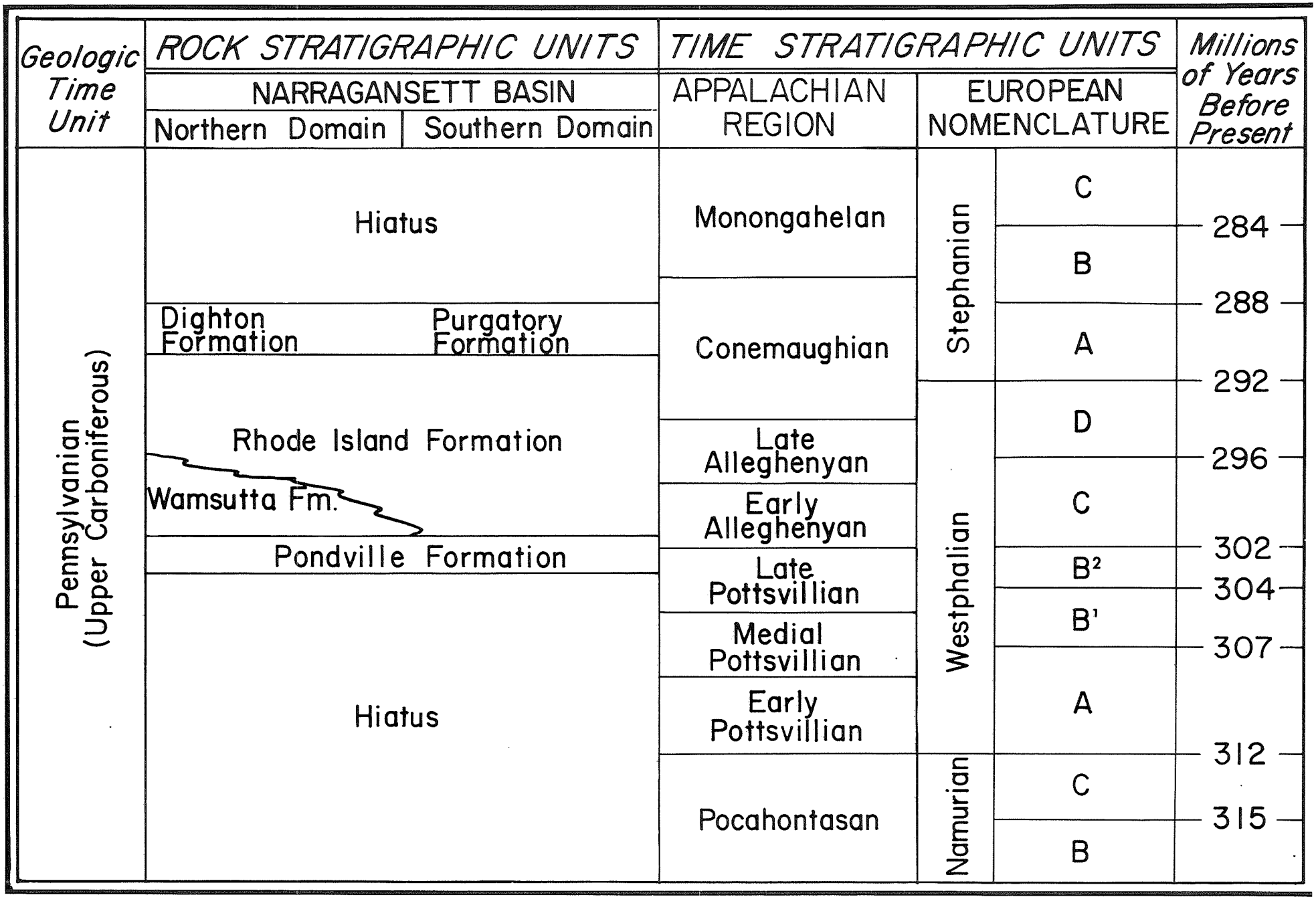


TABLE 1-1 TIME-STRATIGRAPHIC RELATIONSHIPS FOR THE NARRAGANSETT BASIN

and rare volcanics. They were deposited in a predominantly fluviatile environment, possibly associated with active alluvial fans. The Rhode Island Formation and, to a lesser extent, other units as well, contain an extensive and well documented megaflora (Lyons, 1978) which indicates that the period of sedimentation extended from Late Pottsvillian (Westphalian B) to Conemaughian (Stephanian A) time, (Table 1-1).

The Narragansett Basin has undergone a complex history of structural deformation, metamorphism, and plutonism (Skehan and Murray, Chapter 2 and Murray and others, Chapter 3, this volume).

Coal is confined to the Rhode Island Formation, where it occurs in at least two stratigraphically distinct horizons. In general, seams are of variable thickness, ranging from a few inches to approximately 40 ft. The coals have high ash and very low sulfur content. Coal rank varies from semi-anthracite to meta-anthracite (Barton and others, 1977). In the southern part of the Basin where the rocks have been subjected to high intensity metamorphism, coal has been converted to meta-anthracite (Quinn, 1971). The most abundant and thickest coal occurrences identified by recent drilling lie within a 5-10 mile swath along the western, northern, and southeastern margins of the Basin. The most continuous and most extensively mined seams occur at Portsmouth and Cranston, Rhode Island and the thickest seam or seams occur at Bristol and Cranston, Rhode Island and Plainville, Mass. At the Masslite Quarry in Plainville, a 30 ft thick coal seam, which may be relatively continuous, is currently mined and used as a fuel for the production of lightweight aggregate. The Mansfield, Mass. area also contains abundant coal seams which may be rather continuous. Our understanding of the coals is based upon acquisition and analysis of approximately twenty thousand feet of NX (2¼" diameter) drillcore in 28 drillholes by members of the Narragansett Basin Project and cooperating agencies and persons.

Anthracite and meta-anthracite from the Narragansett Basin have been the subject of several studies (Ashley, 1915; Toenges and others, 1948; Quinn and Glass, 1950; Grew, 1974), which in general have produced ambiguous or conflicting results. Only after detailed petrographic analysis of the coal (Gray and others, 1978; Raben, Chapter 3 this volume; and Skehan and Murray, eds., 1978), has it become clear that the Narragansett Basin coals have recorded a very complex history which is, however, decipherable using modern methods of geological analysis. This history, whose basic outlines we believe that we now understand, would make these coals some of the most distinctive yet described. The results of the study of these coals are given below (Chapters 3 and 4).

Age Relationships in the Narragansett Basin

In spite of their critical potential for bracketing the exact chronology of Late Paleozoic thermal activity within the Appalachian Orogen, metamorphic rocks within the Narragansett Basin have not received the study they deserve in recent systematic geochronologic studies. Table 1-2 summarizes the available radiometric ages obtained from the metasediments and plutonic rocks of the Narragansett Basin. Lyons (in press, 1979) has summarized the available floral age data. Figure 1-2 shows dates obtained from the basement rocks that surround and lie within the Basin. The radiometric and floral dates

TABLE 1-2
RADIOMETRIC AND FOSSIL DATES FROM THE NARRAGANSETT BASIN

UNIT	MATERIAL	METHOD	AGE	REFERENCES
Rhode Island Fm	Whole Rock	K-Ar	253 ± 13	Hurley et al., 1960
" " "	" "	" "	230 ± 12	" "
" " "	" "	" "	260 ± 13	" "
" " "	" "	" "	263 ± 13	" "
" " "	Impure biotite	" "	275 ± 15	" "
" " "	Biotite	" "	250 ± 12	" "
" " "	"	" "	237 ± 11	" "
" " "	"	" "	230 ± 11	" "
" " "	"	Rb-Sr	244 ± 15	" "
" " "	"	" "	244 ± 12	" "
" " "	"	K-Ar	200	Harakal, 1964
*Wamsutta Rhyolite	Whole Rock	Rb-Sr	211 ± 23	Bottino, 1963
* " "	" "	" "	225 ± 25	" "
Westerly Granite	Biotite	K-Ar	240 ± 12	Hurley, et al., 1960
" "	Monazite	Pb-a	220	Quinn, et al., 1957
" "	Zircon	"	243	" "
" "	Biotite	Rb-Sr	259 ± 10	Bottino, 1963
" "	Whole Rock	Rb-Sr	299 ± 40	" "
" "	Biotite	K-Ar	240 ± 12	Hurley, et al., 1960
Narragansett Pier Granite	Zircon	Pb-a	208	Quinn, et al., 1957
"	"	" "	225	" "
"	"	" "	235	" "
"	"	" "	274	" "
"	Sphene	U-PB	276	Kocis et al., 1978

TABLE 1-2
RADIOMETRIC AND FOSSIL DATES FROM THE NARRAGANSETT BASIN
(CONTINUED)

UNIT	MATERIAL	METHOD	AGE	REFERENCES
Narragansett Pier Granite	Plant fossil (Annularia stellata) in xenolith in granite.		<290	Brown et al., 1978

* Anomalously low with respect to overlying fossiliferous strata (Rhode Island Fm) of Pennsylvanian age.

together indicate a short period of time between the end of sedimentation and the intrusion of the post-tectonic Westerly Granite. Thus, in the Narragansett Basin, the Alleghanian Orogeny appears to be an abrupt event largely confined to the Early Permian or late Pennsylvanian, based on floral data.

Chapter 2

STRUCTURE

by

James W. Skehan, S.J. and Daniel P. Murray

Introduction

Objectives

One of the objectives of the present study was to determine whether the structural complexity found in the southern part of the basin is typical of the entire Basin or whether the northern part is more gently deformed than the southern. In order to accomplish this objective, we focused attention on several aspects of the structural analysis. One of these was to determine more accurately than was previously possible the shape of the Basin, not only in map outline, but, as possible, also the shape of the Basin in the third dimension. This objective required in part that a better understanding of the pattern of faulting be developed and that the style and intensity of folding be better determined.

Shape of the Basin

The understanding of the map shape of the Basin has changed significantly as a result of work done in each phase of the Project to date by the authors and others (McMaster and Collins, 1978). Figure 1-1 portrays our current understanding of the Basin's configuration. The main changes from earlier geologic maps include:

1. The Basin extends both northeastward and southward into the offshore area south of Boston Bay and into Rhode Island Sound. The distance of these offshore extensions in both cases is in the order of tens of kilometers. A cooperative program of drilling during the summer of 1978 by the U.S. Geological Survey and the State Geologist of Massachusetts has recovered sedimentary rocks considered to be typical of the Wamsutta and Rhode Island Formation. (Joseph Sinnott, personal comm., 1978). This discovery confirms our earlier tentative interpretation that the Carboniferous rocks of the Basin extend into the offshore area near Marshfield, Mass.

2. Sedimentary units previously thought to be Carboniferous in age on Conanicut Island are now known to be Cambrian strata. (Skehan and others, 1978c).

3. Basement granites of Precambrian age, with or without a cover of fossiliferous Cambrian sedimentary rocks, are present along the southern part of Aquidneck Island in the core of a norther-

ly plunging fold; and in Conanicut Island separated from Pennsylvanian rocks to the north by the Beaverhead fault, a major fault zone. Additionally such rocks are present within the southeastern part of the Basin in Portsmouth, R.I. in a horst block surrounded by Pennsylvanian rocks; in Bristol, R.I. probably in the core a northerly plunging fold; at Hoppin Hill, North Attleboro, Mass. and at Manchester Pond Reservoir in Attleboro in probable thrust blocks.

An improved understanding of the structure is essential to developing a more refined plan to explore for coal and ultimately to identify the geometry, location, and reliable tonnage estimates of recoverable coal. The structural analysis of the Basin has always been considered of great significance but it assumes increased importance as the structural complexity of the Basin, and therefore of the coal seams, is progressively better demonstrated by several phases (e.g., metamorphism, Chapter 3 and petrography, Chapter 4), of the present and earlier studies.

Structural Contrast between Southern and Northern Parts of the Basin

The southern half of the Narragansett Basin is better exposed in seacliff outcrops than its northern part, where a blanket of glacial deposits tends to obscure the bedrock. In the earliest phases of this study in 1976 it was clear than the northern part of the Basin differed from the southern in structural and metamorphic characteristics (Quinn, 1971; Skehan and others, 1976a). Later it appeared that this distinction of northern and southern parts of the Basin was valid but that the location of the boundary between the two was not easily placed. Thus we interpreted a NW-trending structural transition zone (Skehan and Murray, eds., 1978a, Fig. 9) near the place where the N-S trending folds gave way to ENE trending folds. Whether this change in trend takes place gradually by folding along a NW-striking axial plane, or whether abruptly by faulting is as yet uncertain due to a lack of outcrop near the head of Narragansett Bay.

Our present understanding is that deformation of the southern part of the Basin is more intense than that in the northern part, and that at least a portion of southern Rhode Island underwent three episodes of folding accompanied by thrusting. The Beaverhead fault in the southern part of the Basin may mark the trace of the Variscan thrust front (Rast and Grant, 1973) as it passes through New England. Within the southern part of the Basin the intensity of deformation generally appears to increase from east to west and especially so west of the Beaverhead fault (Fig. 2-1).

The style and intensity of deformation of the northern part of the Narragansett Basin on the other hand, is less easily analyzed due to poor exposure, but appears to be less deformed than the southern part (Fig. 2-1). This conclusion is based on reconnaissance observations over the entire northern part of the Basin and is reinforced by the presence of diagenetic zone metamorphic rocks in the northwestern corner of the Narragansett Basin (see Hoppin Hill Domain below) and of dominantly anchizone rocks in the remainder of northern part of the Basin (Providence and Taunton Domains). Diagenetic zone and anchizone are subdivisions (Rehmer and others, 1978) of the subchlorite zone of Barrovian regional metamorphism based on illite crystallin-

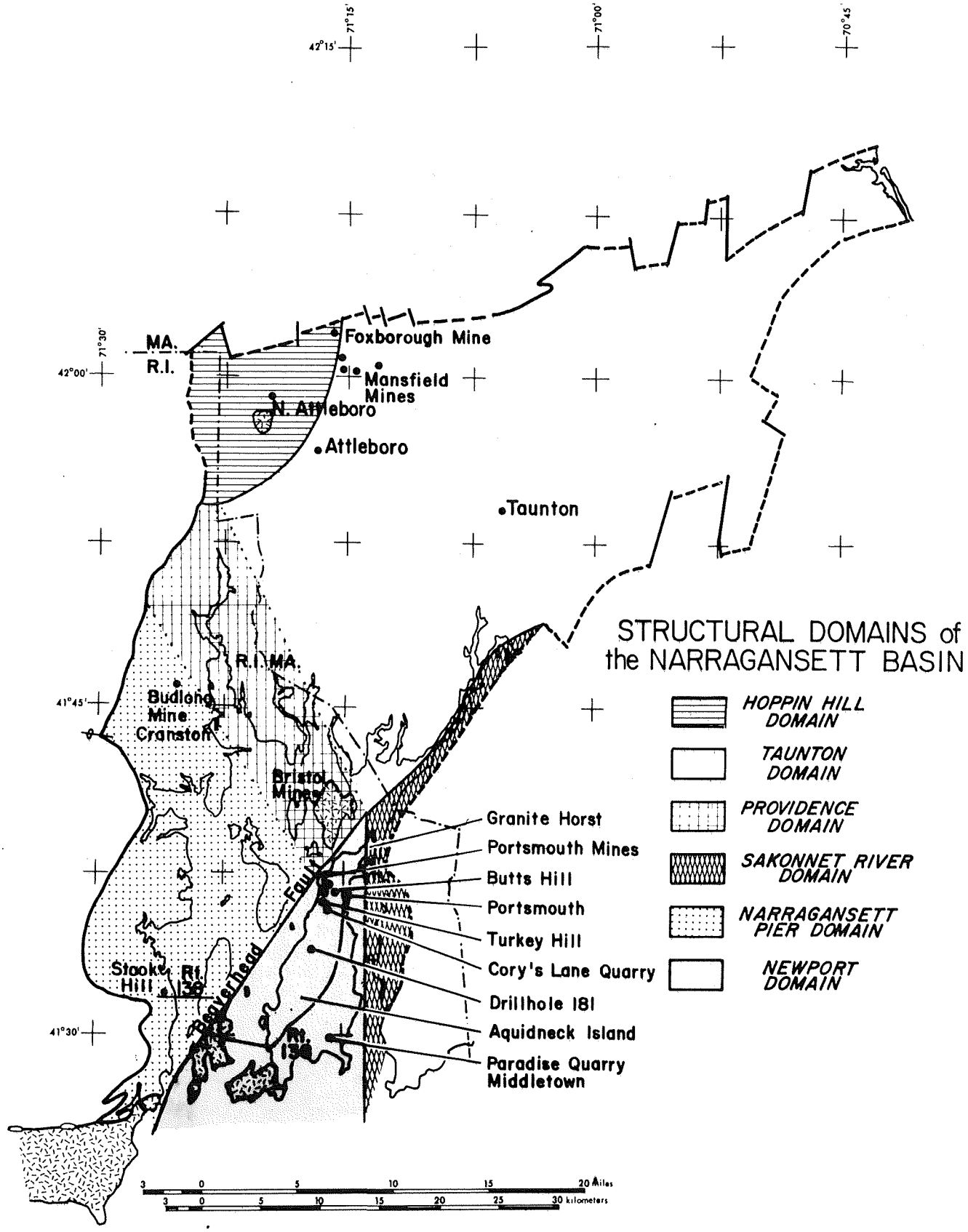


FIGURE 2-1 MAP OF STRUCTURAL DOMAINS IN THE NARRAGANSETT BASIN

ity measurements. The anchizone belongs to subgreenschist facies (Chapter 3). The greenschist facies corresponds approximately with the biotite zone.

The northern part of the Basin is characterized by a steep, pervasive northwestly dipping cleavage which we tentatively correlate with the second deformation of the southern Narragansett Basin. Structures tentatively assigned to the first deformation may be present in the Providence Domain but as yet have not been recognized widely enough to suggest that they constitute the structural framework of the Basin as appears to be the case for the southern part of the Basin. The dominant cleavage however, has been warped as is shown in a schematic cross-section of one typical area in this part of the Basin (Figure 2-2).

In the present study it has become clear that both the southern and northern parts of the Basin have major characteristics that allow them to be further subdivided into what we have referred to as domains.

Structural Domains

In a few instances the boundaries between various subdivisions of the basin are sharp and can therefore be located exactly and the nature of the boundary is known. In others the exact location of the boundary and/or its exact nature are not yet known. Nevertheless we believe it is useful to try to differentiate these domains and, as the opportunity arises, to better define the boundaries.

We have therefore divided the Narragansett Basin into 6 structural or tectonic domains. Field and petrographic studies of drillcore and outcrop permit these division to be defined in terms of structural elements such as the number and intensity of deformational and metamorphic events; the style and sequencing of major and minor structures and distinctive paleontological and sedimentational characteristics.

Domain boundaries may be defined by discontinuities or offsets in isograds and structural elements, and may define the location of major faults within the Basin. More commonly, however, the domain boundaries are gradational or unexposed, and where this is the case an important future task will be to refine this pattern. Models which treat the Basin as a unit must be revised to take the variations and discontinuities into account.

The domains which can be discriminated on the basis of these characteristics are from southeast to northwest:

1. Narragansett Pier Domain (NPD)
2. Newport Domain (ND)
3. Sakonnet Domain (SD)
4. Providence Domain (PD)
5. Hoppin Hill Domain (HHD)
6. Taunton Domain (TD)

The Narragansett Pier Domain (NPD)

Without question the NPD is the most highly deformed and most highly

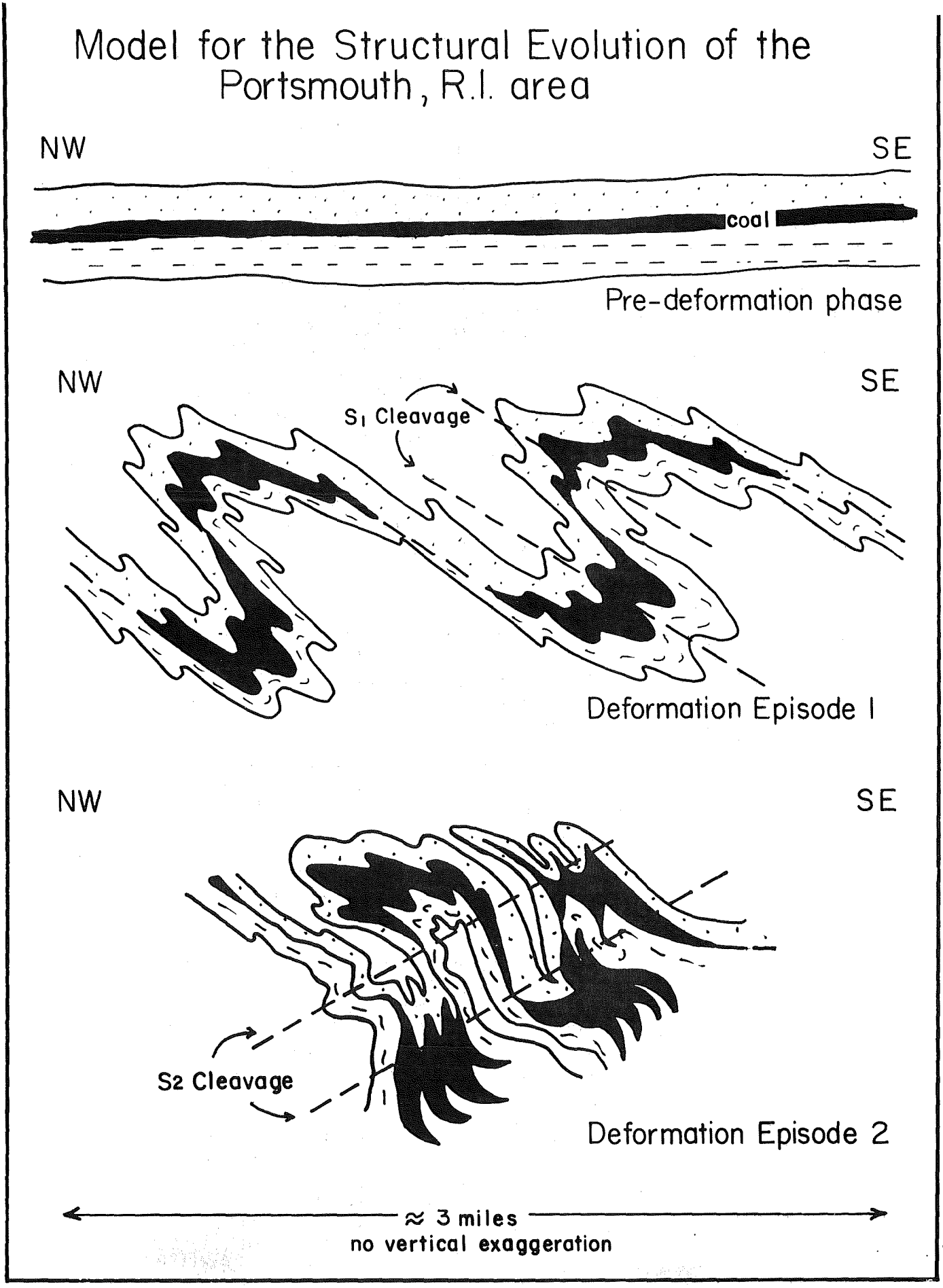


FIGURE 2-2 MODEL FOR THE STRUCTURAL EVOLUTION OF THE PORTSMOUTH, R.I., AREA

metamorphosed part of the Basin (Fig. 2-1). It is the only domain in which Pennsylvanian metasedimentary rocks have been raised as high as the second sillimanite zone and which furthermore are cut by the Permian Narragansett Pier Granite (Fig. 1-1). The southeastern margin of this domain is sharp and distinctive being marked by the highly brecciated Beaverhead fault zone. This fault zone separated three domains, the NPD, the Providence Domain (PD), and the Taunton Domain (TD) to the northwest from two domains to the southeast, namely the Newport (ND) and the Sakonnet (SD) Domains. This fault zone is most probably a southeasterly dipping thrust fault related to the first deformational episode. In this highly probable interpretation the rocks of the ND and the SD have been thrust westward over the domains to the northwest just mentioned (Fig. 2-1). The dominant cleavage throughout most of the NPD is southeasterly dipping but locally at Stook Hill, Route 138 is northeasterly dipping. A northwesterly dipping cleavage is not recognized in the highest zones of metamorphism (sillimanite zones) but is conspicuous on Dutch Island northwest of Beaverhead (Fig. 1-1).

The very thick coals (up to 30 ft.) of the Budlong Mine in Cranston, R.I., which were extensively extracted up to 1959, occur in the northern part of this domain, near the Providence Domain boundary.

Newport Domain (ND)

Three generations of folds, at least two generations of thrust faults and at least one generation of kink banding and normal faulting have now been demonstrated on Aquidneck Island in the present study. All of these structures can be observed in one set of outcrops at the crest of Butts Hill in Portsmouth, R.I. in the State Historical Park.

1. The first deformational episode (Fig. 2-2) consists of asymmetric, folds overturned to the NW with an axial plane cleavage (Mosher and Wood, 1976; and Skehan and Murray, eds. 1978, p.47) which is most readily recognized where it is southeasterly dipping to near vertical.

   These folds typically have a plunge ranging from gently NE to 25° SW, which in conglomerate beds is parallel to the elongation of pebbles, cobbles and boulders.

   Cleavage of the first deformational episode is recognized in roadside outcrops at Turkey Hill on Route 114, Portsmouth, R.I. Thrust faults of the first deformational episode are recognized in several localities in southern Aquidneck Island (Mosher and Wood, 1976; and personal comm., 1976). The Beaverhead fault may be contemporaneous with such faults which are axial planar to F_1 folds.

2. Superimposed on earlier formed structures is a second deformation most readily recognized as a northwesterly-dipping cleavage axial planar to folds developed on both bedding and on the first cleavage. The fold axis of these second folds commonly deviates less than 20° from the azimuth and angle of plunge of the first folds. Note that in contrast to the previously described (NPD) the westward dipping cleavage is the dominant fabric. The second cleavage is the dominant structural feature throughout the Newport Domain being well

developed in the rocks of northern Aquidneck Island. In particular this is the case in the rocks near Drillhole No. 181 in Portsmouth, in the roadcut at Turkey Hill, Portsmouth and in the nearby quarry on Cory's Lane, Portsmouth. A northwesterly-dipping thrust fault parallel to the second cleavage is seen cutting Purgatory Conglomerate in the Paradise Quarry in Middletown, R.I.

3. The third episode of deformation is a broad, undulatory folding most easily recognized in the warping of the second cleavage. This is most commonly recognized by variations in the angle of dip of the second cleavage. This undulatory warping is marked by a steep kink banding which may be associated with normal faulting. Kink bands observed in the Portsmouth Drillhole No. 181 may also have formed during this episode of deformation. This structural feature is well displayed on Butts Hill, Portsmouth, R.I.

Thus the first deformation appears to have established the basic structural framework of the southern part of the Basin. The second, most conspicuous, and fairly pervasive cleavage appears mainly to have flattened earlier structures and to have developed relatively smaller scale structures. It is the dominant structure in most outcrops of the northern part of the Basin. The third deformation may be the result of high angle reverse and/or normal faulting.

The Newport Domain of the southern part of the Basin appears to be, for the most part, fault bounded along its northwestern margin. This boundary is the important Beaverhead fault which brings Middle Cambrian and Precambrian rocks of southern Conanicut Island, as well as Pennsylvanian rocks of probably Conemaughian (Stephanian) age on Aquidneck Island into contact with higher grade metamorphic rocks, of dominantly late Pottsvillian (Westphalian D) age lying to the northwest. During the 19th and early 20th century between 1,000,000 and 2,000,000 tons of coals were mined from two of the several mines in Portsmouth, R.I. (Chase, 1978).

Sakonnet Domain (SD)

The Sakonnet Domain, along the southeastern margin of the Basin, has much in common with the Newport Domain but consists of rocks which are in the biotite zone of metamorphism. As yet we have not determined whether the isograd boundary between the two domains may be a thrust fault or whether it represents a normal increase in metamorphic intensity toward the east. The northwestern boundary of this domain in Portsmouth is marked by a prominent horst which exposes Precambrian Metacom Granite. This granite has been severely deformed by easterly-dipping thrust faults exposed in a quarry in the horst which is bounded on the west and east by north striking normal faults.

Further data will be required to determine whether there are a sufficient number of meaningful differences to warrant the separation of this domain from the Newport Domain. In any case the Newport and Sakonnet Domains together basically form a single tectonic block probably thrust northwestward over the rest of the Basin to the northwest.

Providence Domain (PD)

The separation of the Providence Domain from the Narragansett Pier Domain to the south, and from the Hoppin Hill and the Taunton Domains to the northeast grows out of the observation that N-S structural trends characteristic of the southern part of the Basin change to ENE trends which characterize the northern, Massachusetts part of the Basin. Moreover the polyphase deformation which characterizes much of the southern part of the Basin is present in this domain but has been recognized only locally in the Taunton Domain. Additionally the more or less abrupt southwestern termination of the Dighton, Great Meadow, and Attleboro synclines marked by Dighton Conglomerate in their axial region suggests the possibility that the Providence Domain may, in part at least, be an important NW-striking fault zone. Alternatively this domain may mark the NW-striking axial region of a fold salient convex toward the northwest.

The thick coals (up to 30 ft) encountered in drilling in Bristol, R.I. (Skehan and Murray, eds., 1978) as well as numerous coal sightings and prospects near Providence and Pawtucket are in the northern part of this domain.

Hoppin Hill Domain (HHD)

The Hoppin Hill Domain is a most distinctive zone consisting in large part of Wamsutta Formation and overlying Rhode Island Formation. Fossilferous Lower Cambrian sediments unconformably on Precambrian granitic rocks (Skehan, 1973) are a distinctive feature of this domain. The eastern border of this domain is a fault zone along which are mylonitized blocks of granitic rock. This zone may consist of a series of thrust sheets probably derived from the northwest. The rocks of this domain are distinctive in regard to their grade of metamorphism. Of all the rocks of the entire Narragansett Basin, the rocks of the Hoppin Hill Domain are the least metamorphosed. Illite crystallinity studies (Murray and others, Chapter 3) indicate that the Carboniferous rocks of this domain are dominantly in the diagenetic zone. Other factors being equal, any coals in this domain should be less metamorphosed and therefore contain a higher percentage of combustible volatiles than elsewhere in the Basin.

Taunton Domain (TD)

The remainder of the Basin in Massachusetts may belong to a single domain. There is as yet not a sufficient amount of data available that would suggest the necessity for further subdivision of this northeastern part of the Basin.

The southwestern part of TD is characterized by a series of large scale synclines containing extensively developed Dighton Conglomerate in their cores. The dominant deformational features consist of ENE-striking, NW-dipping cleavage which appears to be axial planar to large scale folds. These features are similar to second deformation structures in the Newport Domain. To date we have discovered only isolated locations in which polyphase deformation features are recognized. Thus it is not clear what may be the relationship between the age of structures in the Taunton Domain relative to those in the Newport Domain. The structural evolution of the TD may be

less complicated than that of the ND. Alternatively further data, not yet available, may show that earlier formed deformational features are regionally important. The former case would suggest that the Newport and Sakonnet Domains may have a far different history from the domains NW of the Beaverhead fault. The second case would suggest that the two parts of the Basin may have a relatively similar history of evolution.

The several coal mines and prospects of Mansfield and Foxborough, from which several thousand tons of coal were extracted in the 19th century (Chase, 1978), are in this domain.

Late High Angle Faults

The northern margin of the Basin is offset locally by high angle faults of various orientations but chiefly striking north to northwest. Normal and other high angle faults may be abundant in the southern part of the Basin but those parallel to structural trends are less easily recognized than those in the northern part of the Basin which are at a high angle to the dominant structural trends.

One set of normal faults in the southern part of the Basin was recognized by Quinn (1971) in Portsmouth, R.I. (Fig. 1-1). These faults bound a granitic horst block located at the northern end of the Sakonnet River and approximately at the boundary between the Newport (ND) and Sakonnet (SD) Domains.

Model for Coal Deformation and Exploration

Petrographic studies and megascopic analyses of coals from cores from several parts of the Basin have shown that they have been brecciated (Gray and others, 1978). Reports from early mining ventures in the Basin indicate that the coal was "rolled" into podlike bodies probably as a result of tectonic thickening since coal is far less competent than the enclosing rocks. Additionally our experience in the analysis of the variability of occurrence of coals in drillcores taken in the course of several phases of the Narragansett Basin Project (Skehan and Murray, eds., 1978, p. 73 ff and Appendix G) suggests extreme variability in thickness and continuity both along presumed strike of beds and down the presumed dip of beds.

All of these features and observations are generally consistent with what one might expect from the style and intensity of deformation recorded in surface outcrops and in drillcores. As a result of field mapping and analysis of structural data during late stages of this present study we have developed the following general model (Fig. 2-2) to explain the deformation of coal seams and consequently a model for exploration of the coals of the Basin. The model is primarily developed for the Newport Domain of the southern Narragansett Basin, but is probably also applicable to the northern part of the Basin whether the first episode of deformation is developed or not. If not, then the pattern of deformation would be expected to be the mirror image of Stage 2 of Figure 2-2. The model is also applicable to the Sakonnet Domain but the fact that it is in the biotite zone of metamorphism (Quinn, 1971), and that a graphite mine was operated there, renders it of academic interest only at the present time.

The generalized model for the structural evolution of coals of the Narragansett Basin (Fig. 2-2) illustrates several features which may prove useful in developing an exploration strategy and drilling program. In particular, the model suggests that drilling strategies commonly used in coal exploration may be insufficient to define adequately the deformed coal seams of the Narragansett Basin as will be suggested below.

Records and descriptions of mining efforts of the past 170 years (Bolhouse, 1967; Ashley, 1915; Jackson, 1840) indicate that in all mining and exploration efforts there were problems of rapid change of dip of seams, "rolling" or rapid thickening and thinning of seams, and generally an inability to trace out seam continuity. The most predictable seams were in the Portsmouth mines, which, although thin, averaging 3-5 ft thick, were apparently continuous along a N 40°E strike for 4000 ft and down the 32° dip for approximately 2100 ft. Figure 2-2 shows the kinds of structural settings which could satisfy all of the known data of which we are aware which apply to the Portsmouth, R.I. mines and to the Bristol, R.I. mine and drillholes. The structure in Figure 2-2 is simplified somewhat since the broad warping, kinking and faulting of the S_3 cleavage developed in Deformation Episode 3 are not shown.

Although the structural deformation of these coals is substantial and complex there are several favorable aspects that should not be overlooked. The first is that the coals are probably highly concentrated tectonically in the crests and troughs of folds. Moreover the coals should have great continuity along the fold axis trends, which generally vary no more than 20° to 30° from the horizontal on the basis of presently available data. Moreover F_1 folds vary in trend no more than 20° from the F_2 folds and both are commonly horizontal. This has profound implications for possible mining of large concentrations of surface and near-surface coal by non-conventional methods.

The initial problem is that of knowing the wave length of the major folds of Deformation Episode 1 which can only be learned by an extensive exploration program. The wave length of major folds in the Newport Domain is about two miles; that in the Tauton Domain appears to be of the order of 5 to 7 miles (Skehan and others, 1978c, Fig. 6, p. 32). Once the average wave length in any given domain can be determined, closer-spaced drilling, geophysical studies and geological analysis of cores and test pits, and reinterpretation of surface outcrops should provide moderately reliable resource estimates at least for those areas for which there is an adequate density of drillholes and geophysical information. The folds, however, have probably been cut by NW-striking cross faults. Thus a delineation of these is also necessary for a successful coal exploration program. All of these factors should form a solid foundation for planning further drilling and ultimately determining reliable resource calculations.

Relation of Surficial to Bedrock Geology

Pre-Pleistocene topographic trends appear to have been controlled by structure and rock hardness. Present topographic trends, including drainage, appear to be controlled by a combination of such Pre-Pleistocene bedrock

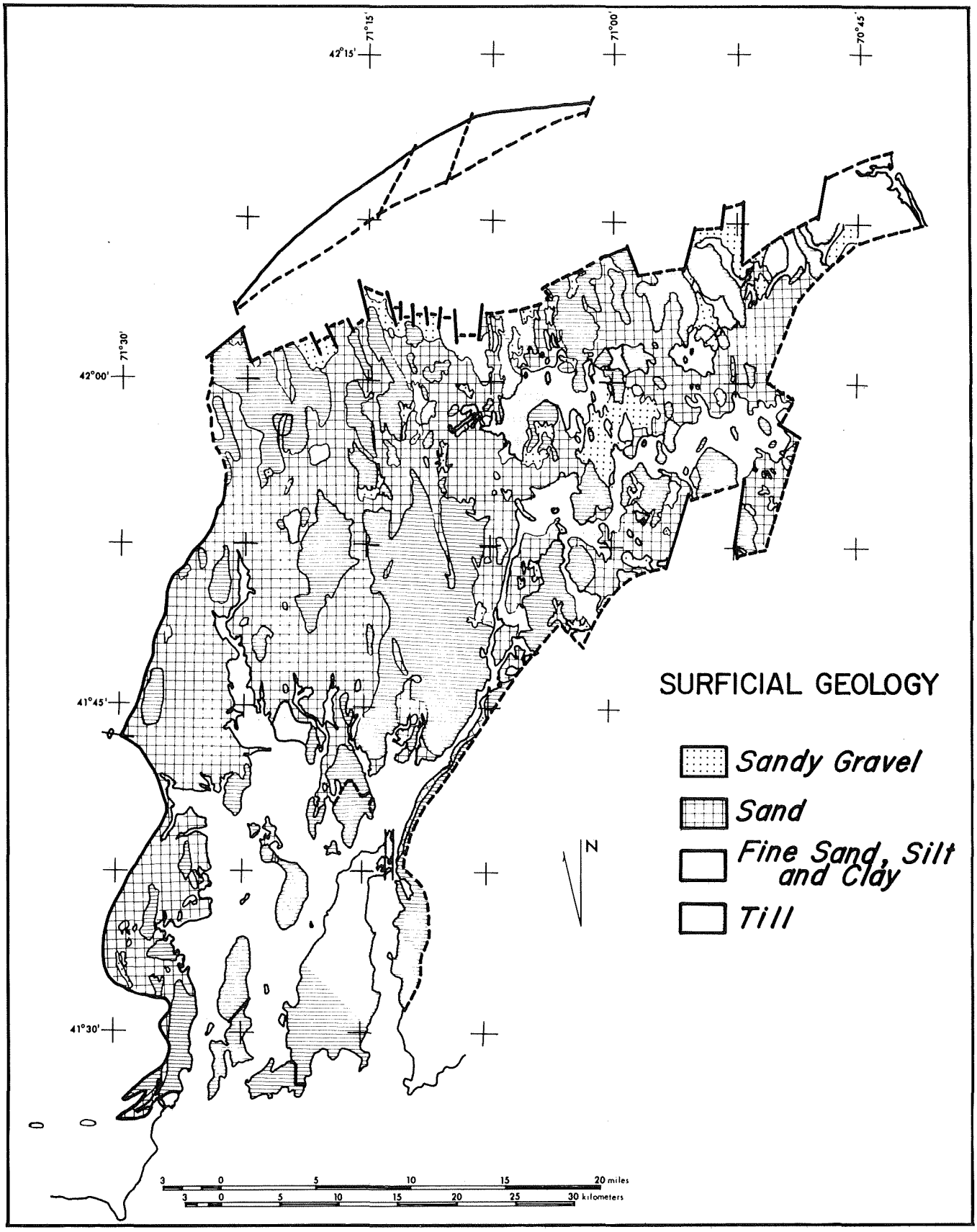


FIGURE 2-3 MAP OF SURFICIAL GEOLOGY

features as well as by Pleistocene processes and deposits. Dominant N to NNE trends in southern Narragansett Basin appear to be largely parallel to major fold axes. In the northern part of the Basin the dominant ENE trends are likewise parallel to fold axes. Additionally in the southern part of Basin, axial planar thrust faults have been demonstrated by Mosher and Wood (1976). Glacial erosion appears to have deepened the resulting fault valleys. The distribution of islands in Narragansett Bay, elongate in a general NNE direction may in part have resulted from the above-mentioned processes, but additionally have probably been modified by later normal and high-angle reverse faults. For example the N-S trending horst block in Portsmouth, R.I. (Fig. 2-1) accentuates the general N-S trends due to other factors noted above.

In part, at least, the alternation of islands and channels, comprising Narragansett Bay may be due to alternation of graben and horst structures. The NE-striking Beaverhead fault (Fig. 2-1) brings Cambrian rocks of southern Conanicut Island (Figs. 2-1 and 2-2) into contact with Pennsylvanian rocks, possibly by NW-directed thrusting. The northeasterly-trending lower reaches of the Taunton River may be controlled by the continuation of the Beaverhead fault.

Secondary topographic features are NW-trending offsets in shoreline particularly well-developed in the Newport and Sakonnet Domains (Fig. 2-1). An inspection of a map of the jagged eastern shore of Aquidneck Island and the eastern shore of the Sakonnet River (Fig. 1-1) may be interpreted as controlled by NW-striking faults. An examination of the NW-trends of brooks and streams on Aquidneck Island suggest the same conclusion. As long ago as 1975 William H. Barton (personal comm.) noted this NW-trend of lowlands along Barker Brook which flows into the Bay between NBP Drillhole Nos. 1 and 2 and BOM Drillhole No. 1 (Toenges and others, 1948). Noting the strong alignment of topographic features along the northern end of Prudence Island, Greenwich Bay and Scituate Reservoir, Barton suggested that this fault, which we have called the Portsmouth Mines fault, may be an important structural feature of the Basin. If it is a throughgoing fault it must be later than the presumed continuation of the Beaverhead fault which itself is synchronous withthe NNE-SSW folds and thrust faults.

A dominant NW-SE trend of brooks and streams throughout most of the northern part of the Basin may follow the dominant trend of NW-SE trending ridges and valleys controlled by elongation of Pleistocene glacial deposits (Fig. 2-3). Some of these glacially controlled trends may have been accentuated by earlier erosion NW, N-S, and NNE striking faults.

The glacial deposits of the Basin for the most part are less than 50 ft thick (Fig. 2-4). Nevertheless there is much of the basin, particularly near the Basin margin, which has thicknesses of between 50 and 150 ft. Locally these deposits, some of which are brick clays, reach thicknesses of more than 150 ft. The pattern of NE trends for these deposits in the northern and northwestern part of the Basin suggest the dominant influences of fold and fault trends in localizing the relatively limited thicker deposits of glacial materials transverse to SE movement directions of the Pleistocene glacial ice.

These maps (Figs. 2-3 and 2-4), compiled from bedrock outcrop maps, from

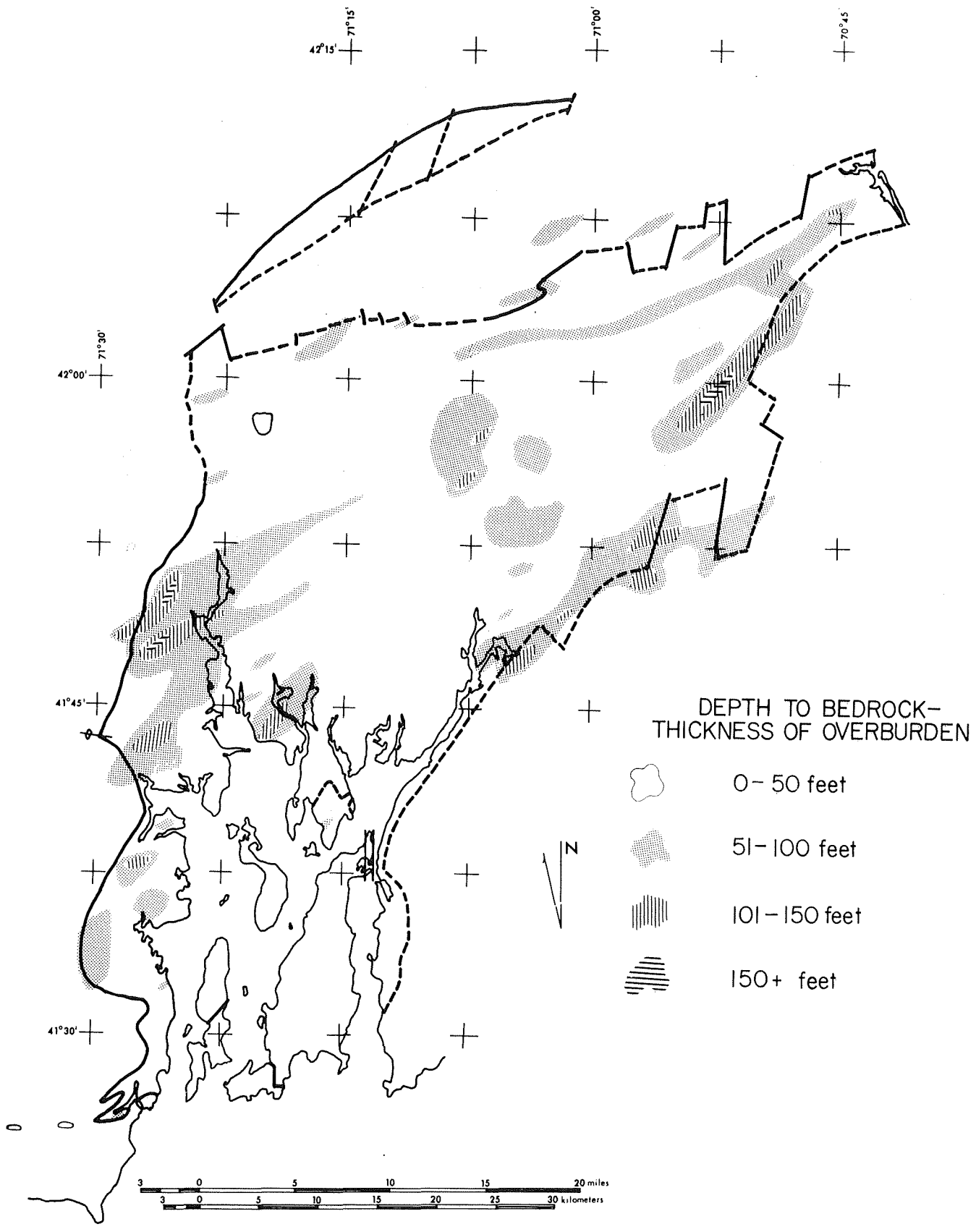


FIGURE 2-4 MAP OF DEPTH TO BEDROCK IN THE NARRAGANSETT BASIN

drillcore, waterwell, and other drill data, and seismic refraction data, when compared with those showing bedrock composition and structural features (Fig. 1-1) suggest the following conclusions:

1. There is no obvious correlation between the presence of coal and the location of large swampy areas.

2. The underlying bedrock surface is irregular and probably reflects the underlying structural fabric and rock type.

3. Outcrops in the northern part of the Basin are mainly ridges of relatively resistant sandstone and conglomerate. However, it is by no means certain that the converse is true, namely that unexposed areas are underlain by fine-grained coal-bearing sedimentary rocks. Several of the NBP drillholes in such areas lacking nearby outcrops, encountered stratigraphic sections dominated by coarse sandstone.

Coal occurrences cannot as yet be predicted based on any of these relationships. Coal appears to occur most characteristically in belts of carbonaceous black slates between Cranston, R.I., Mansfield and Easton, Mass., or along the southeastern margin of the Basin from Newport to Bristol, R.I. to Somerset, Mass. Further drilling and geophysical studies may yield correlations that would be useful in prediction of coal occurrences.

Chapter 3

METAMORPHISM OF THE NARRAGANSETT BASIN

by D.P. Murray, J.C. Hepburn and J.A. Rehmer

Introduction

Studies of the metamorphism of the Narragansett Basin are important for an understanding of the quality of the coals, their tectono-thermal history, and as a guide to coal exploration. The coals of the Basin have been variously categorized as meta-anthracite (Toenges and others, 1948) and anthracite and semi-anthracite (Barton and others, 1977; Skehan and Murray, eds., 1978). However, before the present study no clear relationship was demonstrated for the entire Basin, and especially for its northern part between the rank of the coal, its location in the Basin, and the regional metamorphism. The coal-bearing rocks have undergone a complex history of evolution in terms of their thermal histories and in the relationship of the thermal history of the timing and type of deformation. Studies on the coal itself are presented in Chapter 4. The goal of the metamorphic studies is to obtain an independent evaluation of the pressure, temperature, and tectonic history of the various parts of the Basin, and then relate these studies to the coal. This allows an understanding of the processes and conditions of metamorphism and coalification that cannot be obtained solely from studying the coal. For example, in many cases temperature can be more accurately estimated by examining metamorphic mineral assemblages in the enclosing pelitic rocks than can be obtained from coal rank observations.

The studies on the metamorphic and tectonic evolution of the Narragansett Basin can be divided into two parts for discussion:

1. Those in the higher grade areas of Barrovian metamorphism in the southern Narragansett Basin.

2. Those in areas of the Narragansett and Norfolk Basins that have been metamorphosed to conditions of the lowest greenschist and subgreenschist facies. Murray has largely been responsible for studies in the first case and Rehmer and Hepburn for the latter studies.

Figure 3-1 is a generalized isograd map of the Narragansett and Norfolk Basins modified in part after Rehmer et al., (1978) with the Rhode Island portion modified in part after Quinn (1971).

Southern Narragansett Basin - Barrovian Metamorphism above the Chlorite Zone

This study consists of refining the patterns of metamorphic isograds for the Basin, and separating out the distinct metamorphic episodes that together characterize the polymetamorphic history of the Narragansett Basin. We have endeavored to determine whether it is possible to correlate the individual metamorphic events with episodes of folding and faulting. Such a study is essential, as several of the historically most productive mining areas and

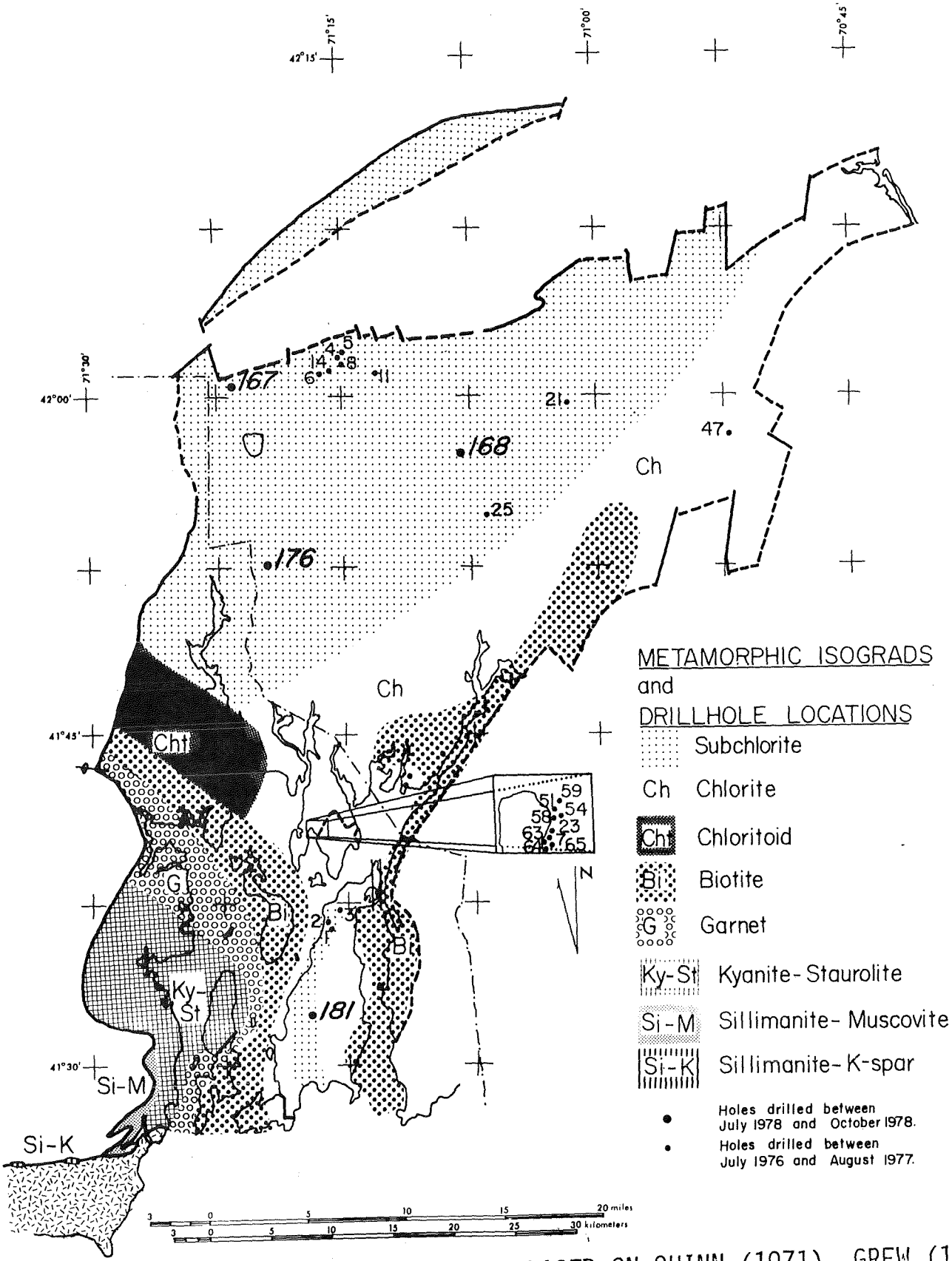


FIGURE 3-1 MAP OF METAMORPHIC ISOGRADS BASED ON QUINN (1971), GREW (1974), AND MURRAY (1978), UNPUBLISHED DATA.

thickest seams encountered during drilling (e.g. Bristol, Cranston, and Portsmouth), came from portions of Rhode Island that have evidently undergone multiple metamorphic and structural episodes.

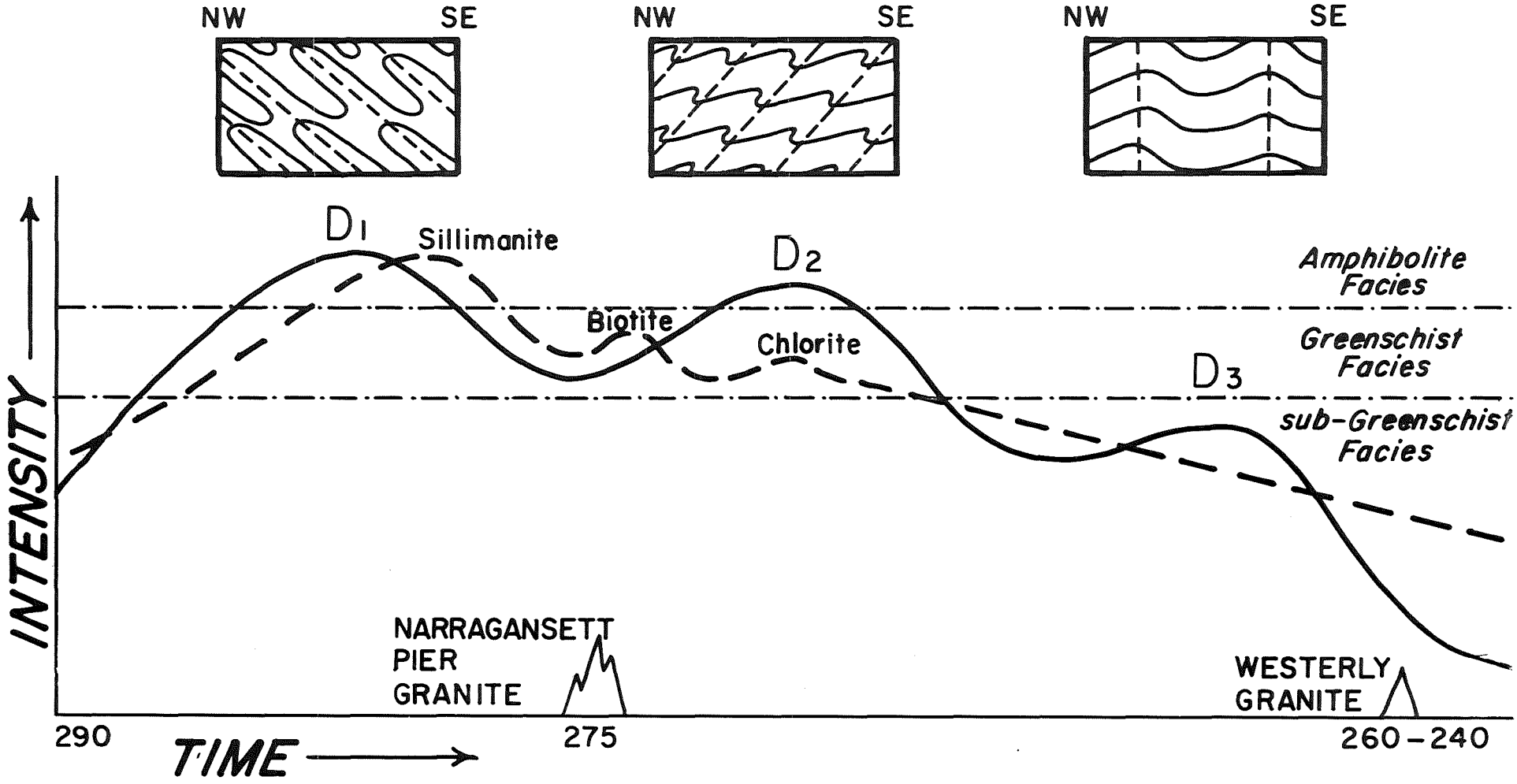
The pattern of isograds (Figure 3-1) is based upon limited field control as well as geochemical reactions involved in the production of mineral assemblages, particularly key index minerals. Ongoing studies by Murray and by the University of Indiana suggest that revisions in the distribution of metamorphic isograds within the Basin may be necessary. Most significantly, it appears that the preliminary isograds of Grew (1974) must be expanded westward from the Basin and that some of the metamorphic rocks mapped southwest of the Basin (previously considered Precambrian or lower Paleozoic in age) may be actually very high grade metamorphic correlatives of the Pennsylvanian rocks found within the Basin.

Previous attempts to estimate the possible conditions of metamorphism within the Narragansett Basin were outlined by Grew and Day (1972). Their work represents a major contribution to our understanding of the Basin, as, among other things, they report the first documented occurrence of kyanite and sillimanite (fibrolite). However, in their assessment of metamorphic parameters these workers used available experimental data on silicate equilibria which were largely obtained in graphite-free pelitic systems. Carbonaceous material is ubiquitous throughout the metamorphic rocks within the Basin and many recent studies (Eugster, 1972, 1977; Ohmoto and Kerrick, 1977; Holloway, 1977; Grangley, 1972) have shown that dilution of the fluid phase by gases liberated during metamorphism of carbon (CO, CO_2, CH_4, etc.) significantly reduces the mole fraction of water. This affects the pressure and temperature at which metamorphic reactions occur. In addition, quite low values of oxygen fugacity can be maintained during metamorphism of carbonacous material because of the buffering effect of CO and CO_2. Many of the experimental equilibria used by Grew and Day (1972) to estimate metamorphic conditions within the Basin were obtained at Oxygen fugacity values equal to or higher than those defined by the QFM buffer. Therefore, a direct correlation between these equilibria conditions and those actually attained during metamorphism of the carbonaceous rocks in the Basin is not possible.

Many peak metamorphic index minerals within the Basin are locally replaced by pseudomorphic aggregates of relatively more hydrous phases formed as a consequence of retrograde and/or metasomatic processes. Grew and Day (1972) incorrectly interpreted these replacement textures (e.g., see their Figure 2D) as prograde reactions and used them to estimate metamorphic parameters.

Relative Time Relationship between Metamorphism (s), Deformation (s), and Intrusion for the Southern Narragansett Basin

Grew and Day (1972) suggested that the Narragansett Pier Granite was emplaced during metamorphism and that the highest grades (first and second sillimanite isograds) were attained at its contact aureole. However, their analysis was based upon a very limited number of samples and without the benefit of information about the structural evolution of the region. Based upon a consideration of petrographic and structural data from the southern part of the Narragansett Basin an alternative interpretation of the sequence of tectonothermal events in this area has been developed and is illustrated in Figure 3-2.



D_1, D_2, D_3 – *Deformational Events*

FIGURE 3-2

TENTATIVE RELATIONSHIPS AMONG METAMORPHISM, DEFORMATION, AND PLUTONIC ACTIVITY IN THE NARRAGANSETT BASIN

Stage A High grade Barrovian metamorphism occurred and was broadly synchronous with a major period of folding (D_1).

Stage B A D_1 axial planar schistosity is overgrown by randomly oriented porphyroblasts of biotite and muscovite. These become increasingly more abundant toward the Narragansett Pier Granite and, therefore, are considered to represent a metasomatic and/or contact metamorphic phenomenon associated with the granite's emplacement.

Stage C Both peak metamorphic index minerals and the randomly oriented biotite porphyroblasts are locally retrogressively overgrown by pseudomorphic aggregates of chlorite in areas where a later crenulation cleavage (D_2) is well-developed.

Stage D A final period of open folding unaccompanied by metamorphism occurred.

This interpretation is in marked contrast to that of Grew and Day (1972), and must be confirmed by detailed petrologic studies.

Conditions of Emplacement of the Narragansett Pier Granite

The thermal maxima of regional (Barrovian) metamorphism is roughly centered near the contact between the Narragansett Pier Granite and the Pennsylvanian metasedimentary rocks. However, in detail, it appears the isograds are oblique to structural trends and are truncated by the granite. Both the granite and the isograds are deformed by the D_2 folding. In detail, the contact is an injection migmatite, and the lack of contact effects indicates that the sediments were hot (at near peak metamorphic temperatures) at the time of the granite emplacement. These features, coupled with the petrographic observations mentioned earlier under Stage B, suggest that the granite may be a result of the thermal event that caused the metamorphism, and not the latter's cause.

It has been suggested (D. Wones, pers. comm., 1978) that the Narragansett Pier Granite was H_2O saturated and characterized by a relatively high f_{O2}. The coal-bearing sediments that it intrudes, on the other hand, were probably buffered by a fluid phase of very different composition (e.g., lower f_{O2}). The interaction and circulation of these contrasting fluid phases may be responsible for changes in bulk and mineral chemistry observed in both rock types as their contact is approached. These include:

1. Change in color of granite from red to white

2. Increase in modal muscovite in the granite

3. General absence of sillimanite in metasediments of appropriate composition.

Fluid exchange between post-tectonic granite and metasedimentary host rocks at intermediate to shallow depths has been well-documented in Maine

(Ferry, 1978) and California (Morgan, 1975) respectively. Both these and other studies (Pitcher and Berger, 1972; Taylor, 1977; etc.) dealt with environments that differed from that of the Narragansett Basin in two important aspects. First, they are post-tectonic granites that clearly are responsible for at least the local isograd configuration. The emplacement of the Narragansett Pier Granite, although broadly synchronous with the regional Barrovian metamorphism, appears to post-date growth of peak metamorphic index mineral (Figure 3-2) and has in turn been affected by at least one episode of folding (Stage C in Figure 3-2).

Metamorphism in the low greenschist and subgreenschist portions of the Narragansett and Norfolk Basins

Previous to this project the majority of the Narragansett Basin was assigned to the chlorite zone of regional metamorphism (i.e., the lowest part of the greenschist facies). However, coal rank data from coals in this zone clearly varied one from another, indicating different temperature and pressures within the broad chlorite zone as previously defined.

Thus, a study was undertaken to examine the changes in metamorphism within the low grade portions of the Narragansett and Norfolk Basins to see what subdivisions might be mappable and what the relation of these subdivisions is to the coal rank.

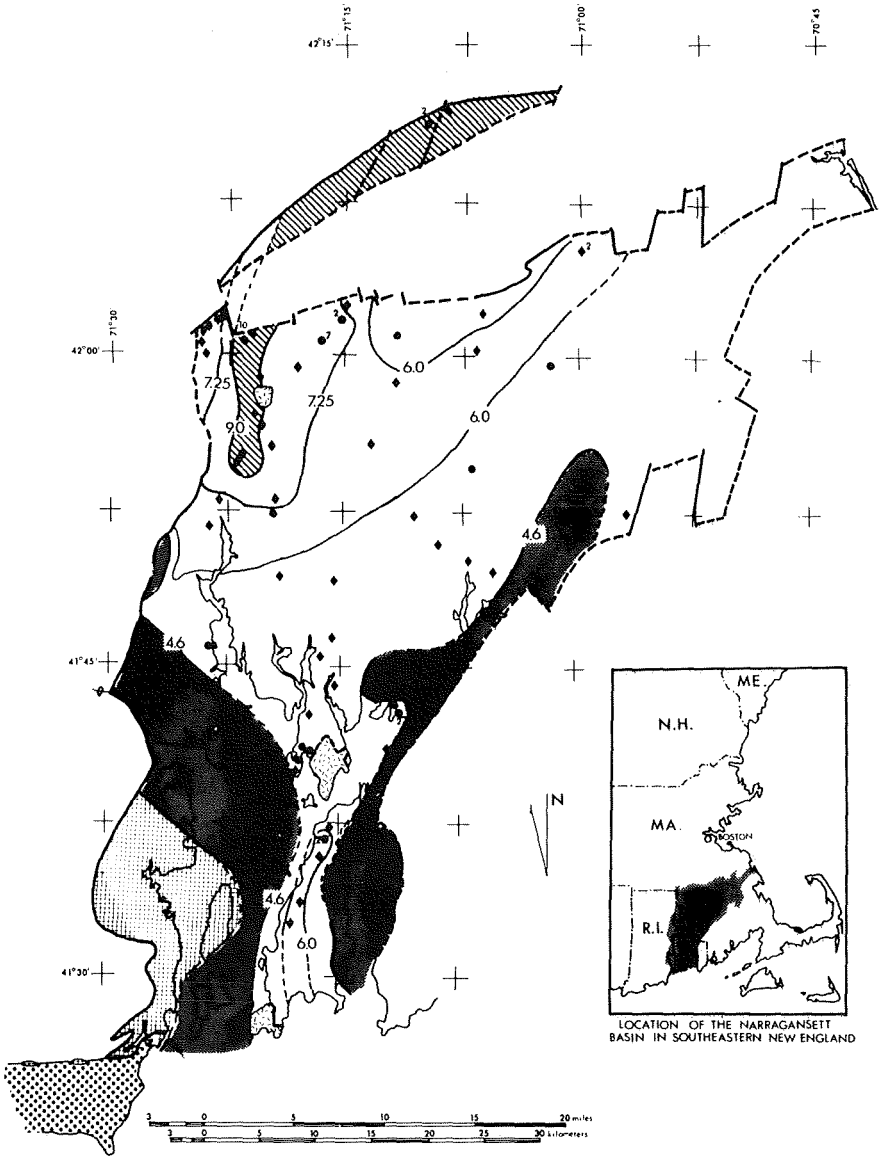
Illite crystallinity can be used as an index of very low grade metamorphism in shales. As the clay mineral illite is heated, it becomes better crystallized as interlayers are given off, and eventually it becomes a well-crystallized muscovite. Thus, the illite crystallinity index is a measure of the gradual change from a fairly disorganized clay mineral to a well-crystallized muscovite that occurs during metamorphism over the temperature interval from about 150° to 300° C. The method of defining isocrystallinity indices on the basis of the sharpness (i.e., degree of crystallinity) of illite X-ray peaks has been used successfully in coal basins in Europe (Frey and Niggli, 1971; Gill et al, 1977) but to our knowledge has not been used previously in this country. Frey and Niggli, (1971); Frey, (1978); Kisch, (1968) and others have established the relationship between illite crystallinity and coal rank. Thus, the regional illite crystallinity studies provide both mapped subdivisions of the lower grade portions of the Narragansett Basin and an indication of the expected coal rank at any place in this part of the Basin. This is a particularly valuable tool for coal exploration as outcrops or cores of rocks other than coal are far more abundant than those of coal, and the procedure for obtaining illite crystallinity data is far simplier and much less expensive than coal rank determinations. Since this method is relatively new in North America, a section follows briefly outlining the method used for determining illite crystallinity.

Method for Determining Illite Crystallinity

Clays that are originally expandable, disordered mixed-layered varieties at sedimentation gradually become ordered, better crystallized and monomineralic upon burial. Under the conditions of diagenesis to low grade metamorphism, these clays gradually unmix and transform into the stable illite-chlorite assemblage typical of most Paleozoic and older shales, as well as those in tectonic

ILLITE ISOCRYSTALLINITY CONTOURS NARRAGANSETT AND NORFOLK BASINS MASSACHUSETTS - RHODE ISLAND

REHMER & HEPBURN, 1978



LEGEND

- Narragansett Pier Granite
- Pennsylvanian
- Pre-Pennsylvanian
- DIAGENETIC ZONE
- ANCHIZONE
  - lower
  - upper
- GREENSCHIST FACIES
- AMPHIBOLITE FACIES
- 6.0 ILLITE ISOCRYSTALLINITY CONTOUR

ARGILLACEOUS SAMPLE ANALYZED

- • FROM CORE
- ♦ FROM SURFACE EXPOSURE
- •5 AVG. FOR 5 SAMPLES, ONE LOCALITY

FIGURE 3-3

MAP OF ILLITE ISOCRYSTALLINITY SUBDIVISIONS WITHIN THE NARRAGANSETT BASIN

settings. These reactions are largely a function of rising temperature, the abundance of suitable available cations to effect this transformation, and time. The increased crystallinity that results from the thermal closing of chloritic interstratified layers within the illite structure has been used to define subzones within low-grade shales and slates of the Narragansett and Norfolk Basins.

The measurements of illite crystallinity are based on the 10 Å basal X-ray reflections of white micas. Samples of argillaceous rock from cores, outcrop and rip-up clasts were gently disaggregated so as to preserve original clast sizes, by a combined method of oxidation of organics in sodium hypochlorite solution followed by brief ultrasoneration. Only the easily dispersed 2 μ clay fraction was used to measure crystallinity. This was done in order to eliminate the possible presence of coarse detrital muscovite flakes, which would make the clays appear anomalously well-crystallized. To further confirm this, illite (001) and (002) peak areas were measured by planimeter. Illite (002)/(001) peak area ratios are lower in the $<2\mu$ fraction than in the whole-rock micas, and also show less scatter. This is due to, either or both, decreased potassium (i.e., increased interlayering) or a more ferromagnesian composition in the $<2\mu$ fraction relative to the whole-rock mica (Weaver, 1965; Esquevin, 1969) and further indicated that coarse detrital muscovite and biotites have been largely eliminated from the fine fraction.

The peak width at 1/2 height of the 10Å mica reflection was measured as an index of illite crystallinity (method of Kubler, 1968) on $<2\mu$ oriented slurries, run at slow scans (1/4° 2θ/min., 60 in/hr. chart speed, CuKα radiation, average of 3 runs per sample; converted to 1° 2θ/min. equivalent peak widths). Kubler's illite crystallinity zone boundary standards were also run under the same instrumental conditions. These yielded, respectively, values of 7.25 mm and 4.6 mm for the diagenetic-anchimetamorphic and anchimetamorphic-greenschist boundaries, as defined by Kubler (1964).

Subdivisions of Low Grade Portions of Narragansett Basin

The illite isocrystallinity lines on Figure 3-3 can be considered to be similar to metamorphic isograds. The 7.25 mm and 4.6 mm have been correlated to the divisions between the diagenetic-anchizone and anchizone-greenschist boundaries that Kubler (1964) established in Europe. The diagenetic zone represents an area that has not been metamorphosed above approximately 175°C - 200°C. The anchimetamorphic zone would correspond approximately with the zeolite and prehnite-pumpellyite-facies of regional metamorphism (Frey and Niggli, 1971). These latter zones cannot be determined in the Narragansett Basin since the rocks do not have the correct bulk composition (volcanic or graywacke) for these minerals to form. The upper anchizone is approximately equal to the chlorite zone of the greenschist facies and the 4.6 mm isocrystallinity line closely approximates the biotite isograd. Above the biotite zone the illite has become well-crystallized and the method no longer is applicable.

Isocrystallinity contours have been mapped for the subgreenschist and lower greenschist argillaceous rocks of the Narragansett and Norfolk Basins (Figure 3-3), and these demonstrate increasing grade toward the south and center of the basin system. These zones reflect conditions of deep diagenesis through anchizone and chlorite metamorphism (approximately 175-300° C). Only a small area in the northwest part of the Basin is sub-metamorphic. In general,

anthracite coals characterize the rocks of the anchizone in the Narragansett Basin. Illite crystallinity appears to be independent of illite composition (based on 002/001 peak area ratios) in the anchizone and greenschist facies; similar results have been reported in other basins (Esquevin, 1969).

Correlations of coal ranks (Chapter 4) and illite crystallinity seem to correlate well and agree with previous determinations (Gray and others, 1978) in the Portsmouth, Cranston, Bristol and Somerset areas. However, in the northern part of the Narragansett Basin, the Mansfield area, where the illite crystallinity indicates the temperatures reached during metamorphism were the lowest, the coal rank is quite high. The exact reason for this discrepancy is still under investigation but preliminary evidence,(Murray, Raben and Rehmer, in press, 1979), indicates the coal in this area has an abnormally high rank for the temperature reached during metamorphism. Thus, other factors such as the effect of shear may have affected the coal in this area. Certainly the coal has had a complex tectono-thermal history (Chapter 4).

Conclusions

The trend of the Barrovian isograds in the southwestern part of the Basin are arcuate, curving from northeasterly to northwesterly. Along the southeastern margin of the Basin, in the Sakonnet Domain, they trend northeasterly. The illite isocrystallinity contours or "isograds" which subdivided the subgreenschist facies appear to trend dominantly in a northeasterly direction. This latter trend is markedly discordant to the high-grade pelitic isograd configuration as shown in Figure 3-1. It is possible that the discordance between high- and low-grade terrains reflects the overprint of two distinct thermal events. This interpretation would suggest an increasing degree of burial metamorphism to the southeast with a higher grade thermal event centered near the southwestern corner of the Basin producing the pattern of pelitic isograds in the high-grade terrain (Murray and Hepburn, 1979).

An understanding of the tectono-thermal history of the Basin is a prerequisite for an identification of those areas that, with respect to coal rank, are most likely to contain economically viable coal.

Chapter 4

COAL: CHEMISTRY, PETROGRAPHY, RANK AND STRATIGRAPHY

by Jonathan D. Raben

Introduction

This section reviews both published and unpublished data (Skehan and Murray, Eds., 1978) and presents the main results obtained during the current BOM Phase 1 study. Additional other relevent data has been incorporated.

Geology of Coal Seams

Coal has been found in many localities in the Narragansett Basin (Skehan and Murray, Eds. 1978),(Appendices B and J). Table 4-1 presents the coal seam thickness data determined from drillcore. The thickest seam encountered in drilling was 30 feet, but an average thickness of 20 feet over an area of at least 1300 feet by 300 feet was reported at Cranston (Toenges and others, 1948). In general, however, the coal beds are neither uniform in thickness nor in distribution. The original geometry of coal seams has changed to a greater extent than adjacent rocks. The coals have been thickened, thinned and podded as a result of folding and faulting while in a rigid state. Veins are associated with nearly every occurrence of coal in the Project's drillcore. Veins containing brecciated coal fragments occasionally cut across bedding (Raben and Gray, 1979 b). This is largely the result of tectonism (see Chapter 2 of this volume). A brief discussion of the stratigraphy of the coal is presented later in this chapter.

Coal Chemistry

Proximate analyses for several Narragansett Basin coals are presented in Table 4-2. Barton and others (1977) reported on the results of chemical analyses of 28 coal samples and on the washing characteristics of 20 samples from the Narragansett Basin. Their major conclusions about the coal are:

1. The coals are anthracites and semi-anthracites
2. They are low sulfur
3. They contain moderate to high amounts of ash
4. They are suitable for physical preparation to a product that generally contains less than 10% ash
5. None of the samples analyzed were found to be meta-anthracite by ASTM D-338 classification
6. Additional exploration, sampling and testing is required to permit appraisal of the Narragansett Basin coals as a resource.

TABLE 4-1 COAL SEAM THICKNESS DATA

COAL SEAM THICKNESS DATA

SEAM THICKNESS (feet)	NUMBER	PERCENT	TOTAL THICKNESS
0.5	32	8.0	14.3
0.6–1.4	25	13.9	24.6
1.5–4.9	21	25.4	44.9
5–9.9	5	18.8	33.3
10	3	33.7	59.5

TABLE 4-2 PROXIMATE AND ULTIMATE ANALYSES OF NARRAGANSETT BASIN COALS

	HOLE NUMBER	DRILLED DEPTH	SEAM THICKNESS	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR	B.T.U.
MOISTURE AND ASH FREE	2	258	8.9	-----	13.3	86.6	-----	0.40	95.7	0.3	3.1	0.4	13607
	6	385	17.5	-----	9.1	90.8	-----	1.60	92.7	0.7	4.0	0.8	13820
	7	230	26.6	-----	7.6	92.3	-----	0.50	94.9	0.2	4.2	0.1	13373
	11	976	1.25	-----	6.8	93.2	-----	1.06	95.12	0.31	1.97	1.54	14158
	23A	463	5.9	-----	8.4	91.6	-----	0.70	93.3	0.5	5.7	0.1	12992
	23B	468.5	1.0	-----	8.56	91.44	-----	0.60	94.64	0.11	4.66	0.0	13869
	33	733.5	11.0	-----	5.4	94.5	-----	0.40	95.7	0.3	3.2	0.3	13859
	51	681	1.0	-----	26,52	73.48	-----	2.56	82.86	0.42	11.36	2.8	11040
	64	625.5	4.7	-----	6.5	93.5	-----	0.40	95.5	0.18	3.7	0.17	13258
AS RECEIVED	2	258	8.9	13.7	8.4	53.3	24.5	1.8	59.1	0.2	14.0	0.3	6970
	6	385	17.5	1.1	5.2	43.4	50.2	1.0	44.6	0.3	3.1	0.5	6630
	7	230	26.6	2.4	6.3	76.0	15.3	0.7	77.9	0.2	5.6	0.07	6263
	11	976	1.25	4.49	5.38	73.84	16.29	1.34	75.35	0.25	5.55	1.22	11215
	23A	463	5.9	0.6	5.0	51.8	36.2	0.5	58.8	0.07	4.3	0.05	8218
	23B	468.5	1.0	0.41	4.37	46.66	48.56	0.35	48.29	0.06	2.74	0.0	7077
	33	733.5	11.0	3.7	4.2	72.8	19.2	0.7	73.7	0.2	5.8	0.1	10669
	51	681	1.0	3.7	4.9	13.58	77.82	0.88	15.32	0.08	5.39	0.52	2041
	64	625.5	4.7	0.8	4.7	68.2	26.1	0.4	71.1	0.13	2.6	0.1	9669

The Narragansett Basin coals are chemically complex. Although volatile matter and carbon contents obtained from chemical analyses would indicate that the coals range in rank from low volatile bituminous to anthracite (Barton and others, 1977), the volatile matter of the coal has been said to be almost entirely non-combustible (Ashley, 1915; Johnson and Auth, 1951) and thus is not a reliable parameter for determining rank. It is probable that the volatile components are comprised of water of dehydration of certain minerals and of CO_2 derived from carbonate. The coals are high ash and contain substantial amounts of quartz, layered silicates and other minerals. This mineral matter appears to be secondary in origin in some coals.

A detailed study of the mineral matter in the coal and how it affects the results of chemical analyses is necessary if the coals are to be considered for use. It is apparent that proximate chemical analyses are not sufficient for determining the rank of the coals. The use of reflectance on carefully selected vitrinites is likely to be a better rank indicator.

The coals are hydroscopic (Ashley, 1915, Johnson and Auth, 1951). The coal takes up as much as 15% moisture if exposed to dampness and may lose an equal amount if exposed to dry air when broken up fine. As a result, the Btu value is largely dependent on conditions of mining and storage. A possible explanation for the coals' hydroscopic nature is given in the petrographic section in this chapter. The effects of moisture on the burning characteristics of the coal is discussed in Ashley (1915) and Johnson and Auth (1951).

Ultimate and Proximate Analyses, Washability Tests

On the basis of analytical work performed under the direction of Albert W.Deuerbrouck, Chief, Coal Preparation and Analysis Laboratory, U.S. Bureau of Mines, Pittsburgh, Pennsylvania, the coal can be characterized generally as anthracite with low sulfur, relatively high ash, and 11,000 to 14,000 Btu (daf basis) (Barton and others, 1977). The washability tests, also performed by the U.S. Bureau of Mines are summarized in Skehan and Murray, Eds., (1978, Appendix K).

Trace Element Analysis

Under the direction of Mr. Gordon Wood, then Chief of the Coal Branch, U.S. Geological Survey, in the laboratory of Dr. Jack Medlin, now Chief of the Coal Branch, semi-quantitative spectrographic analyses of major and trace elements in the coal were carried out. These analyses are presented in Skehan and Murray, Eds., (1978, Appendix M).

Megascopic Analysis

The coals have a dull, graphitic to submetallic appearance, may be sooty and friable to brecciated, and seldom break with a conchoidal fracture except on a very small scale as a result of their friable to brecciated nature. Figure 4-1 shows Narragansett Basin coals in hand sample and in drillcore. A sample of anthracite from Pennsylvania is shown for comparison. The coals are characterized by mylonitized or brecciated textures and by later quartz, chlorite, muscovite, calcite and other vein fillings (Gray and others, 1978).

REFLECTANCE DATA FOR NARRAGANSETT BASIN COAL SAMPLES

SAMPLE LOCATION	NUMBER OF SAMPLES	REFLECTANCE		
		MEAN MAXIMUM	MEAN MINIMUM	MEAN BIREFLECTANCE
MANSFIELD	11	AVERAGE 6.4 HIGH 7.5 LOW 4.8	AVERAGE 3.5 HIGH 4.4 LOW 2.1	AVERAGE 2.8 HIGH 3.0 LOW 2.2
BRISTOL	16	AVERAGE 5.1 HIGH 7.6 LOW 4.0 * (2.8)	AVERAGE 3.1 HIGH 4.5 LOW 2.4 * (0.8)	AVERAGE 1.9 HIGH 3.4 LOW 1.1
PORTSMOUTH	7	AVERAGE 5.0 HIGH 6.0 LOW 3.7 * (2.8)	AVERAGE 2.5 HIGH 3.1 LOW 1.9 * (0.8)	AVERAGE 2.5 HIGH 3.1 LOW 1.6
SOMERSET	3	AVERAGE 4.6 HIGH 6.2 LOW 3.2	AVERAGE 1.8 HIGH 3.1 LOW 1.0	AVERAGE 2.7 HIGH 3.1 LOW 2.2
MASSLITE	1	5.6	3.4	2.2

* Values in parenthesis are questionably low and are not included in averages.

TABLE 4-3 VITRINITE REFLECTANCE DATA OF SELECTED NARRAGANSETT BASIN COALS

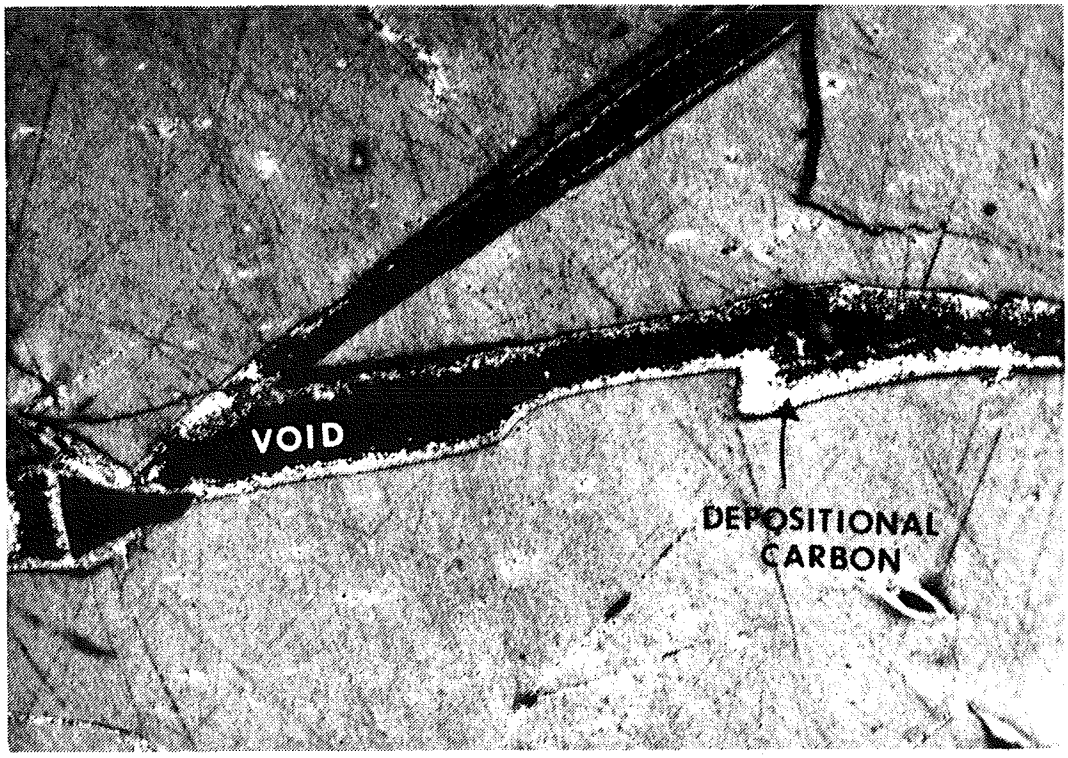


FIGURE 4-2

PHOTOMICROGRAPH OF BRECCIATED ANTHRACITE, FROM THE NARRAGANSETT BASIN. THE SURFACES OF CRACKS, THAT RESULT FROM BRECCIATION, ARE COATED WITH A SECONDARY GRAPHITIC DEPOSITIONAL CARBON. (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

coals that were brecciated were later recemented by this carbon, and in places the carbon and coal particles are so annealed that the sample is essentially optically continuous. This depositional carbon is more abundant in the southern coals studied than ones to the north.

3. Natural coke with graphitic depositional carbon similar to 2) above (Figure 4-3). The presence of natural coke indicates that the coal was of a lower rank than anthracite, which upon heating does not form coke. Because of the very limited extent of coke formation in samples observed, the coals were probably very close to the rank of anthracite. It is presumed that the coals which formed coke had been coalified to the rank of low-low volatile bituminous when they were heated to produce coke. They were subsequently coalified to anthracites and meta-anthracites.

The coals tend to be brecciated (Figure 4-4). The broken fragments are usually quite angular indicating that brecciation most likely took place after the coals had attained a relatively high rank, possibly semi-anthracite.

The presence of secondary carbon could be explained by its release upon thermal cracking of methane, the methane possibly being released upon brecciation of the coal, since it is the most common gas in anthracite.

The "inert organic" components of the coal are unusual. Funsinite, and semifusinite, usually highly reflecting components compared to the vitrinites, are often very low-reflecting components in the Narragansett Basin coals (Figure 4-5). In some cases semifusinites and, to a lesser extent, fusinites are lower reflecting than the vitrinites. We have no explanation for this phenomenon at this time.

The coals have a high ash content, a substantial percentage of which is secondary. Minerals commonly associated with the coal, either as primary or secondary ash, include quartz, sericitized feldspar, chlorite, illite or muscovite, calcite, pyrite, marcasite, chalcopyrite, sphalerite, rutile and others. Quartz and chlorite-muscovite intergrowth, are the predominant minerals in many of the samples observed (Gray and others, 1978). Pyrites include framboidal and euhedral varieties. The presence of mineral matter in some of the voids in brecciated coals enclosed by a graphitic depositional carbon rim, indicates that these minerals were emplaced by solutions of unspecified origin at a stage after substantial coalification, brecciation and carbon deposition had gone to completion. Some samples observed were carbonaceous shales. In these samples the mineral matter is not substantially comprised of minerals that are secondary in origin, but are the product of metamorphism or diagenesis of the primary coal ash (i.e. minerals deposited in the original peat swamp).

Deformational Textures and Implications for Utilization

Tectonic thickening and thinning of anthracites and meta-anthracites in the Narragansett Basin make true thickness estimates difficult. The response of the coals to heating and deformation has resulted in deformational textures which in turn have had an effect on the coals' subsequent history. The coals

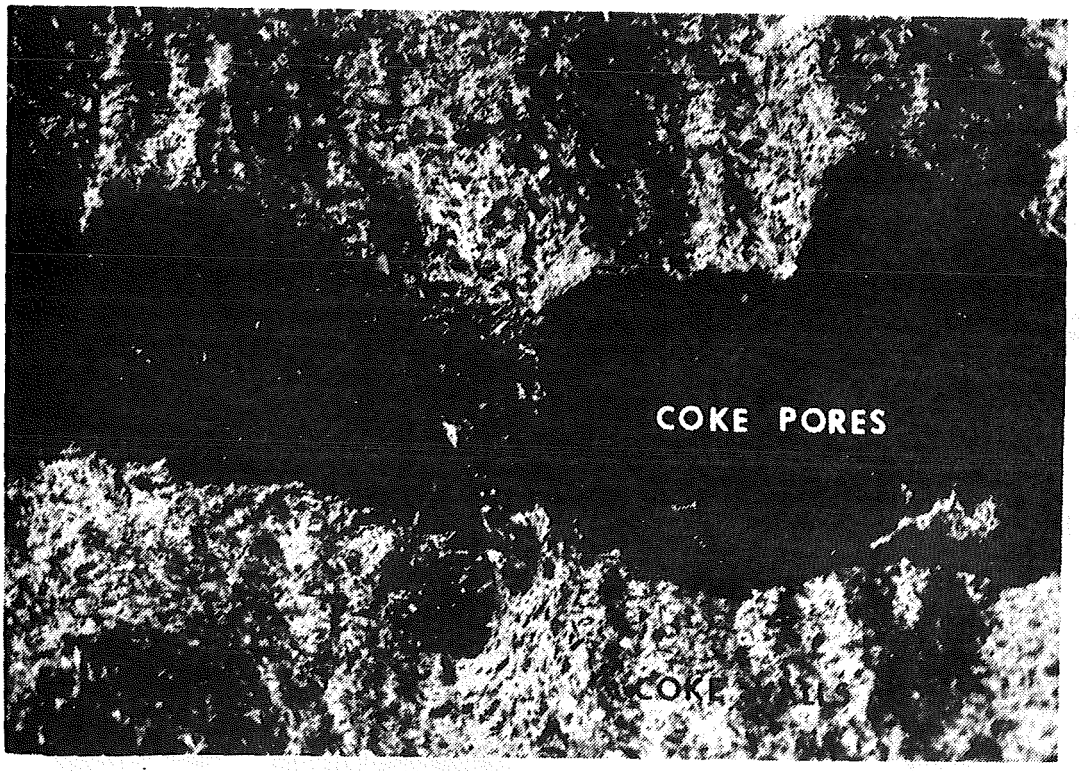


FIGURE 4-3

PHOTOMICROGRAPH OF NATURAL COKE FROM THE NARRAGANSETT BASIN. DARK VOIDS ARE COKE PORES. THE SURROUNDING LIGHTER AREAS ARE COKE WALLS. THE COKE WALLS DISPLAY WELL DEVELOPED MOSAIC ANISOTROPIC TEXTURE (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

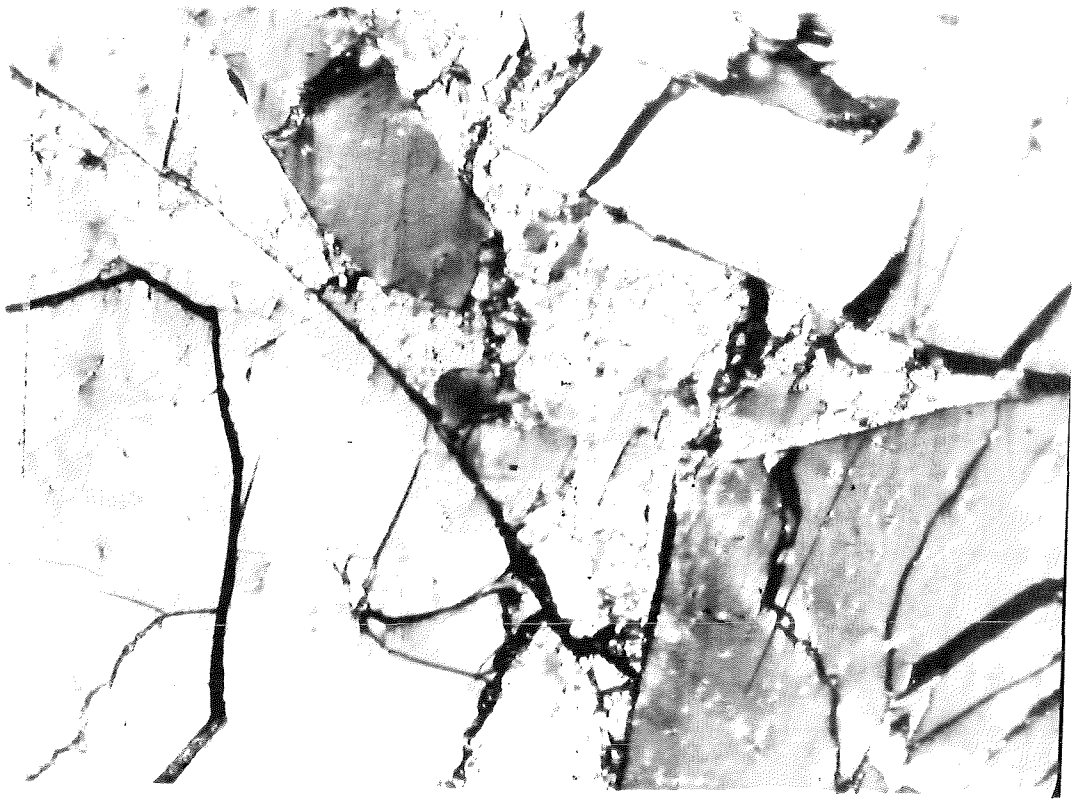


FIGURE 4-4

PHOTOMICROGRAPH OF A LOW ASH PORTION OF BRECCIATED ANTHRACITE FROM THE NARRAGANSETT BASIN. THE DIFFERENT SHADES (FROM GRAY TO WHITE) OF BRECCIATED COAL FRAGMENTS ARE DUE TO ITS ANISTROPIC (BIREFLECTANT) NATURE. THE FRAGMENTS HAVE BEEN ROTATED WITH RESPECT TO ONE ANOTHER AND REFLECT LIGHT DIFFERENTIALLY DEPENDING ON THEIR ORIENTATION. THE SPACE BETWEEN LARGE FRAGMENTS OF ANTHRACITE HAS BEEN FILLED BY SMALLER FRAGMENTS OF VARYING SIZE. THE ENTIRE SAMPLE HAS BEEN PARTIALLY ANNEALED. NOTE THE SURFACE TEXTURE OF THE LARGER FRAGMENTS OF COAL. (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

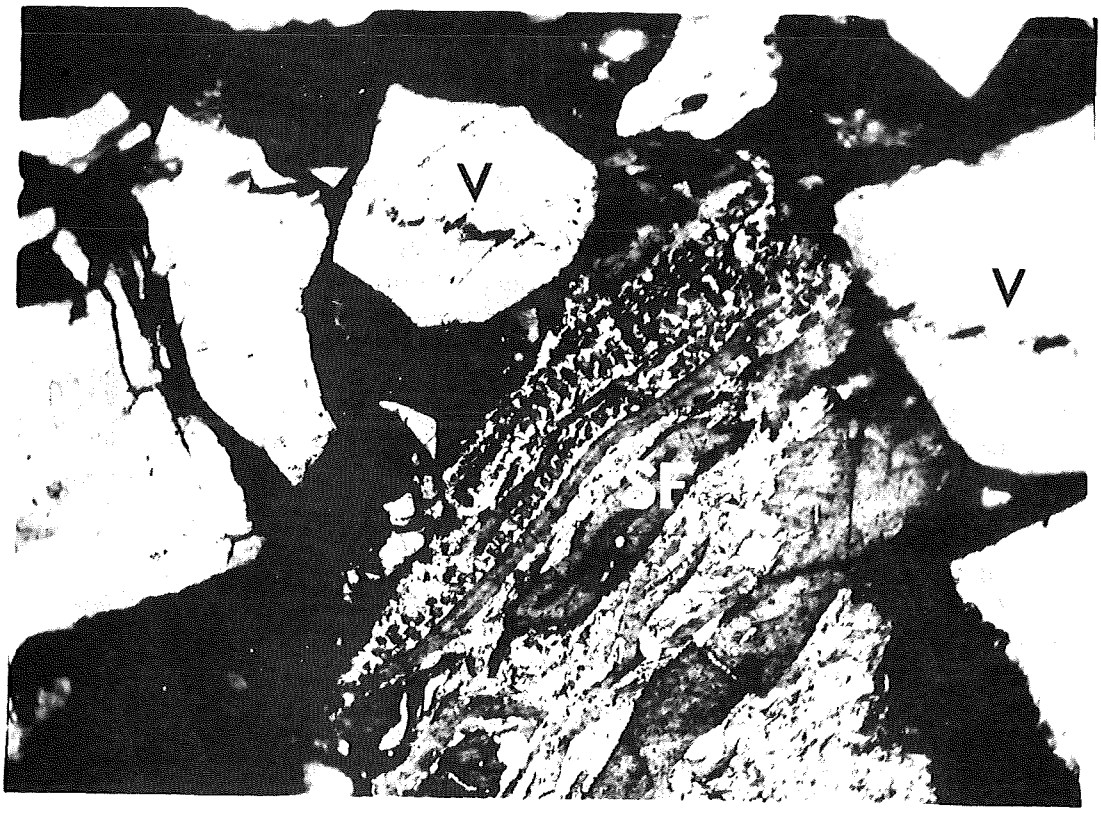


FIGURE 4-5

PHOTOMICROGRAPH OF SEMIFUSINITE (SF) THAT IS LOWER REFLECTING THAN ASSOCIATED VITRINITE (V). (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

have been distorted by folding, faulting, shearing, and brecciation. Petrographic investigations (Raben and Gray, 1979a) have defined several textures that bear directly on the coals' behavior under stress that must be considered when making thickness estimates. Additionally, the identification of certain coal textures and other petrographic features, produced by several subsequent geological events, are of the utmost importance in considering the coals for utilization.

In coals with high primary ash contents, microfolding and faulting appear to be deformational styles often observed (Raben and Gray, 1979a), (Figure 4-6). In these coals the silicate minerals (predominantly phyllosilicates) tend to deform plastically while the coals deform in a more brittle or rigid manner. The coal layers between silicate layers have been broken and rotated slightly to conform to the folding silicates. In coals with lower primary ash contents, brecciation, rotation and displacement are dominant (Figure 4-4). The term primary ash is used to differentiate this material from ash that is clearly of secondary origin such as vein and cavity fillings. The magnitude of the above processes is related to proximity to planes of shear. Rotation can be inferred by the orientation of the anisotropy of the coals. Displacement can be relatively inferred from the degree of rounding of individual fragments (Figure 4-4).

Cracks and voids, which result from brecciation, are commonly coated with secondary depositional carbon which in turn encloses secondary mineral matter. Open voids correspond to thickening; annealing textures and shear-smeared textures correspond to thinning.

The foregoing discussion is generalized in that it describes "end-member" coal types. Thus it is recognized that textural elements of one type of coal may be associated with textural elements of other types.

The coals are hydroscopic and may hold up to 15% moisture if left out in damp air (See coal chemistry, this chapter). Petrographic investigations of the coals indicate that the moisture is most likely held in voids and capillaries associated with brecciation and secondary carbon deposition (Figures 4-2, 4-4). Also the secondary mineral matter is more easily washed than the primary mineral matter in these high specific gravity coals. It is important, when considering particular coals for utilization, to consider: 1) the relative amounts of primary vs. secondary mineral matter, and 2) the amount of void space and secondary carbon (Raben and Gray, 1979a).

Coal Rank

The fact that coal rank increases with depth, has been known for quite some time in many basins and can be observed using different rank parameters obtained from samples selected at different depths in drillcore. The basic assumption is, however, that the stratigraphic column tested is essentially the same as the stratigraphic column at the time the rocks were most deeply buried, and that they have not been markedly disturbed subsequently. Thus, if the rocks have been subsequently faulted or folded the relationship of rank vs. depth of burial may not apply.

A plot of coal chemical parameters vs. depth in drillcore is not infor-

FIGURE 4-6

PHOTOMICROGRAPH SHOWING A TYPICAL HIGH ASH PORTION OF NARRAGANSETT BASIN COAL. THE LOWER REFLECTING AREAS (BLACK) ARE COMPRISED OF MINERAL MATTER. THE HIGH REFLECTING AREAS (WHITE) ARE ANTHRACITE. THE MICROFOLDED AND MICROFAULTED TEXTURE DISPLAYED HERE IS TYPICAL OF THE DEFORMATIONAL TEXTURES OF HIGH ASH SAMPLES. COMPARE TO FIGURE 4-4 WHICH IS A LOW ASH SAMPLE. (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

mative because of the small number of samples in any given drillhole. A plot of coal reflectance vs. depth in drillcore yields a trend that indicates increase of rank with depth. However, an insufficient distribution of samples plus the presence of a few anomalous reflectance readings indicates that there may be no definite relationship of increase of rank with depth.

There are several important aspects that must be considered in any discussion of depth vs. rank relationship of coals in the Narragansett Basin, namely the coals' complex chemical and physical characteristics and the geological complexity of the coal seams. The former directly affect the limits of analytical precision (for example the determination of coal volatile matter).

The parameters used to determine rank for the coals of the Narragansett Basin, include chemical parameters and the reflectance of vitrinites. The results of chemical analyses (Barton and others, 1977) are such that, with one exception (Somerset), in the Narragansett Basin, coal rank increased from south to north, specifically in the following order based on geologic location; Portsmouth, Bristol, West Mansfield, Mansfield and Somerset (Table 4-3). Likewise preliminary coal reflectance data indicates a similar general trend of increase in rank to the north specifically in the following order: Portsmouth, Bristol, Somerset and Mansfield.

The illite crystallinity data from rocks within the chlorite and subchlorite zones of metamorphism and diagenesis indicates that the temperature to which the rocks were heated increases to the southeast (See Chapter 3). Therefore, it was at first thought that the coal rank should increase to the southeast. This is contrary to what is found on the basis of the reflectance of vitrinites and chemistry of the coal. A possible explanation is that the coal rank is affected by frictional heating during tectonism, particularly along the northern basin margin and along faults, and may decrease in intensity toward the interior of the basin or away from zones of shear. The nature and rank of the coal at the time of deformation also influenced its behavior when stressed. The major deformation affecting the Narragansett Basin coals may have been concurrent with or subsequent to the peak regional thermal metamorphic event. Within a single seam, reflectance may be quite variable and related to proximity to planes of shear. A preliminary indication based on reflectance is that the rank of the coal may be higher near the roof and floor of a seam and lower in the middle. Likewise, based on illite crystallinity (Hepburn, pers. comm., 1978) the temperature to which shales surrounding the coals have been elevated is higher than the temperature within the coal. These findings are in agreement with Ashley's (1915) conclusion that the coals are more graphitized near their roof and floor rocks than in the middle of the seam because of more intense shear in these zones where the coal "flowed like so much putty" as he phrased it.

Coal Stratigraphy

The subject of the occurrence of coal in the stratigraphic column can be approached on several different levels: 1) the regional distribution of the coals; 2) the immediate stratigraphy about the coals (i.e., sediments in close proximity to the coal).

All the coals studied occur within the Rhode Island Formation (Coal

Measures of Shaler, 1899), the most extensive and thickest formation in the Narragansett Basin. Comprehensive and abbreviated descriptions of the Rhode Island Formation have been presented by Shaler and others (1899); Skehan and Murray, eds., (1978); and Skehan and Murray, this volume, Chapter 1.

The thickness of the Rhode Island Formation has been variously computed as ranging from 3,000 to 12,000 ft (Skehan and Murray, eds., 1978); Lyons (1978) has computed the thickness at approximately 20,000 ft. Rock types encountered in drillcore include sandstone 43.5%, siltstone 34%, shale (or mudstone) 12%, conglomerate 8%, and coal 1.5% (Skehan and Murray, eds., 1978). The lithologic subdivisions are subject to some variability due to the inherent subjectivity of field identification of grain size. However, attempts were made to adhere as closely as possible to the Udden-Wentworth classification of grain size. The results of lithologic compilations of the 4 holes drilled during the present study are presented in Table 6-1.

Sandstones, the most abundant lithology in the Narragansett Basin, are primarily lithic greywackes (Towe, 1959), which are characterized by quartz contents less than 75%, 15-75% clay matrix and rock fragments in greater abundance than feldspar grains. According to the work of Towe (1959), quartz contents of sandstones analyzed were between 22.2 and 78.0% most being in the range of 22.2-42.6%. Other sandstone lithologies recognized by Towe include subarkose, subgreywacke and feldspathic greywacke. Conglomerates are polymict with quartz and granite comprising the dominant clast types. They are characterized by both grain and matrix supported textures. Work carried out by Valia (written comm., 1978) was in close agreement with Towe's work.

The Rhode Island Formation is characterized by rapid facies changes, i.e., alternations of very coarse grained sequences (primarily conglomerates and sandstones) and finer grained sequences (primarily sandstones, siltstones, and shales). The coals are confined to the finer grained portions which are dominated by sandstones, siltstones, and shales. Shales are the dominant roof and floor lithologies. Specifically, the coals commonly occur at the top of a fining-up sequence. These sequences are generally similar to those formed by lake fill and by bar migration in modern and ancient fluvial systems. The coals also commonly occur interbedded with shales and silty shales. Where several thin seams are closely spaced in the stratigraphic succession, they are usually interbedded with shales and siltstones, whereas most of the thicker seams occur at the top of fining-up sequences. The thicker coal seams tend to be lower in ash than the thinner ones. They are probably allochthonous as evidenced by rooted horizons in close proximity below the coal. Underclays may not be readily recognized in drillcore due to their generally poor recovery, but in outcrop underclays have been observed. Some of the thinner seams may be allochthonous and these tend to grade into surrounding shales.

Some of the finer grained rocks were probably deposited in standing bodies of water. This is evidenced by occasional varved sequences and the presence of thin graded beds that are probably the result of small density flows in ponded water. Some of the fining-up sequences appear to be related to the filling of standing bodies of water with sediments.

The nature of the sediments is quite complex. There most certainly are

several diverse environments of deposition associated with the coal-bearing rocks. The coarse-grained conglomerates and sandstones, which are the dominant lithologies in many parts of the Basin and probably basin wide, have characteristics that suggest they were deposited, or at least reworked, by processes involving mass sediment flowage. Large clasts are commonly supported by matrix in poorly bedded to massive units. These characteristics are similar to those observed in deposits laid down during floods and storms. Extensive sequences of trough cross-stratified coarse sandstones are similar to channel deposits in sandy fluvial systems. Both braided and meandering streams were probably active in different parts of the Basin at different times. The coals in the Plainville and Mansfield areas, Massachusetts, are dated by plant fossils as being Early Alleghanian (Westphalian C) (Oleksyshyn, 1976). The coals in Portsmouth and Bristol, Rhode Island are dated as Conemaughian (Stephanian A) (Lyons, 1978). The Alleghanian (Westphalian) sequences intercepted in drilling tend to contain more comglomerates and sandstones than sequences from drillcore in the Conemaughian (Stephanian A) age rocks.

The character of the stratigraphy reflects proximity to a source area and probably also a relationship to a pulse of tectonic activity in terms of relative vertical movements. In the latter case, sequences of coarse-grained rock may be deposited as a result of new influx of sediment which in turn resulted from either a local downdropping of the Basin or uplifting of a source area. Depositional processes there reworked these sediments and eventually the slope conditions were lowered and finer grained rocks were deposited again. During the development of these finer grained sequences, the deposits are apt to contain coal which required fairly low slope conditions and a high water table. Fine-grained sequences are commonly interrupted abruptly by coarser grained sequences so that it is likely that tectonic activity is at least in part the cause of these rapid changes in depositional style.

Chapter 5

LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIAL (LEES) STUDY

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Chapter 5

LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIAL (LEES) STUDY

Introduction

Contract J0188022 in the Statement of Work on Page 3 requires that Legal, Environmental, Economic and Social Studies (LEES) be conducted and "aimed at extending previous work accomplishments by conducting land use assessments in greater detail, including contact with key people in selected areas of the Basin to determine the nature of the impact of possible mining development."

As part of this requirement contained in Paragraph 1.3.1.1, a series of 7 1/2 minute quadrangle scale geographical maps is required to be developed. This report describes the development of these maps and the required contact with several key people relative to the potential development of mining.

The same work statement on Page 3 in Paragraph 1.4.1 requires a synthesis of Parts I and II, being defined as the combination of "the two series of maps generated in Parts I and II so that the resultant maps will constitute a geographic base from which to identify specific sites that may be amenable to future investigation - i.e., sites in which potentially mineable coal is likely to exist and in which any LEES problems are either nonexistent or minimal."

The next section of this report, Initial Contact with Mansfield, Massachusetts, addresses the first set of requirements, including the development of quadrangle scale maps, and the section entitled Map Development and Synthesis addresses the requirement for synthesis of Parts I and II. In the case of the latter requirement, the approach used and approved by the Bureau Project Monitor was the development of a computer program with a grid system which allows the mapping of the Narragansett Basin considering both geological and LEES criteria.

In the referenced work statement in Paragraph 1.5.1.D, a requirement exists to carry out LEES investigations at each site, including title searches and other activities related to evaluating any local nongeological barriers to mining. Response to this requirement is contained in Follow-Up Investigations in Drillsite Areas, which section contains the results of visits to the areas in which drilling was performed under this contract. In each case ownership records were examined from public information, assessments were made of the nature of each of the areas with respect to potential mining development, and other potential nongeological barriers were identified as individually assessed. Ownership of the parcels of land surrounding the drillsites was identified, and for purposes of this report the ownership density is reported, while the names and addresses of actual owners are omitted. While these individuals do indeed hold title to the land, it seems appropriate that for purposes of this report the nongeological barriers concern primarily ownership density and not owner identification. This information is available, however, in the Weston Observatory offices and may be made available to the extent that it exists at that location.

Initial Contact with Mansfield, Massachusetts

As indicated in the introduction, a series of 7 1/2 minute quadrangle scale maps are to be developed, and this initial contact aided in reasonable establishment of priorities for the subsequent map development. The next section of the report contains a detailed explanation of this development and references the maps themselves. Appendix G contains reduced copies of the maps, which are contained herein for reference purposes as differentiated from purposes of meeting contract requirements.

The contract work statement requires contact with key people in the Basin to determine impact of possible development. In August of 1978 a representative of Weston Observatory met with members of the Board of Selectmen and the Planning Board of the Town of Mansfield, Massachusetts. The Mansfield area has an early history of mining, with the Harden and Skinner mines, and is also representative of Narragansett Basin towns in an area where nongeological considerations, particularly environmental and ground water, could be most important. Weston's representative explained that the purpose of the visit was to discuss a hypothetical mine and was to gain the reactions and insights of town leaders towards such a development. Both boards were realistic and objective in their responses. No member of either board spoke against the hypothetical mine, although most members did voice questions reflecting genuine concern over certain side effects of a coal mine in the area. There was a universal interest in the energy resource aspects of a mine operation, especially if the power generating plant were to be built locally. Specifically, the boards offered the following comments:

Board of Selectmen:

1. Educating the town as to the impacts and benefits would be very important. An objective appraisal of the costs and benefits to allow for citizen involvement in the decision-making process was seen as mandatory;

2. Economic benefits to be derived from the town, i.e., property tax, jobs, business expenditures;

3. Impact on the abutters, in relation to a long-term increase in truck traffic;

4. Reclamation of the exhausted mine area to restore it to its original state;

5. Mineral rights ownership, and the role of the town. Specific concern was voiced over what rights the state may take away from the landowner and/or the town;

6. Concern over the amount of land to be used in developing the mine, and that it may overwhelm the town;

7. Water table impacts.

Planning Board

1. Echoed the concerns over water table impact, traffic considerations, and the amount of land to be used;

2. Concern over the sufficiency of current laws in Massachusetts concerning environmental protection and land reclamation;

3. Concern over what happens to Mansfield, as a community, once the coal supply is exhausted. Will it be just another Boom-to-Ghost town?

4. Concern over the contamination of town wells;

5. Concern that Mansfield may be too densely populated for such an activity.

The respective boards were receptive to discussing the hypothetical coal mine possibilities, and were candid in their appraisals of the problems attendant both to the mine itself and to the host town. Concern over developing a viable energy source for local consumption was evident, counterbalanced by an understandable concern over environmental costs.

Map Development and Synthesis

In Paragraph 1.4.1 the work statement requirement for synthesis of Parts I and II of the contract states that the resultant maps should constitute a geographic base from which to identify specific sites that may be amenable to future investigation. One of the key considerations in the response to this requirement is that analyses of different parts of the Basin be conducted on a basis which is completely uniform from point to point, and allows the relative weighting of barriers and geological criteria in order best to identify the priority in which sites should be explored. This approach suggests the use of a computer analysis as the basis for the synthesis of data.

On the basis of this rationale and after discussions with the Bureau of Mines relative to this contract, it was decided to develop such an approach. A program was therefore developed at Weston Observatory which examines eight geological criteria and ten LEES criteria and which combines these criteria on a basis weighted by the user for that particular map on a square mile by square mile basis throughout the Basin. The system can be adapted to 1/10 square mile units.

The entire Narragansett Basin was analyzed from the perspective of land use and environmental resources. A series of maps was produced displaying the extent of developed lands, wetlands, fragile ground water resources, and surface mining, both active and inactive. Since it was recognized that the first three items all constituted barriers to mining development, a search was made for sites of appropriate size with minimal obstacles. A surprisingly large number of sites with apparently surmountable barriers were identified. A careful quantitative analysis was made. The possibility of favorable mining conditions under wetland areas was entertained, and a second search for favorable sites was undertaken from this perspective. The results suggested considerable potential. Sites of this type, apart from being numerous and extensive, occur in portions of the Basin not otherwise amenable to mining. A possible connection between wetland regions and bedrock geology is a serious possibility. The results of the analysis are later combined with geologic information to design a drilling program with the capability of satisfying multiple objectives.

1. Development of the Maps

Contract J0188022 required that two sets of maps be developed for the Narragansett Basin. One set is to show geological characteristics, particularly with respect to the likelihood of coal, and the second set is to illustrate significant land use related barriers to potential mining. The contract further required that these maps be superimposed to identify overlap areas in which geological indications were favorable and constraints were likely to be acceptable. As the work proceeded, it was discovered that the presentation alone of the negatively oriented barrier type of information was misleading because of its lack of tie to geological information. A decision was therefore made to computerize both sets of maps, not only for consistency but also for easy synthesis and applicability as data bases improved.

The discussion which follows below addresses the development of 7 1/2 minute quadrangle nongeological barrier maps as required. That discussion is followed by treatment of the computerized maps, which by agreement with the Bureau of Mines are used to meet the terms of the contract and which also represent a useful tool for future application not only to the Narragansett Basin but to any other area thought to have underground resources.

a. Mapping Rationale: The Nature and Significance of the Information Displayed.

i. Base Map. Standard U. S. Geological Survey 7 1/2 minute topographic maps were used as base maps for the study. LEES information is displayed in a manner suitable to the preservation of all data recorded on the base maps.

ii. Basin Border. The surface limit of Pennsylvanian age rocks is indicated and defines the limit of the study. There is currently no information suggesting the occurrence of Pennsylvanian rocks underneath the surrounding terrain at mineable depths. Extractive activity, therefore, will have only indirect effects on regions peripheral to the study area.

iii. Political Boundaries. The Narragansett Basin has a large population and no recent history of commercial coal mining. Any effort to develop reserves will require careful consideration of political and societal issues. With this in mind, state and township boundaries have been highlighted on the maps. Since county and planning council boundaries are coterminous with township and state boundaries, they are readily located on the LEES maps. The four regional planning councils in the Basin were important sources of advice and

information during production of the maps. Their jurisdictions are indicated on Figure 5-1.

iv. Developed Lands. To develop a mining site within the Basin, one of three approaches may be taken: (1) Complete avoidance of all land which is developed and in use; (2) acquisition of land titles from all property owners; or (3) acquisition of mineral rights from all property owners and assumption of liability.

Given these criteria, the LEES maps ideally should display: (1) Intensity of development, or capital investment per unit area; and (2) the number of owners per unit area.

These considerations were combined with the available data sources, and three classifications were developed: (1) Highly developed (HD); (2) moderately settled (MS); and (3) lightly settled (LS).

These three categories are defined and discussed below.

Highly Developed (HD). This includes the following: industrial facilities; airports; port facilities; railyards; truck terminals; storage facilities; public installations such as water works, sewage treatment plants, disposal sites; limited access highways; downtown commercial areas; shopping centers; commercial strips along highways; public institutional land supporting major facilities, such as hospitals, churches, colleges, prisons; recreational facilities involving large capital investment, such as racetracks, outdoor theaters, stadiums, fairgrounds, etc.; cemeteries; nurseries with greenhouses; apartment buildings; and all residential land with lot sizes less than one-half acre. Residential lots of this size generally have a street frontage of from 50 to 100 feet.

Moderately Settled (MS). This includes only residential land. Lot sizes fall in the range of one-half to one acre, with the majority being one acre in size. In general, two types of areas appear. First, there are suburban or semi-rural areas located on the peripheries of cities and towns, and also along major secondary roads. Second, there are clusters of three to ten dwellings in a rural setting.

Lightly Settled (LS). This also includes only residential land. Lot sizes typically fall in the

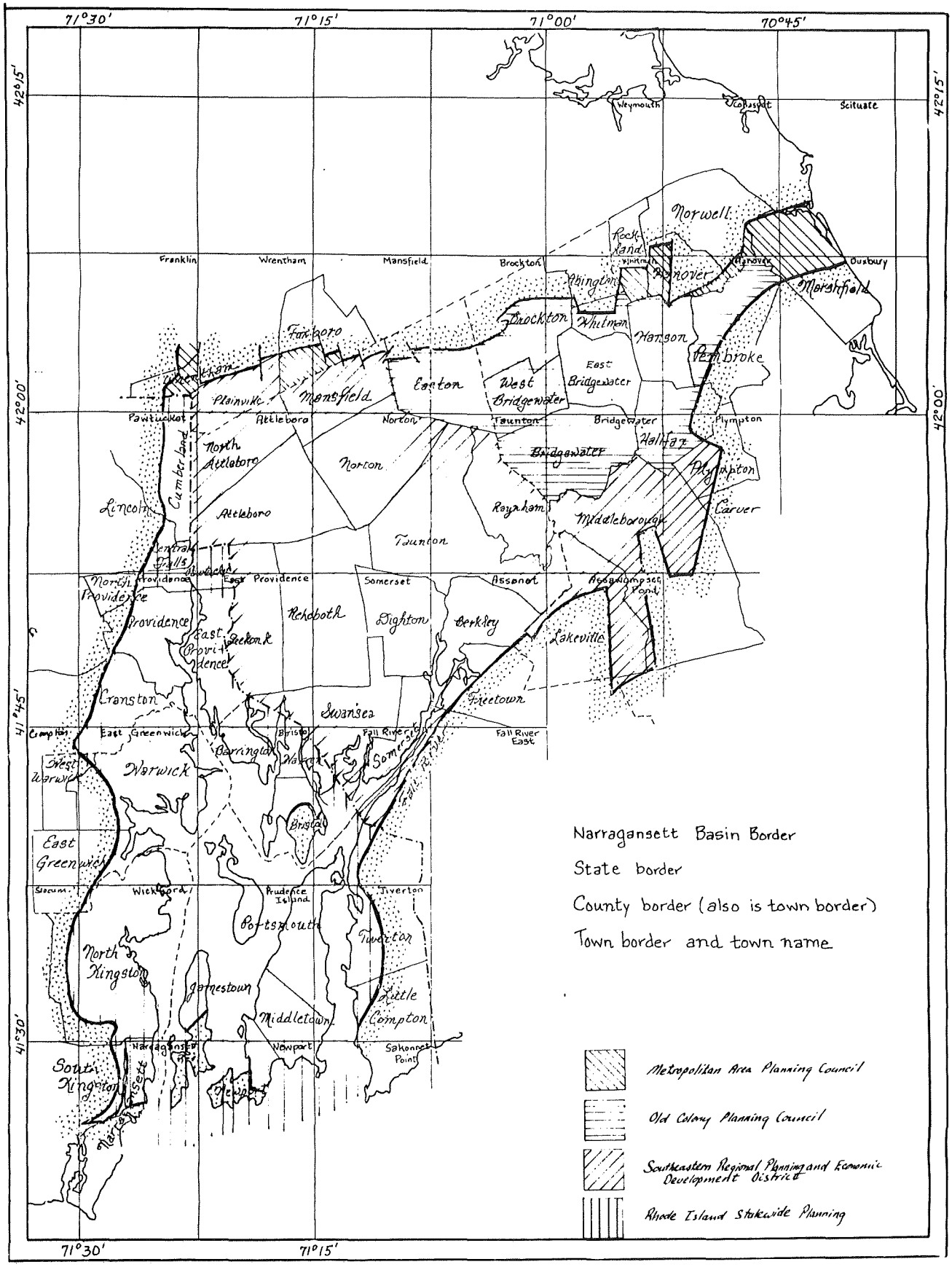


FIGURE 5-1

REGIONAL PLANNING COUNCILS WITHIN THE NARRAGANSETT BASIN.

range of one to three acres. Two types of residence appear. First, there are rural homes which often leave up to 75 percent of the acreage as uncleared forest or open field. Second, this category includes urban estates of two to three acres with extensive landscaped gardens.

Agricultural Land and Farm Residences. The proportion of developed agricultural land in the Basin has been declining in recent years, with a growing number of fields untilled, abandoned, or sold for development. In the interest of economy of space, agricultural land is not displayed on the LEES maps. As preliminary analysis indicates sites favorable for development, the addition factor of agricultural land use can be studied in these more limited areas. An approximate indication of farm lands and residences is given by the U. S. Geological Survey base maps. House symbols falling outside of the three LEES classifications are generally farmhouses, and the rectangular white-colored areas adjacent to rural roads are generally agricultural fields.

Summary. By use of the above scheme, the LEES maps develop a simple picture of land development in the Basin. The category "highly developed" delineates all major urban areas, the central districts of towns, and small commercial clusters centering on the junction of roads. The category "moderately settled" identifies perhaps 90 percent of the non-urban residential lands in the Basin. The category "lightly settled" serves to classify the remaining areas of non-agricultural settlement.

v. Unique Cultural Features. Historical sites, wildlife preserves, and archaeological zones were considered for inclusion on the maps. Historical sites often correspond to developed areas; wildlife preserves are frequently wetlands; and archaeological zones are extensive and loosely delineated. For these reasons it seems unnecessary to attempt precise mapping of such features. They should, however, be investigated by local inquiry in any area later identified as favorable for potential development.

Major archaeological zones in the Basin are located along the Taunton River and in lakeshore areas of the Assawompset Pond quadrangle. Additional sites are ubiquitous throughout the Basin. This historic and prehistoric record is regarded as part of the national heritage and protected by both Federal and State law. Therefore, expert assessment will be

required before mine development can be initiated. The Anthropology Department of Brown University in Providence, Rhode Island, operates a Public Archaeology Laboratory. This is a permanently staffed facility, readily available for consultation and capable of providing the requisite expertise. The Laboratory has just completed a survey and is conducting salvage excavations along the route of the proposed Interstate Highway 495 extension between Mansfield and Bridgewater. This right of way is 400 feet wide, 14.3 miles in length, and lies entirely within the Basin. The survey resulted in the identification of twenty-one historic and thirty-four prehistoric archaeological sites. An additional project currently underway at the Laboratory has the goal of locating all known prehistoric sites in Bristol, Plymouth, and Barnstable Counties.

vi. Surface Mining. Surface mining is surprisingly extensive and widely scattered throughout the Basin. With the exception of the Masslite Quarry and a small number of clay pits and borrow pits, these operations are confined to sand and gravel extraction. All surface mining, both active and inactive, is indicated on the LEES maps. This information is significant for the following reasons: (1) These quarries are convenient and accessible locations for exploratory drilling. Active operations may provide some measure of security for drilling equipment; (2) both till and possible bedrock exposures may be helpful for geologic mapping; (3) larger quarries might be desirable locations for a mine entrance shaft. Overburden is removed and roadways are somewhat developed. Surface reclamation at the close of mining activity has the advantage of restoring to public use an area which in all likelihood would have remained distressed.

vii. Wetlands. The Wetlands Protection Act written into law by the states of Rhode Island and Massachusetts has recently provided for the legal protection of wetlands. At both the state and local level, procedural channels for implementation of these laws are developing rapidly. Even minor activity such as the construction of a gravel pad under a drill rig or the discharge of drilling mud may require issuance of a permit from the appropriate township. In addition to these legal barriers, wetlands, of course, represent potential engineering problems in the planning and operation of an underground mine. Given all of these factors, mapping and careful consideration of wetlands is one of the most important aspects of the study.

A significant conceptual point arises when wetlands are viewed in map form. Since they are now legal entities, there is some urgency about placing rigidly fixed, "legal" boundaries around them. Wetlands, however, are naturally variable and shifting. The Wetlands Protection laws relate to actual, existing wetlands and not to geographic areas. In Rhode Island in particular this concept has been articulated as official policy by the Department of Environmental Management. The result is that on-site investigation is usually necessary before a permit for wetland alteration can be issued. In Massachusetts the permit process is the responsibility of Town Conservation Commissions with appeal to the Department of Environmental Quality Engineering possible. In Rhode Island permit application is made directly to the Department of Environmental Management with the townships retaining absolute veto power.

Although the above discussion does apply to wetlands administration in the Massachusetts portion of the Basin at present, the future situation is more complicated. New state laws provide for the "restriction" of inland (131-40A) and coastal (130-105) wetlands. "Restriction" in this case does mean the delineation of geographical boundaries within which activities detrimental to wetland ecology are prohibited. Once such boundaries have been determined, the restriction will be incorporated into all land deeds covering the affected area. The majority of Massachusetts wetlands apparently will be so classified. The wetland restriction program is administered by the Department of Environmental Management. Wetlands which are not restricted will remain under the administration of the Department of Environmental Quality Engineering, and the "site-specific" approach discussed previously will probably be retained.

The Massachusetts Department of Environmental Management is currently in the process of preparing detailed maps on which restricted wetlands are identified, and will shortly undertake to notify all affected property owners. The basis of wetlands identification will be aerial photography and field survey. [See Section 1(e), General Comments on the Character of the LEES Maps and Future Sources of Information, for further discussion.]

In mapping wetlands, the goal of the study has been to attain the closest possible correspondence

between the wetlands displayed on the LEES maps and the "wetlands" as a legal entity. Both because of the subtleties of the laws as discussed above and because wetlands mapping and management are quite new to the region, existing sources are erratic and variable throughout the Basin. The best data was sought out, and an accurate record of the sources used has been maintained. Detailed discussions will be found under Section 1(b), Data Sources, and Section 1(c), Mapping Procedures and Accuracy.

Finally, coastal wetlands are distinguished from inland wetlands on the LEES maps. In both Rhode Island and Massachusetts separate state agencies are responsible for management of coastal as opposed to inland areas. In Rhode Island coastal wetlands are administered by the Division of Coastal Resources, and inland wetlands, by the Division of Land Resources. Both divisions are included within the Department of Environmental Management. In Massachusetts coastal wetlands are administered by the Coastal Zone Management Council, and inland wetlands, by the Department of Environmental Quality Engineering. Both function under the Executive Office of Environmental Affairs.

viii. Ground Water Resources and Well Protection Areas.

The recent Southeastern New England Study Report of the New England River Basins Commission makes two relevant points in its discussion of water resources in the LEES study area: (1) Many townships already rely heavily on ground water, tapped both privately and publicly, to meet existing needs; and (2) Growing demand will require extensive development of ground water resources in these as well as other areas.

The report recommends that legislation be formulated to achieve two primary goals: (1) Regulation of ground water extraction to prevent depletion; (2) prevention of groundwater contamination by surface seepage in recharge areas.

To provide for implementation of Section 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL92-500), Metropolitan Area Planning Council, Old Colony Planning Council, Southeastern Regional Planning and Economic Development District, and Rhode Island Statewide Planning have all recently completed or are in the process of drafting reports which make specific recommendations for such legislation, with particular emphasis on contamination control.

The Old Colony Planning Council report serves as a case in point. There, consultants were hired to map the upper and lower contours of the transmissive layers, transmissivity, and surficial geology. Groundwater basins and divides and general recharge patterns were determined. This, in combination with patterns of surface drainage plus the location of existing and intended public supply wells, served as a basis for defining present and future well protection areas. In the final report of the Planning Council, these areas are delineated on maps, and the townships are urged to protect them by law from any surface activity which might lead to contamination.

The location of a mine shaft, surface storage and processing operations in an important recharge area is environmentally questionable to begin with and apparently may become legally restricted as well in the immediate future. Given such considerations it was deemed important to indicate these areas on the LEES maps and weigh them in any recommendation of favorable exploration sites. In addition, public and industrial wells, with output indicated in millions of gallons per day if known, are located on the maps. It should be kept in mind that no information is given on the locations of private wells. Presumably, their distribution will correspond to the locations of farms and rural residences. The possible lowering of the water table and consequent debasement of public and private wells is an important environmental factor which should be allowed for in the planning of an underground mine.

Just as with wetlands, surface recharge areas are important from a purely engineering point of view as well. They delineate areas where surface runoff is minimal and permeation of meteoric water is maximal. Hence, they represent a higher probability of encountering water problems in the process of underground mining. In the Old Colony Planning Council area this is not strictly true because some areas of high surface runoff immediately peripheral to recharge areas have been included in the well protection areas. In the remainder of the region covered by the LEES maps, however, the recharge areas displayed do correspond to the areas of highest surface permeability.

Only in the Old Colony Planning Council area has the recent concern over water protection advanced to the actual delineation of well protection areas. In the remainder of the Basin hydrological maps and appropriate consultation were relied upon to anticipate the

locations of emerging well protection areas. For a detailed discussion, refer to Section 1(b), Data Sources.

b. Data Sources

The precise description of data sources for the entire area is, unfortunately, quite complicated. To facilitate study of this detailed description, it is recommended that the reference map of the study area be referenced. For the sake of expediency the following abbreviations will be used:

MAPC	-	Metropolitan Area Planning Council
OCPC	-	Old Colony Planning Council
SRPEDD	-	Southeastern Regional Planning and Economic Development District
RISWP	-	Rhode Island Statewide Planning
USGS	-	U. S. Geological Survey

i. Base Map. The most up-to-date USGS maps were used. In Massachusetts most of the maps were published between 1962 and 1964. In Rhode Island most of the maps were published between 1955 and 1957 with photo updating in 1970 and 1975. It should, therefore, be borne in mind that whereas the base maps are useful in indicating the character of an area, they can frequently be completely out of date. Figure 5-2 indicates the date of publication and the date of any photo revision for all the LEES base maps.

ii. Basin Border. The surface limit of Pennsylvanian age bedrock was located on the basis of published geological maps of the region and field studies conducted by Weston Observatory. This boundary is discontinued where it passes under the waters of Narragansett Bay, as no information exists on which to base its location.

iii. Developed Lands. The primary source used for mapping of developed lands throughout the entire study area was the 1971 Land-Use and Vegetative Cover Mapping series developed by the Massachusetts Agricultural Experiment Station under the direction of William P. MacConnell and herein referred to as MacConnell maps. This 1971 study was based upon air photo interpretation, and the information was transferred onto USGS 7 1/2 minute series topographic maps. The three categories of land development used on the LEES maps are a composite of forty categories used on the MacConnell maps. Thus, considerable interpretation was required to meet the needs of this study. (See Section c, Mapping Procedure and Accuracy, for a detailed discussion.)

TABLE 4-1 COAL SEAM THICKNESS DATA

COAL SEAM THICKNESS DATA

SEAM THICKNESS (feet)	NUMBER	PERCENT	TOTAL THICKNESS
0.5	32	8.0	14.3
0.6–1.4	25	13.9	24.6
1.5–4.9	21	25.4	44.9
5–9.9	5	18.8	33.3
10	3	33.7	59.5

TABLE 4-2 PROXIMATE AND ULTIMATE ANALYSES OF NARRAGANSETT BASIN COALS

	HOLE NUMBER	DRILLED DEPTH	SEAM THICKNESS	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR	B.T.U.
MOISTURE AND ASH FREE	2	258	8.9	-----	13.3	86.6	-----	0.40	95.7	0.3	3.1	0.4	13607
	6	385	17.5	-----	9.1	90.8	-----	1.60	92.7	0.7	4.0	0.8	13820
	7	230	26.6	-----	7.6	92.3	-----	0.50	94.9	0.2	4.2	0.1	13373
	11	976	1.25	-----	6.8	93.2	-----	1.06	95.12	0.31	1.97	1.54	14158
	23A	463	5.9	-----	8.4	91.6	-----	0.70	93.3	0.5	5.7	0.1	12992
	23B	468.5	1.0	-----	8.56	91.44	-----	0.60	94.64	0.11	4.66	0.0	13869
	33	733.5	11.0	-----	5.4	94.5	-----	0.40	95.7	0.3	3.2	0.3	13859
	51	681	1.0	-----	26,52	73.48	-----	2.56	82.86	0.42	11.36	2.8	11040
	64	625.5	4.7	-----	6.5	93.5	-----	0.40	95.5	0.18	3.7	0.17	13258
AS RECEIVED	2	258	8.9	13.7	8.4	53.3	24.5	1.8	59.1	0.2	14.0	0.3	6970
	6	385	17.5	1.1	5.2	43.4	50.2	1.0	44.6	0.3	3.1	0.5	6630
	7	230	26.6	2.4	6.3	76.0	15.3	0.7	77.9	0.2	5.6	0.07	6263
	11	976	1.25	4.49	5.38	73.84	16.29	1.34	75.35	0.25	5.55	1.22	11215
	23A	463	5.9	0.6	5.0	51.8	36.2	0.5	58.8	0.07	4.3	0.05	8218
	23B	468.5	1.0	0.41	4.37	46.66	48.56	0.35	48.29	0.06	2.74	0.0	7077
	33	733.5	11.0	3.7	4.2	72.8	19.2	0.7	73.7	0.2	5.8	0.1	10669
	51	681	1.0	3.7	4.9	13.58	77.82	0.88	15.32	0.08	5.39	0.52	2041
	64	625.5	4.7	0.8	4.7	68.2	26.1	0.4	71.1	0.13	2.6	0.1	9669

The Narragansett Basin coals are chemically complex. Although volatile matter and carbon contents obtained from chemical analyses would indicate that the coals range in rank from low volatile bituminous to anthracite (Barton and others, 1977), the volatile matter of the coal has been said to be almost entirely non-combustible (Ashley, 1915; Johnson and Auth, 1951) and thus is not a reliable parameter for determining rank. It is probable that the volatile components are comprised of water of dehydration of certain minerals and of CO_2 derived from carbonate. The coals are high ash and contain substantial amounts of quartz, layered silicates and other minerals. This mineral matter appears to be secondary in origin in some coals.

A detailed study of the mineral matter in the coal and how it affects the results of chemical analyses is necessary if the coals are to be considered for use. It is apparent that proximate chemical analyses are not sufficient for determining the rank of the coals. The use of reflectance on carefully selected vitrinites is likely to be a better rank indicator.

The coals are hydroscopic (Ashley, 1915, Johnson and Auth, 1951). The coal takes up as much as 15% moisture if exposed to dampness and may lose an equal amount if exposed to dry air when broken up fine. As a result, the Btu value is largely dependent on conditions of mining and storage. A possible explanation for the coals' hydroscopic nature is given in the petrographic section in this chapter. The effects of moisture on the burning characteristics of the coal is discussed in Ashley (1915) and Johnson and Auth (1951).

Ultimate and Proximate Analyses, Washability Tests

On the basis of analytical work performed under the direction of Albert W.Deuerbrouck, Chief, Coal Preparation and Analysis Laboratory, U.S. Bureau of Mines, Pittsburgh, Pennsylvania, the coal can be characterized generally as anthracite with low sulfur, relatively high ash, and 11,000 to 14,000 Btu (daf basis) (Barton and others, 1977). The washability tests, also performed by the U.S. Bureau of Mines are summarized in Skehan and Murray, Eds., (1978, Appendix K).

Trace Element Analysis

Under the direction of Mr. Gordon Wood, then Chief of the Coal Branch, U.S. Geological Survey, in the laboratory of Dr. Jack Medlin, now Chief of the Coal Branch, semi-quantitative spectrographic analyses of major and trace elements in the coal were carried out. These analyses are presented in Skehan and Murray, Eds., (1978, Appendix M).

Megascopic Analysis

The coals have a dull, graphitic to submetallic appearance, may be sooty and friable to brecciated, and seldom break with a conchoidal fracture except on a very small scale as a result of their friable to brecciated nature. Figure 4-1 shows Narragansett Basin coals in hand sample and in drillcore. A sample of anthracite from Pennsylvania is shown for comparison. The coals are characterized by mylonitized or brecciated textures and by later quartz, chlorite, muscovite, calcite and other vein fillings (Gray and others, 1978).

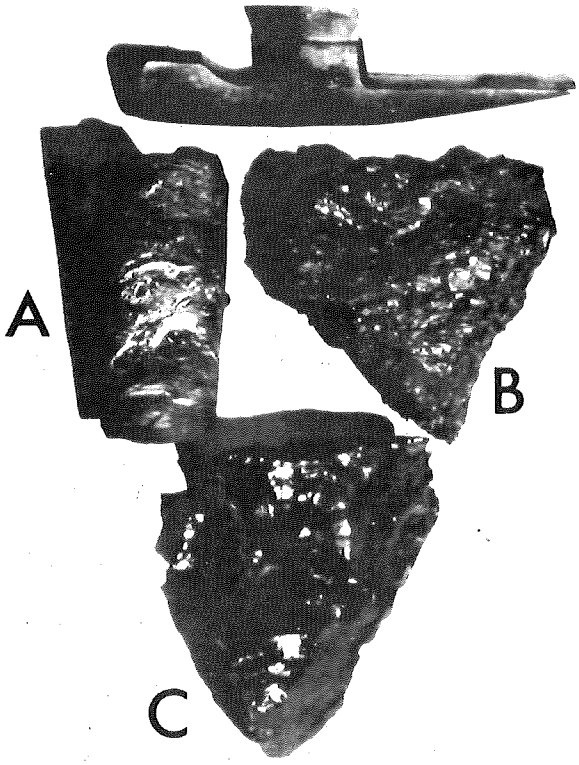


FIGURE 4-1

MEGASCOPIC ATTRIBUTES OF ANTHRACITE FROM THE NARRAGANSETT BASIN COMPARED TO ANTHRACITE FROM PENNSYLVANIA. NOTE HAMMER FOR SCALE.

A SECTION OF NX CORE FROM THE NARRAGANSETT BASIN CONTAINING BRECCIATED COAL WITH ASSOCIATED SECONDARY SILICEOUS MINERALIZATION. THE PORTIONS OF THE CORE THAT ARE NOT AS EXTENSIVELY MINERALIZED ARE CARBONACEOUS SHALE LAYERS. NOTE THAT IN THE MORE MINERALIZED PORTION SOME BROKEN FRAGMENTS APPEAR 'SUPPORTED' BY VEIN MATERIAL.

B HAND SAMPLE OF COAL DISPLAYING THE TYPICAL BRECCIATED NATURE OF MANY OF THE NARRAGANSETT BASIN COALS. THE COAL HAS A SUBMETTALIC LUSTER AND DOES NOT BREAK WITH A PRONOUNCED CONCHOIDAL FRACTURE.

C SAMPLE OF TYPICAL ANTHRACITE FROM PENNSYLVANIA DISPLAYING CONCHOIDAL FRACTURE AND VITREOUS LUSTER.

Coals are rocks that are least resistant to directional pressure, and are thus invariably more highly deformed than the accompanying roof and floor rocks. The nature of the deformation is discussed more completely later in this section and in Chapters 2 and 3. Where subjected to deformation, the coals may occur in irregular lenses and are commonly brecciated. In the process of brecciation and shearing, an extensive network of fractures was formed which were subsequently coated with secondary graphitic depositional carbon and then permeated by silica bearing solutions. Thus, the coals have acted as zones of accelerated movement during deformation and as avenues to direct mineralization (veins and cavity fillings) and gases (which were cracked to produce graphitic depositional carbon). In some seams, individual brecciated fragments may be entirely supported by vein material (Raben and Gray, 1979 b).

Microscopic Analysis

Forty samples of coal from selected Narragansett Basin Project cores, drilled during the NSF phase of exploration, were analyzed petrographically, both during that phase and concurrently with the present study (Gray and others, 1978; Raben and Gray, 1979 a,b). The coals discussed here are those obtained from drillcore in Mansfield and Seekonk, Massachusetts and from Bristol and Portsmouth, Rhode Island, and from hand samples in Plainville, Massachusetts, within the chlorite and subchlorite zones of metamorphism.

The microscopic attributes (habit, texture, mineralogy and maceral content) were described, and the reflectance of vitrinites measured to determine rank. The mean maximum reflectance for samples analyzed ranged from a questionable low of 2.84% to a high of 7.62% under green light in oil. All reflectances indicate that the coal is dominantly anthracite with minor amounts of meta-anthracite (Table 4-3). In a few instances the coal has been altered to natural coke, as evidenced by the occurrence of mosaic anisotropic texture. Vitrinites observed included both textured and untextured varieties.

Three general types of coal are differentiated based on petrography (Gray and others, 1978):

1. Normal anthracite similar to anthracites found in the Pennsylvania anthracite fields.

2. Brecciated anthracite with graphitic depositional carbon coating surfaces of voids and cracks. The identification of this feature helps explain why many of the past analyses of the coals were confusing and often contradictory (see also coal chemistry section, this chapter). Coals that contain amounts of graphitic depositional carbon microscopically identifiable are such that the individual brecciated fragments of coal are rimmed with a layer of carbon (Figure 4-2). The amount of secondary carbon varies from sample to sample. If one x-rays or conducts other analyses of the coal, they would test not only the coal particles, but also the secondary carbon, thus yielding erroneous results. For this reason, among others, reflectance measurements are considered the most reliable rank indicator because the measurements can be positioned so as to avoid the secondary carbon. In some samples,

REFLECTANCE DATA FOR NARRAGANSETT BASIN COAL SAMPLES

SAMPLE LOCATION	NUMBER OF SAMPLES	REFLECTANCE		
		MEAN MAXIMUM	MEAN MINIMUM	MEAN BIREFLECTANCE
MANSFIELD	11	AVERAGE 6.4 HIGH 7.5 LOW 4.8	AVERAGE 3.5 HIGH 4.4 LOW 2.1	AVERAGE 2.8 HIGH 3.0 LOW 2.2
BRISTOL	16	AVERAGE 5.1 HIGH 7.6 LOW 4.0 * (2.8)	AVERAGE 3.1 HIGH 4.5 LOW 2.4 * (0.8)	AVERAGE 1.9 HIGH 3.4 LOW 1.1
PORTSMOUTH	7	AVERAGE 5.0 HIGH 6.0 LOW 3.7 * (2.8)	AVERAGE 2.5 HIGH 3.1 LOW 1.9 * (0.8)	AVERAGE 2.5 HIGH 3.1 LOW 1.6
SOMERSET	3	AVERAGE 4.6 HIGH 6.2 LOW 3.2	AVERAGE 1.8 HIGH 3.1 LOW 1.0	AVERAGE 2.7 HIGH 3.1 LOW 2.2
MASSLITE	1	5.6	3.4	2.2

* Values in parenthesis are questionably low and are not included in averages.

TABLE 4-3 VITRINITE REFLECTANCE DATA OF SELECTED NARRAGANSETT BASIN COALS

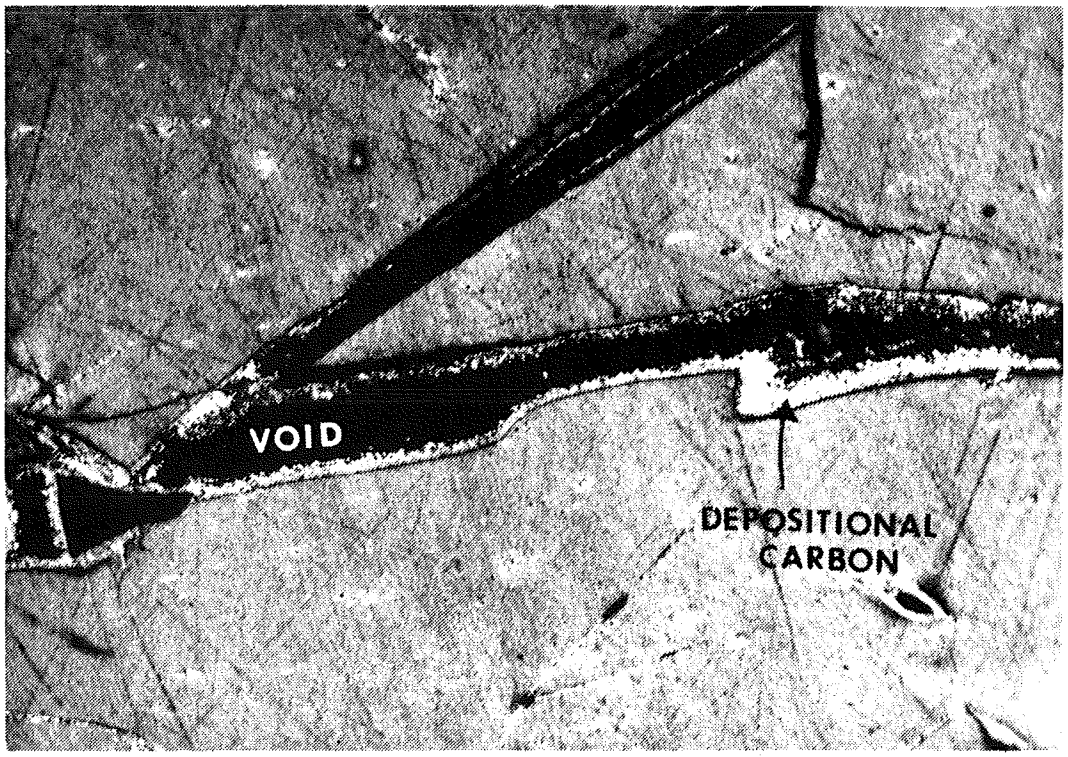


FIGURE 4-2

PHOTOMICROGRAPH OF BRECCIATED ANTHRACITE, FROM THE NARRAGANSETT BASIN. THE SURFACES OF CRACKS, THAT RESULT FROM BRECCIATION, ARE COATED WITH A SECONDARY GRAPHITIC DEPOSITIONAL CARBON. (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

coals that were brecciated were later recemented by this carbon, and in places the carbon and coal particles are so annealed that the sample is essentially optically continuous. This depositional carbon is more abundant in the southern coals studied than ones to the north.

3. Natural coke with graphitic depositional carbon similar to 2) above (Figure 4-3). The presence of natural coke indicates that the coal was of a lower rank than anthracite, which upon heating does not form coke. Because of the very limited extent of coke formation in samples observed, the coals were probably very close to the rank of anthracite. It is presumed that the coals which formed coke had been coalified to the rank of low-low volatile bituminous when they were heated to produce coke. They were subsequently coalified to anthracites and meta-anthracites.

The coals tend to be brecciated (Figure 4-4). The broken fragments are usually quite angular indicating that brecciation most likely took place after the coals had attained a relatively high rank, possibly semi-anthracite.

The presence of secondary carbon could be explained by its release upon thermal cracking of methane, the methane possibly being released upon brecciation of the coal, since it is the most common gas in anthracite.

The "inert organic" components of the coal are unusual. Funsinite, and semifusinite, usually highly reflecting components compared to the vitrinites, are often very low-reflecting components in the Narragansett Basin coals (Figure 4-5). In some cases semifusinites and, to a lesser extent, fusinites are lower reflecting than the vitrinites. We have no explanation for this phenomenon at this time.

The coals have a high ash content, a substantial percentage of which is secondary. Minerals commonly associated with the coal, either as primary or secondary ash, include quartz, sericitized feldspar, chlorite, illite or muscovite, calcite, pyrite, marcasite, chalcopyrite, sphalerite, rutile and others. Quartz and chlorite-muscovite intergrowth, are the predominant minerals in many of the samples observed (Gray and others, 1978). Pyrites include framboidal and euhedral varieties. The presence of mineral matter in some of the voids in brecciated coals enclosed by a graphitic depositional carbon rim, indicates that these minerals were emplaced by solutions of unspecified origin at a stage after substantial coalification, brecciation and carbon deposition had gone to completion. Some samples observed were carbonaceous shales. In these samples the mineral matter is not substantially comprised of minerals that are secondary in origin, but are the product of metamorphism or diagenesis of the primary coal ash (i.e. minerals deposited in the original peat swamp).

Deformational Textures and Implications for Utilization

Tectonic thickening and thinning of anthracites and meta-anthracites in the Narragansett Basin make true thickness estimates difficult. The response of the coals to heating and deformation has resulted in deformational textures which in turn have had an effect on the coals' subsequent history. The coals

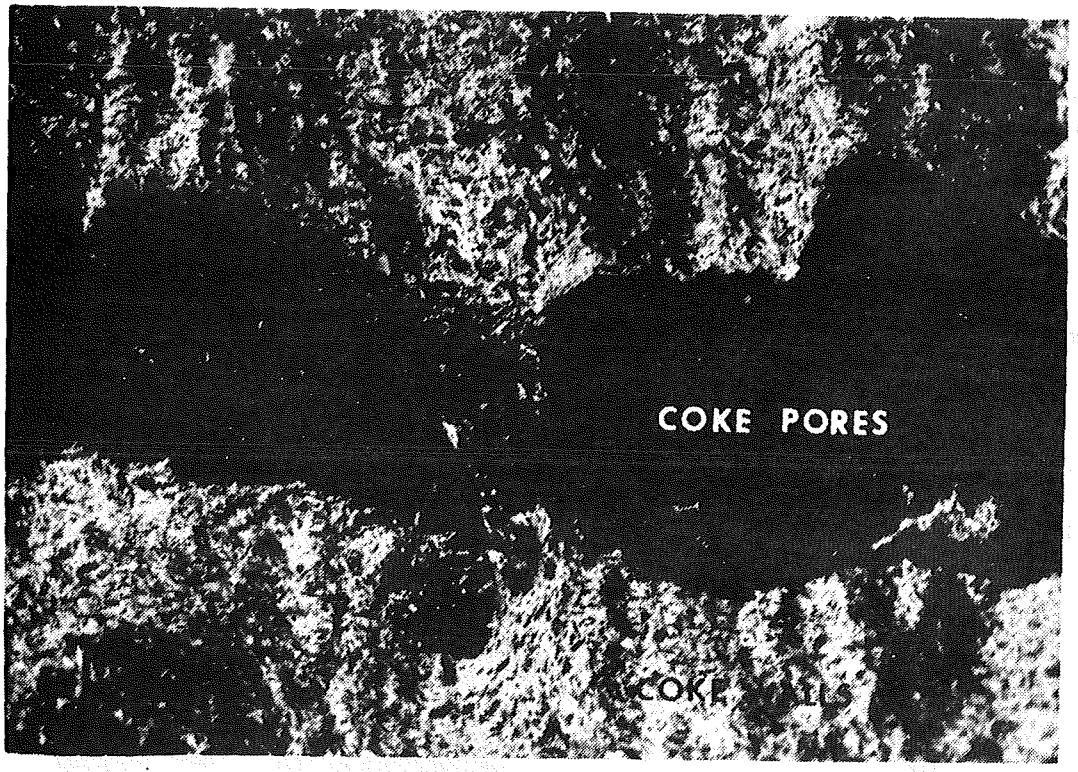


FIGURE 4-3

PHOTOMICROGRAPH OF NATURAL COKE FROM THE NARRAGANSETT BASIN. DARK VOIDS ARE COKE PORES. THE SURROUNDING LIGHTER AREAS ARE COKE WALLS. THE COKE WALLS DISPLAY WELL DEVELOPED MOSAIC ANISOTROPIC TEXTURE (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

FIGURE 4-4

PHOTOMICROGRAPH OF A LOW ASH PORTION OF BRECCIATED ANTHRACITE FROM THE NARRAGANSETT BASIN. THE DIFFERENT SHADES (FROM GRAY TO WHITE) OF BRECCIATED COAL FRAGMENTS ARE DUE TO ITS ANISTROPIC (BIREFLECTANT) NATURE. THE FRAGMENTS HAVE BEEN ROTATED WITH RESPECT TO ONE ANOTHER AND REFLECT LIGHT DIFFERENTIALLY DEPENDING ON THEIR ORIENTATION. THE SPACE BETWEEN LARGE FRAGMENTS OF ANTHRACITE HAS BEEN FILLED BY SMALLER FRAGMENTS OF VARYING SIZE. THE ENTIRE SAMPLE HAS BEEN PARTIALLY ANNEALED. NOTE THE SURFACE TEXTURE OF THE LARGER FRAGMENTS OF COAL. (400X, REFLECTED LIGHT IN OIL, COURTESY OF RALPH J. GRAY, U.S. STEEL CORP.).

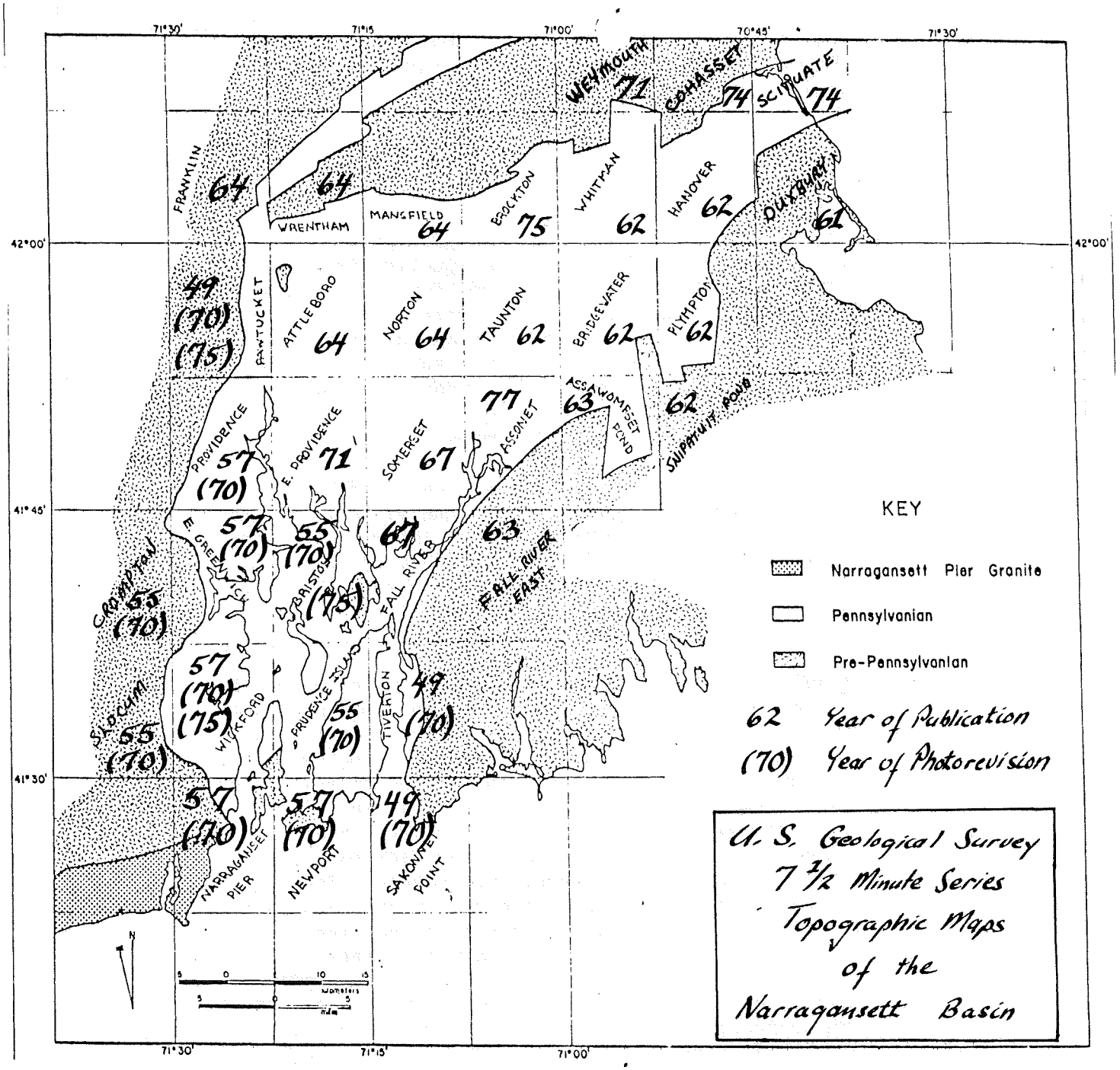


FIGURE 5-2

U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAPS OF THE NARRAGANSETT BASIN.

In Rhode Island, as part of studies undertaken in connection with the "208" Water Quality Program, RISWP has developed a colored series of MacConnell maps with land use information updated on the basis of April 1975 air photos. These maps were nearly complete at the time the LEES maps were produced, and it was possible to use them as a basis for mapping in virtually all the Rhode Island portion of the Basin. Figure 5-3 indicates the area for which up-to-date information was available.

In the OCPC area, recent maps, again produced in connection with the "208" Water Quality Program, with up-to-date land use information were available. These maps, completed in 1977, were based on information provided by town assessors and departments of public works and were thoroughly substantiated by field survey. The MacConnell information was updated by comparison with the OCPC maps and subsequently included in the LEES maps.

One final source of updating was the USGS base maps themselves. Specifically, the Assonet, Scituate, and Duxbury quadrangles contained information more recent than that available from other sources which was incorporated into our mapping scheme. Refer to Figure 5-2 for the dates of publication and photo update of all LEES base maps.

iv. Surface Mining. All surface mining indicated on the MacConnell maps was replicated on the LEES maps with the exception of a few sites known to have been converted to residential or industrial use between 1971 and the present. New sites identified on the up-to-date RISWP MacConnell series were also included on the LEES maps. (See Figure 5-3 for the area covered by these newer maps.) The USGS base maps, which the reader will recall are mostly fifteen years older than the MacConnell study, indicate a substantial number of extractive operations not identified as such by MacConnell. On examination these prove to be mostly classified by MacConnell as abandoned field, heath, or land with a very young forest cover. The conclusion implied is that these represent abandoned quarry operations. Because these workings are indicated only by symbols on the USGS base maps, it is not possible with data at hand to determine their surface extent. Aerial photography could be useful in providing current extent. For this reason they are indicated by schematic circles with an area chosen to be a conservative average of quarry sizes in the Basin.

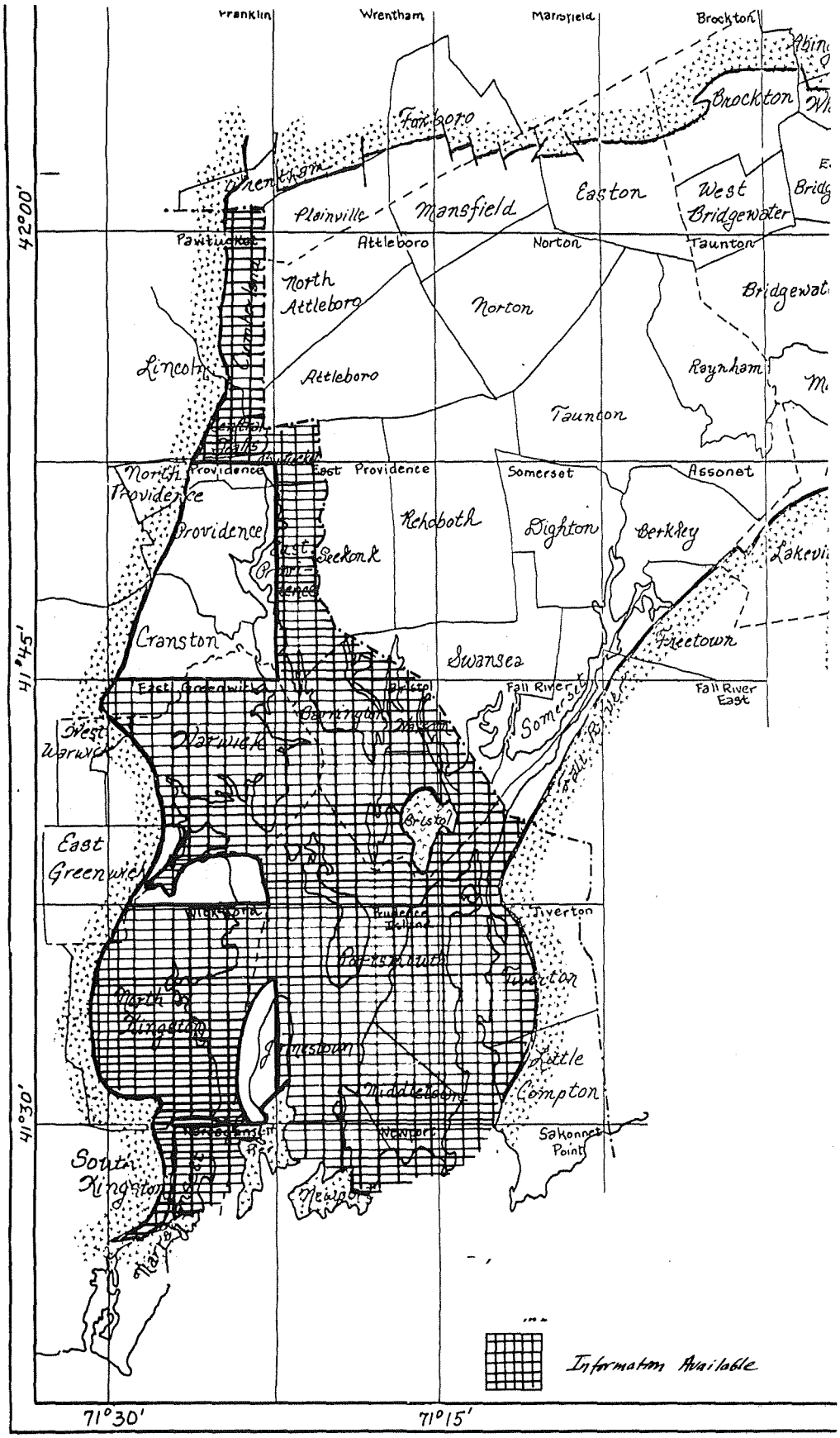


FIGURE 5-3

PORTIONS OF RHODE ISLAND FOR WHICH APRIL 1975 LAND USE INFORMATION WAS AVAILABLE

v. Wetlands. As mentioned earlier, the mapping of wetlands is problematic. A well-developed and uniform data source for the study area simply does not exist. The LEES maps represent the most accurate and consistent picture that could be developed given existing data services. Many townships are in the process of mapping their wetlands, and others will shortly undertake to do so. As these local maps appear, they will no doubt disagree with the LEES maps both by adding a number of small wetlands and by modifying boundaries of those which are indicated. However, the general picture developed by the maps may be regarded as essentially correct.

Rhode Island. In general the best information available is in Rhode Island. A series of wetlands maps covering the entire state has been developed by the Soil Conservation Service of the United States Department of Agriculture, the Rhode Island Department of Environmental Management (previously the Department of Natural Resources), and the Rhode Island State Conservation Committee. The basis of these maps is general soils information, air photo interpretation, using photos at a scale of 1 inch = 1,000 feet, and some field checking. The maps were completed in January 1972. Wetlands are delineated on city or town maps. The base maps used are USGS 7 1/2 minute series topographic maps composited and enlarged to 1 inch = 1,000 feet. The wetlands are numbered beginning at one in each city or township, and are classified according to type. Complete sets of these maps are located at both the Rhode Island Department of Environmental Management and the offices of Rhode Island Statewide Planning. They were the primary source of wetlands information used in compiling the LEES maps, and all of the information which they include has been recorded, with the exception of floodplains and minor wetlands occurring in highly urbanized areas.

The single exception was the city of East Providence, where the Department of Planning and Urban Development has conducted its own study and produced a highly detailed wetlands map. This map was used as the source for the LEES maps. Because of the very detailed scale of the East Providence map, it was necessary to generalize the indicated wetlands.

Although the official wetlands maps do include coastal wetlands, more detailed and up-to-date maps of the coastal area are available. The Coastal Resources Center, operating under the auspices of

the Coastal Resources Management Council, has prepared and published these maps in 1976, as the Atlas of Rhode Island Salt Marshes. This atlas was used as a secondary source in mapping coastal wetlands on the LEES maps.

Massachusetts. The Army Corps of Engineers developed a series of Inland Wetlands maps for the New England River Basins Commission Southeastern New England Regional Report. These maps were developed on the basis of two primary sources: (1) The MacConnell maps - here it should be borne in mind that the MacConnell maps identify only unforested wetlands which comprise no more than 10 to 15 percent of total wetlands in the Basin; and (2) the USGS 7 1/2 minute series topographic maps which identify swampy areas with no differentiation as to type.

Information from these two sources was combined using the MacConnell maps as a base, with minor modification where field data was available. A nearly identical approach has been used by the majority of Massachusetts townships in the study area to produce very preliminary wetlands maps, the main difference being the inclusion of information from U. S. Soil Conservation Service maps as well. In the OCPC area such preliminary maps were actually provided to the townships by the Planning Council. A set of these maps is available at OCPC; they are in the form of simple overlays done on drafting paper at a scale of 1 inch = 1,000 feet.

With this background it seemed that the Inland Wetlands maps would serve as a readily available and uniform data source. They proved, however, to be undesirable for the following reasons: (1) A large number of MacConnell wetlands were omitted; (2) the perimeters drawn around swampy areas on the USGS maps were somewhat generalized and misplaced; and (3) no cognizance was taken of alteration and development of wetlands as indicated by MacConnell. To overcome these difficulties, an independent approach was developed with the result that wetlands shown in the Massachusetts portion of the LEES maps were generated by the following procedure, since 80 to 90 percent of inland wetlands in the Basin occur in forested areas: (1) Wetlands indicated on the MacConnell maps were replicated - this is also the sole basis for discrimination of coastal as opposed to inland wetlands; and (2) swampy areas indicated on the USGS base maps were encircled, provided that their existence was not

contradicted by the MacConnell classification of the area.

Floodplains are not included on the LEES maps. Detailed examination of a potential mining site should consider floodplains. They are included under the wetlands protection laws and would represent potential hazards if made the site of surface installations.

Cranberry bogs are indicated on the USGS base maps by both symbols and words. These have been compared with the MacConnell maps to determine if they were actively cultivated in 1971. If so, they have been left as displayed on the base maps. It should be noted that although cultivated, they are otherwise equivalent to open wetlands.

The township of Pembroke has produced a wetlands map based on MacConnell and on the field work of a summer intern. This map was used as a source for the LEES maps and as the single exception to the procedures listed above for the mapping of wetlands in Massachusetts.

The townships of Dighton and Berkeley have just recently completed accurate wetlands mapping, and the town of Seekonk has produced maps based on infrared photography. None of these, however, was readily available while the LEES maps were being drafted. The remaining townships in the Massachusetts portion of the Basin rely, at this point, on wetlands maps based on some combination of MacConnell's maps, USGS topographic maps, and U. S. Soil Conservation Service maps.

vi. Ground Water Resources and Well Protection Areas. The OCPC has produced a single large map of its area at a scale of 1 inch = 2,000 feet on which recommended well protection areas, both present and future, are delineated, and public wells, both existing and anticipated, are located. The base map is a composite of USGS 7 1/2 minute series topographic maps. These areas and well locations were replicated on the LEES maps.

Similar, clearly defined well protection areas can be expected to appear in the remainder of the Basin in short order. The towns of Attleboro, Mansfield, Middleboro, and Swansea have contracted with SRPEDD to produce such recommendations for them during 1978. The towns of North Attleboro, Norton, and Taunton have made equivalent requests and will be accommodated

if funding permits. MAPC has collected some information on ground water favorability and is recommending the designation of protection districts by the townships, especially those relying heavily on ground water for public supply.

The LEES maps attempt to provide information on ground water resources which will permit anticipation of the approximate location of these protection areas. In Massachusetts the basic sources were the Ground Water Recharge and Favorability maps prepared by the U. S. Geological Survey for the New England River Basins Southeastern New England Regional Study. The ultimate sources of these maps are USGS Hydrologic Atlas Series, consultant engineers' reports, and field data and analyses of ongoing USGS water resources studies. For the sake of brevity these maps are hereinafter referred to as the SENE maps. These maps are organized on the basis of river basins. The Narragansett Basin is almost wholly contained in these USGS maps: (1) Narragansett Bay and Block Island; (2) Ten Mile River Basin; (3) Taunton River Basin - A; and (4) Taunton River Basin - B. For the majority of the Rhode Island area, and a very small portion of Massachusetts, the basic source was a water resources map prepared by the Rhode Island Water Resources. Figure 5-4 is a reference map indicating the areas covered by each of the six source maps. Note that the town of Halifax is a recent addition to the OCPC jurisdiction, and therefore well protection recommendations have not yet been formulated by OCPC.

Well output data for the entire Basin is derived from the SENE maps. In the SRPEDD areas the figures have been updated by SRPEDD to indicate 1976 output. Well locations in all parts of the Basin except within OCPC well protection areas are also derived entirely from the SENE maps.

Unfortunately, the five source maps used for areas outside of the OCPC area do not use consistent mapping criteria. In order to make maximal use of the information on the LEES maps, it is important to understand precisely what is mapped in each of these areas, as well as in the OCPC area. Precise definitions, as well as the symbols actually used on the maps, are given on Figure 5-5.

c. Mapping Procedures and Accuracy

This section provides a precise description of the methodology used in drafting the LEES maps. In that process it was often noted that this type of information was the most useful in

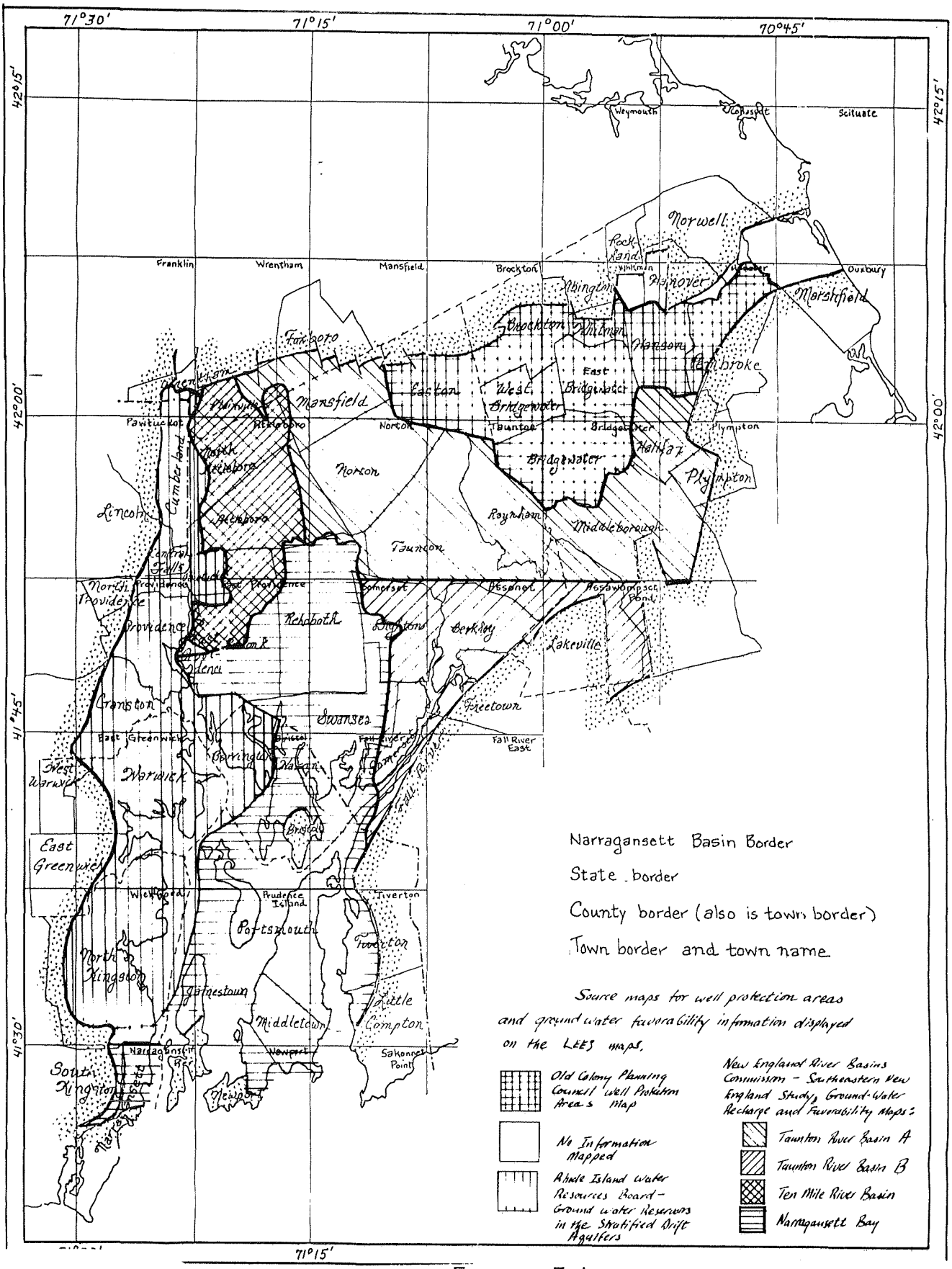
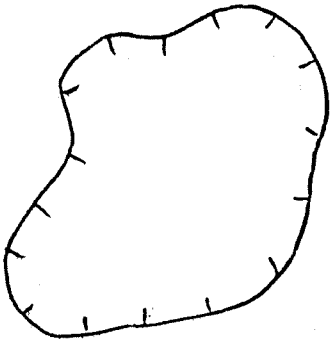


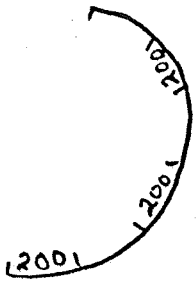
FIGURE 5-4

SOURCE MAPS FOR WELL PROTECTION AREAS AND GROUND WATER FAVORABILITY INFORMATION DISPLAYED ON THE LEES MAPS

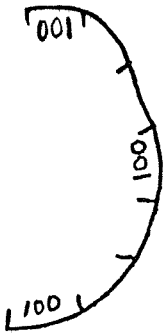
GROUND WATER RESOURCES AND WELL PROTECTION AREAS



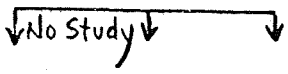
Areas of significant to essential ground water resources with high susceptibility to contamination from surface seepage. Wells located immediately within the perimeter will generally yield less than 300 gpm whereas wells more centrally located will yield 300 gpm or more. Potential well output in Rhode Island is not included.



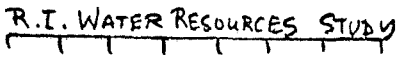
As above, except that wells near the perimeter will generally yield less than 200 gpm. Centrally located wells will yield 300 gpm or more.



As above, except that all wells within the area will generally yield 100 gpm or more.



Indicates the limit of Rhode Island Water Resources Board Study Area.



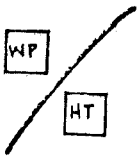
Used in Massachusetts only to indicate data derived from Rhode Island Water Resources Board ground water study.

FIGURE 5-5 A

SYMBOLS USED IN MAPPING WELL PROTECTION AREAS AND GROUND WATER INFORMATION ON THE LEES MAPS

Municipal - Industrial Supply Well with output in millions of gallons per day listed if available; output for closely spaced wells listed as a total.

Proposed Municipal Supply Well - used only in Old Colony Planning Council area.



Well Protection Areas with active wells (WP) or proposed wells (HT) - used only in Old Colony Planning Council area; WP = Well protection area; HT = area of high transmissivity to be protected for future use; single, unbroken line indicates boundary between WP and HT areas.

FIGURE 5-5 B

SYMBOLS USED IN MAPPING WELL PROTECTION AREAS AND GROUND WATER INFORMATION ON THE LEES MAPS

assessing reliability and applicability of data sources. This is particularly true when applying information to an end it was not specifically designed to accommodate. The following discussion, therefore, serves three purposes: (1) It outlines a methodology useful as a starting point for any similar project; (2) it increases the flexibility of the LEES maps, facilitating their application to purposes other than mine development; and (3) it provides frank assessment of map accuracy. The order of discussion corresponds to that in which information was collected and mapped. As in the preceding section, abbreviations will be used for the sake of expediency. The following are employed:

MAPC - Metropolitan Area Planning Council
OCPC - Old Colony Planning Council
SRPEDD - Southeastern Regional Planning and Economic Development District
RISWP - Rhode Island Statewide Planning
USGS - U. S. Geological Survey
SENE - Southeastern New England Water and Related Land Resources Study of the New England River Basins Commission.

i. Basin Border. This information exists on geologic maps employing USGS topographic maps as a base. Typically, however, the scale is reduced from the standard 1 inch = 2,000 feet. The Basin border was carefully transferred onto the LEES maps.

ii. Developed Lands. The following topics are discussed: (1) Combination of MacConnell categories; (2) transfer of MacConnell Data to LEES maps; (3) update of MacConnell data in Rhode Island; (4) update of MacConnell data in Old Colony Planning Council area; (5) update of MacConnell data from USGS base maps.

Combination of MacConnell Categories. The LEES category "Highly Developed" (HD) includes the following twenty-six MacConnell categories entirely:

UI Heavy Industry
UL Light Industry

UTA Airports
UTW Port Facilities
UTR Railyards
UTT Truck Terminals
HW Divided Highways

D Dump
DA Automobile Dump
FB Filter Bed

UP Hospitals, Colleges, Prisons, etc., with Grounds
✓ Cemeteries
UC Downtown Commercial
UH Highway Strip Commercial
US Shopping Center

RM Marinas or Boatyards
RT Racetracks
RA Athletic Fields and Stadiums
RAP Commercial Amusement Parks
RFG Fairgrounds
RI Drive-In Theaters

UO Vacant Lots within Urban Areas.

UA Garden Apartments
UT Tenements
URH Residential - High Density, Lots less than 1/4 acre
URM Residential - Moderate Density, Lots 1/4 to 1/2 acre.

When greenhouses were indicated on the USGS base map, the following MacConnell category was included:

N Nurseries

When they occurred within decidedly urban regions, the following eight MacConnell categories were included:

RFB Freshwater Beach with Bathhouse
RSB Saltwater Beach with Bathhouse
RS Swimming Pools (3 acres or more)
RC Tennis Courts (3 acres or more)
RG Golf Courses
RD Golf Driving Ranges, Shooting Ranges
RP Urban Park
RPG Playground

The LEES category "Moderately Settled" (MS) includes the following two MacConnell categories entirely:

URL Residential - Light Density, Lots 1/2 to 1 acre
UCR Clusters of three to ten houses in Rural Areas

The LEES category "Lightly Settled" (LS) includes the following three MacConnell categories entirely:

URF Residential, Lots in Excess of 1 acre, predominantly 2 acres in size, with more than 75% of forest cover left intact

URO Residential, open land with large lots, from 1 to 2 acres in size

UE Residential, garden estates of 3 acres or more with extensive landscaped grounds.

The three LEES categories, then, totally include thirty-one MacConnell categories and partially include an additional nine MacConnell categories.

Transfer of MacConnell Data to LEES Maps. The MacConnell maps are extremely difficult to use for wholesale transfer of data without the time-consuming intermediate step of coloring. As part of the Southeastern New England Regional Study, the New England River Basins Commission contracted with MAPC to produce a series of Land Use Maps covering the SENE study region. For this purpose the MacConnell maps were photo reproduced with a reduction in scale of approximately 62%. The resulting maps were roughly 6.4 by 8.5 inches in size. The 104 MacConnell categories were combined into 18 composite categories, and the reduced maps were then hand colored accordingly. These maps are presently stored in the drafting department of MAPC. The SENE Land Use Maps themselves were extracted from the colored MacConnell series, generalized, further reduced, and printed as single color outlines on a base map showing only political boundaries.

The MacConnell data was transferred to the LEES maps from the MAPC colored series rather than from the original MacConnell series. The LEES category "Highly Developed" (HD) includes the following SENE Land Use categories:

I Industrial (MacConnell UI, UL)

T Transportation (MacConnell UTA, UTW, UTR, UTT, HW)

D Disposal Site (MacConnell D, DA, FB)

PI Public Institutional (MacConnell UP, ⌿)

C Commercial (MacConnell UC, UH, US)

Rl Residential 1 (MacConnell UA, UT, URH)

R2 Residential 2 (MacConnell URM)

Additionally, the following SENE Land Use categories are partially included, as indicated:

OS Open Space and Recreation (MacConnell RM, RT, RA, RAP, RFG, RI, RFB, RSB, RS, RC,

RG, RD, RP, RPG). LEES maps include all capital intensive recreation facilities, and any type of recreation space within a decidedly urban area.

OT Open Transitional (MacConnell PL - Power Lines, AF - Abandoned Fields, UO - Urban Vacant Lots). LEES maps include only MacConnell UO.

AC Cropland (MacConnell T, TU, O, AO, CB, N). LEES maps include only MacConnell N - Nurseries when these are recognized to include greenhouses.

The LEES categories "Moderately Settled" (MS) and "Lightly Settled" (LS) correspond respectively to the SENE Land Use categories R3 - Residential 3 and R4 - Residential 4.

The MacConnell data was transferred to the LEES maps from the MAPC colored MacConnell series by careful judgment. Since the base map used was identical, this could be accomplished with more accuracy than might be supposed. Additionally, at the outset of the process, portions of the East Providence and Somerset quadrangles were precisely mapped using the original MacConnell maps. This provided a basis for correct scaling in the less precise transfer of MacConnell information from the MAPC colored series. As each map was finished, it was examined; any questionable areas were checked against the original MacConnell map. Similarly, where questions existed as to, say, the nature of a recreational area, the original MacConnell map was consulted. However, the Massachusetts MacConnell series provided to Weston Observatory used a preliminary residential classification scheme employing only five categories (UA, UT, UR, UE, UCR). The final scheme used nine categories (UR was broken down into URH, URM, URL, URO, URF). Because of this the LEES maps depend almost entirely upon the MAPC colored series for residential categorization in Massachusetts.

Update of MacConnell Data in Rhode Island. RISWP has two full-sized, fully colored sets of MacConnell maps for the State of Rhode Island. The first is colored according to the scheme recommended by the MacConnell study with twenty-eight composite categories. The second set was updated in 1977-78 by RISWP using April 1975 air photos and employs a somewhat different scheme for compositing categories as well as different pencil colors. Neither scheme of compositing is compatible with the LEES scheme. In order to obtain the updated information for the LEES maps, the following procedure was used: (1) Familiarity with

both schemes was acquired; (2) each pair of maps was held side by side and carefully inspected for divergence; (3) all divergence, along with appropriate category, was recorded on a set of MacConnell maps; and, finally, (4) this information was transferred by hand to the LEES maps.

Note that updated information was not available for the entire Rhode Island portion of the Basin. Refer to Figure 5-3 to determine updated area.

Update of MacConnell Data in Old Colony Planning Council Area. The recent land use maps developed by OCPC are done on a township basis at a scale of 1 inch = 1,000 feet. The base maps used are Department of Public Works maps showing only public highways and streets. Although these maps are highly accurate and excellently produced, they proved of limited usefulness for three reasons:

> Residential land was not categorized beyond a division into that supporting single versus multiple family dwellings. Individual houses and internal lot boundaries are not shown. Thus it was not possible to place reliably new development in the LEES categorization scheme.
>
> Farm residences were included in the residential category. MacConnell, of course, includes them in agricultural categories. To include farm residences in a "Developed Lands" category in the OCPC area would have introduced significant inconsistency into the LEES mapping scheme.
>
> The OCPC maps identify actual lot boundaries. Whereas this is excellent, it is not at all compatible with the character of the MacConnell-based LEES maps. MacConnell identifies land use rather than ownership. The two approaches yield results which are visually distinct.

Therefore, "Developed Lands" in the OCPC area were mapped by the procedure described below:

> The area was mapped in pencil using the MAPC reduced and colored MacConnell series as previously described.

Then the OCPC maps were checked for correspondence. Where any new development was noted, it was added freehand to the LEES maps in a style graphically consistent with MacConnell. Rigid lot boundaries were drawn inward and rounded. Small residences surrounded by agricultural land were assumed to be farm houses and were not mapped. New single-family residential areas were usually included in our "Moderately Settled" (MS) category, as this best reflects the one-acre zoning now applied to most undeveloped areas in OCPC townships.

In effect, very minor changes were difficult to notice, but new subdivisions and industrial sites were effectively recognized.

Update of MacConnell Data from USGS Base Maps. This is of particular significance in the Assonet, Duxbury, and Scituate quadrangles. These base maps are more recent than the MacConnell study. After the MacConnell data had been mapped and checked, all areas of additional development indicated by house symbols or urban perimeters were mapped as such. Categorization was estimated from visual character, and outlining was essentially schematic. Finally, developed sites indicated by MacConnell but not appearing on the newer base map were assumed to be abandoned and therefore not mapped.

Because the MacConnell maps are based on "leaves on" aerial photography, they not infrequently fail to recognize houses which are "buried in the trees," such as clusters of lakeshore cottages. Where recognized on the USGS base maps, such residential areas were included in the appropriate "Developed Lands" category.

iii. Surface Mining. Surface mining was mapped in a manner analogous to that used in mapping developed lands. Transfer to the LEES maps was effected using the MAPC colored MacConnell maps with updating from appropriate sources. The MacConnell categories combined in the LEES category "Surface Mining" are:

SG Sand and Gravel
OM Other Mining

The single SENE Land Use category is:

X Extractive Mining (MacConnell SG, OM)

All quarry operations indicated on the USGS base maps were checked against the original MacConnell maps. Where abandoned workings were suggested, a schematic circle was placed on the LEES map as described in Section b, Data Sources. An appropriate size for these circles was estimated visually by examining typical quarries as they appeared on the maps.

iv. Wetlands. The following topics are discussed: (1) Rhode Island Wetlands; (2) Massachusetts Wetlands; (3) Open Water.

Wetlands and developed land are almost mutually exclusive, but not quite. Wetlands especially are frequently coterminous with recreational areas and residential land of rural type. As these overlaps would have been very minor on the LEES maps, they were totally eliminated for the sake of clarity and to permit unambiguous data quantification. Small wetlands within urbanized areas were included within the category "Highly Developed" (HD), their delineation being pointless within the context of the current study. Larger urban wetlands are indicated.

Rhode Island Wetlands. For all areas except the city of East Providence, wetlands were transferred to the LEES maps from the official township wetlands maps by careful visual reference, possible since the base maps used are identical.

As the Rhode Island Wetlands maps are at a scale twice that of the LEES maps, transparent grids were used to facilitate accurate reduction. The township identification number and wetland type were recorded. For the city of East Providence the detailed city wetlands map was examined, and the indicated wetlands were drawn on the LEES maps in generalized form. Highways, buildings, landforms, etc., were used as guides for proper location and size.

All coastal wetlands included on the Rhode Island Wetlands maps and the city of East Providence map were transferred to the LEES map. Then the Atlas of Rhode Island Salt Marshes was examined for correspondence. Any additional coastal wetlands were added by simple visual reference and their source noted on the LEES maps. However, coastal wetlands previously recorded were altered on the basis of the second source, as the correspondence was good.

Massachusetts Wetlands. The original intention was to utilize the Army Corps of Engineers Inland Wetlands maps by overlaying the LEES maps on a light table and tracing. As this procedure was applied, the objections to use of the Inland Wetlands maps enumerated in Section b, Data Sources, gradually became apparent. The maps already completed were corrected, and the following methodology was developed:

> The MacConnell maps were scanned, and all wetlands were colored or outlined with a felt-tip pen.
>
> The LEES maps were overlain on a light table, and the MacConnell wetlands were traced in pencil.
>
> All swampy areas indicated on the USGS base maps in forested areas were encircled. Where MacConnell open wetlands were immediately adjacent, a single line enclosed both areas. Developed lands had already been mapped. Therefore, it was possible to recognize when previously wet areas had been altered in character and avoid the error of mapping them as wetlands.
>
> Comparison of mapped wetlands in Rhode Island and the township of Pembroke with the swampy areas indicated on the USGS topographic base maps suggests that the former are perhaps 10 percent more extensive. For this reason some license was taken in connecting several proximate but separate wetlands indicated by the MacConnell and USGS maps to form a single wetland.

In the township of Pembroke the above procedure was allowed but amended before final inking and patterning. The township wetlands map was obtained and studied. Because this map was at twice the scale of the LEES maps and showed only highways for reference, precise transfer was not attempted. Comparison was made, and any significant variation was corrected on the LEES maps using judgment.

Open Water. In a few instances it was noted that the various sources studied differed in the extent indicated for some bodies of open water. In these cases the maps were corrected to correspond to the most recent source, the assumption being that human activity had resulted in a lower or higher water level. No methodical search

for such discrepancies was undertaken, but when noted in the course of map preparation, appropriate corrections were invariably made.

v. Ground Water Resources and Well Protection Areas

Old Colony Planning Council Area. Since a map of well protection areas in this region exists at the same scale, the LEES maps were overlain on a light table to permit tracing of area perimeters and well locations. Neither well outputs nor the locations of wells outside of the protection areas are given on the OCPC map. This information was added from the appropriate SENE Ground Water Recharge and Favorability maps. Well locations derived from this source are only approximate. The OCPC map does not include the township of Halifax. Ground water resources information in Halifax was taken from the SENE maps and drafted onto the LEES maps by judgment.

Massachusetts Outside the OCPC Area. SRPEDD has used the SENE Ground Water Recharge and Favorability maps to produce accurate transparent mylar overlays containing the same information at a scale of 1 inch = 2,000 feet. The overlays are organized on a township basis. The LEES maps were overlain on a light table, and information was traced. Very small areas were omitted. The overlay for the township of Swansea was not available; information on that township was transferred to the LEES maps by judgment. In the townships of Attleboro and North Attleboro, some information was transferred, again by judgment, from the Rhode Island Water Resources Board map.

Rhode Island. A map of ground water resources covering most of the study area in Rhode Island was provided by the state Water Resources Board. Information on this map is at a small scale with a very limited base map. Transfer to the LEES maps relied largely on the clear relationship between till areas and elevated ground characteristic of the area. For portions of Rhode Island outside of the Water Resources Board Study areas, ground water resources information was transferred from the SENE Ground Water Recharge and Favorability maps by judgment. Well locations and output data for the entire state were derived from the SENE maps.

d. LEES Reference Grid

i. Purpose and Rationale. The final step in the development of the LEES maps was the overprinting of a faint

reference grid, subdividing each full sheet into sixty equal area cells. This grid is designed to serve four purposes: (1) Permit ready reference and location of any specific feature; (2) serve as a basis for the tabulation of map data; (3) permit that data to be stored in digital form with further subdivision readily possible; and (4) allow for easy coordination with geological data.

Before undertaking to design a grid specifically adapted to the LEES study, investigations were made to determine: First, if any standard practice existed for the definition of such a data grid; and second, failing this, if there was a uniform grid system in use by agencies operating within the study area. Extensive queries proved that the answer to the first question is "no." Demonstrating the truth of this assertion, different grid systems are actually in use within the Basin. Rhode Island Statewide Planning, for instance, has digitized land use information for its area, using UTM coordinates and a 10-acre cell size. The Massachusetts Department of Environmental Management in its current project to delineate restricted wetlands is using Massachusetts Plane Coordinates.

Based on these considerations, the following conclusions relative to a grid system were reached: (1) The information on land use and wetlands location the LEES maps contain is not new; (2) new information provided by the LEES maps and associated studies will be (a) the location of possibly favorable sites for potential mine development, (b) areas of favorable and unfavorable societal response to this potentiality, and (c) geologic information; (3) this new information will be at a much more gross scale than that generally used to digitize land use and wetlands information; (4) it can, as a result, most usefully be provided to interested parties in the form of areas graphically delineated on USGS topographic base sheets; and (5) the grid placed on the LEES maps should, therefore, be designed to serve the internal needs of the Coal Resources Survey.

ii. Design. Each of the USGS 7 1/2 minute series base maps was divided along its vertical dimension into ten equal sections and along its horizontal dimension into six equal sections. This serves as the basis for division of each sheet into sixty rectangular cells. Because lines of longitude converge in a northerly direction, it will immediately be observed that these cells cannot be precisely of equal area. However, in the study area, which extends over 45 minutes of latitude, the variation in cell size is 0.0086 square miles or 0.92%. Given the purposes for which it is intended, the

convenience and simplicity of the LEES grid system more than balances this loss of accuracy.

Each of the rectangular cells has a vertical dimension of 45 seconds of latitude equal to ≈0.86 miles and a horizontal dimension of 75 seconds of longitude equal to ≈1.08 miles. The area of the cell is ≈0.93 square miles.

For digital storage and retrieval a standard coordinate system with an origin outside of the study area will be used. For field work and internal communication during the study, a less opaque numbering system is employed. Each quadrangle is given a one or two-letter code based on its name. For example, the Assonet quadrangle is coded "AS." Refer to Figure 5-6 for a full list of the codes employed. The horizontal divisions of each map are numbered, left to right, from 0 to 5. The vertical divisions are numbered, top to bottom, from 0 to 9. Each cell can now be given a unique two-digit designation, the first digit referring to the horizontal location and the second to the vertical location. Combination of the letter code and two-digit cell designation results in the unique identification of every grid cell within the study area. Refer to Figure 5-7 for a graphic explanation and example.

iii. Application to Geologic Mapping

The reference grid has been used to catalog all geologic information for the quadrangles in the Basin. Location points for the data are plotted on quadrangle maps, and each location is assigned a number corresponding to the grid cell. Actual measurements and other information for each location are catalogued on the basis of this numbering.

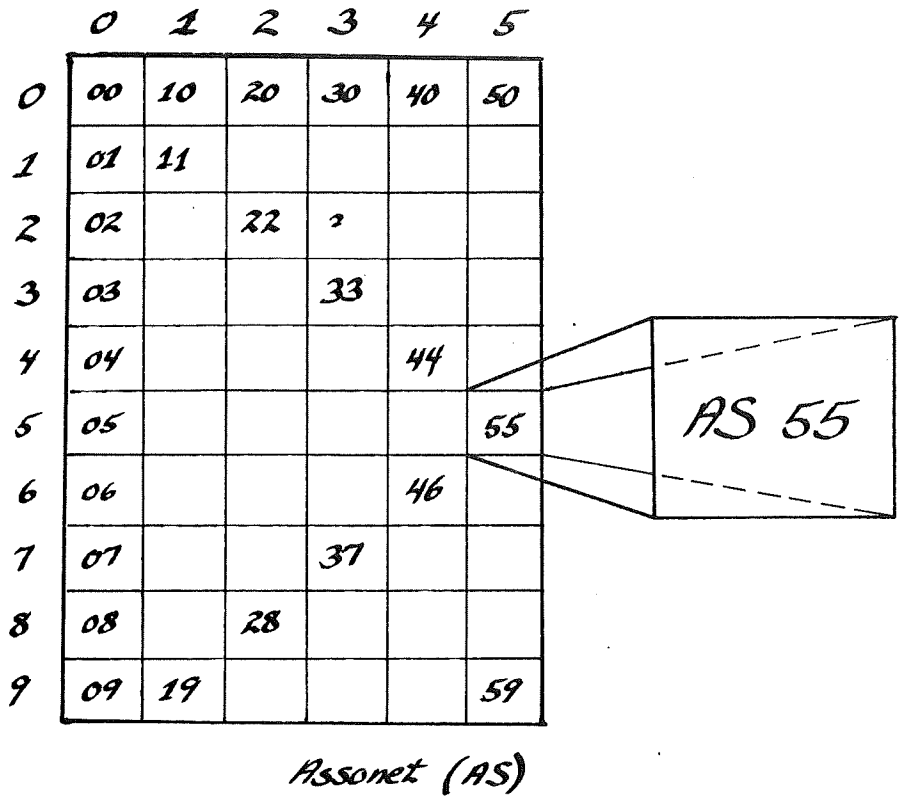
The information that has been tabulated in this form is: (1) Outcrops (presently existing and historical); (2) coal sightings; (3) floral localities; and (4) boreholes, wells, and Narragansett Basin Project drillholes.

Each locality is assigned the cell number plus an identifying number within the cell. Thus, AS55-6 is the sixth locality (outcrop, floral locality, etc.) in Cell 55 of the Assonet Quadrangle. Separate catalogs for the different types of information have been prepared, using the identifying number and listing the important data. An example of this is shown as Figure 5-8.

A	Assawompsett Pond	N	Newport
AS	Assonet	NR	Norton
AT	Attleboro	P	Pawtucket
B	Bridgewater	PL	Plympton
BR	Bristol	PR	Providence
BN	Brockton	PI	Prudence Island
CH	Cohasset	SK	Sakonnet Point
CR	Crompton	SC	Scituate Point
D	Duxbury	SL	Slocum
EG	East Greenwich	SN	Snipatuit Pond
EP	East Providence	S	Somerset
FR	Fall River	T	Tiverton
FE	Fall River East	TN	Taunton
FK	Franklin	WM	Weymouth
H	Hanover	W	Whitman
M	Mansfield	WI	Wickford
NP	Narragansett Pier	WR	Wrentham

FIGURE 5-6

SHORTHAND FORMS OF U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE TOPOGRAPHIC MAP TITLES USED FOR "IN-HOUSE" NOTATION



"In-house" numbering system used on the LEES maps. A one or two letter code is used as shorthand for the U.S. Geological Survey quadrangle name. Two digits identify the specific grid cell. The first digit refers to the horizontal position, the second to the vertical position.

FIGURE 5-7

"IN-HOUSE" NUMBERING SYSTEM USED ON THE LEES MAPS

Out-Crop#	City	Lithology	Data	XRef	Location

FIGURE 5-8

USE OF THE LEES GRID TO CATALOGUE OUTCROP INFORMATION

The usefulness of this system is in referencing specific points within a quadrangle. The unique numbering system allows for exact location of any data point once the system is known. Also, the system grants great ease in adding new material. Each new data point is assigned a number based on the grid cell system. Thus, data points within the square mile cell have the same identifying number. It must be noted that data points within the grid cells are numbered somewhat arbitrarily.

The grid system makes graphic reduction of quadrangle maps an easy process. Quadrangle maps are very awkward to use; the geologic information is not easily displayed at this scale. For the Narragansett Basin Project, each quadrangle has been reduced to a page-size (1" = 4500'; 1:54000) map. See Figure 5-9 for an example. At this scale, graphic presentation is manageable.

The grid system is an excellent tool for mapping in an area. The reduced-size quadrangle maps immediately show which areas have no geologic information and therefore which areas need close field examination. New outcrops can be easily catalogued, and information which has been compiled previously can be added very easily.

It is important to note that the size of the unit cell is important for geologic mapping. The 1 square mile cell is used for the Narragansett Basin which has limited outcrop. Other areas may use a different size grid cell.

Other important features of this system are the computer applicability and the relationship with nongeologic data. The systematic data cataloging allows easy transfer to computer storage and maps can be produced using the grid system. All data which has been compiled with the system in mind and any map which has a grid superimposed may be used with the geologic maps. Comparison of these different types of information is made easier by the grid system.

e. General Comments on the Character of the LEES Maps and Future Sources of Information

i. Character of the LEES Maps. The Basin Border and political boundaries are clearly delineated and require little discussion. Map information stops at the Basin Border, chosen as a rational limit for the current study. Development of coal resources extending under the surrounding non-Pennsylvanian terrain or right up to the Basin border will obviously impact areas adjacent to the Basin, either directly or

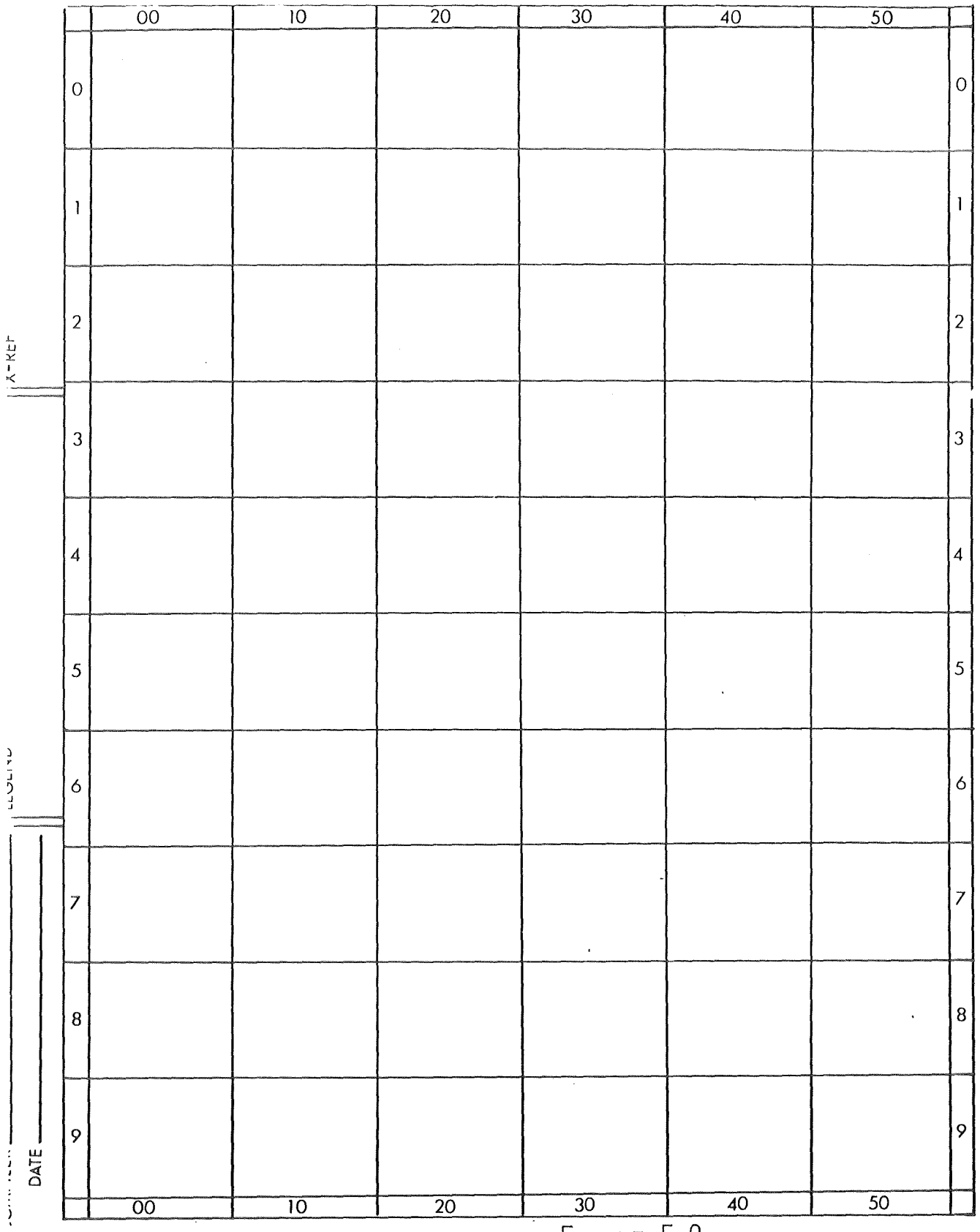


FIGURE 5-9

PAGE-SIZE QUADRANGLE MAP WITH LEES GRID - USED FOR GRAPHIC PRESENTATION AND FIELD REFERENCE

indirectly. Should geologic information suggesting this eventuality appear, the current study area should be extended.

Developed lands are mapped on the basis of MacConnell air photo interpretation. The LEES maps, therefore, identify land use rather than ownership. This is advantageous if the maps are used to determine actual land use, but disadvantageous if they are applied directly to the problem of property acquisition, which should be addressed by future mine developers. Surface mining is carefully mapped, allowing advantageous coordination with ongoing geological investigation as well as a useful reference point when the impact of mining in the region is discussed. Wetlands mapped represent a usable and basically sound picture of wetlands in the area. Except in Rhode Island, however, they are not discriminated as to type and will have expectably imperfect correspondence to forthcoming township wetlands maps. Ground Water Resources and Well Protection Areas can only be suggested at this early stage in their evolution. In this regard the LEES maps indicate an existing environmental and engineering factor and anticipate a forthcoming legal barrier.

ii. Future Sources of Information. The Massachusetts Department of Environmental Management is currently producing a series of orthophotographic maps in conjunction with the Wetlands Restriction Program. [See Section 1(a)(vii), Mapping Rationale (Wetlands), for a discussion of this program.] The maps covering the Massachusetts portion of the Basin will rely upon "leaves-off" aerial photographs planned for April 1978. Although interpretation of these photos will not extend beyond wetland identification, they remain a valuable and up-to-date source of information for future studies.

2. Manual Application of the Maps

a. Approach to Site Selection

i. Normal Development Sites. It was necessary to establish what, from a Legal-Economic-Environmental-Societal viewpoint, constitutes a site favorable for development of an underground mine. The following preliminary criteria are suggested:

Potential sites should be reasonably equant in shape with a simple, regular outline.

Given typical coal reserves, the minimum acceptable size for a potential site should be in the range of four to five square miles. Allowing for exceptional reserves, a questionable lower limit of three square miles can be applied.

Potential sites should be located so as to interfere minimally with existing land use and resources.

This final point requires some expansion. The information on the LEES maps may be translated into the following obstacles to mine development:

Small lot sizes and consequent large number of land owners.

Substantial investment in property and land development necessitating either purchase or the assumption of large liabilities by mining interests.

The possible need to displace people from their houses or relocate nonresidential facilities.

The potentially negative response of area residents to alteration of their immediate environment.

The environmental and legal ramifications of either intentional or potential alteration of wetlands or ground water recharge areas.

Potential depression of the water table in areas relying on public and private wells.

The engineering problems associated with mining under areas with wetlands, open water, or high rates of surface infiltration by meteoric water.

Given the criteria of site size and shape, the LEES maps readily demonstrate that no potential sites completely free of these problems exist in the study area.

From the preceding considerations, the following approach to site selection was evolved and applied:

> Detailed visual inspection of the maps was carried out to locate areas of the appropriate size with the least amount of implied problems;
>
> The suggested sites were graphically delineated;
>
> The site area and LEES map information were carefully quantified and tabulated; and
>
> On the basis of this data a rating scheme indicating relative site favorability was developed and applied.

These sites are referred to as "Normal Development Sites." The LEES maps contain no geologic information other than the delineation of the Basin border. Site selection is made without regard for geologic favorability. In this fashion an information base is established which remains readily applicable as geologic interpretation changes in response to new data and ideas.

Note that for purposes of synthesis of information, both geologic and LEES data are combined. It is only for isolated analyses that the geological data are put aside for this section of the report.

Once a site is identified and analyzed, the final question to be addressed is: "How feasible is the development of a coal mine on this site?" The question may be answered by combining the quantified LEES data with several additional types of information. For example, the geologic situation of the coal enables estimation of the expectable character and severity of subsidence. This combined with the LEES data enables cost estimation of probable property damage and subsidence control measures, as well as adverse environmental effects. The data may also be used to develop a rough estimate of expenses for compensation and relocation of area residents where necessary. This can be combined with economic information on extractable reserves, cost of extraction, and current prices to determine the economic viability of a mine development. Finally, in soliciting local societal response to the prospect of mining, the data enables the interviewer

to make specific, quantitative statements about the disruption which must be tolerated before mining can proceed.

ii. Wetland Development Sites. The ubiquitous occurrence of wetlands in the Basin requires that they be given some special consideration. In a number of areas the existence of wetlands has virtually precluded land development and will continue to do so over extensive areas, some as large as ten square miles. Expectably, the number of individual property owners in a wetland area would be small. If any one of the following three conditions can be met, mining under wetland areas should be possible: (1) Existence of an appropriately strong and impervious rock layer between the wetland and the coal reserve; (2) existence of thick deposit of impervious clays underlying the wetland; or (3) the wetland can be drained during mining and appropriately restored at the close of operations.

At the present time information is inadequate to assess the technical feasibility of this mining concept. In order to quantify the potentials inherent in the wetland approach, a secondary set of "Wetland Development Sites" were identified based on the concept of wetland favorability. The criteria used in choosing these secondary sites were those discussed earlier, with these exceptions: (1) Wetlands were regarded as desirable; and (2) the tolerance levels for developed lands were approximately halved.

A small degree of overlap between normal and wetland development sites occurred. As the desire was to analyze the potentials of each mining concept separately, this was not regarded as a problem.

iii. Auxiliary Sites. When a site was identified, adjacent areas, of clearly inferior desirability and often too small to be acceptable as independent sites, were noted in some instances. These were identified as "Auxiliary Sites," the concept being that should development of the primary site occur, then extension into the adjacent less desirable area might be feasible, but not otherwise.

b. Methodology

Just as in Section 1(c), Mapping Procedure and Accuracy, the purpose of this section is to facilitate ready application of the methodology elsewhere and permit frank estimation of accuracy.

i. Site Search. A simple but effective graphical solution to this problem was obtained. Three circles

having areas respectively of three, four and five square miles were cut through separate sheets of dark cardboard. These "windows" were used to scan repeatedly the entire study region in a search for areas presenting the least degree of "obstacles" as defined previously in Section 2(a), Approach to Site Selection.

ii. Site Identification. As favorable areas were recognized, a transparent mylar was overlain and affixed. An appropriate perimeter was drawn. Irregular and indented outlines were deemed unacceptable both because they would yield unrealistically favorable data and were not accountable to the reasonable requirements of mine engineering. Tic marks were placed on the overlay at the intersection of all LEES grid lines within the site. One grid cell on each LEES map covering a part of the site was identified by the in-house letter-number code. Refer to Section 1(d), LEES Reference Grid, for a description of the grid numbering code. Each site was named for the USGS quadrangle in which the greatest part of its area fell, followed by a number to permit discrimination of sites within a single quadrangle, as, for example, Norton 1, Norton 2, etc. All sites were numbered, even if only one was present. Auxiliary sites took their name from the adjacent primary site with the suffix "aux" added. Where two or more auxiliary sites occurred adjacent to a single primary site, they were discriminated by the addition of a lower case letter, as, for example, Attleboro 1 aux a, Attleboro 1 aux b, etc. Wetland development sites were identified in the same fashion, excepting only that drafting paper patterned in green with a 45-degree line was used for visual distinctness, and the site number was preceded by the prefix WL, as, for example, Taunton WL 1, Taunton WL 1 aux, etc.

iii. Quantification and Tabulation of Site Data. The following items were measured and recorded for each site: (1) Total area; (2) total area classified as "Highly Developed" (HD); (3) total area classified as "Moderately Settled" (MS); (4) total area classified as "Lightly Settled" (LS); (5) total area classified as Wetlands (active cranberry bogs and open water were included in the measurement of Wetlands); (6) total area designated as well protection area or identified as a significant recharge area.

Measurements were made using a simple dot grid, and the majority were recorded in both square miles and acres. Refer to Appendix E for explanation of the dot grid and its use. Public-Industrial supply wells, both within and immediately adjacent to sites, were noted along with output data. Any unusual characteristics were commented upon.

The data collected was assimilated in tables which are reproduced in Section 2(c), Results - Potential Development Sites. All LEES information measured was expressed as a percentage of total area. Additionally, the three "Developed Lands" categories were summed and likewise expressed as a percentage of total area.

iv. Site Rating. A simple relative scheme for site rating was developed. It should be stressed that it is based almost entirely upon quantified LEES data. It does not reflect visual assessment of sites, location, societal favorability, geological favorability, or field inspection. Different schemes were used for normal and wetland development sites.

The following procedure was applied to normal development sites:

The percentage of the site area occupied by "Developed Lands" (HD, MS, and LS) was multiplied by 3.

The result was added to the percentage of the site area occupied by "Wetlands" (WL).

A preliminary rating was given according to the scheme below:

Rating	%(HD + MS + LS) x 3 + %(WL)
A	Less than 16
B	Less than 20
C	Less than 30
D	Greater than or equal to 30

Sites falling close to the arbitrary boundaries defined above were moved up or down one letter on the basis of ground water problems, special features, or sub-standard size.

The rating categories are strictly arbitrary, designed only to organize the sites into convenient groups for comparison.

Wetland development sites were rated strictly on the basis of percentage of site area occupied by "Developed Lands." The ratings carry the following significance:

Rating	%(HD + MS + LS)
A	0.0 to 1.6
B	1.6 to 3.4
C	Greater than 3.4

Again adjustment was made to reflect special site features and problems.

The data accumulated for each rating category in both normal and wetland sites was summated and average character was calculated. The normal and wetland rating categories were themselves summated and averaged to yield total area and average character for normal sites, and separately, the same information for wetland sites.

c. Results - Potential Development Sites

i. Normal Development Sites. A total of twenty normal development sites and five normal auxiliary sites were identified, having a total area of 112.5 square miles. Tables 5-1 and 5-3 present site analysis in tabular form. Table 5-4 defines the favorability rating scheme which was applied. If developed land in the range of 3 to 5 percent of total site area and wetlands on the order of 10 percent of total site area prove to be surmountable obstacles, then extensive lands suitable for mining development exist within the Narragansett Basin.

Figure 5-10 shows the locations of the identified potential development sites.

ii. Wetland Development Sites. A total of eleven wetland development sites was identified, having a total area of 59.1 square miles. Of this, 4.56 square miles are coterminous with normal development sites. Tables 5-2 and 5-3 present site analysis in tabular form. Table 5-4 defines the site rating scheme which was applied. If mining under wetlands is feasible, then the total area with a potential for mine development within the Narragansett Basin is increased by 50 percent. In comparison to normal sites, wetland sites generally exhibit larger sizes and lower degrees of development.

In terms of geographical distribution, wetland sites occupy the interior of the Basin and the southeastern corner in Massachusetts. Very importantly, wetland sites occupy portions of the

TABLE 5.1 Results of quantitative analysis of LEES NORMAL DEVELOPMENT SITES.

Special Features – Comments	Rating		Site Name
OW ≡ open water included in figures given under "WETLANDS".	Numerical	Letter	Named for quadrangle in which it mainly lies.
Close to Taunton river and Assonet Bay	21.6	C	ASSONET (1)
Upper ⅓ of site separated by Rte 140	28.2	C	ASSONET (2)
Part of area close to Arnold Mills Reservoir	8.9	A	ATTLEBORO (1)
Includes Maselite Quarry	33	D	ATTLEBORO (1 and a)
Problematically close to Diamond Hill Reservoir	12.4	A	ATTLEBORO (1 and b)
WETLANDS include some small ponds and Cranberry Bogs	19.6	B	BRIDGEWATER (1)
	7.8	A	BRIDGEWATER (2)
Crossed by Taunton River. Close to Mass Prision.	20.0	B	BRIDGEWATER (2 aux)
Bisected North/South by Highway 24; HO includes several industrial sites; OW = 0.117 sq. mi	37.4	D	BROCKTON (1)
High % WETLANDS for A-rating but low development and large area compensate	15.7	A	EAST PROVIDENCE (1)
	35.6	D	EAST PROVIDENCE (2)
Immediately adjacent to Mansfield Urban area; important Water Resources magic prolem	11.6	A	MANSFIELD (1)
Rte 495 crossed	18.1	B	MANSFIELD (2)
Adjacent to Norton Reservoir; Rte 495 will pass through NE part of area (495 effect)	19.7 (32.6)	B (C)	NORTON (1)
Water Resource is all 100 type; 40% of HO is U.S. Military Reservation	19.9	C	NORTON (2)

TOTAL HD-MS-LS	WETLANDS Includes Cranberry Bogs + Ponds			WATER RESOURCES See Map Legend for Ex of Type			Municipal-Industrial Wells +(Output does not incl. all wells)	
% of total Area	Square Miles	Acres	% of total Area	Square Miles	Irregular Type?	% of total Area	Number of Wells ○ Existing ■ Proposed (outside area)	Millions of gallons / Day (parens = outside)
3.6	0.418	267.5	10.8	0.84	-	21.7	1	0.03
6.2	0.601	385	9.6	Nil	-	0	0	—
2.0	0.145	92.5	2.9	Nil	-	0	0	-
11.0	Nil	Nil	0	Nil	-	0	(2) just East	(1.44)
2.5	0.160	102.5	4.9	Nil	-	0	0	—
2.8	0.349	242.5	11.2	1.12	-	33.0	0	—
0.4	0.359	230	6.6	Nil	-	0	0	-
3.8	0.328	210	8.6	0.08	-	2.1	0	-
8.4	0.512	327.5	12.2	0.42	-	10.0	(1) just South	(0.6)
0.8	0.691	442.5	13.3	0.55	-	10.6	0	-
8.7	0.301	192.5	9.5	1.42	-	44.8	0	-
2.9	0.086	55	2.9	1.14	-	38.5	0	—
2.7	0.766	490	10.0	0.62	-	8.1	(2 ■) just West	(1.0+)
1.8 (6.1)	0.774	495	14.3	Nil	-	0	0	-
3.7	0.383	245	8.8	0.75	100	17.3	0	-

TABLE 5-1 (cont)

Area	Highly Developed-HD			Moderately Settled-MS			Lightly Settled-LS		
Square Miles	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area
3.87	0.035	22.5	0.9	0.078	50	2.0	0.028	17.5	3.6
6.28	0.153	97.5	2.4	0.184	117.5	2.9	0.057	37.5	0.9
4.99	0.012	7.5	0.2	0.028	17.5	0.6	0.062	40	1.2
1.22	0.024	15	2.0	0.086	55	7.1	0.024	15	2.0
3.25	0.035	22.5	1.1	0.004	2.5	0.1	0.043	27.5	1.3
3.39	Nil	Nil	0	0.062	40	1.8	0.035	22.5	1.0
5.44	0.008	5	0.1	0.012	7.5	0.2	Nil	Nil	0
3.83	0.090	57.5	2.3	0.031	20	0.8	0.028	17.5	0.7
4.19	0.215	137.5	5.1	0.113	72.5	2.7	0.034	15	0.6
5.17	Nil	Nil	0	0.031	20	0.6	0.012	7.5	0.2
3.17	Nil	Nil	0	0.266	90	8.4	0.016	10	0.3
2.96	0.020	12.5	0.7	0.066	42.5	2.2	Nil	Nil	0
7.61	0.047	30	0.6	0.254	162.5	3.3	0.141	90	1.8
5.40	0.008 0.234 (0.242)	5 1/150 (155)	0.1 (4.3)	0.066	42.5	1.2	0.028	17.5	0.5
4.34	0.097	62.5	2.2	0.020	12.5	0.5	0.047	30	1.1

TABLE 6-1 (cont.)

TABLE 1 (Continued)

Special Features – Comments	Rating		Site Name
OW ≡ Open water included in figures given under "WETLANDS".	Numerical	Letter	Named for quadrangle in which it mainly lies.
Contains much abandoned army land with roads; Rte 495 will pass through NE of area (495 effect)	31.6 (37.7)	D	NORTON (3)
WETLANDS include 3 Cranberry bogs and 2 small ponds; bisected by Highway	23.8	C	PLYMPTON (1)
	27.2	C	SCITUATE (1)
Water Resource is all 100-type; may be well problems	19.8	C	SOMERSET (1)
Water Resource is all 100-type and peripheral to area	21.4	C	SOMERSET (2)
Water Resources are peripheral but there are 3 wells just to the East	19.6	B	SOMERSET (3)
Water Resources is all 100-type and peripheral to area	25.9	C	SOMERSET (3 aw)
Crossed by Rte 25	16.5	B	TAUNTON (1)
Very problematic municipal wells in southern half of site.	22.6	D	WHITMAN (1)
Immediately adjacent to North Attleboro urban area; close to Turnpike Lake	13.9	A	WRENTHAM (1)

TABLE 5-1 (cont.)

Area	Highly Developed-HD			Moderately Settled-MS			Lightly Settled-LS		
Square Miles	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area
4.77	0.172 + 0.101 (0.273)	110 + 65 (175)	3.6 (2.1) (5.7)	0.090	57.5	1.9	0.020	12.5	0.4
4.56	0.090	57.5	2.0	0.124	82.5	2.8	0.047	30	1.0
3.65	0.062	40	1.7	0.226	145	6.2	0.035	22.5	1.0
4.53	0.016	10	0.4	0.141	90	3.1	0.028	17.5	0.6
6.94	0.004	2.5	0.1	0.262	167.5	3.8	0.024	15	0.3
7.05	0.035	22.5	0.5	0.195	125	2.8	N.I	N.I	0
2.61	0.016	10	0.6	0.137	87.5	5.3	0.008	5	0.3
5.27	0.137	87.5	2.6	0.078	50	1.5	0.039	25	0.7
4.53	0.055	35	1.2	0.156	100	3.4	0.037	25	0.9
3.49	0.028	17.5	0.8	0.054	37.5	1.7	0.012	7.5	0.3

TABLE 5-1 (cont)

TOTAL HD-MS-LS	WETLANDS Includes Cranberry Bogs + Ponds			WATER RESOURCES See Map Legend for Ex of Type			Municipal-Industrial Wells +(Output does not incl. all wells)	
% of total Area	Square Miles	Acres	% of total Area	Square Miles	Irregular Type?	% of total Area	Number of Wells ○ Existing ■ Proposed	Millions of gallons/Day
5.9 (8.0)	0.664	425	13.9	1.12	–	23.5	4 (2) just outside	1.0+ (2.4)
5.8	0.243	157.5	6.4	0.47	–	21.3	0	–
8.8	0.028	17.5	0.8	Nil	–	0	0	–
3.8	0.374	245.5	8.4	3.32	100	73.3	(2) just south	(0.57)
4.2	0.609	390	8.8	0.21	100	3.0	0	–
3.3	0.684	437.5	9.7	0.08	–	1.1	(2) just west	(0.4)
6.2	0.191	122.5	7.3	0.058	100	2.2	0	–
4.8	0.109	70	2.1	0.28	–	5.3	(1) just north	(?)
5.5	0.270	172.5	6.0	1.71	–	37.7	2 (1 ●) (2 ■) just outside	0.7+ (1.0) –
2.8	0.226	145.5	5.5	Nil	–	0	0	–

TABLE 5-1 (cont.)

TABLE 2. Results of quantitative analysis of L...
WETLAND DEVELOPMENT SITES.

Special Features – Comments	Rating		Site Name
OW ≡ Open water included in figures given under "WETLANDS".	% of total area classified as "Developed"	Letter	Named for quadrangle in which it mainly lies.
Adjacent to Middleboro airport area	3.4	B	BRIDGEWATER WL 1
	2.5	B	HANOVER WL 1
OW = 0.25 sq mi Local site center; WETLANDS also include 4 large Cranberry Bogs	0.5	B	HANOVER WL 2
	3.0	B	NORTON WL 1
	3.2	B	NORTON WL 2
WETLANDS include some Cranberry Bogs; Area is adjacent to an A-rated "Normal" site.	1.4	A	PLYMPTON WL 1
WETLANDS include a number of small ponds and Cranberry Bogs	1.6	A	PLYMPTON WL 2
Route 495 passes through southern area (Addition to be caused by Rte 495 + existing rd)	1.1 (2.4)	A	TAUNTON WL 1
Site bisected by Route 25 OW = 0.46 sq mi	4.8	C	TAUNTON WL 2
	3.9	C	WHITMAN WL 1
	0.0	A	WICKFORD WL 1

TABLE 5-2 (cont.)

Area	Highly Developed-HD			Moderately Settled-MS			Lightly Settled-LS		
Square Miles	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area	Square Miles	Acres	% of total Area
3.74	0.012	7.5	0.3	0.093	60	2.5	0.024	15	0.6
3.40	0051	32.5	1.5	0 035	22 5	1.0	Nil	Nil	0
5.09	Nil	Nil	0	0 024	15	0.5	Nil	Nil	0
4.77	0.035	22.5	0.7	0.101	65	2.1	0 012	7.5	0.3
4.06	Nil	Nil	0	0.101	65	2.5	0.028	17.5	0.7
11.37	0 024	15	0.2	0 078	50	0.7	0.062	40	0.5
5.37	0.062	40	1.2	0 062	40	1.2	0 020	12.5	0.3
9.67	0.008 +0.125 (0.133)	5 +80 (85)	0.1 (1.3)	0.066	42.5	0.7	0 031	20	0.3
5.50	0 149	95	2.7	0.024	15	0.4	0.093	60	1.7
3.50	0.078	50	2.2	0.047	30	1.3	0,012	7.5	0.3
2.69	Nil	Nil	0	Nil	Nil	0	Nil	Nil	0

TABLE 5-2 (cont.)

TOTAL HD-MS-LS	WETLANDS Includes Cranberry Bogs + Ponds			WATER RESOURCES See Map Legend for Ex of Type			Municipal-Industrial Wells (Output does not incl. all wells)	
% of total Area	Square Miles	Acres	% of total Area	Square Miles	Irregular Type?	% of total Area	Number of Wells ○ Existing □ Proposed	Millions of gallons/Day
3.4	0.97		25.9	1.03	-	27.5	Nil	-
2.5	1.71		50.3	Nil	-	0	Nil	-
0.5	3.02		59.3	1.47	-	28.9	Nil	-
3.0	1.67		35.0	0.09	-	1.9	Nil	-
3.2	2.34		57.6	0.71	-	17.5	Nil	-
1.4	5.84		51.4	2.89	-	25.4	Nil	-
1.6	1.37		25.5	1.21	-	22.5	Nil	-
1.1 (2.4)	6.04		63.0	0.25	-	2.5	Nil	-
4.8	3.88		70.5	0.46	-	8.4	Nil	-
3.9	1.30		37.1	Nil	-	0	Nil	-
0	0.93		34.6	0.40	-	34.5	Nil	-

SUMMARY OF POTENTIAL DEVELOPMENT SITES ANALYSIS

NORMAL DEVELOPMENT SITES

Rating (No. of Sites)	Area Sq. Mi.	% Developed Land RANGE	% Developed Land AVERAGE	% Wetlands RANGE	% Wetlands AVERAGE
A(6)	25.30	0.4- 2.9	1.69	2.9-13.3	6.6
B(6)	32.55	1.8- 4.8	3.16	2.1-14.3	9.3
C(8)	36.78	3.6- 8.8	5.17	0.8-10.8	7.9
D(5)	17.88	5.5-11.0	7.23	0.0-13.9	9.8
(25)	112.51	0.4-11.0	4.13	0.0-14.3	8.3

WETLAND DEVELOPMENT SITES

Rating (No. of Sites)	Area Sq. Mi.	% Developed Land RANGE	% Developed Land AVERAGE	% Wetlands RANGE	% Wetlands AVERAGE
A(4)	29.10	0.0- 1.6	1.21	25.5-63.0	48.9
B(5)	21.06	0.5- 3.4	2.42	25.9-59.3	47.5
C(2)	9.00	3.9- 4.8	4.45	37.1-70.5	57.6
(11)	59.16	0.0- 4.8	2.19	25.5-70.5	49.7

Table 5-3: Tabular summary of LEES site analysis showing the results obtained using both the "normal" and "wetland" concepts of favorability. There is an overlap of 4.6 square miles between the "normal" and "wetland" type sites.

NORMAL DEVELOPMENT SITES

Numerical Rating = % of total site area classified as "Developed Lands" (HD - MS - LS)

X multiplied times 3

\+ to which is added the % of total site area classified as "Wetlands"

Resulting number used as basis for letter rating.

Letter Rating

A $\equiv$ Numerical Rating $<$ 16

B $\equiv$ 16 $\leq$ Numerical Rating $<$ 20

C $\equiv$ 20 $\leq$ Numerical Rating $<$ 30

D $\equiv$ 30 $\leq$ Numerical Rating

Adjustments of letter grades falling near the defined boundaries were made to reflect site size, occurrence of water resources, location of municipal-industrial supply wells, and the character of land development.

WETLAND DEVELOPMENT SITES

Letter Rating Only

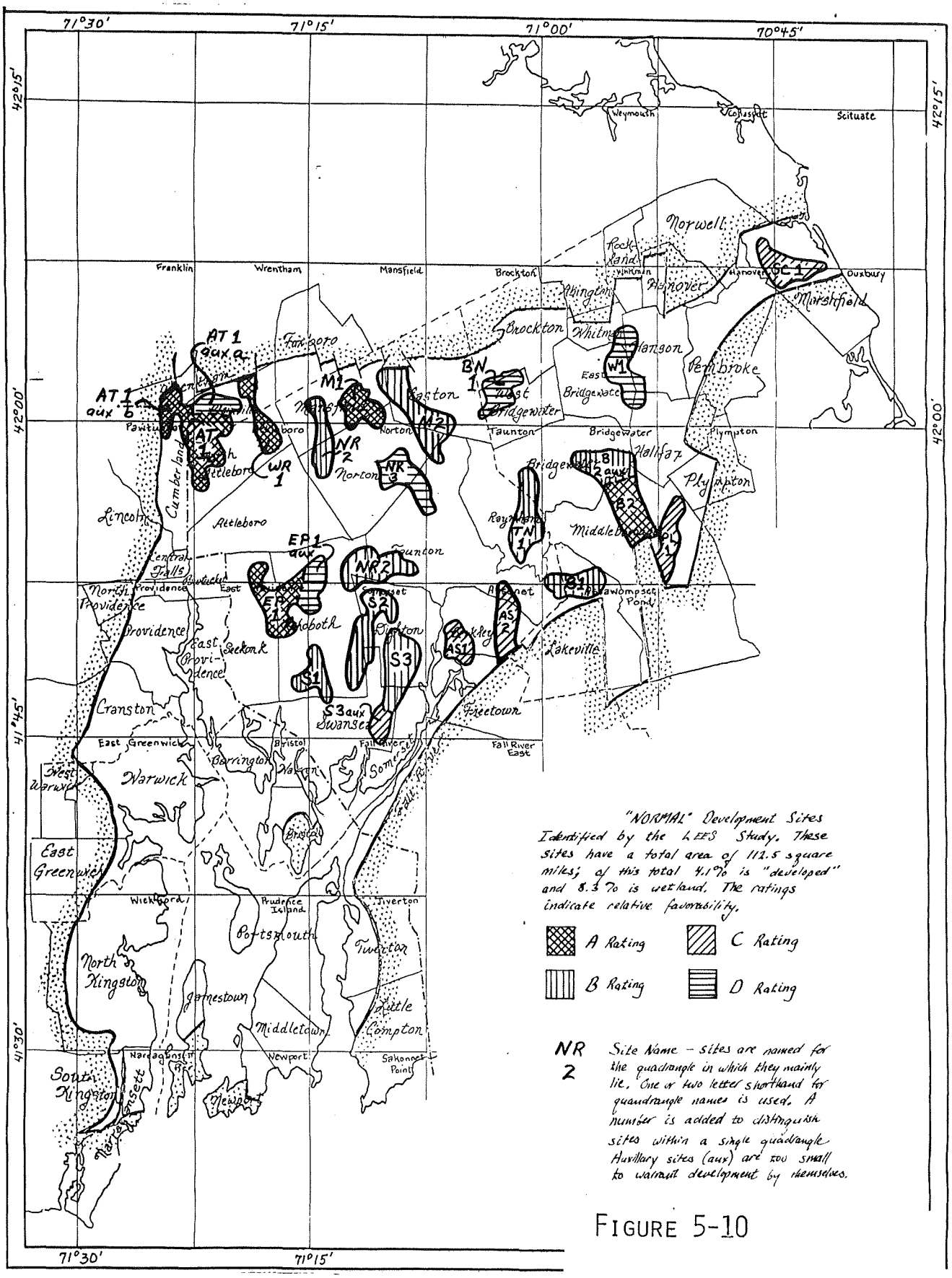
A $\equiv$ "Developed Lands" $\leq$ 1.6% Area

B $\equiv$ 1.6% Area $<$ "Developed Lands" $\leq$ 3.4% Area

C $\equiv$ 3.4% Area $<$ "Developed Lands"

Adjustments were made to reflect site size and special problems such as large bodies of open water.

TABLE 5-4: Explanation of Site-Rating Schemes



"NORMAL" Development Sites Identified by the LEES Study. These sites have a total area of 112.5 square miles; of this total 4.1% is "developed" and 8.3% is wetland. The ratings indicate relative favorability.

A Rating

B Rating

C Rating

D Rating

NR 2 — Site Name – sites are named for the quadrangle in which they mainly lie. One or two letter shorthand for quandrangle names is used. A number is added to distinguish sites within a single quadrangle. Auxiliary sites (aux) are too small to warrant development by themselves.

FIGURE 5-10

"NORMAL" DEVELOPMENT SITES IDENTIFIED BY THE LEES STUDY

Basin where normal sites do not occur. Figure 5-11 shows the locations of the identified wetland development sites.

d. Selection of Exploratory Drilling Sites

On the basis of the LEES analysis and the above observations, the following represent the goals of exploratory drilling from a strictly LEES point of view:

i. Determine if coal reserves exist at sites with development favorability.

ii. Determine if a geological dichotomy exists between the interior as opposed to the more external portions of the Basin.

iii. Examine the surficial and bedrock geology in wetland areas to determine the technical feasibility of subsurface mining.

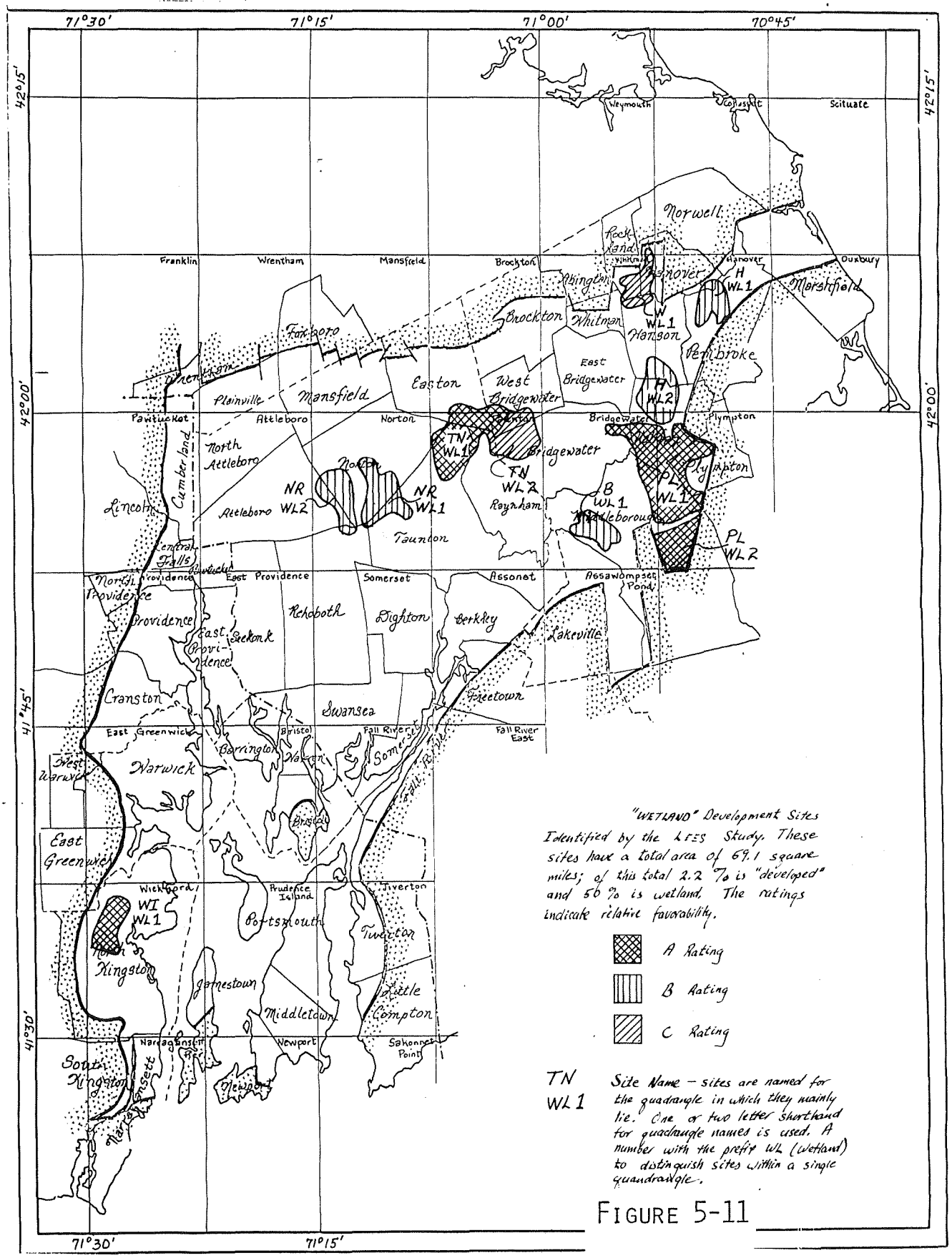
Preliminary selection of drilling sites was accomplished in the following manner:

i. A single reference map showing the locations of both normal and wetland type sites was prepared.

ii. An overlay showing the locations of areas favorable for subsurface exploration from a geologic point of view was prepared.

iii. The two were combined, and all areas of overlap were identified. These areas were given first priority for on-site inspection, mapping, and drill site location.

Figure 5-12 is a composite map with the areas of overlap identified.



"WETLAND" Development Sites Identified by the LEES Study. These sites have a total area of 69.1 square miles; of this total 2.2 % is "developed" and 56 % is wetland. The ratings indicate relative favorability.

A Rating

B Rating

C Rating

TN WL1 — Site Name – sites are named for the quadrangle in which they mainly lie. One or two letter shorthand for quadrangle names is used. A number with the prefix WL (Wetland) to distinguish sites within a single quandrangle.

FIGURE 5-11

"WETLAND" DEVELOPMENT SITES IDENTIFIED BY THE LEES STUDY

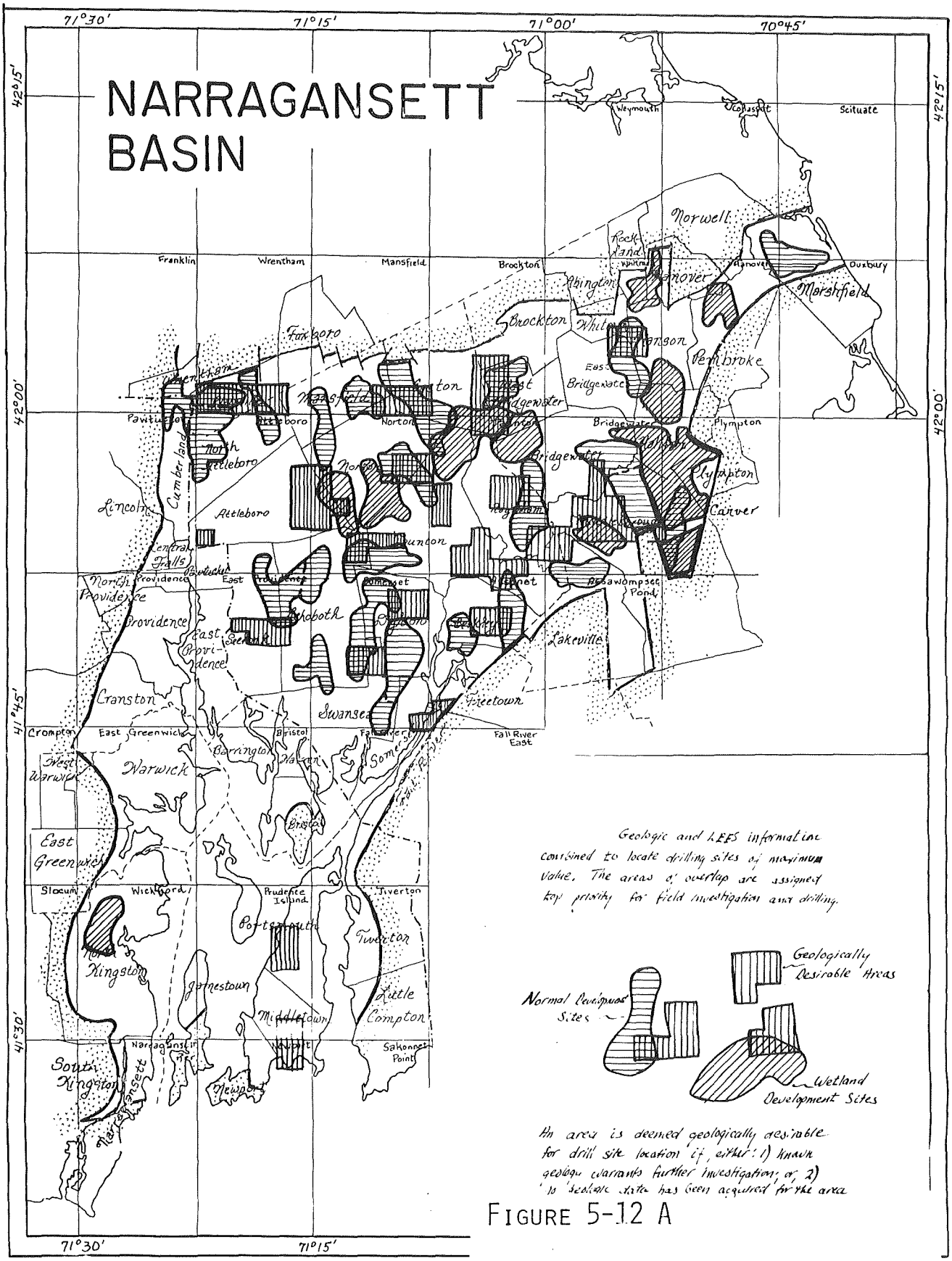


FIGURE 5-12 A

GEOLOGIC AND LEES INFORMATION COMBINED TO LOCATE DRILLING SITES OF MAXIMUM VALUE

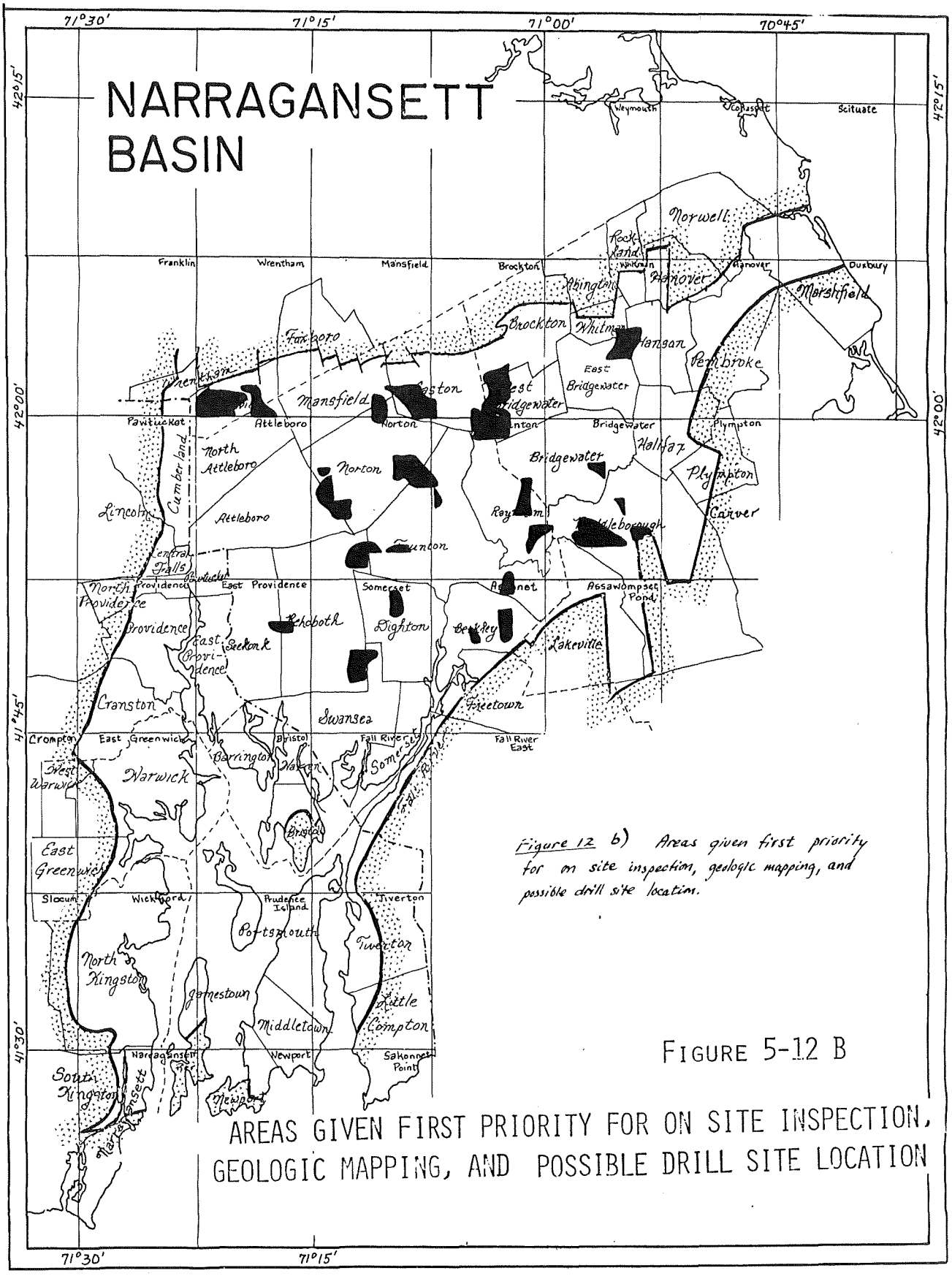


Figure 12 b) Areas given first priority for on site inspection, geologic mapping, and possible drill site locations.

FIGURE 5-12 B

AREAS GIVEN FIRST PRIORITY FOR ON SITE INSPECTION, GEOLOGIC MAPPING, AND POSSIBLE DRILL SITE LOCATION

3. Computer Application of the Maps

The foregoing material represents efforts in accordance with the contract work statement to synthesize manually at quadrangle map scale relevant nongeological data for interpretation of the desirability of exploring particular areas within the Narragansett Basin.

As this project proceeded, it became evident that for purposes of consistency and completeness, an ideal methodology for synthesis of all data would be the utilization of a computer program which evaluated both LEES and geological criteria, thus resulting in a map which could show on a square mile by square mile basis the desirability of exploring based upon both kinds of criteria.

A computer program (Appendix H) was prepared for this purpose. It was first made operational by the author on a personal microcomputer and then was adapted to the Boston College PDP-11. The original microcomputer model was presented in June 1978 at Weston Observatory. This program depicts the Narragansett Basin using alphanumeric characters to represent every square mile within the Basin. Each character represents an evaluation of land usage and/or geological parameters for every square mile. The program can use the result of the several years of ongoing research and analysis within the area, and provides the user the opportunity to place varying levels of significance, or weights, on each of eighteen different criteria.

This program actually resembles a cost/benefit analysis in that there are known negative and positive factors which the user can emphasize individually or de-emphasize to present new opportunity maps. The negative factors are referred to as LEES (Legal, Economic, Environmental, and Societal) barriers. By definition, any significant impact by a LEES factor operates appropriately on the analysis, thereby changing the relative attractiveness for development purposes of any square mile accordingly.

These LEES factors include:

Inland Wetlands: The calculated surface area of wetlands described and defined by either state or local governments, which impose certain development restrictions;

Coastal Wetlands: The same as above, except that they refer to certain coastal areas;

High Density Development: The calculated surface area of commercial, industrial and municipal development. Also includes residential development on lots of one-half acre or less;

Medium Density Development: The calculated surface area of residential development only, on lots of one-half to one acre;

Low Density Development: The calculated surface area of residential development only, on lots of one to three acres;

Fresh Water: The calculated surface area of bodies of water that are totally or predominantly fresh water;

Ocean Water: As above, except that the bodies of water are totally or predominantly salt water;

Surface Mining: The calculated surface area of previous mining activities conducted mainly at surface level, such as gravel pits, quarries, etc. (This in reality is a positive factor, since the existence of present surface mining suggests the acceptability of coal mining.)

Town Wells: The calculated surface area of town wells, although no approximation of subsurface area is made;

Groundwater Reserve: The calculated subsurface area which provides a source of water to communities. This is the only LEES criterion that is not mutually exclusive, and commonly does occur as a subsurface condition underneath another, identified and calculated surface usage.

These criteria, as noted above, indicate the surface area of land used in a developmental sense. In other words, the absence of entries within these LEES criteria does not mean the absence of land, but rather the presence of undeveloped, unfettered land. As seen in this analysis, any square mile of undeveloped land is seen as neutral, and each entry under a LEES criterion, representing a physical or societal barrier to development making that square mile more negative, respectively.

With the exception of Groundwater Reserve, the LEES criteria can combine to equal, but never exceed, the total surface area of the square itself. The Groundwater Reserve subsurface usage, when added to the analysis, can result, theoretically, in a square which is as much as 200 percent negative.

The positive factors are the Geological ones, and these include:

Previous Coal Mining Activity: Has coal ever been mined in the area?

Recent Drilling Activity: Has drilling been done recently, and are the results negative or positive?

Recent Field Research: Has field research been done, and are the results negative or positive?

Non-Pennsylvanian Formations: Is there evidence of other non-Pennsylvanian rocks or Granite Basement?

Evidence of Metamorphic Grade Rock: Is there evidence of metamorphic grade rock, and if so, is it biotite, chloritoid or subchloritoid?

Structural Complexity: What is known of the structural complexity of the area?

Depth of Coal: What is the depth or average depth at which coal is found?

Dip of Rock: What is the general dip of the rock of the area?

Understanding these criteria, the map user is now ready to choose the appropriate weights for each criterion and input them in the following format, which automatically appears as the program is operated:

LEES WEIGHTS

Inland and Coastal Wetlands	? _____, _____
High, Medium, and Low Density Development	? _____, _____, _____
Fresh and Ocean Water Body	? _____, _____
Groundwater Reserve and Town Well	? _____, _____
Surface Mining and Previous Coal Mining	? _____

GEOLOGICAL WEIGHTS

Previous Coal Mining	? _____
Drilling Activity and Field Research	? _____, _____
Non-Pennsylvanian Formation, Metamorphic Analysis and Structural Complexity	? _____, _____, _____
Depth and Dip	? _____, _____

These criteria are grouped according to similarities, the first ten being the LEES and the last eight being Geological entries.

There is no single "correct" weight to assign to any criterion. There is, however, a desirable range which should be kept in mind prior to running the program. The LEES and Geological sides are balanced, so that variation of any weights will be reflected on a new map. In order to achieve a full range of map values, the weight of ten (10) may be given to each factor selected to be

represented. In other words, if the map user wants the most sensitive, responsive analysis of a criterion, covering the full range possible, then the weight of ten (10) should be assigned. A weight much greater than ten shows the range to the extreme end, either positive or negative. A weight much less than ten reduces the impact of the factor, and tends to reduce contrast.

The map generator, therefore, can choose any weight for each criterion to reflect interest in any area. The participant may assign a weight of any size, positive or negative. The program is set up so that it automatically assigns a negative value to the LEES factors and weights, with the exception of surface mining, and a positive value to the Geological factors and weights. Therefore, if the user feels that a LEES criterion is not really negative but actually a positive factor, then the impact can be reversed under LEES by assigning a negative value to that individual criterion. For example, if surface mining for some reason is considered to be a negative aspect, then it can be removed from the negative LEES side by assigning it a negative weight. Normally, it will be positive. To eliminate a criterion from evaluation, merely assign a weight of zero. Figure 5-13 illustrates the balancing concept of this technique, yielding coded weights used for map content.

Each map run will cover the area depicted in Map 1, Figure 5-14A, which indicates which USGS quadrangles are involved, the bold outline being the perimeter of both the Basin and the map. Superimposed on the maps will be a grid system utilized for easy identification of individual squares and easy update of the data files.

Map 2 (Figure 5-14B) represents a full-range composite map, demonstrating total interaction of all the test criteria. In this case, geological factors have been set to average 0.1 artificially, in order to show the nature of balance achievable when better geological data are available. At the bottom of each map is a key which is self-explanatory. When running a map of LEES considerations only, the negative symbols reflect the negative impact of non-geological considerations in increasing increments, a minus sign (-) being a minor impact and a darkened square (■) being a major impact. When running a map considering geology only, the positive symbols reflect probability of coal, with an asterisk being an absolute coal siting, or previous mining activity. A further explanation of entries and scales is in Table 5-5.

Appendix I indicates the computer files in which the data for each square may be found, for verification or update purposes.

FIGURE 5-13

GEOLOGICAL/NONGEOLOGICAL FACTOR BALANCE

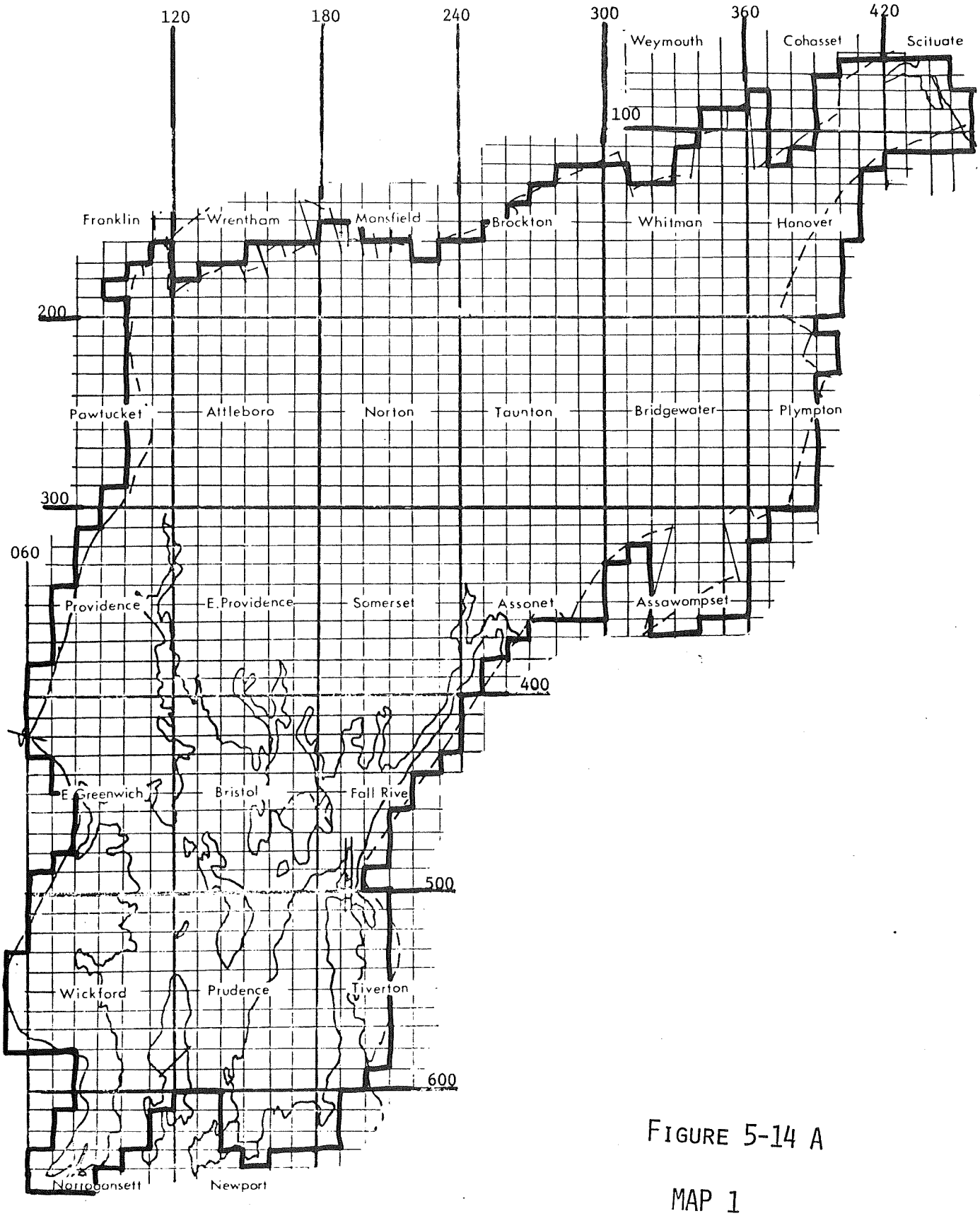


FIGURE 5-14 A

MAP 1

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

ORIGINATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. N. RIDER, BOSTON COLLEGE, MANAGING DIRECTOR, NECEP;
ADAPTED TO PDP-11 & EDITED BY E. ANN DAVIS, BOSTON COLLEGE; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS PLACED ON THE FOLLOWING FACTORS.

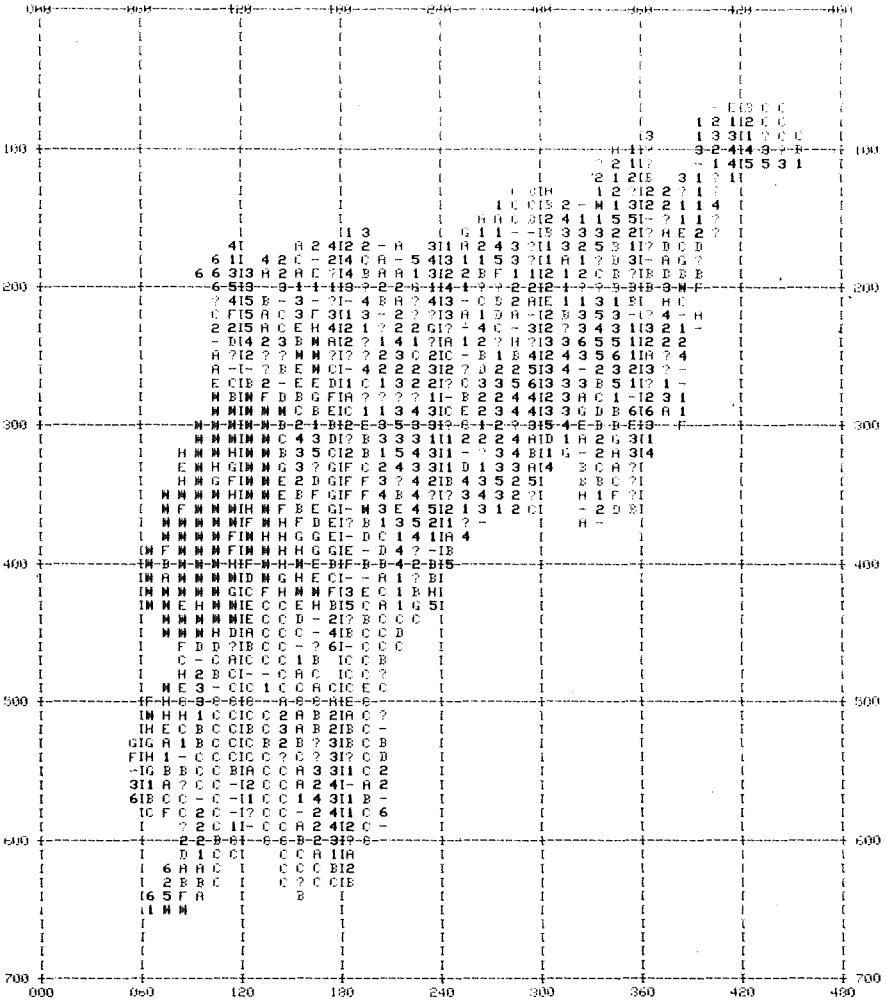
INPUT APPROPRIATE WEIGHTS ON A SCALE OF 0 TO 10:

LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIETAL WEIGHTS:

INLAND AND COASTAL WETLANDS IMPACT	10
HIGH, MEDIUM, AND LOW DENSITY POPULATION	10,10,10
FRESH AND OCEAN WATER BODY IMPACT	10,10
GROUND WATER RESERVE AND TOWN WELL IMPACT	10,10
SURFACE MINING IMPACT (POSITIVE = FAVORABLE)	10

GEOLOGICAL WEIGHTS:

PREVIOUS COAL MINING ACTIVITY	10
DRILLING ACTIVITY AND FIELD RESEARCH IMPACT	10,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY	10,10,10
DEPTH AND DIP IMPACT	10,10



EXPLANATION OF SYMBOLS

M	H	G	F	E	D	C	B	A	-	?	1	2	3	4	5	6	7	8	9	X
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

FIGURE 5-14 B

MAP 2

TABLE 5-5

Factors and Scales

C1	Inland Wetlands (0 - 400)	C6	Fresh Water Body (0 - 400)
C2	Coastal Wetlands (0 - 400)	C7	Surface Mining (0 - 400)
C3	High Density Development (0 - 400)	C8	Groundwater Reserve (0 - 400)
C4	Medium Density Development (0 - 400)	C9	Town Wells (0 - 400)
C5	Low Density Development (0 - 400)	C10	Ocean Water (0 - 400)

G1 Previous Coal Mining Activity

0 = No
1 = Yes

G2 Drilling Activity

0 = No
1 = Yes + Coal Found
-.2 = Yes - No Coal

G3 Field Research

0 = No
1 = Yes
-.2, -.5 = Negative Signs
.2, .5 = Positive Signs

G4 Non-Pennsylvanian

0 = No
-1 = Yes

G5 Metamorphic Analysis

0 = No
-.1 = Subchloritoid
-.5 = Chloritoid
-.9 = Biotite

G6 Structural Complexity

0 = Don't Know
-.5 = Complex
.5 = Simple

G7 Depth

0 = Unknown
.1 = 0 - 200'
.2 = 200 - 400'
.5 = 400 - 800'
-.2 = 800+'

G8 Dip

0 = Unknown
.1 = 20 - 50°
.2 = 0 - 20°
-.2 = 50 - 90°
-.3 = Variable

Follow-Up Investigations in Drillsite Areas

In order to begin to evaluate site specific potential nongeological barriers to mining, visits were made to the offices of the four towns in which drilling has taken place under this contract: Plainville, Massachusetts, Seekonk, Massachusetts, Norton, Massachusetts, and Portsmouth, Rhode Island. Table 5-6 relates the geographical location to the computer file data currently used, and may be compared to Table 5-7, showing earlier map-developed criteria, particularly relative to high, low and medium development.

In the case of each visit appropriate town maps were identified and are referenced herein so that subsequent research can be initiated from the point where the current efforts terminate.

1. Plainville, Massachusetts

   In the case of Plainville the maps contained in the town records were synthesized into a single map for analytical purposes. This area contained 2.4 square miles and contains 383 lots in the area surrounding the drill hole, located in the Masslite Quarry.

   Table 5-7 illustrates the summary figures for Plainville, indicating that in the area of 2.4 square miles, or 1,540 acres, there is an average of 160 lots per square mile. The implication of this number is that for a potential mine of one square mile area located in the site of the Plainville drill hole area, negotiations would have to be conducted with the owners of that many lots. It appears clear that not all of the lots are necessarily owned by different people or corporations; however, the negotiations which would have to be conducted for a mine of one square mile in surface area would approximate that number.

2. Seekonk, Massachusetts

   In Seekonk town maps numbered 27, 28 and 35 were examined, the drill hole being located within the confines of Map No. 28. Analysis of these maps shows that a total of 2,646 acres, or 4.1 square miles, are contained in the area around the drill hole. In the same area contained within the three maps, a total of 280 numbered lots have been identified. Therefore, an average of 68 lots per square mile have been identified for Seekonk. In a manner similar to that discussed above, this number is an indication of the number of negotiations which may be required in order to mine in this area on the basis of a potential mining area of one square mile.

   Further, in Seekonk on town Map 35 a parcel of slightly over 61 acres is identified to be owned by the Caratunk Wildlife Refuge Trust, Trustees. This parcel may be unique in presenting an additional barrier to potential mining beneath. In Map No. 28 Lot 29 is also owned by the same trust and totals slightly over 37 acres.

Criteria	#167 Plainville X = 12 Y = 18 File #1 Area = 266	#168 Norton X = 23 Y = 23 File #5 Area = 400	#176 Seekonk X = 14 Y = 29 File #4 Area = 400	#181 Portsmouth X = 16 Y = 55 File #9 Area = 400
LEES				
Inland Wetland	8	61	104	16
Coastal Wetland	0	0	0	0
High Dev.	0	17	39	42
Medium Dev.	15	0	15	5
Low Dev.	3	0	0	8
Fresh Water	4	0	0	76
Ocean Water	20	0	9	0
Ground Water	25	160	272	0
Town Wells	0	2	0	0
Strip Mining Now	0	0	0	0
GEOLOGICAL				
Prev. Coal Mine	1	0	0	0
Drilling Act.	1	0	0	0
Field Res.	1	0	0	1
Non-Penn.	1	0	0	0
Metamorphic	0	0	0	0
Complexity	.5	0	0	0
Depth	.1	0	0	0
Dip	.2	0	0	0

TABLE 5-6

DRILL HOLE LOCATIONS AND FILE DATA

Town	Maps	Lots	Acres	Sq. Mile	Lots/ Sq. Mile
Plainville	1	383	1,540	2.4	160
Seekonk	27	174			
	28	79	2,646	4.1	68
	35	27			
Norton	18	144			
	19	196			
	24	58	2,668	4.2	114
	25	80			
Portsmouth	55/55A	130			
	56	46	1,836	2.9	70
	60	26			
SUMMARY		1,343	8,690	13.6	99

TABLE 5-7

SUMMARY SHOWING ACRES, SQUARE MILES,
AND LOTS/SQUARE MILE IN DRILLSITE AREAS

3. Norton, Massachusetts

In Norton a total of four town maps in the area of the drill hole were examined. These maps indicate a total of 2,668 acres, or 4.2 square miles, and show a total of 478 numbered lots. The average lot density is therefore 114 lots per square mile.

Within the area examined in Norton is Winnecunnet Pond, which covers an area of 143 acres. There are other large parcels, including one shown on Map No. 25 totalling 302 acres which belongs to the Commonwealth of Massachusetts and is Dever School property. Offsetting these and other large parcels are numerous small residential parcels.

4. Portsmouth, Rhode Island

In Portsmouth a total of three major maps were examined, including Map 55A, which details part of Map 55. The area contained within these maps totals 1,836 acres, or 2.9 square miles. Within this area are contained 202 lots, accounting for an average of 70 lots per square mile.

Significant on these maps is the fact that a majority of the lots identified on Map 55 are owned by both the U. S. Government and the Roman Catholic Archdiocese of Providence.

The final line of Table 5-7 indicates a summary which shows that of the towns and maps examined a total of 1,343 lots were identified in an area of 8,690 acres, all surrounding the drill holes which were produced for this contract. A total of 1,343 lots in 13.6 square miles averages 99 lots per square mile for the areas examined.

As subsequent research in the Narragansett Basin in the area of non-geological mining considerations, a similar approach will be certain to identify lot per square mile densities different from those identified above. It appears likely, however, that as additional research is conducted in less populated areas, the number will drop significantly. Depending on the potential resources identified, moreover, it may be that areas of higher density can hold considerable attraction.

Chapter 6

THE EXPLORATION PROGRAM

by

James W. Skehan, S.J., Daniel P. Murray, Jonathan D. Raben, James W. Ring, S.J., Robert Bouchard, Peter A. Rushworth and George Cutter

Introduction

The program during the initial NSF phase of the Narragansett Basin Project consisted of a broadly based reconnaissance geological study, and core drilling of 24 holes for a total of 17,900 ft., downhole geophysical logging (by the U.S. Geological Survey), analysis of coals (by the U.S. Bureau of Mines and the U.S.G.S.), and the identification of LEES factors of potential importance to considerations of mining.

The program proposed by Weston Observatory for the BOM Phase of the Project was a drilling effort of about 40 holes and related geophysics exploration and a supporting LEES component. In negotiations with BOM officials, this proposed plan was modified to consist of Phase 1 and Phase 2. Phase 1 was to consist of continuing geological activities, an analysis of the Basin and its component parts from the LEES point of view, and a drilling effort consisting of four core holes. Phase 2, contingent on the results of Phase 1, is planned to consist of the drilling of some 20 drillholes and related geophysics with continuing but supporting LEES analysis from March, 1979 to March 1980.

Geological Studies

During Phase 1 - BOM certain transition activities from the NSF phase were carried out. During the NSF phase, the core had been logged in a preliminary way. In the course of this phase, however, it became clear that an improved core logging scheme was necessary if we were to properly evaluate the relevant data on sedimentation, stratigraphy, structure, and metamorphism of coal and rock. This core logging scheme, developed during the NSF phase, was applied to the BOM Phase 1. The method and preliminary results of logging in the early part of the BOM Phase 1 were presented in Skehan and Murray, eds. (1978).

Geological data has been collected in a systematic way in the Narragansett Basin since Jackson (1840) and Hitchcock (1841), who did reconnaissance studies of the geology of Rhode Island and Massachusetts respectively. Geological observations on a wide range of bedrock data have been recorded by a number of geologists over the years and we have undertaken a systematic mapping and recording program as a fundamental part of our geological studies. Geological science has undergone a rapid evolution on many fronts over the past several decades. This evolution of its theoretical principles as well as practical applications mean that observations recorded by earlier geologists or even by peers must be reexamined and may be subject to reinterpretation depending on the area or areas of expertise represented by the observer.

Thus, for each 7.5' quadrangle, a compilation of all available field data has been prepared that includes:

1. Outcrop location

2. Type of data (e.g., lithology, strike and dip, structural, mineralogical, paleontological, etc.)

3. Source of data

A grid system was also developed to expedite retrieval of outcrop data and to provide data in a coordinate system compatible with that being used in the LEES investigation, both of which are computer compatible. A description of the Coordinate System and an example of the data acquired for one quadrangle (Norton 7.5' quadrangle) are presented in Appendices A and B.

The data compiled for each quadrangle and the results of regional studies were used to define general areas which on the basis of present understanding of the Basin are considered likely to contain coal. Maps showing these areas have been continually updated with the results of field work of our own staff and of other individuals.

These geological maps, which we have prepared, show that there are large tracts for which there is no geological information as well as large areas for which there is only limited data. The planar and linear nature of some geological data (such as that on faults and fold axes respectively) allows the geologist to extrapolate data from the place of observation to nearby places where there is limited data or no outcrop. Where the geology is simple, this may be done over larger distances, possibly miles. In the case of the complex Narragansett Basin, however, the distances over which extrapolations may reasonably be made is very limited and depends on the specific geological feature in question.

Results of several aspects of geological studies have been summarized in Chapter 2, Structural Geology; Chapter 3, Metamorphism; and Chapter 4, Coal Petrography, Chemistry, Rank and Stratigraphy.

Drilling Program

Geologic considerations for the selection of drillsites included:

1. The reported or observed presence of coal in that part of the stratigraphy being considered.

2. Stratigraphic, sedimentologic and structural characteristics

3. Metamorphic grade; because of the limited extent of proposed drilling, sites of low metamorphic grade were given priority. Questions concerning metamorphism at Cranston during Phase 1, for instance, precluded drilling. Recent information (Gray and Raben, 1979c) would make Cranston a priority drillsite in BOM Phase 2.

4. One drillsite was chosen to investigate the stratigraphy under a major swampy lowland (based on discussion with U.S. Bureau of Mines officials - line item 1.2.1.1.E).

Figure 5-12a shows a location map of the areas most favorable for coal exploration from a geologic standpoint. This map was superimposed upon a companion map prepared using LEES criteria (see Chapter 5), portraying areas having factors indicating favorability for mining from a LEES standpoint. Coinciding favorable areas from the two maps constituted a list of areas deserving futher evaluation for their potential as drilling areas.

Because the computerized information relates to 1-sq mile gridded areas, the site specific selection of drillholes was done on the following basis:

1. Geologic mapping and other relevant information in the vicinity of favorable areas.

2. Accessibility of water for drilling.

3. Permission to drill on the property of interest.

Of the several areas of interest in early stages of selection, four drillsites (Figure 6-1) were chosen for the BOM Phase 1 drilling. They include:

1. Plainville, MA, Wrentham, MA Quadrangle (#167) NBP Drillhole

2. Seekonk, MA, Attleboro, MA Quadrangle (#176) NBP Drillhole

3. Norton, MA, Norton, MA Quadrangle (#168) NBP Drillhole

4. Portsmouth, R.I., Prudence Island, R.I. Quadrangle (#181) NBP Drillhole

Drilling Procedures

The four sites mentioned above were drilled by the Sprague and Henwood Co. during the Summer and Fall of 1978. The drilling was monitored and logged on site, in a preliminary way, by a member of the Weston Observatory Staff. The drilling schedule is presented in Table 6-1. All core was subsequently brought to the Observatory where it was logged for graphic representation at the scale of one inch to two feet. Logs are presented as Plate 1 in this report (pocket). The logging scheme used for this work is given in Appendix B. All core is currently indexed, and is in the Core Storage Library at Weston Observatory. Plate 1 present the dip-corrected stratigraphic logs for the four BOM Phase 1 drillholes. Structural information on these holes is in the detailed logs at Weston Observatory.

Drilling Activity and Results

Masslite Quarry, Plainville, Mass.

The Masslite Quarry is the only active coal mining site in the Basin. It is also an outstanding locality for the study of structure, stratigraphy, and

Table 6-1 Drill Site Data

Site No.	167	176	168	181
Location	Plainville, Mass. Masslite Quarry Wrentham Quad.	Seekonk, Mass. Pine Street Attleboro Quad.	Norton, Mass. Washington Street Norton Quad.	Portsmouth, R.I. Union Street-W.Maine St. Prudence Is. Quad.
Longitude Latitude	71° 21' 30" 42° 00' 51"	71° 19' 13.5" 41° 53' 02"	71° 08' 03" 41° 57' 46.5"	71° 17' 15" 41° 33' 34.5"
Elevation	335 ft	80 ft	80 ft	140 ft
Overburden	27.1 ft	47.6 ft	29 ft	0 ft
Depth of Hole	882.5 ft	830.5 ft	580 ft	1000 ft
Capped	Yes	Yes	Yes	Yes
Casing Length	116 ft	49 ft	40 ft	10 ft
Rock Types				
Conglomerate	28%	19.5%	4%	1.0%
Sandstone	57%	63%	77%	37%
Siltstone	10%	15.5%	19%	51%
Shale	5%	1.0%	0%	11%
Lost	0%	1.0%	0%	
Begun	6/26/78	8/10/78	9/18/78	10/3/78
Ended	8/4/78	9/11/78	9/28/78	10/31/78
Logger	J. Jones	M. Tiberio J. Jones G. Cutter	G. Cutter	G. Cutter

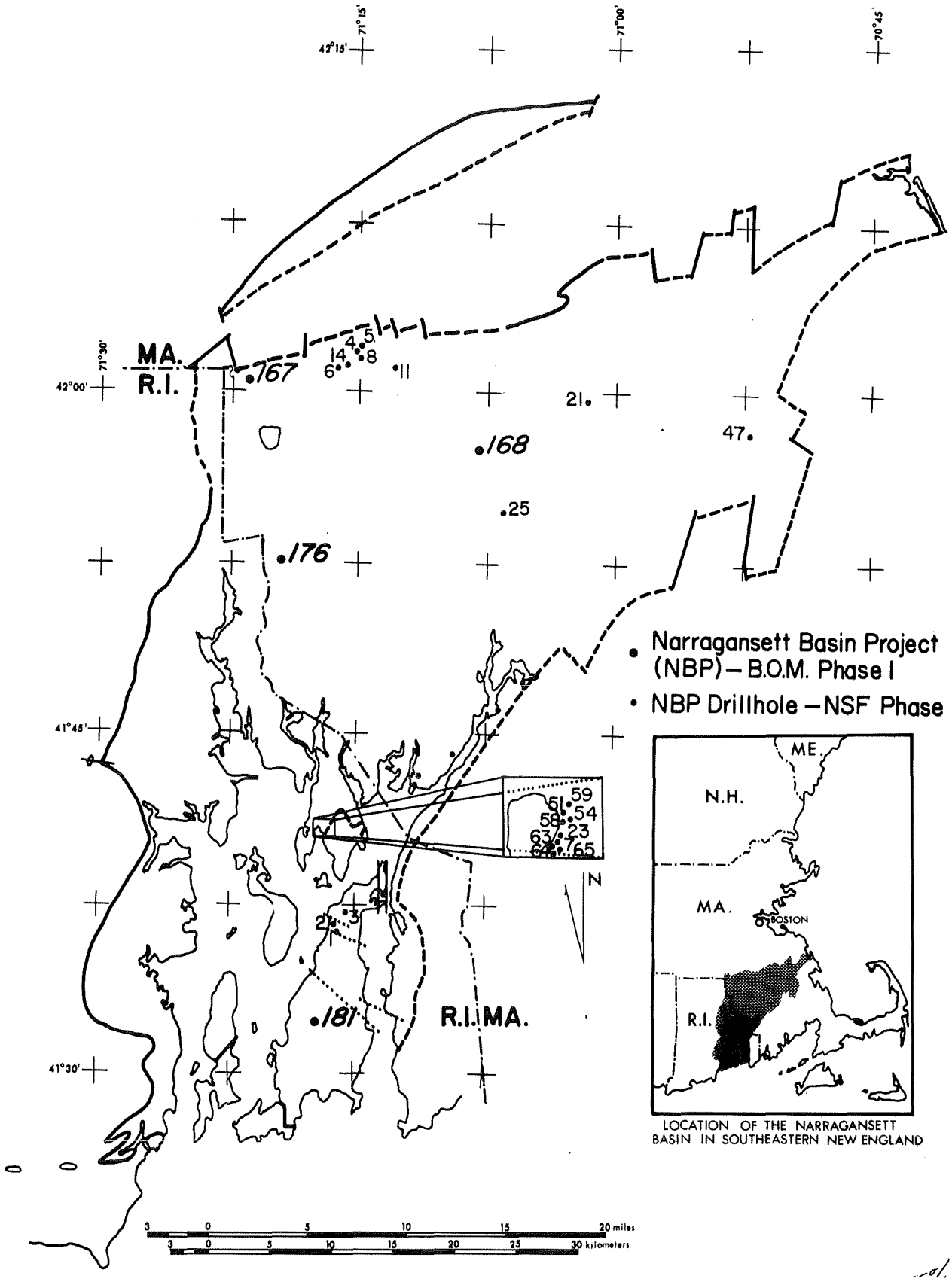


FIGURE 6-1

MAP OF LOCATION OF DRILLSITE FOR U.S. BUREAU OF MINES DRILLING, SUMMER AND FALL 1973.

paleobotany of the Rhode Island Formation. Six coal beds or horizons are known from the general Plainville area (Lyons and Chase, 1976, p.415). The Masslite Quarry (Figure 6-2) produces a light-weight aggregate used in road construction. The aggregate is manufactured by the heating of shale and siltstone from the quarry. Coal mined in the quarry, is used as fuel for the production of the aggregate and thus provides a substantial savings (Bruce MacDonald, Plant Supervisor, personal comm.). If indigenous coal was not available, anthracite from Pennsylvania would have to be used exclusively. At present, 3 parts Narragansett Basin anthracite is mixed with 1 part Pennsylvania anthracite. A discussion of the geologic setting and mining activity was given in Skehan and Murray, eds. (p. 92-94, 1978).

The exact location of the site was to a certain extent determined by current mining (and blasting) activity, and proximity to water. The quarry operators were kind enough to bulldoze a good access road to the site. A summary of the drilling activity is given in Table 6-1.

The beds in the quarry consist mainly of southerly dipping layers. A stratigraphic section approximately 450 ft thick includes: a coal seam 25 ft thick (Figure 6-3). The location of Hole #167 is shown on Figures 6-1 and 6-2. The stratigraphic log is given in Plate 1, and a summary of a percentage of lithologies is included in Table 6-1. The core is characterized by coarse sandstones and conglomerates and simple structure, the dip of the beds varying from 10° to 30°.

The coal exposed in the quarry wall is part of a sequence that fines up from below the coal and coarsens above it (Figure 6-4). Such a sequence is typical of those found throughout much of the northern half of the Basin.

Hole #167 correlates quite well with the quarry section, as can be seen in Figure 6-5, although the variations are noteworthy. Two small seams of coal were found in the drillhole below the level of the quarry floor. The hole was terminated about 10 feet into the basement, the contact between the basement and the coal-bearing rocks being an unfaulted unconformity. The coal exposed in the quarry is, therefore, one of the oldest coals in the Basin, Alleghenian (Westphalian) Lyons and Chase (1976), as determined by fossil dates and by stratigraphic position. This coal is believed to be proper stratigraphic position, although its upper surface is faulted (Figure 6-3).

Recommendation

The Narragansett Basin Project Hole #167 tested the stratigraphy below the exposed coal. It would be appropriate to test the stratigraphy above the coal, especially in close proximity to the seam. This would allow one to determine whether the exposed coal is a pod, or is a laterally continuous bed of relatively uniform thickness. Illite crystallinity data (Figure 3-3) suggests the possibility that the lowest rank coals may occur in this part of the Basin. The potential for the presence of relatively low rank, thick coal seams in the Hoppin Hill and in the northern two-thirds of the Taunton Domains (Chapter 2, this volume), indicates that further exploration is warranted.

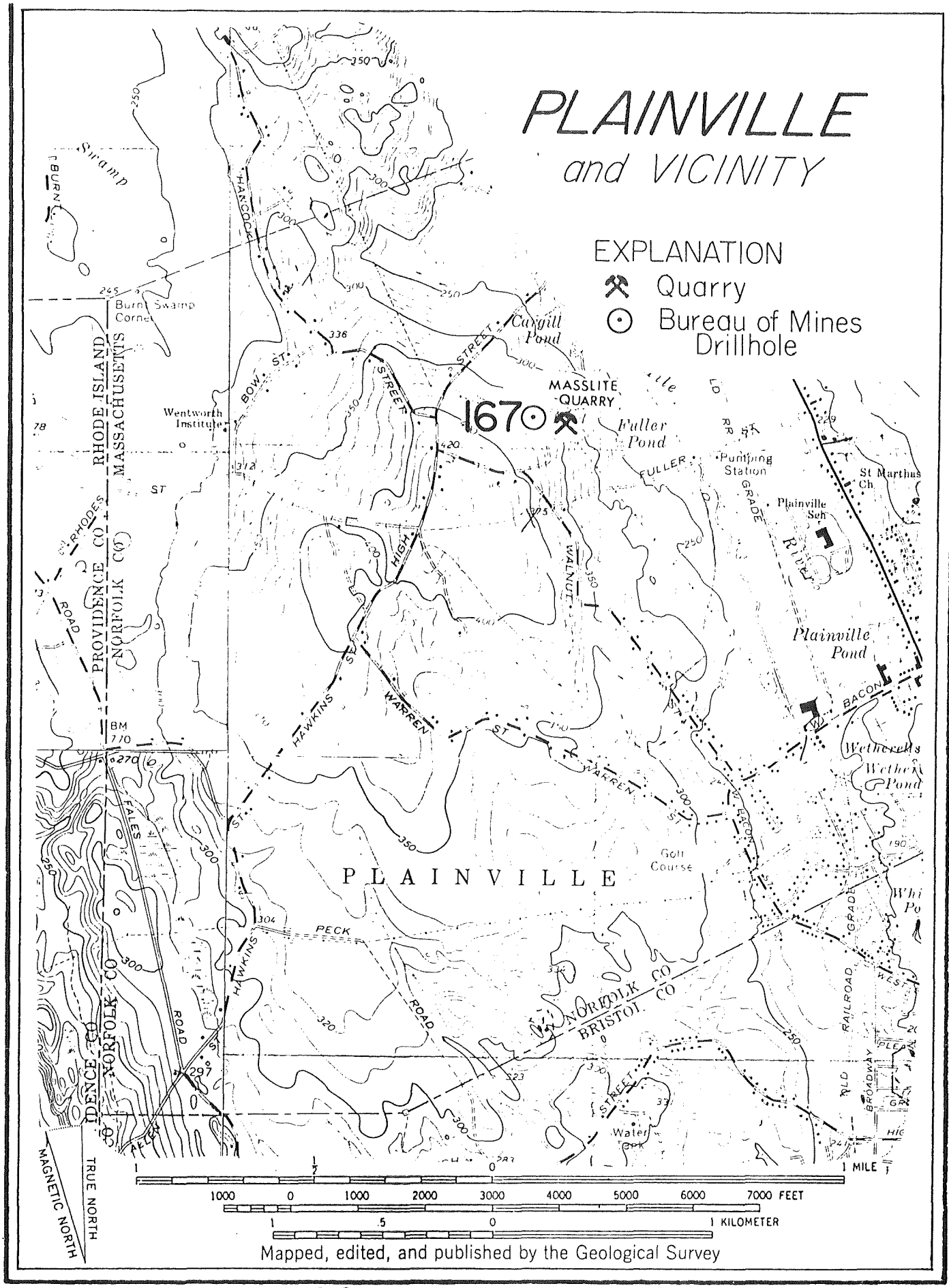


FIGURE 6-2 MAP OF PLAINVILLE AND VICINITY

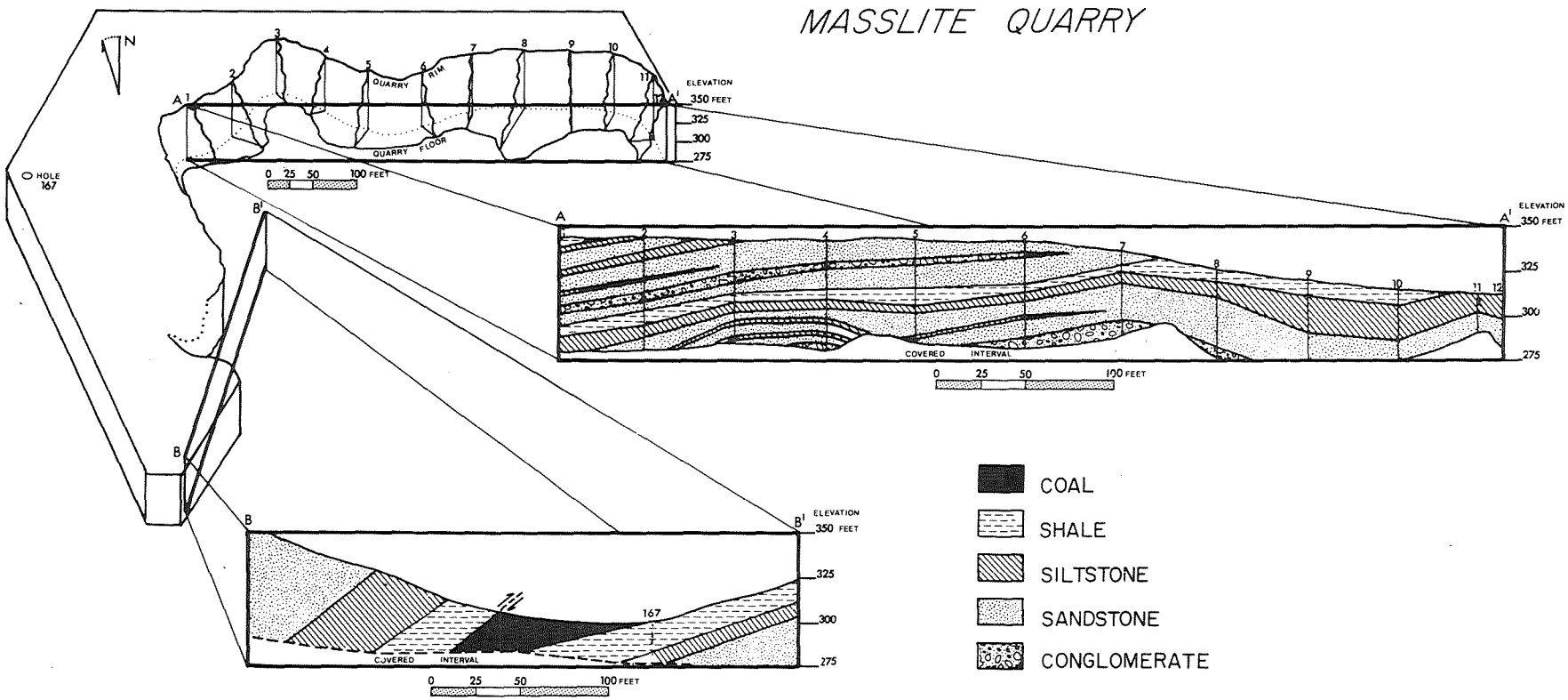
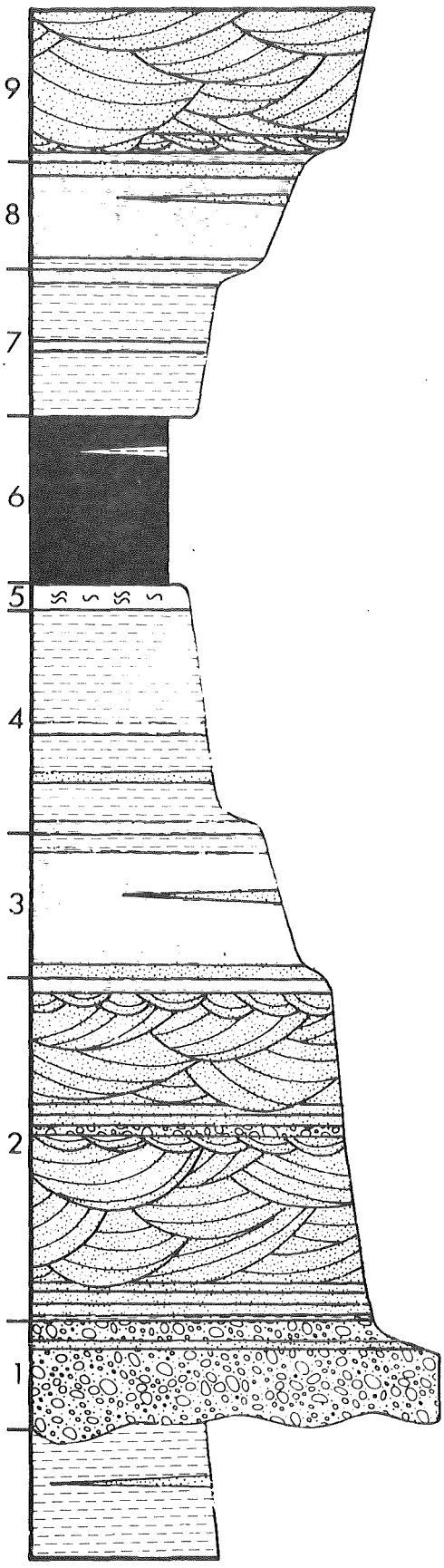


FIGURE 6-3

CROSS SECTION THROUGH THE MASSLITE QUARRY: GEOLOGY



IDEALIZED COAL SEQUENCE

Modeled after the Masslite Quarry, Plainville, Massachusetts

COAL

SEAT EARTH

SHALE

SILT

SAND

CONGLOMERATE

FIGURE 6-4

IDEALIZED COAL SEQUENCE BASED ON OUTCROP AT MASSLITE QUARRY, PLAINVILLE, MASS.

MASSLITE QUARRY
Correlation of Drillcore and Outcrop Below Coal

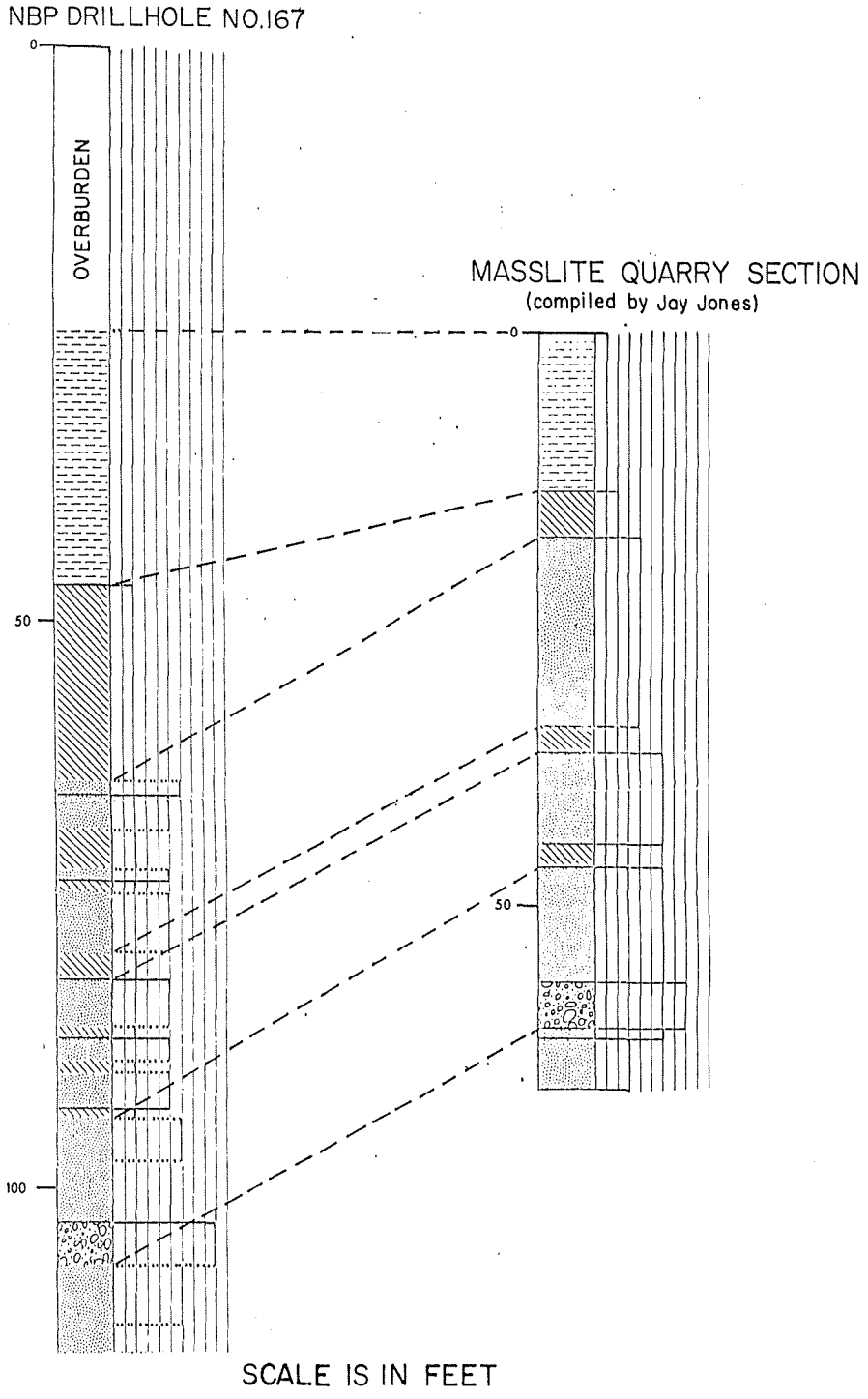


FIGURE 6-5

CORRELATION OF DRILLCORE AND OUTCROP IN THE MASSLITE QUARRY: GEOLOGY

Seekonk, Mass.

General Statement

The Weston Observatory Hole #176 (in Seekonk) (Figure 6-6) was drilled in order to determine whether the lithologic sequence at this site could be correlated with the coal-bearing sequence of rocks described from the area in 1885 by Seekonk Coal Co. (Shaler and others, 1899). On strike with the Seekonk Coal Co. section is a measured section (Lyons and Chase, 1976) of outcrop at Perrins Crossing. Both of these and the drillhole are located in Figure 6-6. Additionally this hole is within a few hundred feet of the contact of the Dighton Conglomerate of the Great Meadow syncline.

Table 6-1 covers the record of drilling of Hole #176 at the Seekonk site. Our first choice for drilling in this area became unobtainable at the last minute when permission was revoked. That site would have overlapped with the stratigraphy of the Seekonk Coal Co. and the section exposed at Perrins Crossing.

Plate 1 shows the graphic log of Hole #176 in Seekonk, Mass. and Figure 6-7 shows the logs of Perrins Crossing outcrop and the 1885 Seekonk Coal drillhole. Figure 6-6 showing the position of Hole #176, the Perrins Crossing measured section, and the 1885 Seekonk Co. drillhole reported on by Shaler (1899).

The measured section at Perrins Crossing (Lyons and Chase, 1976), Shaler's interpretation of an 1885 driller's log (Shaler and others, 1899) of a hole located to the northwest of Perrins Crossing and the NBP drillhole #176, (reported on in this volume), are in general of similar lithologies if a few assumptions are made. In drillcore it is our experience that grainsize tends to appear coarser on the average than in sections measured in outcrop very close to the drillhole. Shales and siltstones in the outcrop descriptions may well be logged in drillcore as siltstones and fine sandstones. Grainsize is better determined from a polished fresh surface of a drillcore, than from a weathered or broken outcrop sample. The rocks of the Basin are usually quite poorly sorted and compositionally variable and one's first approximation of grainsize on field sampling may reflect these complexities. Petrographic investigations are necessary to accurately determine rock texture. Since the 1885 drillcore was logged by a driller and then reinterpreted by Shaler (1899), we presume the accuracy of this procedure possibly falls short of outcrop descriptions.

Attitudes of beds in the Perrins Crossing (PC) outcrop, in the 1885 hole and in the NBP Hole #176, all indicate that the PC section should intersect the 1885 Seekonk Coal Co. section close to the bottom of the 1885 hole and that both of these sections should lie below the NBP section, based on the simplest structural interpretation (Figure 6-8).

Recommendations

All three sections (PC, Shaler's Hole and NBP Hole #176) are coarser grained than most of the sections that have been found to be coal bearing. However, Shaler (1899) reports that many of his shales were carbonaceous ("coal shales") and that thin beds of coal were present.

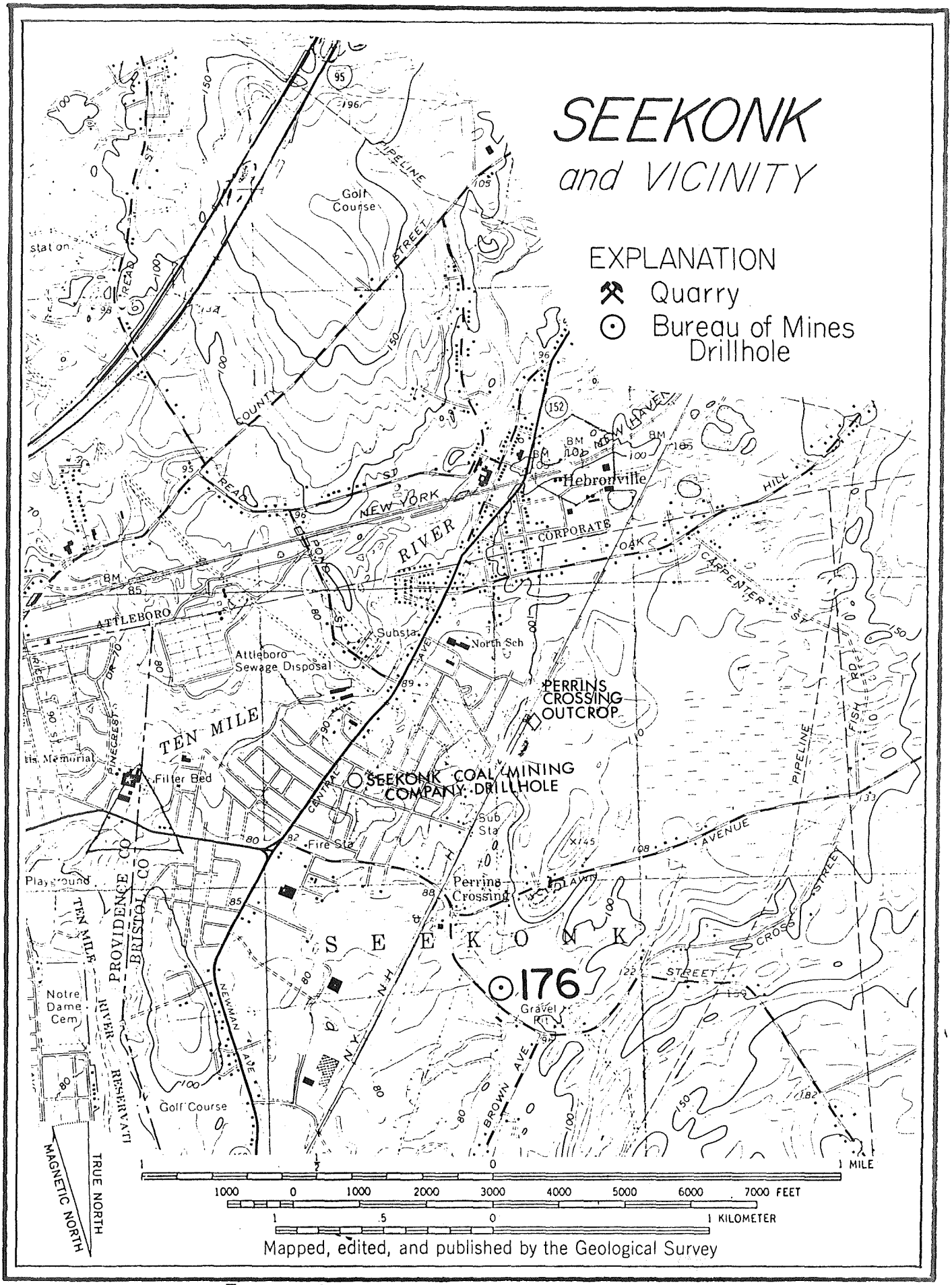


FIGURE 6-6 MAP OF SEEKONK AND VICINITY

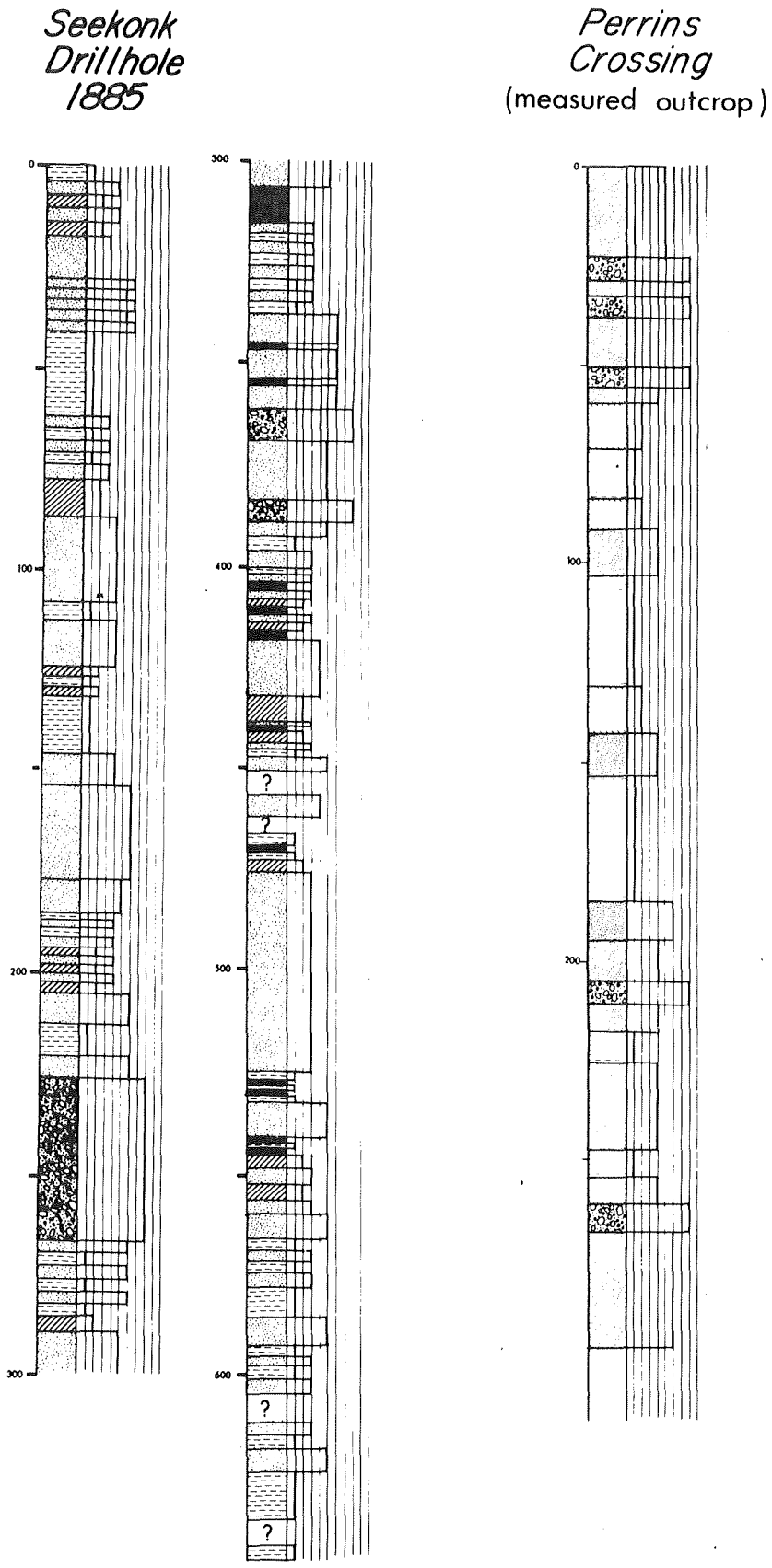


FIGURE 6-7 GRAPHIC LOGS OF PERRINS CROSSING OUTCROP AND THE LOG OF THE SEEKONK COAL COMPANY BOREHOLE OF 1885.

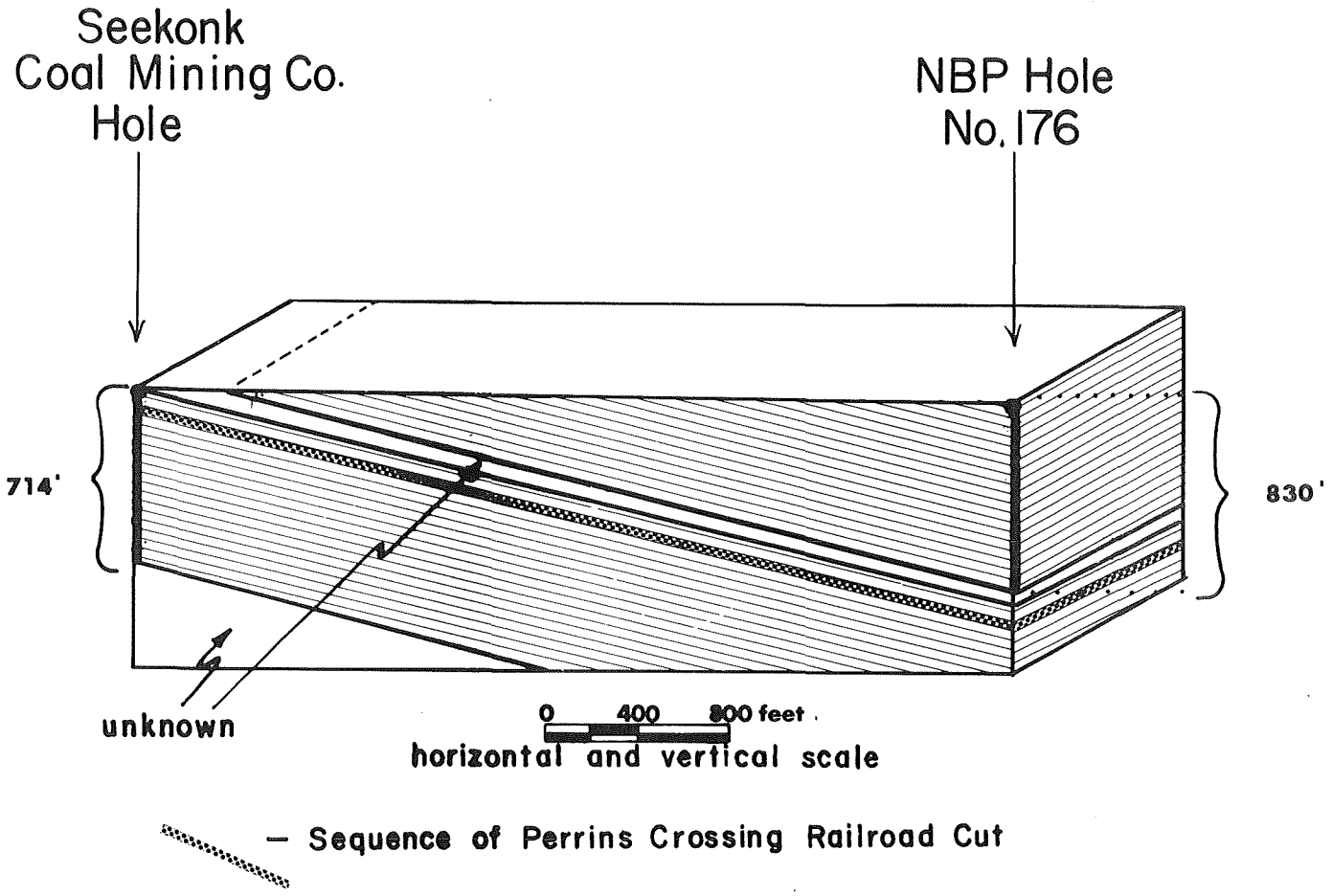


FIGURE 6-8

CROSS-SECTION OF DRILLHOLES AND OUTCROP IN SEEKONK

Future drilling should test the ground between the NBP Hole #176 and the other two localities mentioned above.

The log of the Seekonk Coal Co. Hole suggests that there is a greater abundance of carbonaceous shale and coal than in Hole #176. Thus drilling in BOM Phase 2 should be undertaken further to the north.

Norton, Mass.

General Statement

The main reason for drilling here (Figure 6-9) was to test the stratigraphy in a relatively unexposed part of the Basin associated with a major swamp. Our first two choices for a site in this area were in the middle of the Hockamock Swamp. However, permission to drill at these locations could not be procured. The site actually drilled was chosen for the following reasons:

1. It lies near the western margin of the Hockamock Swamp, the largest swamp in the Basin. This part of the Basin is very poorly exposed, and the nearest outcrop is approximately a mile away.

2. The site lies within one of the largest undeveloped tracts of land in the Basin. The U.S. Army had a large camp here that was abandoned after World War II. Now only the Dever State School, a small Industrial Park (under construction), and a sewage treatment plant (under construction) exist on the several square mile area.

Drilling Activity and Results

Table 6-1 covers the record of drilling of Hole #168 at the Norton site. The stratigraphy (Plate 1) and structure of the Norton hole were comparable to that of the Plainville site in that both were dominated by sandstone and simple structure. The Norton hole shows an overall trend from relatively coarse to fine-grained lithologies with increasing depth. The dip varied from 20° to 50°. No coal was encountered.

Conclusions

Because of the paucity of outcrops in this part of the Basin, the cross-section, Figure 6-10, is hypothetical and schematic. It is based on information from some distance from the site of NBP Hole #168. The fact that no coal was encountered suggests that at least in this area the swampy ground may not be underlain directly by easily eroded fine-grained rocks but that the presence of such lowlands may be structurally controlled. More drilling in similar settings should take place in order to determine the relationship between the presence of large swamps and the nature of the bedrock.

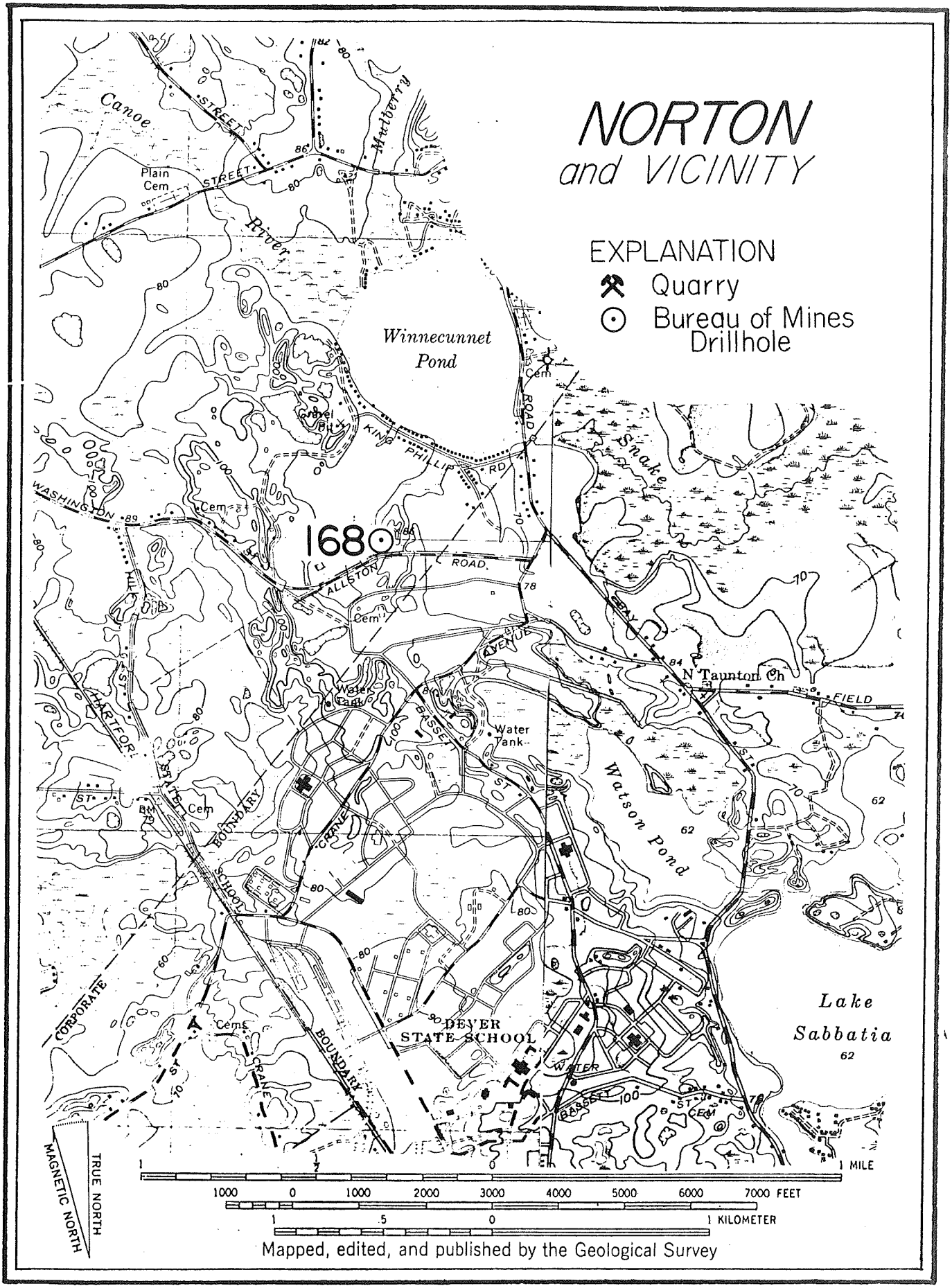
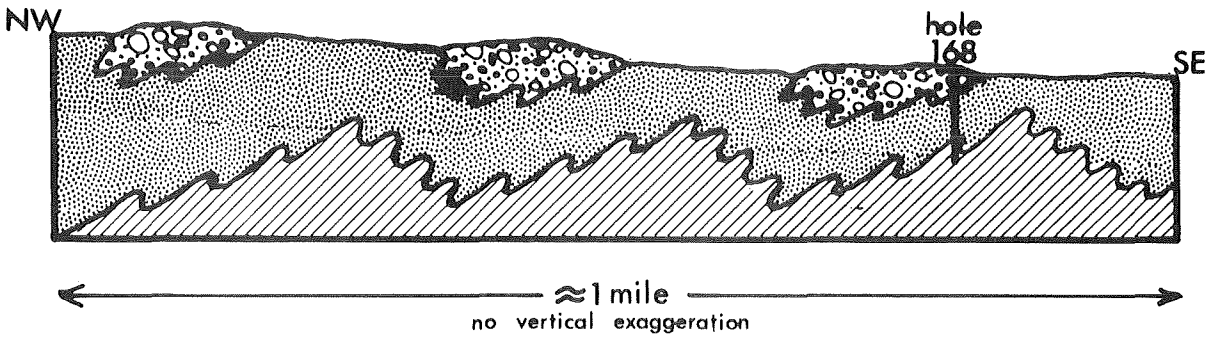


FIGURE 6-9 MAP OF NORTON AND VICINITY

Hypothetical and Schematic Cross-Section: Northeastern Norton U.S.G.S. 7½' Quadrangle



Siltstone Sandstone Conglomerate

FIGURE 6-10

HYPOTHETICAL AND SCHEMATIC CROSS-SECTION: NORTHEASTERN NORTON U.S.G.S. 7 1/2' QUADRANGLE

Portsmouth, R.I.

General Statement

The first reported coal discovery in the Narragansett Basin was in the northern part of Portsmouth in the mid-1700's. This led to the formation of plans to form a mining company in 1760. An extensive mining development took place at Portsmouth Station in the 19th century (Chase 1978, pg. 24 in Skehan and Murray, Volume 1). The mining activity, carried out more or less continuously by various companies until 1914 resulted in a substantial amount of coal being extracted from the Portsmouth Mines, possibly in the range of 1 to 2 million tons. Earlier drilling by the Narragansett Basin Project explored, in a preliminary way, the limits of the coal near the Portsmouth Mines (Skehan and Murray, eds., 1978 pg. 82ff).

Drilling Activity

The record of the Narragansett Basin Project drilling at Portsmouth in BOM Phase 1 is presented in Table 6-1. The site at Hole #181, (Figure 6-11) the deepest hole in BOM Phase 1, is located on a large vacant lot from which overburden had been stripped away to expose a nearly flat lying, dominantly dark gray siltstone and black phyllite sequence. Much of the residual soil consisted of fragmented rock which we thought might represent grout from a former mining activity dumped at the site. No written or verbal record of mining activity at this site, however, is known to Police Chief Pierce (pers. comm. 1978), a student of coal mining history in Portsmouth.

The property owner made the site available for drilling and the lack of overburden eliminated the need for more than a minimum of casing.

Drilling Results

The stratigraphic log of Hole #181, presented in Plate 1, indicates that with the relatively large percentage of siltstone and shale (Table 6-1), this drillcore is finer-grained than the other three drillcores obtained during BOM Phase 1. The Portsmouth drillcore is also structurally more complex than the others and contains at least two cleavages. Finally, it is the only core that contains ubiquitous metamorphic porphyroblasts (ilmenite and carbonate). Although carbonaceous shales, similar to the sequence at the Portsmouth Mines, were relatively abundant, no coal was encountered.

Aquidneck Island, long called the Island of Rhode Island, has been interpreted by geologists as a generally symmetrical, upright synclinal fold (Jackson, 1840). Mosher and Wood (1976 and written comm., 1977); and Skehan and others, 1976; Skehan and Murray (1978) and Skehan and Murray (this volume) have shown that the geological structure of Aquidneck Island, has evolved through a series of complex steps that have important implications for drilling and other exploration.

Basically the northern part of Aquidneck Island appears to be synclinal but, having been subjected to several deformational episodes (Skehan and Murray this volume, Figure 2-2), is exceedingly complex in the detail that is required for prediction in a drilling program.

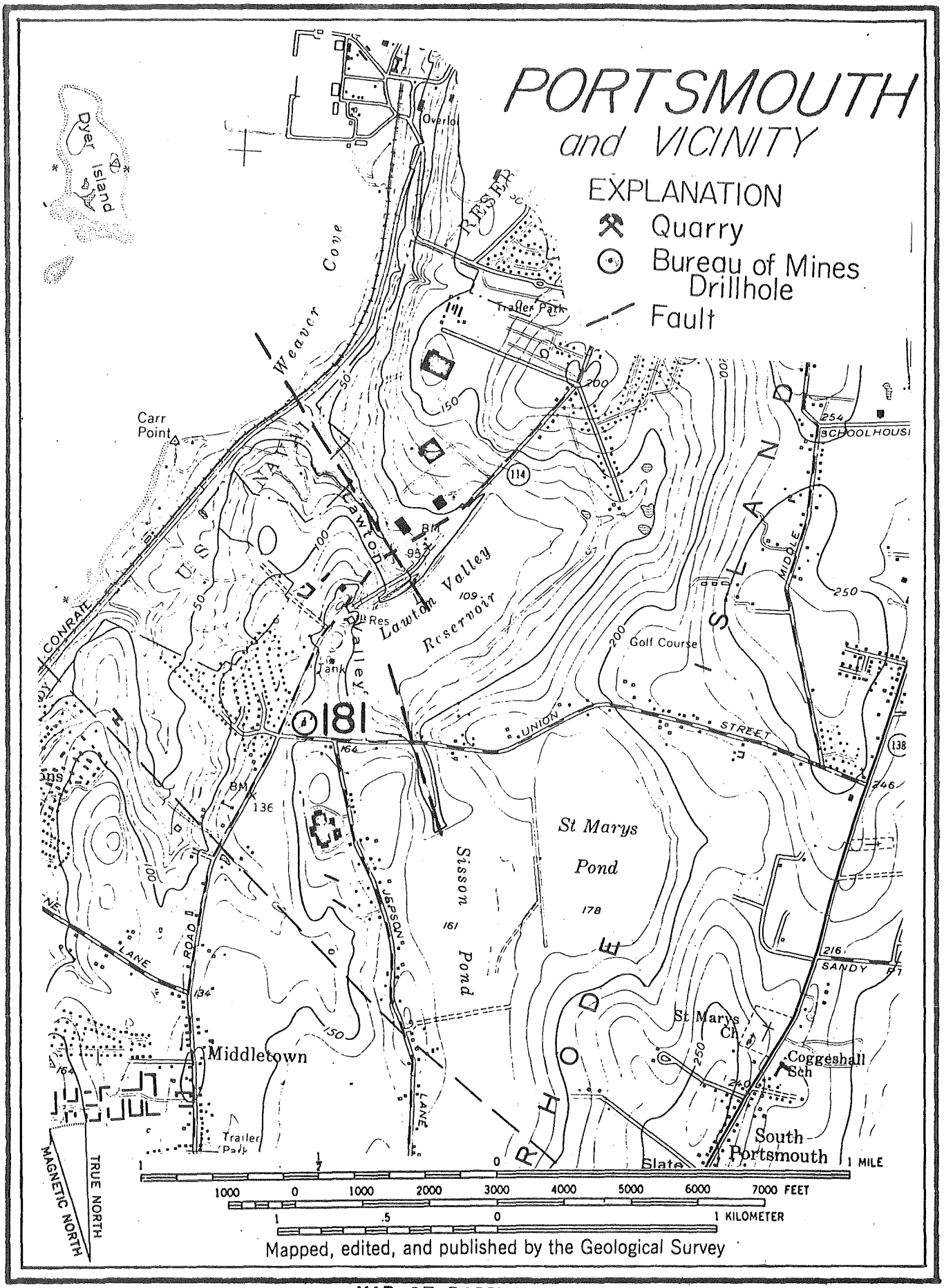


FIGURE 6-11 MAP OF PORTSMOUTH AND VICINITY

Hole #181 is on the western side of the higher hills that form the central ridge of the Island, which is mainly held up by sandstones and conglomerates. The drilling done by Toenges and others (1948) and by the Narragansett Basin Project (Skehan and Murray, 1978) suggests the possibility that faults may be located along certain linear lowlands or streams. Northern Aquidneck Island is divided into several areas separated by prominent WNW linear valleys tentatively identified by us as fault valleys. Thus the site of Hole #181 would be located on the second block south of that on which the Portsmouth Mines are located (Figure 6-1).

The site of Hole #181 was a second choice in our present priority listing of sites in Portsmouth and Middletown, R.I. but was drilled because the first choice, near the quarry on Cory's Lane, at the last minute permission was revoked. Nevertheless, Hole #181 is located on the western flank of the structure but in a somewhat higher topographic and possibly higher stratigraphic position than the Cory's Lane site.

The beds at the Portsmouth Mines are Conemaughian (Stephanian A) in age, some of the youngest coals in the Basin (Lyons, 1978). The next block south from the Mines has exposed rocks, including conglomerates and sandstones, that appear to be stratigraphically younger than the rocks at the Mines. These blocks are separated by the NW-striking Portsmouth Mines fault, discovered by William Barton (pers. comm., 1975).

The stratigraphic relationship of the blocks on which Hole #181 is located with respect to the one immediately north is uncertain. Folds of both first and second generation plunge 10° to 20° SW toward Block 3, the two blocks probably being separated by a fault or faults near the Middletown Reservoir. The stratigraphic throw on this fault is probably small as the rocks on either side are similar.

Hole #181, therefore, has provided us with stratigraphic information on a part of the youngest stratigraphic section in the Basin, which, in the Portsmouth Mines, records the most continuous and the most productive coal seams worked in the past 170 years.

Chapter 7

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Those parts of the 960 sq. mile Narragansett Basin, which we consider to be favorable as potential producers of anthracite, lie in the 660 sq. mile area underlain by rocks in the chlorite and subchlorite zone of metamorphism.

2. In widely spaced localities of this part of the Basin, Weston Observatory has drilled 28 holes (Figure 6-1) and has recovered 20,000 ft. of core. The results in terms of thickness of seams and quality of coal have been most encouraging as the anthracite seams in such widely spaced localities as the following ranged upward in thickness as indicated:

Bristol, R.I.	30 ft.
Plainville, MA.	25-30 ft.
Mansfield, MA.	13 ft.
Portsmouth, R.I.	7 ft.

3. The coal, moreover, has been shown by BOM and U.S.G.S. analyses to be a very low sulfur, high ash anthracite. In a significant number of samples analyzed, the ash appears to be secondary. According to washability studies (BOM), the coals were found to be "suitable for physical preparation to a product that generally contains less than 10% ash". None of the coal samples analyzed during either phase of the Narragansett Basin Exploration Project (NSF phase or the BOM phase) were found to be meta-anthracite by ASTMD-338 classification. Petrographic investigations of the coals indicate that its moisture-holding capacity is most likely due to the moisture being held in voids and capillaries associated with brecciation and secondary carbon deposition. Coal rank does not correlate well with depth. Coal rank is variable within a seam and may be higher near its roof and floor.

4. Although we have not as yet drilled in Cranston, R.I., recent preliminary analyses (Gray, Personal comm., 1979) of coal from the extensively exploited Budlong Mine indicate that it is properly classified as a very low sulfur (.002 percent), high ash (20 percent) anthracite and not a meta-anthracite as it was earlier referred to (Toenges and others, 1948).

5. The Basin is complex and variable. This complexity is due in part to its having undergone a complex history of sedimentation in a fluvial environment. Its structural evolution during the Late Pennsylvanian-Permian Alleghanian Orogeny consisted of three episodes of folding recorded in the rocks and in the coal accompanied by at least two and possible three episodes of thrust faulting, and followed by two stages of normal and high angle reverse faulting.

6. The result of the early folding and thrusting, as we now understand the model, was to mobilize the coal so that it was concentrated in the crests and troughs of folds and faulted folds. This seems to have occurred not only on the scale of the largest folds, but also on the scale of smaller folds as well. While this mobilization process thickens the coals greatly in the crests and troughs, they may be thinned or disappear in the down dip direction. However, the thickening in the axial region of folds suggests that the widespread presence of horizontal to subhorizontal fold axes means that these concentrations of thickened coals can be traced for considerable distances along the direction of plunge of the fold axes.

   Thus, the geological exploration program required for this structurally unconventional coal is itself different from standard exploration programs. Later cross faults cutting these folds may offset these thickened pods of anthracite, but the offset may be determined by modern structural analysis based on data from geological observations.

7. The complexity of structural deformation and metamorphism appears to be greater in the southern part of the Basin than in the north. The early episode of folding may not have pervasively affected the rocks of the Hoppin Hill and Taunton Domains. The powerful analytical tools of illite crystallinity studies suggest that if coals of semi-anthracite rank are to be found here, it will be in the unmetamorphosed to highly metamorphosed rocks of the diagenetic zone, which appears to constitute the northwestern two-thirds of the Basin and a large part of Aquidneck Island, R.I. Results from illite studies suggest that temperatures to which the Basin rocks were subjected were greater in the south than in the north.

   The other equally powerful analytical tools, coal chemistry, petrography and reflectance measurements and studies suggest that pressures due to deformation may have been greater in certain districts in the northern Taunton and Hoppin Hill Domains than farther south. Earlier conclusions from the illite studies, which appeared in part to be contradictory to those from chemistry, petrography and reflectance studies, are now believed to be complementary, providing different kinds of information on temperature and pressure. Such insights are very important to the understanding of the large scale as well as specific site structure and metamorphism of the Basin.

8. The 4 holes of the present BOM Phase 1 study have provided significant data on several parts of the Basin stratigraphy. More specifically, the drillhole and quarry studies in Plainville, MA. provide information on the strata underlying the late Pottsvillian age coal and carbonaceous shales in the lowest part of the Pennsylvanian succession.

   The Seekonk, Mass. hole provided data on that part of the stratigraphic succession immediately below the Dighton Conglomerate of the Great Meadow Syncline and provides data bearing on the stratigraphy just above the fossiliferous Pottsvillian age rocks of Perrins Crossing and the sequence in the Seekonk Coal Co. hole in Seekonk described by Shaler and others (1899).

The hole in Norton, MA., on the margin of the extensive Hockomock Swamp, consists dominantly of sandstone. This suggests that the vast tracts of lowlands in the northern part of the Basin may be structurally rather than lithologically controlled. However, further testing in other lowland areas is required to be definitive.

The drillhole at Portsmouth, R.I. (#181) is dominated by very fine-grained carbonaceous shales which, with rooted zones and abundant fossils, are suggestive of a coal-forming environment. These rocks are similar to those of the Portsmouth Mines, some of the youngest in the Basin, from which 1-2 million tons of anthracite were extracted in the last century for, among other purposes, to fuel a mine-mouth copper smelter.

9. LEES Conclusions

With respect to the non-geological portion of this effort, three conclusions may be made:

1. A substantial number of areas have been identified in the Narragansett Basin in which mining could be carried out without undue difficulty from a land use point of view.

2. Substantially more than two hundred instances of past or current mining activities have been identified in the Basin. Many of these are in areas defined as geologically interesting, and may be advantageous from the point of view of future exploration.

3. The map synthesis technique developed for this contract is successful and may easily be adapted to future exploration in its current form and also in its expandable form dealing with unit measurements of one-tenth mile.

RECOMMENDATIONS

1. Additional exploration is necessary to permit appraisal of the Narragansett Basin coals as a resource.

2. Analytical Studies

   a. Analytical work should be conducted to determine the nature of the volatile matter in the Narragansett Basin coals.

   b. Studies should be conducted to determine the nature of coal ash, since the type of ash (e.g., primary vs. secondary) may have significant effects on the washing characteristics of the coal.

c. Tests should be conducted to determine the burning characteristics of the coals from different areas of the Basin.

d. Detailed petrographic analyses should be conducted to determine the microstructure of the coal. The coal is distinctive in that it contains features which are not completely understood. Very little work has been done on high rank, high ash coals.

e. An examination of the coal should be undertaken to determine the causes of its hydroscopic nature.

f. In considering coal rank, both vitrinite reflectance and chemical parameters should be used and compared.

g. Combined geologic and petrographic studies should be conducted to determine the geometry of coal seams.

3. The New England Energy Congress, established in May, 1978 by the New England Congressional Caucus, under the Chairmanship of Honorable Edward Boland and Silvio Conte, has made important recommendations concerning exploration and evaluation of this potentially indigenous energy source for this energy-poor region of the United States. The first of such recommendations on indigenous energy sources is:

   "Incorporate in the D.O.E. budget a program to evaluate the Narragansett Coal Basin. A 7-year program at an approximate cost of $10 million is proposed for 650 drillholes to an average depth of 1,000 feet, supplemented by related downhole and surface geophysical studies. This program would establish whether commercial development of this potential resource is feasible".

4. A multi-phase exploration program is required that will mainly consist of drilling and geophysics and related field and laboratory investigations. For example, we recommend that BOM Phase 2, during the coming year, initiate a systematic program of drilling deep holes on a grid, with associated downhole geophysics. At the same time, a few selected, special purpose holes at specific locations should be drilled, near the Budlong Mine, Cranston. Recent preliminary data by Gray has revived interest in several aspects of such thick coals of high quality. Additionally during BOM Phase 2, some drillholes should test the new structural model (Figure 2-2) to determine its applicability to finding concentrations of coal in the axial regions of folds. The place where it should be tested is near the Case Mine in Portsmouth, R.I., provided permissions can be obtained.

5. Once a series of holes on a large scale grid has been drilled and analyzed, a second program of drilling on a smaller scale grid should probably be developed for the most promising sectors of the Basin as determined from earlier drilling. This activity would have as its goal to establish the nature of the anthracite resource for at least a limited part of the Basin.

6. A further recommendation is the need to bring on line a fully computerized geological data storage and retrieval capability for the large and growing base of highly varied information on a wide variety of geological factors. Existing programs at the University of Massachusetts at Amherst, MA., the U.S. Geological Survey, and the University of South Carolina, are already available and would allow swift analysis capability, the printout of maps and other illustrations showing a variety of geological data and interpretations. This kind of computer capability is over and above that developed in connection with the LEES aspects of BOM Phase 1 and the further refinement recommended below.

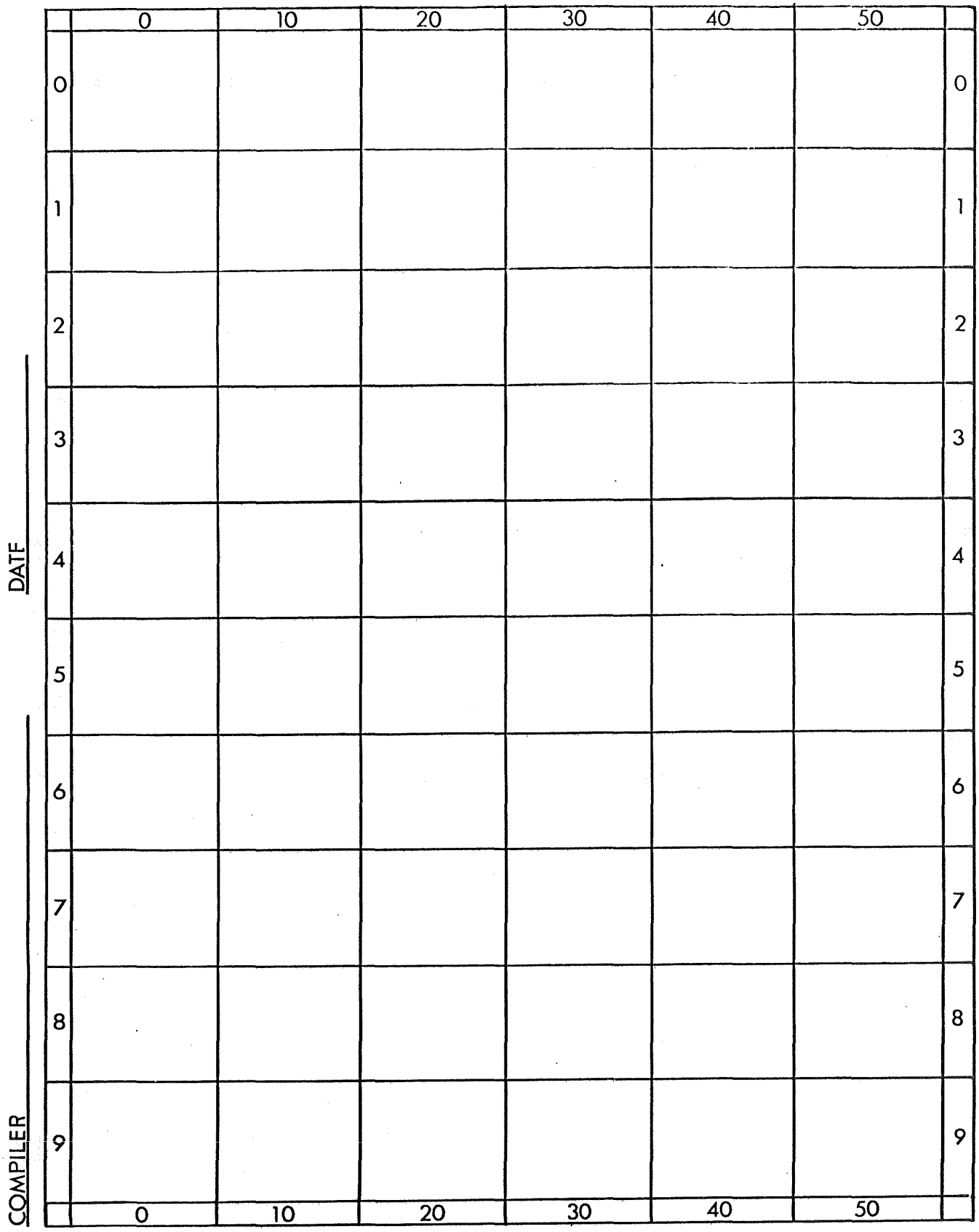
7. LEES Recommendations

For the coming year we recommend that the map synthesis program be made operational on a one-tenth mile basis, and that the data files be updated to include all of the work done during 1978 which could not be included in addition to the work to be done during 1979, so that at the end of the Bureau of Mines Phase 2, the data files will be current.

8. Congressional Charge to BOM for Phase 2 of Narragansett Basin Project

The New England Delegation has felt a deep concern about the New England region's overwhelming dependence on imported foreign oil. For this reason steps were taken to provide funding for a substantial preliminary exploration program of the Narragansett Basin. This resulted in the following language being incorporated into the House of Representatives Report #95-1251 of the 95th Congress, 2nd Session, Union Calendar No. 681, to accompany the U.S. Bureau of Mines budget during fiscal 1978 and 1979:

> "The Committee expects the Bureau to continue studies involved in ascertaining the extent and quality of low sulfur coal reserves in the Narragansett Basin in New England including necessary drilling and geophysical studies. The knowledge of the extent of such deposits is of great importance to this 'energy poor' area".



LEGEND

QUAD

X-REF

APPENDIX A GRID SYSTEM FOR THE RECORDING OF GEOLOGIC DATA IN THE NARRAGANSETT BASIN

APPENDIX B CATALOG OF OUTCROP DATA FOR THE NORTON 7 ½ ' QUADRANGLE

OTCP #	CITY	LITHOLOGY	DATA	X REF	LOCATION
N-32-1	NORTON	very fine to very coarse gr. ss. to granule to pebble cong. with 6" clasts	N50E, 38S glacial striae: S25E	Lyons (73)	intersection Pine St. and Rte 123
N-13-1	NORTON	coarse to very coarse ss. to granule cong to pebbly cong. - clasts 2½" 50% quartzite	N55E, 87S tops SE glacial striae: S15E	Lyons (106)	just W of Oak St., ½ mi. N of intersection of Oak St. and Rte 123
N-4-1	ATTLEBORO	sed. rock	—	Williams + Wilkey (1967)	just E of Pike Ave., ¼ mi. S of RR.
N-15-1	NORTON	—	N55E, 80S	Shaler (1899)	0.2 mi SE of intersection of West Hodges St. and Slater St.
N-15-2	NORTON	shale ?	30' deep borehole	?	just N. of West Hodges St. and 0.1 mi west of dirt road linking Harvey St and W Hodges St.
N-15-3	NORTON	medium to coarse gr. ss. - shale, mudstone, siltstone	N80E, 79N	Lyons (107) Shaler (1899)	beneath power lines on N side of Harvey St., ½ mile west of intersection of Harvey and Maple St.
N-15-4	NORTON	shale ?	N78E, 62N N75E, 71N	Lyon's (108) Crosby (1977)	0.2 mile NW of intersection of Harvey St. and dirt road linking it to West Hodges St.
N-6-1	ATTLEBORO	med. gr. ss., pebbly cong. clasts 5" - 90% quartzite clasts	N85E, 25S	Lyons (109)	just N. of Wilmarth St. approx. 0.1 mi W of intersection of Wilmarth St. and dirt road
N-6-2	ATTLEBORO	—	N80E, 15S FOSSIL LOCALITY	Shaler (1899)	just N of Wilmarth St., ¼ mi W of intersection of Wilmarth St. and Pike Ave.
N-6-3	ATTLEBORO	sed. rock	—	—	just west of intersection of Smith St. and dirt road to gravel pit
N-46-1	TAUNTON	conglomerate	—	—	just S. of Worcester St. and 0.1 mile E of intersection of Worcester St. and E. Hodges St.
N-8-1	REHOBOTH	—	N85E, S	Shaler (1899)	on W. side of hill, ¼ mi S of trail, 1½ mi. W. of Rte 118.
N-8-2	REHOBOTH	—	N85E, S	Shaler (1899)	on N side of trail, 1½ mi W of Rte. 118
N-8-3	REHOBOTH	—	N85E, S	Shaler (1899)	¼ mi. NW of end of light duty road the Bethel Mission Church is located on
N-8-4	REHOBOTH	—	N85E, S	Shaler (1899)	⅛ mi S of trail, ¾ mi. W. of Rte. 118
N-19-1	REHOBOTH	—	N95E, S	Shaler (1899)	just W. of junction of trail and Rte. 118
N-9-1	REHOBOTH	—	N85E, S	Shaler (1899)	on S. side of hill, ¾ mi S. of trail 1¼ mi. W. of Rte 118
N-9-2	REHOBOTH	—	N85E, S	Shaler	¼ mi SW of end of light duty road off of Rte. 118, approx. 2½ mi S. of Rte 118 and Pack St. intersection
N-9-3	REHOBOTH	—	N85E no dip	Shaler (1899)	1 mi. W. of Rte 118 along pipeline

NORTON QUAD.

(ALL LYONS OUTCROPS R.I.F. UNLESS NOTED OTHERWISE.

OPEN CIRCLES ON MAP ARE BEDROCK OUTCROPS (WILLIAMS & WILLEY) NO INFORMATION ASSOC.

OTCP #	CITY	LITHOLOGY	DATA	X REF	LOCATION
N-1-1	NORTON	SHALE, SILTSTONE, MUDSTONE, VERY FINE TO COARSE GRAINED SS.. GRANULE AND PEBBLE CONG.	BEDDING N 38E, 60-70 S	Chase and others unpub. data	1 mile S on Oak St. from intersection of Oak and Elm, 0.2 mi due East
N-1-2	NORTON	—	N50E, 76 N QTZ VEIN: N30E, 41 S	Lyons (105)	at end of road branching SW from Oak St., 1 1/2 mi S. of intersection of Oak and Elm
N-1-3	NORTON	RED BEDS	N50E, 90 PLANT FOSSIL LOCALITY	Shaler (1999)	just E. of Oak St., 1 mile N of intersection of Walker and Oak
N-21-1	NORTON	—	N50E, 90	Shaler (1895)	at end of dirt road off Reservoir Ave., 1/2 mile S. of intersection of Reservoir Ave and Elm St.
N-21-2	NORTON	fine to coarse gr. ss., shale, siltstone, mudstone, pebble cong.	N50E, 67 S JOINT: N52E, 88 S QTZ VEIN: N50±, 57 S	Lyons (103)	just SE of intersection of Reservoir Ave. and dirt road listed for outcrop N-21-1
N-21-3	NORTON	—	N50E, 85 S	G. Webb	intersection of Reservoir Ave. and Elm St.
N-21-4	NORTON	fine to coarse gr. ss. to granule cong. shale, siltstone, mudstone	N50E, 86 S	Lyons (104)	1/4 mile NE of outcrop N-21-3
N-31-1	NORTON	—	N55E, 30N	Crosby (1977)	halfway between ends of second and third roads on East side of Reservoir Ave. approx. mi S of intersection of Cobb St. and Res. Ave.
N-31-2	NORTON	?	N35 E, 32 S	G. Webb	1/4 mi NE. of Cross St., 3/4 mi. N of Cross St. Elm St. intersection
N-40-1	NORTON	—	NO 5E, steep dip	Crosby	just E. of Rte 123, 3/4 mi. N. of intersection Rte 123 and Leonard St.
N-12-1	NORTON	coarse ss. to granule to pebble cong. fine to v.f. ss to shale, siltstone, mudstone	N70E, 78S JOINTS: N57E, 77N N25W, 73S QTZ. VEINS: N55W, 68N N57W, 73N	Lyons (124)	on W. side of hill due N. of paved road which becomes dirt, located off Rte 123 approx. 1/2mi E of intersection of Power St. and Rte 124
N-12-2	NORTON	—	N70E, 84N	G. Webb	1/2 mi N of dirt road described for outcrop N-12-1
N-22-1	NORTON	?	N65E, 90	Shaler (1899)	0.2 mi due W of Reservoir Ave., 1/2 mi N of Rte 140 and " "
N-22-2	NORTON	?	N65E, ?	Shaler (1899)	just W of intersection of Reservoir Ave. and Rte 140
N-22-3	NORTON	—	N55E, 70 N	G. Webb	approx. 1/2 mi W of midpt. of light duty road which separates from Freeman St for short distance
N-22-4	NORTON	—	N55E, 90	G. Webb	approx. 1/4 W of road described for outcrop N-22-3

NORTON QUAD.

Outcrop #	City	Lithology	Data	X Ref	Location
N-9-4	REHOBOTH	—	N85E, S	Shaler	1/8 mi due N of end of dirt road located 2 mi S. of intersection of Rte. 118 and Peck St.
N-28-1	REHOBOTH	(122) - cobble cong. max clast length 11 1/2", 95% clasts quartzite medium gr. ss to pebble DIGHTON (123) cobble cong., clasts 10 1/2", 95% quartzite, coarse ss to granule cong. to pebble cong. DIGHTON	(122) N65E, 22S JOINT: N-S, 89E (123) N65E, 20S	Lyons (122) Lyons (123)	just S. of Peck St., 1/2 mi W. of intersection of Peck and Francis St.
N-29-2	TAUNTON	med. gr. ss to granule cong. to pebble cong with max clasts 2 1/2"	N55E, 33S	Lyons (120)	on Glebe Ave., 1/4 mi W of intersection of Glebe Ave. and North Reynolds Rd.
N-28-3	TAUNTON	coarse to v coarse ss cobble cong. with 8" clasts DIGHTON	N60E, 24S	Lyons (121)	3/4 mi SW of intersection of Glebe Ave and N. Reynolds Rd.
N-29-4	TAUNTON	Very fine to v. coarse ss.	—	Lyons	1/4 mi SW of Glebe Ave Reynolds Rd. intersection
N-38-1	TAUNTON	v. coarse ss to pebble	N75E 25S JOINT: N30E, 77 NW N20W, 74 NE GLACIAL STRIAE: 38OE	Lyons (118)	just S. of Glebe Ave, 3/4 mi E of intersection of Glebe Ave and N. Reynolds Rd.
N-38-2	TAUNTON	coarse ss to pebble cong to cobble cong.	N80E, 15S	Lyons (119)	1/4 mi S of Glebe Ave, 3/4 mi E of intersection " and N. Reynolds
N-38-3	TAUNTON	coarse ss to pebble cong. DIGHTON ?	N25E, 25S JOINTS: N65W, 55N S20W, 84W FOSSIL LOCALITY	Lyons (110)	intersection of Burt St. and Glebe St.
N-29-1	DIGHTON	—	N55E, N	Shaler	1/4 mi N of Chestnut St., 1/2 mi W of inter. of Chestnut St. and N. Reynolds Rd.
N-39-1	TAUNTON	coarse ss to pebble cong. - very fine to fine ss.	N65E, N QTZ VEIN: N10W, S	Lyons (116)	W side of Burt St., 1/4 mi. N of Burt St., Gulliver St. intersection
N-39-2	TAUNTON	coarse ss to pebble - cobble cong. max. clasts 7" - 95% clasts quartzite	N60E, 45N GLACIAL STRIAE: S70E S75E S77E	Lyons (115)	NE corner of intersection of Burt St. and Gulliver St.
N-39-3	TAUNTON	coarse ss to pebble	N70E, 30N Q-Z VEINS: S85E, 52S FOSSIL LOCALITY	Lyons 45	at intersection of Rte 144 and dirt road 1/4 mile SW of Wades Corner
N-39-4	TAUNTON	cobble cong. DIGHTON	—	Lyons (117)	SE corner of intersection of dirt road and light duty road located on W side of Burt St. 1 mi N of Burt St. Gulliver St. intersection
N-39-5	DIGHTON	—	N11E, N	Shaler	1/8 mi N of Rte 144, 1/4 mi W of intersection Rte 144 and Gulliver St.
N-48-1	TAUNTON		N7OE, N	Shaler	1/8 mi S of Rocky Woods St., 3/4 mile W of " " and Range Ave intersection

NORTON QUAD.

Outcrop #	City	Lithology	Data	XRef	Location
N-48-2	TAUNTON	(111) cobble cong. w/ 11" clasts / c. to v.c. ss DIGHTON (112) cobble cong., 95% quartzite DIGHTON (113) cobble cong w/ 6½" clasts / c to v.c. ss. to pebble DIGHTON	(111) N30E, 32N QTZ VEIN: N80E, 68S (112) N85E, 35N QTZ VEIN: S80W, 65S	Lyons (111) (112) (113)	just NW of intersection of Woods St and Range Ave.
N-49-1	TAUNTON	cobble cong w/ 12" clasts, 95% clasts quartzite / coarse to v. coarse ss DIGHTON	E-W, 29 N QTZ VEIN: S75W, 73N	Lyons (114)	just N. of Woods St, ½ mi W. of Woods St.- Range Ave intersection
N-58-1	TAUNTON	pebble cong. / coarse to very coarse ss to granule cong. to pebble DIGHTON ?	N40E, 29S	Lyons (128)	just N. of Woods St., 1 mile W intersection of Woods St – S. Walker St.
N-58-2	TAUNTON	—	N80E, 28 N	Shaler	just N. of Woods St., 3/4 mi W of intersection Woods St. - S. Walker St.
N-58-3	TAUNTON	coarse to very coarse ss to granule cong. – cobble cong. w/ 13" clasts – pebble cong w/ 3" clasts DIGHTON	S40W, 42N JOINTS: S75W, 58S N20W, 86W	Lyons (129)	just N. of Woods St. on S. side of hill, 1/9 mi W of Woods St., S. Walker St. intersection
N-58-4	TAUNTON	—	N70E, 47N	Shaler	½ mi E of Woods St. – S. Walker St. Intersection
N-58-5	TAUNTON	(126) coarse to very coarse ss, pebble cong w/ 5" clasts, 90% quartzite DIGHTON ? (127) cobble cong. w/ 11" clasts, 90% quartzite DIGHTON	(126) N60E, 47S (127) JOINTS: N10W, 90 N80E, 72S	Lyons (126) (127)	just S. of Fisher St., 1/4 mi. W of Fisher St – S. Walker St. intersection
N-58-6	TAUNTON	—	N75E, N	Shaler	1/4 mi W of S. Walker St., 1/4 mi N of Cohannet St – S. Walker St. intersection

P#	City	Lithology	Data	XRef	Location/Comm
Nr 40-1 ?	Norton	siltstone (w) shaley laminae	N60°E, L30NW N68°E, L41° NW	RgB 78	Plain St. Rd from previous - Crosby
Nr 13-1	Norton	coarse SS & siltstone (w) congl. lenses	N62E, L90° N65E, "	RgB 78	Oak St., .2 mi N of Rt. 123
Nr 01-2	Norton	laminated silt & shale	N60E, L86 NW	RgB 78	Rd - Lyons
Nr 22-4	Norton	coarse sand & congl.	N65E, L25 NW	RgB 78	Rd
Nr 22-3	"	SS/congl. shale layers	N55°E, L74° NW	RgB 78	Rd
Nr 15-3	"	fine silt	N25E, L70-90° SE cleavage - N70°E, 80NW N70°E, 47NW		Harvey St Rd
N45-1	TAUNTON	pebble cong.	N80W, 40N S65W, 27NW	D.P. R.B. '78	just N of Hodges St., 0.2 mi W of Pound St. S. side Worcester St.
N-18-2	REHOBOTH	[illegible] coarse gr. massive SS.	—	D.P. R.B. '78	W side of Rte 118, 0.15 mi S of Cemetery
N-18-3	"	med. to coarse gr. SS and pebble cong. w/ 2½" clasts	S80W, —	D.P. R.B. '78	0.05 mi S of loop [illegible] side of Rte 118 [illegible] of road
N-38-4	TAUNTON	[illegible] SS. [illegible]	N38E, 18N N55E, 35N	D.P. Ring '78	0.2 mi S of [illegible] St., [illegible]
N-38-5	[illegible]	med to coarse gr. SS. interbedded w/ pebble cong. [illegible]	S63W, 50S S67W, 32S	D.P. Ring '78	just [illegible] of [illegible] St.

NORTON QUAD.

tcrop #	City	Lithology	Data	X Ref	Location
N-48-2	TAUNTON	(111) cobble cong. w/ 11" clasts / c. to v.c. ss DIGHTON (112) cobble cong., 95% quartzite DIGHTON (113) cobble cong w/ 6 1/2" clasts / c to v.c. ss to pebble DIGHTON.	(111) N30E, 32N QTZ VEIN: N8OE, 68S (112) N8SE, 35N QTZ VEIN: S8OW, 6ES	Lyons (111) (112) (113)	just NW of intersection of Woods St. and Range Ave.
J-49-1	TAUNTON	cobble cong w/ 12" clasts, 95% clasts quartzite / coarse to v. coarse ss DIGHTON	E-W, 29 N QTZ VEIN: S75W, 73N	Lyons (119)	just N. of Woods St., 1/2 mi W. of Woods St.- Range Ave intersection
I-58-1	TAUNTON	pebble cong. / coarse to very coarse ss to granule cong. to pebble DIGHTON ?	N40E, 28S	Lyons (129)	just N. of Woods St., 1 mile W intersection of Woods St - S. Walker St.
I-58-2	TAUNTON	—	N80E, 28 N	Shaler	just N. of Woods St., 3/4 mi W of intersection Woods St. - S. Walker St.
I-58-3	TAUNTON	coarse to very coarse ss to granule cong. - cobble cong. w/ 13" clasts - pebble cong w/ 3" clasts DIGHTON	S40W, 42N JOINTS: S75W, 89S N20W, 86W	Lyons (129)	just N. of Woods St. on S. side of hill, 1/9 mi W of Woods St., S. Walker St. intersection
I-58-4	TAUNTON	—	N70E, 47N	Shaler	1/2 mi E of Woods St. - S. Walker St. intersection
J-58-5	TAUNTON	(126) coarse to very coarse ss, pebble cong w/ 5" clasts, 90% quartzite DIGHTON ? (127) cobble cong. w/ 11" clasts, 90% quartzite DIGHTON	(126) N60E, 47S (127) JOINTS: N10W, 90 N80E, 72S	Lyons (126) (127)	Just S. of Fisher St, 1/4 mi W of Fisher St - S. Walker St. intersection
I-58-6	TAUNTON	—	N75E, N	Shaler	1/4 mi W of S. Walker St., 1/9 mi N of Cohannet St - S. Walker St. intersection

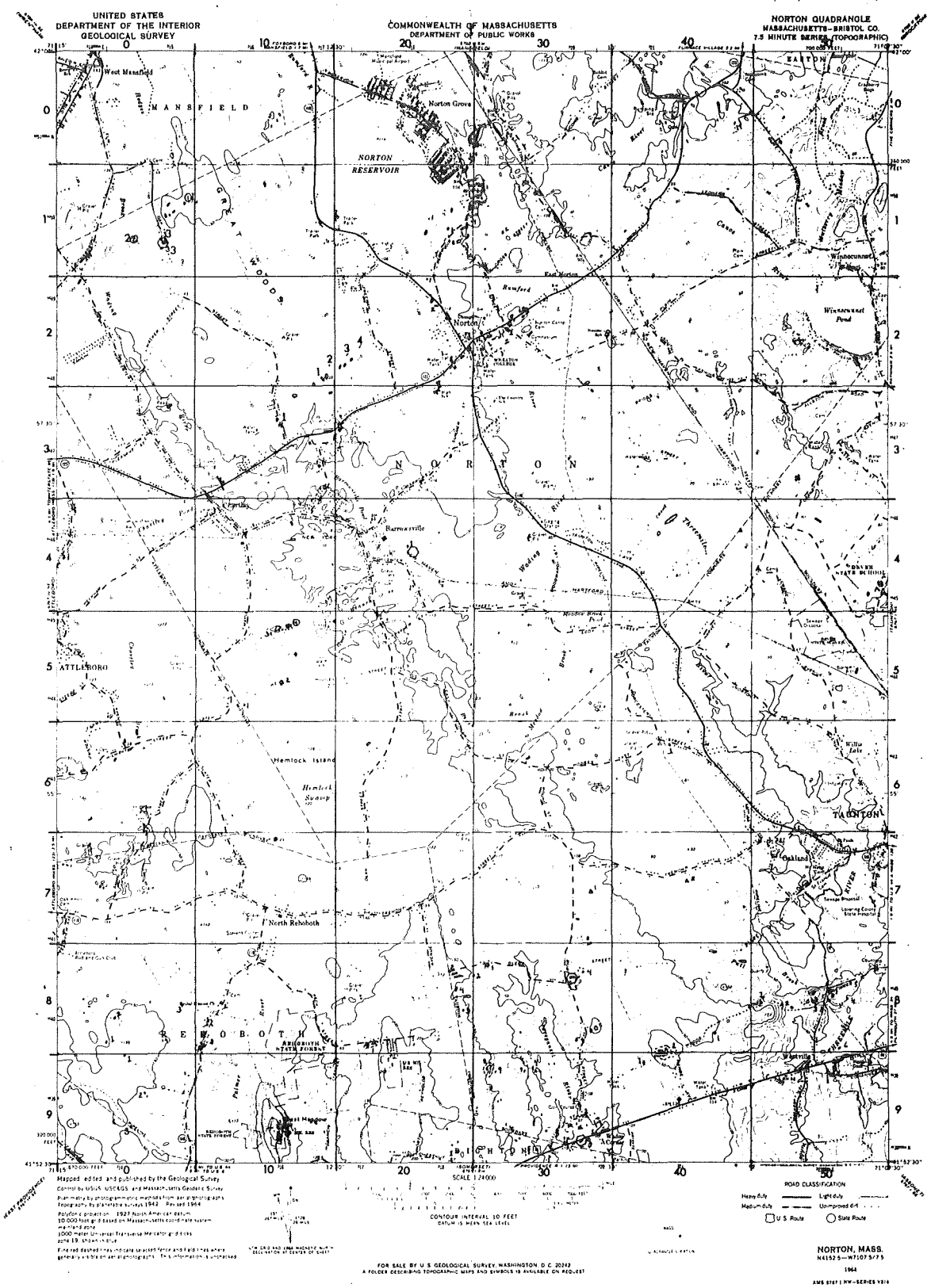
44?

NORTON QUAD.

STOP #	CITY	LITHOLOGY	DATA	X REF	LOCATION
N-39-6	TAUNTON	med to coarse gr. SS (some floating pebbles) and a few thin cong. lenses (clasts 2-3") - cong. outcrops also DIGHTON	N36E, 37N N15E, 34N N25E, 40N cleavage: N49E, 35S N6E, 44S	D.P. Ring '78	behind white house at loop N-39-4.
N-39-7	"	pebble to cobble cong. w/ clasts up to 10" (clast supported) - a med. gr. ss. bed.	N05E, 8W cleavage: N33E, 40S	D.P. Ring '79	0.2 mi SW of N-39-6
N-39-8	"	med to coarse gr ss w/ pebble cong. pebble to pebble cong. - 90% quartzite - 6" clasts	N50E, 12S	D.P. '78	0.3 mi W of cemetery at end of dirt road which leads W. off Burt St.
N-39-9	"	med. gr. ss. and pebble cong.	N15E,	D.P. '78	1000' E of N-39-8
N-39-10	"	pebble to cobble cong. w/ 6" quartzite clasts - matrix support	N36E,	D.P. '78	0.4 mi SW of cemetery described for N-39-
N-39-11	"	pebble to cobble cong.	—	D.P. '78	250' S of N-39-
N-28-5	REHOBOTH	pebble to cobble cong. w/ 10" clasts - pebble 95% quartzite. pebble + matrix support	—	D.P. '78	at E corner of sharp bend in powerline
N-28-6	"	"	—	D.P. '78	0.1 mi N of N-28-5
N-39-12	TAUNTON	pebble to cobble cong w/ 10" clasts - interbedded w/ med to coarse gr. SS (cong. is pebble and matrix supported	N-S, 45W N23E, 54N N32E, 45N	D.P. '78	just S. of Cullivers St., 0.1 mi W. of Burt St.
N-37-1	"	coal siting	—	Chase	0.4 mi SE of intersection of Tremont + Burt St.
N-47-1	"	"	—	Chase	0.1 mi S of Tremont St., 0.9 mi E of Burt St.

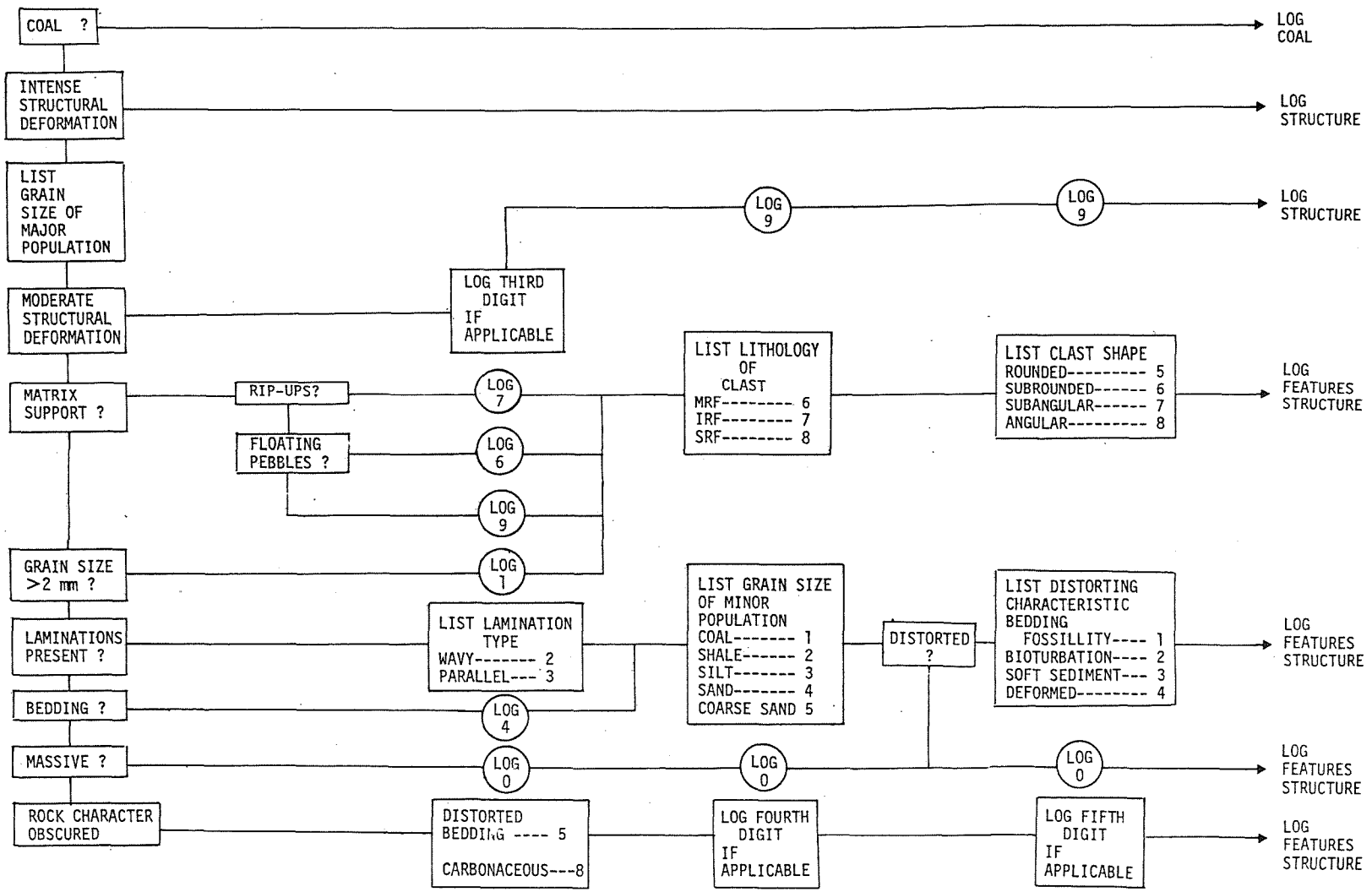
Norton

Outcrop #	City	Lithology	Data	XRef	Location
Nr58-7	Taunton	③Coarse SS ← Cong.	N65E, 40-50 NW	RgB'78	SE cor. of Fisher & N. Walker Sts.
		④Cong.	N73E, 35 S fault - N65E, 40-60 NW bedding N73, vert	"	200' S of ③
		Cong./SS	contact: N90E, 37 NW		base of cliff
58-4	"	Cong.	fault N05E, 77SE		on strike, to E.
58-5	"	Cong			quarry, opp. 85 Fisher St.
Nr58-8	"	SS - gray, massive, coarse	N78W, 26 SW joints: N02E, 84SE		Quarry, S. of Globe
		SS	N45E, ∠53 NW		Smaller quarry to south
Nr38-6	"	SS	cleavage N30E, 72NW		Globe St, .4 W of Burt St.



APPENDIX C 1:24000 MAP OF OUTCROP LOCATIONS IN THE NORTON 7 ½' QUADRANGLE

APPENDIX D FLOW-CHART FOR LOGGING NX DRILLCORE FROM THE NARRAGANSETT BASIN



APPENDIX E

THE DOT GRID: DESCRIPTION AND EXAMPLE OF USE

APPENDIX E

THE DOT GRID: DESCRIPTION AND EXAMPLE OF USE

The dot grid is a simple, cost-free graphic device for accurate approximation of irregular planar areas. Properly used, it should be accurate to within two or three percent. Basically, an area is measured by counting the number of squares of known area falling within it. Partial squares are counted by use of appropriately placed dots. The dot grids used in the LEES study used squares with four dots, placed as shown in Figure A1.

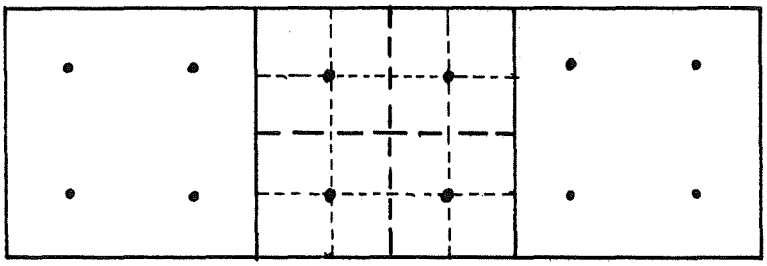


Figure A1 Three squares of the dot grid showing how proper dot location is determined. Each grid square is quartered to form four equal-area squares. The dot is placed in the centers of the smaller squares.

In using the dots to count partial squares, one must apply three rules:

1) Dots falling within the area are counted;

2) Dots falling outside the area are not counted; and

3) When dots fall on the perimeter of the area, only every other one is counted.

For best results the rules should be followed mechanically and rigidly, as shown in FigureA2.

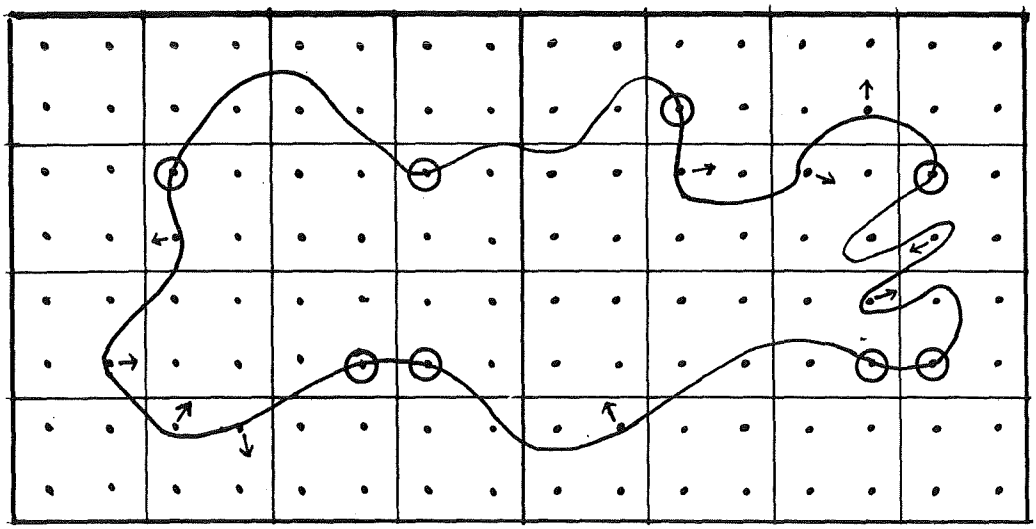


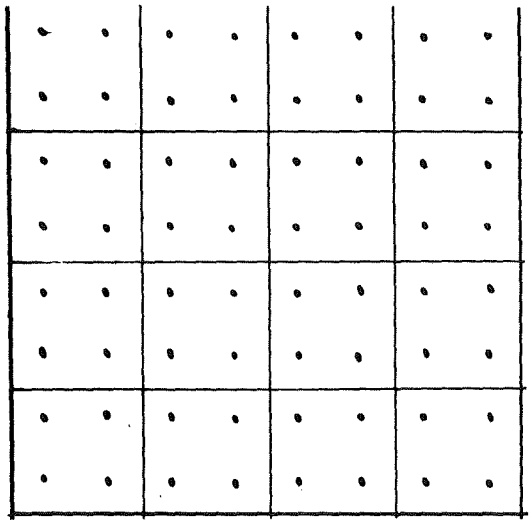
Figure A2 Counting of partial squares by use of the dots indicating how counting rules are applied. Arrows show whether dots are *within* or *outside* of area being measured. Circles indicate dots falling *on* the area perimeter.

The LEES study made use of two dot grids, one having a 40-acre grid square, and the second a 10-acre grid square. Note in Figures A3 and A4 how this makes for easy division of a square mile.

Once the squares are counted, reference is made to a simple table which yields the area equivalent to any number of squares in the desired units. If, for example, each grid square equals 10 acres and each dot therefore equals 2.5 acres, a count of 22 squares plus 3 dots equals 227.5 acres. Conversion tables for the LEES grids are shown in Figures A5 and A6. As the process of counting, combining, recording, and translating is easily confusing, the best procedure is to use a standard work sheet to prevent error. Examples of typical work sheets are shown in Figures A7, A8, and A9.

A hypothetical site is fully measured using the dot grids in Figures A10 to A15.

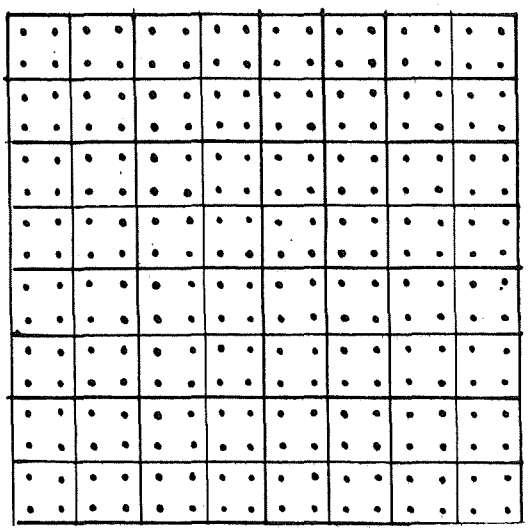
1 Square equals 0.06 square miles or 40 acres



1 Dot equals ~0.02 square miles or 10 acres

Figure A3 One square mile section of the 40 acre dot grid (actual size). One square mile contains 16 squares of 40 acres each.

1 Square equals 0.016 square miles or 10 acres



1 Dot equals 0.004 square miles or 2.5 acres

Figure A4 One square mile section of the 10 acre dot grid (actual size). One square mile contains 64 squares of 10 acres each.

No. of Squares	Square Miles	Acres
1	= 0.06	40
2	= 0.12	80
3	= 0.19	120
4	= 0.25	160
5	= 0.31	200
6	= 0.37	240
7	= 0.44	280
8	= 0.50	320
9	= 0.56	360
10	= 0.62	400
11	= 0.69	440
12	= 0.75	480
13	= 0.81	520
14	= 0.87	560
15	= 0.94	600
16	= 1.00	640

		Square Miles	Acres
1 DOT	=	0.016 or ~ 0.02	10
2 DOTS	=	0.031 or ~ 0.03	20
3 DOTS	=	0.047 or ~ 0.05	30

Squares	Square Miles
16	= 1
32	= 2
48	= 3
64	= 4
80	= 5
96	= 6
112	= 7
128	= 8
144	= 9
160	= 10
176	= 11

Acreage equals the number of squares times 40.

Figure A5 Conversion table for 40 acre dot grid.

1 DOT	= 0.004 Sq. Miles	= 2.5 Acres	Acreage equals
2 DOTS	= 0.008 Sq. Miles	= 5.0 Acres	number of squares
3 DOTS	= 0.012 Sq. Miles	= 7.5 Acres	times 10.

1 .016	9 .141	17 .266	25 .391	33 .516	41 .641	49 .766	57 .891
2 .031	10 .156	18 .281	26 .406	34 .531	42 .656	50 .781	58 .906
3 .047	11 .172	19 .297	27 .422	35 .547	43 .672	51 .797	59 .922
4 .062	12 .187	20 .312	28 .437	36 .562	44 .687	52 .812	60 .937
5 .078	13 .203	21 .328	29 .453	37 .578	45 .703	53 .828	61 .953
6 .093	14 .218	22 .343	30 .468	38 .593	46 .718	54 .843	62 .968
7 .109	15 .234	23 .359	31 .484	39 .609	47 .734	55 .859	63 .984
8 .125	16 .250	24 .375	32 .500	40 .625	48 .750	56 .875	64 1.000

Figure A6 Conversion table for 10 acre dot grid. Smaller figure is number of whole squares; figure in larger print is equivalent in square miles. For example 31 whole squares equals 0.484 square miles.

Figure A7 Work sheet for use with 40 acre dot grid.

Figure A8 Work sheet for use with 10 acre dot grid.

Figure A9 Short form work sheet for use with 10 acre dot grid.

16's Work Sheet (40 Acre Grid)

Figure A7

SITE:

ITEM MEASURED:

Whole 16's	TOTAL	Stray Dots	Whole 16's	DOTS
			4	

16's _____ 16-1, 32-2, 48-3, 64-4, 80-5, 96-6, 112-7

16's + _____

TOTAL 16's _____

Whole Miles _____ = .00 SQ MI

Rem 16's _____ = 0. SQ MI

TOTAL . SQ MI

PLUS ____ DOTS = 0.0 SQ MI

. SQ MI

SITE:

ITEM MEASURED:

Whole 16's	TOTAL	Stray Dots	Whole 16's	DOTS
			4	

16's _____ 16-1, 32-2, 48-3, 64-4, 80-5, 96-6, 112-7

16's + _____

TOTAL 16's _____

Whole Miles _____ = .00 SQ MI

Rem 16's _____ = 0. SQ MI

TOTAL . SQ MI

PLUS ____ DOTS = 0.0 SQ MI

. SQ MI

SITE:

ITEM MEASURED:

Whole 16's	TOTAL	Stray Dots	Whole 16's	DOTS
			4	

16's _____ 16-1, 32-2, 48-3, 64-4, 80-5, 96-6, 112-7

16's + _____

TOTAL 16's _____

Whole Miles _____ = .00 SQ MI

Rem 16's _____ = 0. SQ MI

TOTAL . SQ MI

PLUS ____ DOTS = 0.0 SQ MI

. SQ MI

64's WORK SHEET (10 Acre Grid)

Figure: A8

SITE: ITEM MEASURED:

Whole 64's	TOTAL	Stray Dots	Whole 64's	DOTS
			4	

64's _____
64's + _____
TOTAL 64's _____
Whole Miles _____ = .000 Sq Mi
Rem. 64's _____ = 0. Sq Mi
TOTAL . Sq Mi
PLUS ____ DOTS = 0.0 Sq Mi
. Sq Mi

SITE: ITEM MEASURED:

Whole 64's	TOTAL	Stray Dots	Whole 64's	DOTS
			4	

64's _____
64's + _____
TOTAL 64's _____
Whole Miles _____ = .000 Sq Mi
Rem. 64's _____ = 0. Sq Mi
TOTAL . Sq Mi
PLUS ____ DOTS = 0.0 Sq Mi
. Sq Mi

SITE: ITEM MEASURED:

Whole 64's	TOTAL	Stray Dots	Whole 64's	DOTS
			4	

64's _____
64's + _____
TOTAL 64's _____
Whole Miles _____ = .000 Sq Mi
Rem. 64's _____ = 0. Sq Mi
TOTAL . Sq Mi
PLUS ____ DOTS = 0.0 Sq Mi
. Sq Mi

64's Scratch Sheet (10 Acre Grid)

Figure A9

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

SITE: _____ ITEM MEASURED: _____

_____ Whole 64's plus _____ Dots

4 | _____ Number of Dots counted

Whole 64's = . SQ MI _____ ACRES

Dots = 0.0 SQ MI . ACRES

TOTAL . SQ MI . ACRES

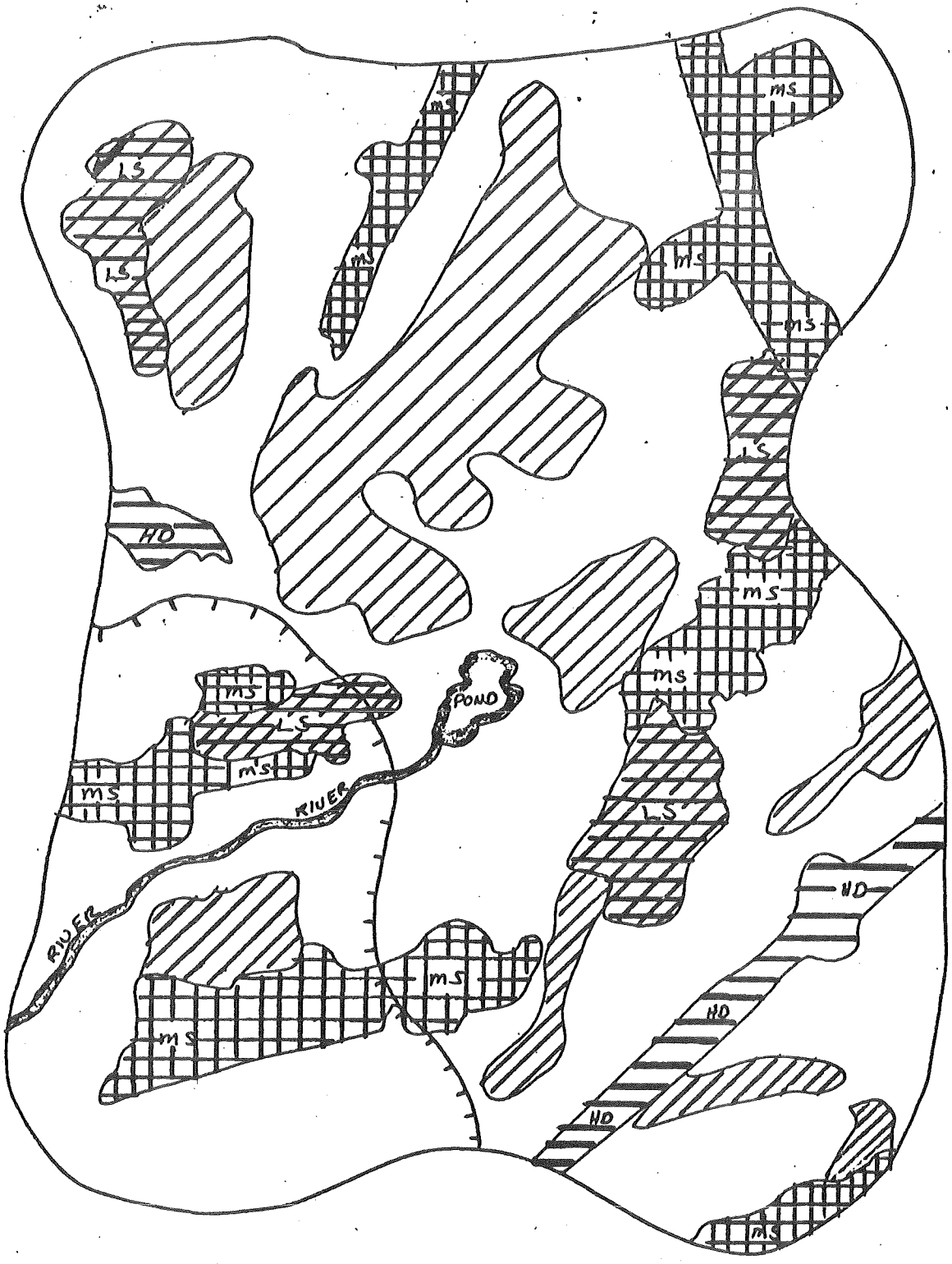


Figure A10 Hypothetical development site. Three developed lands categories are shown: HD - Highly developed; ms - Moderately settled; and LS - Lightly settled. Slanted-line pattern indicates wetlands and the solid line with ties (⊤⊤⊤) delineates a well protection area.

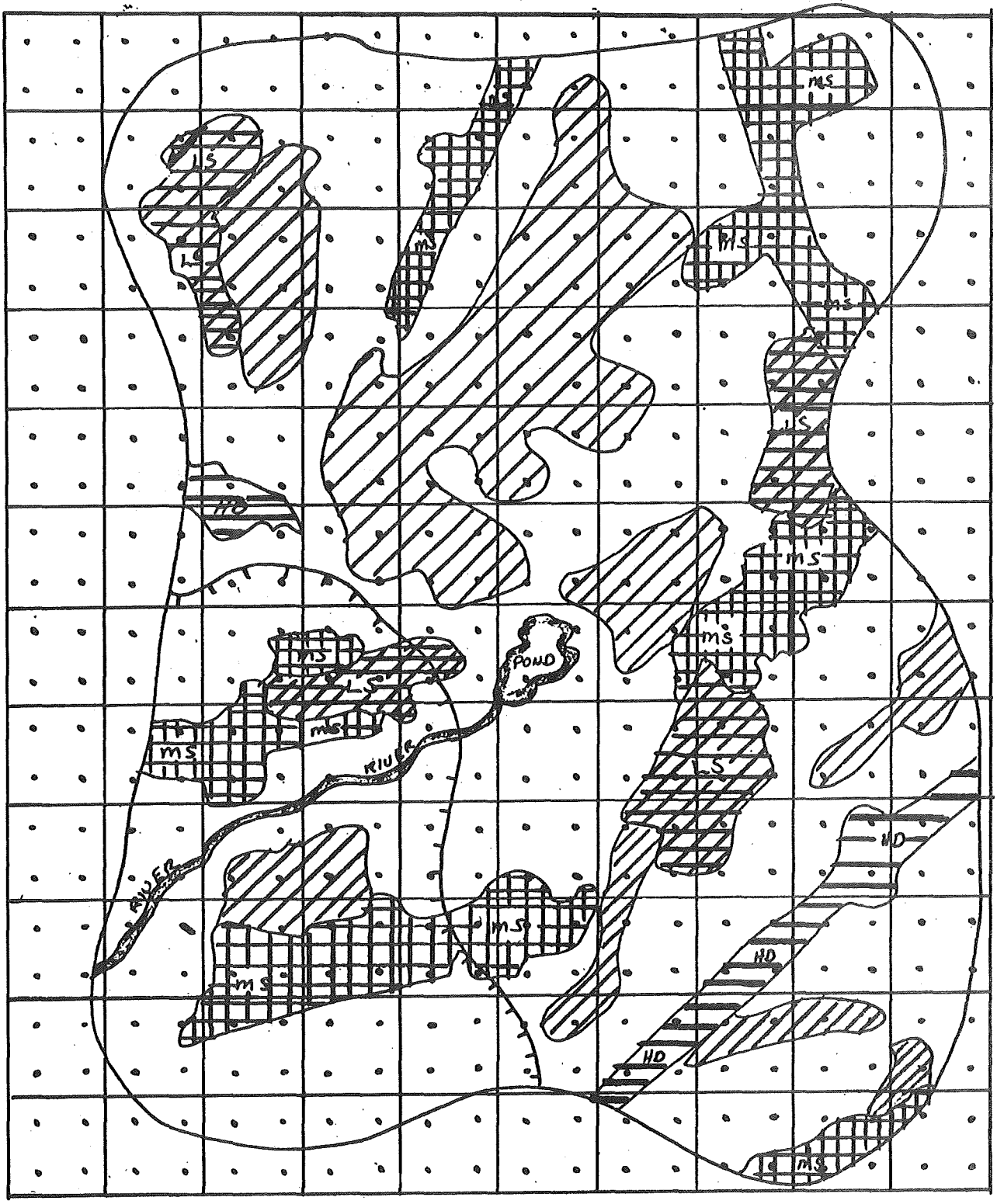


Figure A 11 Forty acre dot grid in place to measure total site area and total well protection area.

16's Work Sheet (40 Acre Grid)

Site: Hypothetical Site **Item Measured:** AREA

Whole 16's	TOTAL 77	Stray Dots	51	Whole 16's 4	12 / 51	Dots 3

16-1, 32-2, 48-3, 64-4, 80-5, 96-6, 112-7

16's 77
16's + 12
TOTAL 16's 89
Whole Miles − 80 = 5.00 sq mi
Rem. 16's 9 = 0.56 sq mi
TOTAL 3.56 sq mi
PLUS 3 DOTS = 0.05 sq mi

5.61 sq mi

Site: Hypothetical Site **Item Measured:** WATER PROTECTION

Whole 16's	TOTAL 14	Stray Dots	21	Whole 16's 4	5 / 21	Dots 1

16-1, 32-2, 48-3, 64-4, 80-5, 96-6, 112-7

16's 14
16's + 5
TOTAL 16's 19
Whole Miles − 16 = 1.00 sq mi
Rem. 16's 3 = 0.19 sq mi
TOTAL 1.19 sq mi
PLUS 1 DOTS = 0.02 sq mi

1.21 sq mi

Figure A12 Work sheet recording measurement of site area and well protection area.

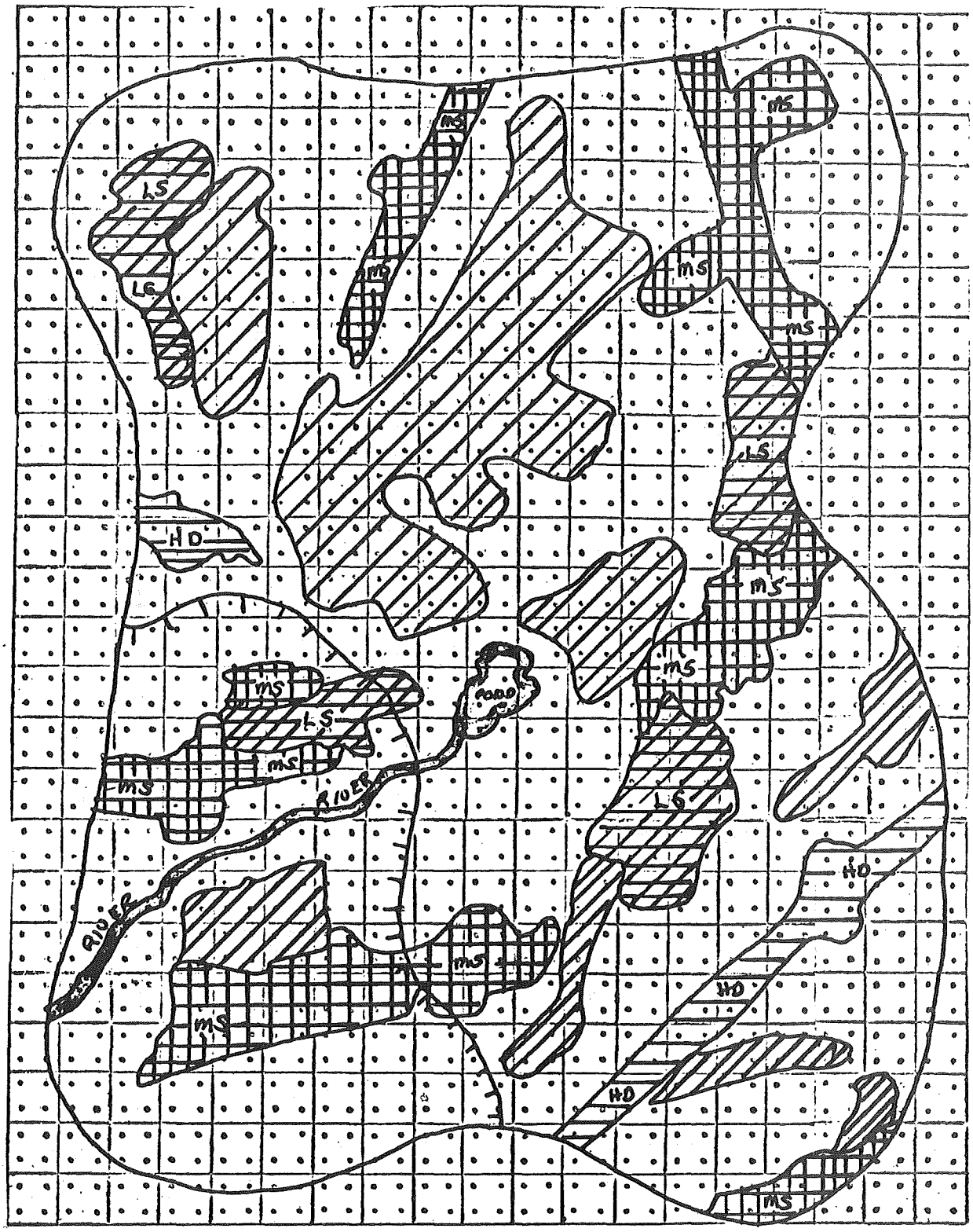


Figure A13 Ten acre dot grid in place to measure developed lands and wetlands.

64's Scratch Sheet (10 Acre Grid)

SITE: Hypothetical Site ITEM MEASURED: HO

10 Whole 64's plus 3 Dots Whole 64's = 0.156 sq mi 100 ACRES

4 | 43 Number of Dots counted Dots = 0.012 sq mi 7.5 ACRES

TOTAL 0.168 sq mi 17.5 ACRES

SITE: Hypothetical Site ITEM MEASURED: HIS

46 Whole 64's plus 2 Dots Whole 64's = 0.718 sq mi 460 ACRES

4 | 186 Number of Dots counted Dots = 0.008 sq mi 5.0 ACRES

TOTAL 0.726 sq mi 465.0 ACRES

SITE: Hypothetical Site ITEM MEASURED: LS

22 Whole 64's plus 2 Dots Whole 64's = .343 sq mi 220 ACRES

4 | 90 Number of Dots counted Dots = 0.008 sq mi 5.0 ACRES

TOTAL 0.351 sq mi 225.0 ACRES

SITE: Hypothetical Site ITEM MEASURED: Wetland

59 Whole 64's plus 2 Dots Whole 64's = 0.922 sq mi 590 ACRES

4 | 238 Number of Dots counted Dots = 0.008 sq mi 5.0 ACRES

TOTAL 0.930 sq mi 595.0 ACRES

SITE: Hypothetical Site ITEM MEASURED: Open Water

4 Whole 64's plus 0 Dots Whole 64's = 0.062 sq mi 40 ACRES

4 | 16 Number of Dots counted Dots = 0.000 sq mi 0.0 ACRES

TOTAL 0.062 sq mi 40.0 ACRES

Figure A 14 Short form work sheet recording measurement of developed lands and wetlands.

Site Name: Hypothetical site

AREA 5.61 square miles

	Square Miles	Acres	% Total Area
HD - Highly Developed	0.168	17.5	3.0
MS - Moderately Settled	0.726	465.0	12.9
LS - Lightly Settled	0.351	225.0	6.3
TOTAL	1.245	707.5	22.2
Wetlands	0.930	595.0	16.6
Open Water	0.062	40.0	1.1
TOTAL	0.992	635.0	17.7
Well Protection Area	1.21	780	21.6

Figure A15 Tabular summary of data for hypothetical site.

APPENDIX F

LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIAL STUDY MAPS

MAP LEGEND

APPENDIX F

LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIAL STUDY MAPS

MAP LEGEND

BASIN BORDER

Basin Edge - precise or inferred contact is on the BASINWARD side of the line.

Basin Edge? - subaqueous extension of contact wall.

POLITICAL BOUNDARIES

Township Boundary

Rhode Island/Massachusetts State Line

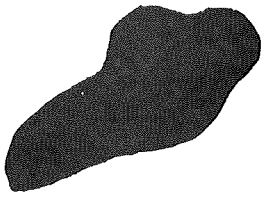
DEVELOPED LANDS

Highly Developed (HD) - industrial facilities; airports; port facilities; railyards; truck terminals; storage facilities; public installations such as waterworks, sewage treatment plans, disposal sites, etc.; limited access highways; downtown commercial areas; shopping centers; commercial strips along highways; public institutional land supporting major facilities such as hospitals, churches, colleges, prisons, etc.; recreational facilities involving large capital investment such as racetracks, outdoor theaters, stadiums, fairgrounds, etc.; cemeteries; nurseries with greenhouses; apartment buildings; and all residential land with lot sizes less than 1/2 acre.

Note: The horizontal pattern is used in preference to solid color for ease in mapping

extensive urban areas; the two symbols are equivalent in meaning.
(Pencil Color: Eagle 945)

Moderately Settled (MS) - residential areas with lot sizes in the range of 1/2 to 1 acre; includes clusters of 3 to 10 houses in rural areas.
(Pencil Color: Eagle 921)

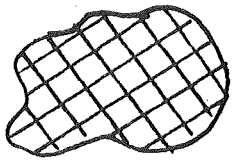


Lightly Settled (LS) - residential areas with lot sizes in the range of 1 to 3 acres.
(Pencil Color: Eagle 942)

Proposed Limited Access Highway

Proposed Secondary Road

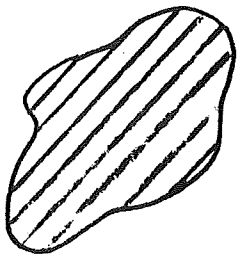
SURFACE MINING



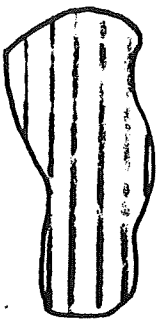
Quarry - primarily sand and gravel extraction, also includes extraction of clay, slate, and fill

Quarry - Abandoned Workings? - no recent extraction, typically overgrown with grass and shrubs

WETLANDS



Inland Wetland



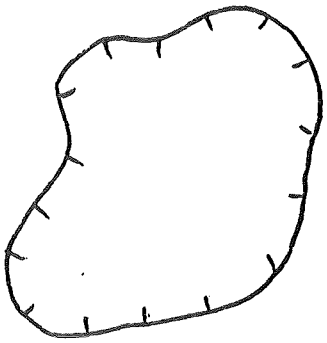
Coastal Wetland

ADDITIONAL SYMBOLS PERTAINING TO RHODE ISLAND WETLANDS

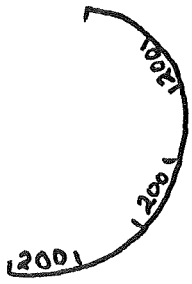
S1 174	Wetland type and town number - Upper symbol refers to wetlands type (see below); lower number is township identification - each township begins numbering at one.
SMA	Indicates a coastal wetland identified only in the Atlas of Rhode Island Salt Marshes - not shown on township wetlands maps.
S1	Organic Swamps
S2	Mineral Swamps
M	Marsh
B	Bog
F	F is used as a prefix on wetlands in floodplain areas.

⊖	Bog of less than one acre
T1	Coastal Tidal Marshes
T2	Estuarine Marshes
⊕	Salt Marsh of less than one acre

GROUND WATER RESOURCES AND WELL PROTECTION AREAS

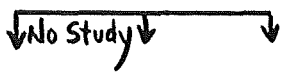


Areas of significant to essential ground water resources with high susceptibility to contamination from surface seepage. Wells located immediately within the perimeter will generally yield less than 300 gpm whereas wells more centrally located will yield 300 gpm or more. Potential well output in Rhode Island is not included.

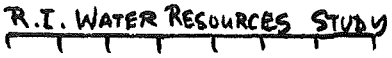


As above, except that wells near the perimeter will generally yield less than 200 gpm. Centrally located wells will yield 300 gpm or more.

As above, except that all wells within the area will generally yield 100 gpm or more.



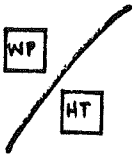
Indicates the limit of Rhode Island Water Resources Board Study Area



Used in Massachusetts only to indicate data derived from Rhode Island Water Resources Board ground water study.

Municipal - Industrial Supply Well with output in millions of gallons per day listed if available; output for closely spaced wells listed as a total.

Proposed Municipal Supply Well - used only in Old Colony Planning Council area.



Well Protection Areas with active wells (WP) or proposed wells (HT) - used only in Old Colony Planning Council area; WP = well protection area; HT = area of high transmissivity to be protected for future use; single, unbroken line indicates boundary between WP and HT areas.

SITE OVERLAYS - LEGEND

NORTON

Site Name - normal development site

ATTLEBORO

Site Name - auxiliary development site

TAUNTON

Site Name - wetland development site

Site Rating

Site Boundary

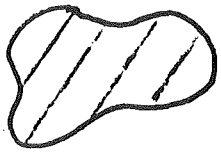
Boundary between normal and auxiliary site

Intersection of Grid Lines

TN 06

Grid Cell Identifier

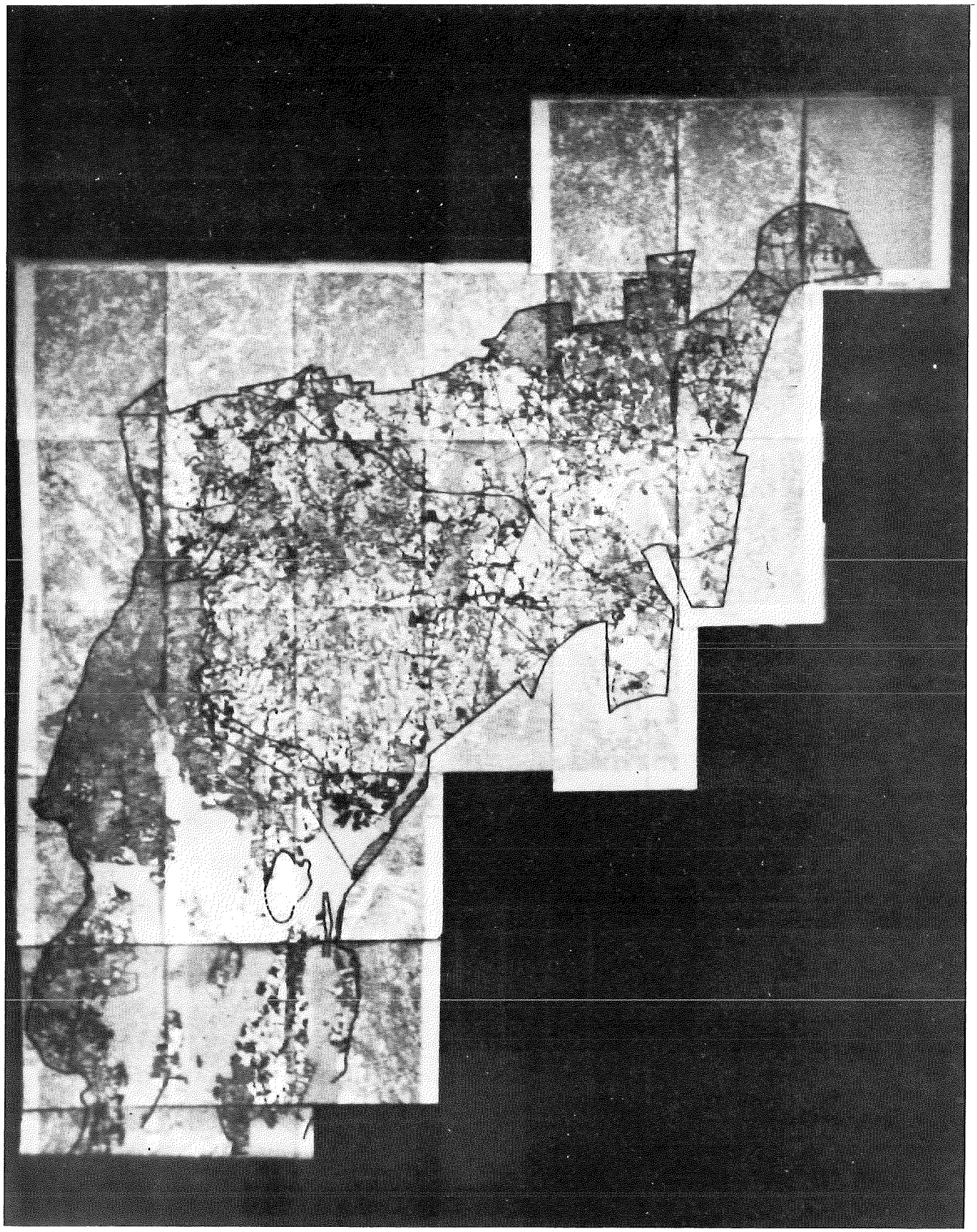
Normal Development Site



Wetland Development Site (Eagle 910)

APPENDIX G

7 1/2 MINUTE QUADRANGLE MAPS



APPENDIX H

COMPUTER PROGRAMS

NBPROG TO CREATE MAPS

FYPRT TO PRINT OUT FILES

```
LIST
NBPROG  01:44 PM        20-Jan-79
100 RESTORE\ON ERROR GOTO 190
105 INPUT"DO YOU WISH TO ANALYZE A SINGLE GEOLOGICAL FACTOR";Q$\PRINT
110 INPUT"ADVANCE TO MIDDLE OF NEXT PERFORATION AND PRESS 'RETURN.' (DO NOT USE 'LINE FEED' KEY.)";F\GOTO 240
120 DIMM(70,48),C(10),V(10),G(8),W(8),A$(12)\M(A,B)=9999FORA=1 TO 70FORB=1 TO 48
130 B$="NB.BAS"\A$(1)=MID(NUM$(I),2,1-(I<9))+B$FORI=1TO12
140 FOR Z=1 TO 12\OPEN A$(Z) AS FILE Z
150 INPUT #Z,Y,X,A2,C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10)
160 IF Y=999 THEN 200
170 INPUT #Z,G(1),G(2),G(3),G(4),G(5),G(6),G(7),G(8)
180 GOTO 210
190 PRINT"MISTAKE IN FILE";Z\PRINT Y;X;A2\PRINTC(I);FORI=1TO10\STOP
200 NEXT Z\GOTO 400
210 G(4)=-G(4)\IFQ$="YES"THEN230ELSEIFG(1)=1ORG(2)=1THENG(4)=0\G(5)=0\G(8)=.5
220 IF G(3)=1 THEN G(1)=0 FOR I=4 TO 5 ELSE G(6)=-.5 IF G(5)=-.9
230 C=0\S=0\C=C+C(I)*V(1)/--A2FORI=1TO10\G=G+G(I)*W(I)FORI=1TO8\M(X+1,Y+1)=INT(C+G+.5)\GOTO150
240 PRINTTAB(36)"***NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP***"\PRINT\PRINT
250 PRINTTAB(7)"ORIGINATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, BOSTON COLLEGE, "
251 PRINT"MANAGING DIRECTOR, NELEP"
260 PRINTTAB(10)"ADAPTED TO PDP-11 & EDITED BY S. WINN DAVIS, BOSTON COLLEGE; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH."
270 PRINT\PRINT\RESTORE
280 PRINTTAB(17)"THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY"
290 PRINTTAB(17)"SQUARE MILE WITHIN THE BASIN.  EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL"
300 PRINTTAB(21)"PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS PLACED ON THE FOLLOWING FACTORS."\PRINT\PRINT
310 PRINT TAB(46)"INPUT APPROPRIATE WEIGHTS:"\PRINT\PRINT
315 PRINT"LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIETAL WEIGHTS:"
316 PRINT
320 PRINT"INLAND AND COASTAL WETLANDS IMPACT";TAB(90);\INPUT V(1),V(2)
330 PRINT "HIGH, MEDIUM, AND LOW DENSITY POPULATION";TAB(90);\INPUT V(3),V(4),V(5)
340 PRINT"FRESH AND OCEAN WATER BODY IMPACT";TAB(90);\INPUT V(6),V(10)
350 PRINT"GROUND WATER RESERVE AND TOWN WELL IN ACT";TAB(90);\INPUT V(8),V(9)
360PRINT"SURFACE MINING IMPACT";TAB(90);\INPUTV(7)
362 PRINT\PRINT\PRINT\PRINT"GEOLOGICAL WEIGHTS:"
365 PRINT
370PRINT"SEISMOLOGY LOCAL MINING ACTIVITY";TAB(90);\INPUTW(1)
375 PRINT"DRILLING ACTIVITY AND FIELD RESEARCH IMPACT";TAB(90);\INPUT W(2),W(3)
380 PRINT"NORTHERN APPALACHIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY";TAB(90);\INPUT W(4),W(5),W(6)
390 PRINT"DEPTH AND ITS IMPACT";TAB(90);\INPUTW(7),W(8)\GOTO 120
403PRINTFORI=1TO10\PRINT"AB";16;"000";TAB(28);"060 ";\PRINT"       ",60*I;FORI=2TO8
413 PRINT CHR$(13);TAB(17);\PRINT"_";FOR I=1TO97
420 FOR X=1 TO 70\PRINT\PRINTTAB(17);"|";
430 FORY=1TO48\IF M(X,Y)=999 THEN PRINT " ";\GOTO 490
440 IF M(X,Y)>0 THEN PRINT"*";\GOTO 490
450 IF M(X,Y)<0 THEN PRINT"#";\GOTO 490
460 IF M(X,Y)=0 THEN PRINT CHR$(48+M(X,Y));\PRINT CHR$(8);CHR$(46+M(X,Y));FORI=1TO3\GOTO 490
470 IF M(X,Y)=-1 THEN PRINT CHR$(63-M(X,Y));\GOTO 490
480 IF M(X,Y)<0 THEN PRINT "=";ELSE PRINT"-";
485 IF G*6=INT(Y/6) THEN PRINT"|";\CLOSE\PRINT "
500 NEXT\PRINTCHR$(13);\IFX/10<>INT(X/10)THENS10ELSEPRINTTAB(12);10*X;\PRINT"_";FORI=1TO97\PRINT10*X;
510 NEXT\PRINT\PRINTTAB(16);"000";TAB(28);"060 ";\PRINT"       ";60*I;FORI=2TO8\PRINTFORI=1TO4
520 PRINTTAB(64);"EXPLANATION OF SYMBOLS"\PRINT"=";FORI=1TO132\PRINT
530 PRINTTAB(15);"#";CHR$(13);TAB(15);"A    ";\PRINTCHR$(73-I);"    ";FORI=1TO8\PRINT"-    =    ";
540 \PRINTCHR$(I);"    ";FORI=49TO57\PRINT"$"\CLOSE#IFORI=1TO12\PRINTTAB(8);"\";
550 READ I\ON ERROR GOTO 560\PRINT TAB(I);".";\GOTO 550
560 PRINT TAB(62);"/";CHR$(13);TAB(9);
570 PRINT"_____  ";FORI=1TO3\PRINT"_______  ___  _______  ";\PRINT"_____  ";FORI=1TO3
580 PRINT\PRINTTAB(54);"SLIGHTLY   ?   SLIGHTLY"
590 PRINTTAB(11);"WORST CASE     VERY BAD          BAD          BAD          GOOD         GOOD         VERY GOOD";
        "          BEST CASE"\PRINT FOR I=1 TO 45\DATA 22,37,52,62,67,77,92,107


Ready
```

```
LIST
FYPRT    04:27 PM          20-Jan-79
5DIMA$(12)
10B$="NB,BAS"\A$(I)=MID(NUM$(I),2,1-(I>9))+B$FORI=1 TO 12
20 FOR Z=1 TO 12
25PRINT\PRINT\PRINT
27PRINT"                              NARRAGANNSETT BASIN FILE"Z
28PRINT\PRINT\PRINT
30OPEN A$(Z)AS FILE Z
40INPUT #Z,Y,X,A2,C(1),C(2),C(3),C(4),C(5),C(6),C(7),C(8),C(9),C(10)
45IFY=999THENPRINTY
46 IF Y = 999 THEN 100
48PRINT"COORDINATES:     X ="Y;"    Y ="X;"          GRID AREA:    "A2;"UNITS"
50PRINT"LEES:   ";
51FORI=1TO10\PRINTTAB(5*I+10);C(I);\NEXTI
56PRINT\PRINT"GEOLOGICAL:    ";
57INPUT #Z,G(1),G(2),G(3),G(4),G(5),G(6),G(7),G(8)
58FORI=1TO8\PRINTTAB(5*I+10);G(I);\NEXTI
60 PRINT\PRINT
62 P=P+1\IF(P/13)-(INT(P/13))=0 THEN PRINT FOR I=1 TO 14
70GOTO40
100 NEXTZ
110END

Ready
```

APPENDIX I

FILE LOCATOR MAP

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

ORIGINATED FOR THE BUREAU OF MINES, CONT. #J0180022, 1978, BY T. H. RIDER, BOSTON COLLEGE, MANAGING DIRECTOR, NECEP; ADAPTED TO PDP-11 & EDITED BY E. WINN DAVIS, BOSTON COLLEGE; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS PLACED ON THE FOLLOWING FACTORS.

INPUT APPROPRIATE WEIGHTS:

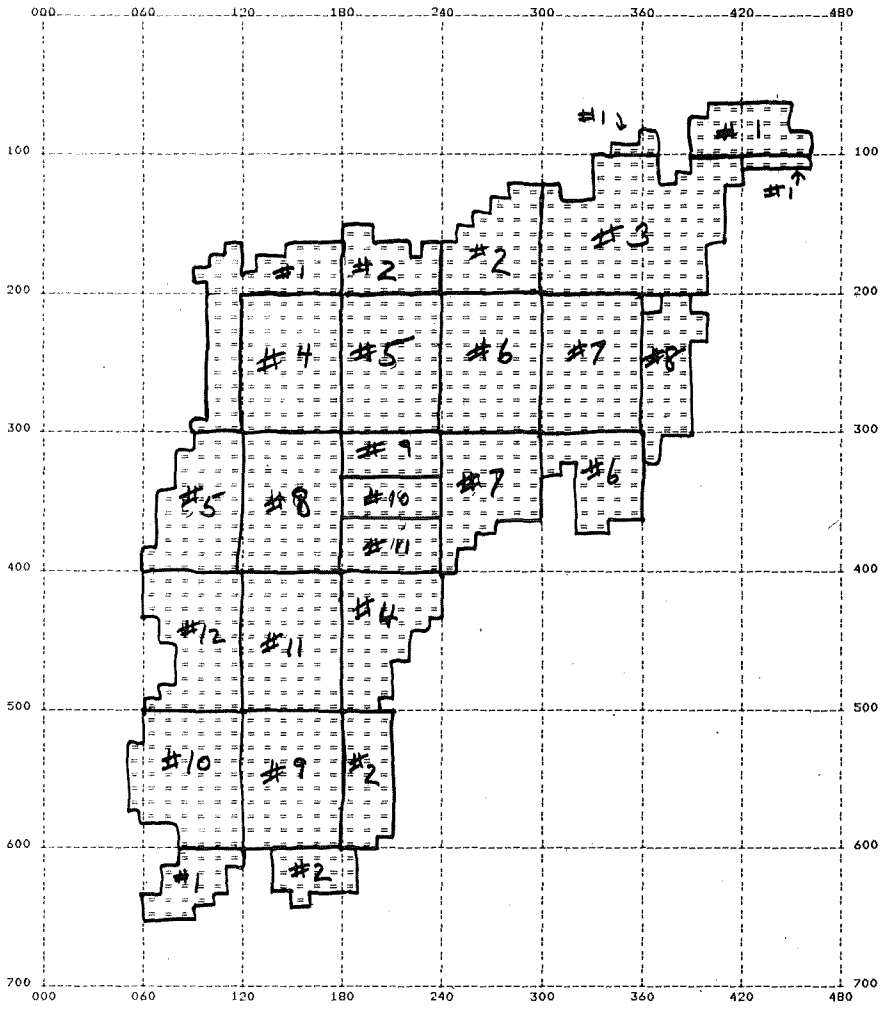
LEGAL, ECONOMIC, ENVIRONMENTAL AND SOCIETAL WEIGHTS:

INLAND AND COASTAL WETLANDS IMPACT	? 0,0
HIGH, MEDIUM AND LOW DENSITY POPULATION	? 0,0,0
FRESH AND OCEAN WATER BODY IMPACT	? 0,0
GROUND WATER RESERVE AND TOWN WELL IMPACT	? 0,0
SURFACE MINING IMPACT	? 0

GEOLOGICAL WEIGHTS:

PREVIOUS COAL MINING ACTIVITY	? 0
DRILLING ACTIVITY AND FIELD RESEARCH	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSES AND STRUCTURAL COMPLEXITY	? 0,0,0
DEPTH AND DIP IMPACT	? 0,0

DATA FILE LOCATOR



EXPLANATION OF SYMBOLS

*	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
								SLIGHTLY	?	SLIGHTLY										
WORST CASE		VERY BAD			BAD			BAD		GOOD		GOOD			VERY GOOD			BEST CASE		

APPENDIX J

INPUT DATA

BY SQUARE MILE

COORDINATE

NARRAGANNSETT BASIN FILE 1

COORDINATES:	X = 34		Y = 9			GRID AREA:			129 UNITS	
LEES:	56	0	36	0	0	0	5	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 9			GRID AREA:			387 UNITS	
LEES:	118	0	63	0	0	0	3	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 40		Y = 6			GRID AREA:			50 UNITS	
LEES:	16	0	3	5	9	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 41		Y = 6			GRID AREA:			111 UNITS	
LEES:	38	8	3	60	15	5	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 39		Y = 7			GRID AREA:			10 UNITS	
LEES:	0	0	0	5	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 40		Y = 7			GRID AREA:			346 UNITS	
LEES:	45	0	4	61	4	10	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 41		Y = 7			GRID AREA:			400 UNITS	
LEES:	138	1	8	33	14	9	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 8			GRID AREA:			29 UNITS	
LEES:	5	0	0	3	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 39		Y = 8			GRID AREA:			55 UNITS	
LEES:	0	0	0	19	10	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 40		Y = 8			GRID AREA:			400 UNITS	
LEES:	72	0	0	33	18	10	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 41		Y = 8			GRID AREA:			400 UNITS	
LEES:	18	0	7	49	34	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 9			GRID AREA:			253 UNITS	
LEES:	84	0	36	22	2	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 39		Y = 9			GRID AREA:			98 UNITS	
LEES:	0	0	0	0	26	6	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 40		Y = 9			GRID AREA:		400 UNITS	
LEES:	126	0	0	0	21	16	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 41		Y = 9			GRID AREA:		400 UNITS	
LEES:	0	0	0	16	45	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 11		Y = 16			GRID AREA:		42 UNITS	
LEES:	2	0	5	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	-.2		
COORDINATES:	X = 10		Y = 17			GRID AREA:		91 UNITS	
LEES:	0	0	2	2	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.1		
COORDINATES:	X = 11		Y = 17			GRID AREA:		345 UNITS	
LEES:	131	0	44	2	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.2		
COORDINATES:	X = 10		Y = 18			GRID AREA:		380 UNITS	
LEES:	2	0	2	0	13	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	0		
COORDINATES:	X = 11		Y = 18			GRID AREA:		400 UNITS	
LEES:	95	0	2	0	4	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.1		
COORDINATES:	X = 9		Y = 18			GRID AREA:		12 UNITS	
LEES:	0	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.2		
COORDINATES:	X = 10		Y = 19			GRID AREA:		398 UNITS	
LEES:	0	0	15	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.1		
COORDINATES:	X = 11		Y = 19			GRID AREA:		400 UNITS	
LEES:	27	0	0	0	9	7	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	-.5	0	.1		
COORDINATES:	X = 10		Y = 20			GRID AREA:		354 UNITS	
LEES:	0	0	13	16	0	122	0	49	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 11		Y = 20			GRID AREA:		400 UNITS	
LEES:	40	0	0	6	5	15	0	12	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 10		Y = 21			GRID AREA:		328 UNITS	
LEES:	5	0	34	40	41	63	0	154	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 11		Y = 21			GRID AREA:		400	UNITS		
LEES:	15	0	6	65	0	86	0	346	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 22			GRID AREA:		345	UNITS		
LEES:	13	0	46	32	45	0	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 22			GRID AREA:		345	UNITS		
LEES:	13	0	46	32	45	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 23			GRID AREA:		137	UNITS		
LEES:	4	0	95	0	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 23			GRID AREA:		400	UNITS		
LEES:	35	0	46	37	0	0	48	257	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 24			GRID AREA:		93	UNITS		
LEES:	2	0	76	0	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 24			GRID AREA:		400	UNITS		
LEES:	4	0	46	20	3	0	4	146	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 25			GRID AREA:		57	UNITS		
LEES:	6	0	38	1	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 25			GRID AREA:		400	UNITS		
LEES:	29	0	89	10	0	2	71	89	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 26			GRID AREA:		64	UNITS		
LEES:	7	0	59	0	0	0	[illegible]	16	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 26			GRID AREA:		400	UNITS		
LEES:	9	0	212	6	0	9	0	152	0	0	
GEOLOGICAL:	1	0	1	0	0	0	.1	0			
COORDINATES:	X = 10		Y = 27			GRID AREA:		229	UNITS		
LEES:	35	0	126	0	0	29	0	229	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 11		Y = 27			GRID AREA:		400	UNITS		
LEES:	2	0	266	0	0	25	37	42		0	
GEOLOGICAL:	0	0	0	0	0	0		0			

COORDINATES:	X = 10		Y = 28			GRID AREA:		292 UNITS		
LEES:	42	0	201	0	0	49	0	292	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 11		Y = 28			GRID AREA:		40[illegible] UNITS		
LEES:	0	0	363	0	0	27		332	0	0
GEOLOGICAL:	1	0	1	0	0	0	.1	0		
COORDINATES:	X = 9		Y = 29			GRID AREA:		36 UNITS		
LEES:	[illegible]	0	34	0	0	0	0	36	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 10		Y = 29			GRID AREA:		378 UNITS		
LEES:	13	0	332	0	0	0	0	378	0	0
GEOLOGICAL:	0	0		1	0	0	0	0		
COORDINATES:		11	Y = 29			GRID AREA:		400 UNITS		
LEES:	0	0	393	0	0	7	0	269		0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 42		Y = 6			GRID AREA:		308 UNITS		
LEES:	7	204	0	40	0	0	0	0	0	30
GEOLOGICAL:	0	0	0	0	0		0	0		
COORDINATES:	X = 43		Y = 6			GRID AREA		210 UNITS		
LEES:	0	52	0	0	0	0	0	0		152
[illegible]OGICAL:	0	0	0	0	0	0	0	0		
COORD[illegible]TES:	X = 44		Y = 6			GRID AREA:		25 UNITS		
LEES:		0	0	0	0	0	0	0	0	25
GEOLOGICAL:	0	0		0	0	0	0	0		
COORDINATES:	X = 42		Y = 7			GRID AREA:		400 UNITS		
LEES:	0	27	23	37	30		0	0	0	37
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 43		Y = 7			GRID AREA:		[illegible] UNITS		
LEES:	0	273	7	12	0	0	0	0	0	[illegible]
GEO[illegible]AL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 44		Y = 7			GRID AREA:		250 UNITS		
LEES:	0	27	40	0	0	0	0	0	0	185
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 42		Y = 8			[illegible]D AREA:		400 UNITS		
LEES:	0	0	25	111	45	1	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 43		Y = 8			GRID AREA:		400 UNIT[illegible]		
LE[illegible]:	0	136	65	26	4	0	0	0	0	1
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 41		Y = 8			GRID AREA:			260 UNITS	
LEES:	0	84	95	0	6	0	0	0	0	63
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 42		Y = 9			GRID AREA:			400 UNITS	
LEES:	0	0	16	53	11	1	3	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 43		Y = 9			GRID AREA:			400 UNITS	
LEES:	0	0	85	6	7	2	6	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 44		Y = 9			GRID AREA:			400 UNITS	
LEES:	0	50	166	2	4	0	0	0	0	15
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 45		Y = 9			GRID AREA:			70 UNITS	
LEES:	0	11	31	0	0	0	0	0	0	7
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 42		Y = 10			GRID AREA:			260 UNITS	
LEES:	0	0	4	35	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 43		Y = 10			GRID AREA:			200 UNITS	
LEES:	5	0	11	4	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 44		Y = 10			GRID AREA:			141 UNITS	
LEES:	0	14	10	16	10	0	5	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 45		Y = 10			GRID AREA:			69 UNITS	
LEES:	0	12	0	0	0	0	0	0	0	25
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 45		Y = 8			GRID AREA:			25 UNITS	
LEES:	0	0	0	0	0	0	0	0	0	25
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 16			GRID AREA:			23 UNITS	
LEES:	2	0	0	0	0	0	17	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 16		Y = 16			GRID AREA:			121 UNITS	
LEES:	7	0	3	14	0	0	7	30	2	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 17		Y = 16			GRID AREA:			235 UNITS	
LEES:	16	0	6	26	1	0	8	0	0	0
GEOLOGICAL:	0	0	1	1	0	0	.1	.2		

COORDINATES:	X = 13		Y = 17			GRID AREA:		52 UNITS		
LEES:	7	0	0	0	0	0	0	2	0	0
GEOLOGICAL:	0	0	1	1	0	0	.1	0		
COORDINATES:	X = 14		Y = 17			GRID AREA:		207 UNITS		
LEES:	58	0	0	2	0	0	0	16	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	.1		
COORDINATES:	X = 15		Y = 17			GRID AREA:		334 UNITS		
LEES:	55	0	35	52	0	27	3	157	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	.1		
COORDINATES:	X = 16		Y = 17			GRID AREA:		400 UNITS		
LEES:	59	0	64	22	0	25	7	113	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 17			GRID AREA:		400 UNITS		
LEES:	8	0	98	63	0	0	14	0	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 12		Y = 18			GRID AREA:		266 UNITS		
LEES:	8	0	0	15	3	4	20	25	0	0
GEOLOGICAL:	1	1	1	1	0	.5	.1	.2		
COORDINATES:	X = 13		Y = 18			GRID AREA:		393 UNITS		
LEES:	0	0	114	8	0	6	13	197	6	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 14		Y = 18			GRID AREA:		400 UNITS		
LEES:	36	0	17	6	4	41	0	67	0	0
GEOLOGICAL:	1	0	1	0	0	0	.1	0		
COORDINATES:	X = 15		Y = 18			GRID AREA:		400 UNITS		
LEES:	69	0	31	21	2	23	0	186	3	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 18			GRID AREA:		400 UNITS		
LEES:	11	0	51	30	0	31	0	344	0	0
GEOLOGICAL:	0	0	0	0	0	0	.2	0		
COORDINATES:	X = 17		Y = 18			GRID AREA:		400 UNITS		
LEES:	87	0	62	78	0	2	2	31	0	0
GEOLOGICAL:	1	1	1	0	0	0	0	.1		
COORDINATES:	X = 12		Y = 19			GRID AREA:		400 UNITS		
LEES:	6	90	6	9	13	0	0	0	0	0
GEOLOGICAL:	1	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 19			GRID AREA:		400 UNITS		
LEES:	20	0	115	35	0	3	0	96	4	0
GEOLOGICAL:	1	0	1	0	0	0	.1	.2		

COORDINATES:	X = 14	Y = 19		GRID AREA:	400 UNITS				
LEES:	16 0	107 10	0	3	0	4	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 15	Y = 19		GRID AREA:	400 UNITS				
LEES:	21 0	112 7	5	5	25	81	3	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 16	Y = 19		GRID AREA:	400 UNITS				
LEES:	17 0	61 45	0	30	54	9	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 17	Y = 19		GRID AREA:	400 UNITS				
LEES:	23 0	27 44	15	4	0	102	2	0	
GEOLOGICAL:	0 0	1 0	0	0	0	-.2			
COORDINATES:	X = 8	Y = 60		GRID AREA:	330 UNITS				
LEES:	3 1	168 0	0	13	0	176	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 9	Y = 60		GRID AREA:	400 UNITS				
LEES:	32 0	64 0	0	0	0	0	3	89	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 10	Y = 60		GRID AREA:	385 UNITS				
LEES:	0 0	21 0	0	0	0	0	0	352	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 11	Y = 60		GRID AREA:	32 UNITS				
LEES:	0 0	0 0	0	0	0	0	0	32	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 7	Y = 61		GRID AREA:	7 UNITS				
LEES:	0 0	0 0	0	0	0	0	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 8	Y = 61		GRID AREA:	384 UNITS				
LEES:	12 20	122 0	0	0	0	146	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 9	Y = 61		GRID AREA:	400 UNITS				
LEES:	36 8	177 0	0	34	0	0	0	46	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 10	Y = 61		GRID AREA:	248 UNITS				
LEES:	0 0	0 0	0	0	0	0	0	248	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 7	Y = 62		GRID AREA:	134 UNITS				
LEES:	0 0	22 0	30	0	0	0	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			

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COORDINATES:    X = 8    Y = 62          GRID AREA:    400 UNITS
LEES:           38   25   74   0    9    0    0    204  0    25
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 9    Y = 62          GRID AREA:    400 UNITS
LEES:           0    6    115  2    8    4    0    0    0    214
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 10   Y = 62          GRID AREA:    78 UNITS
LEES:           0    0    0    0    0    0    0    0    0    78
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 6    Y = 63          GRID AREA:    2 UNITS
LEES:           0    0    0    0    0    0    0    0    0    0
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 7    Y = 63          GRID AREA:    290 UNITS
LEES:           0    3    24   0    1    0    0    7    0    0
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 8    Y = 63          GRID AREA:    300 UNITS
LEES:           16   60   32   0    5    0    0    214  0    54
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 9    Y = 63          GRID AREA:    229 UNITS
LEES:           5    0    0    48   2    0    0    0    0    119
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 6    Y = 64          GRID AREA:    15 UNITS
LEES:           0    0    7    0    0    0    0    0    0    0
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 7    Y = 64          GRID AREA:    205 UNITS
LEES:           1    67   6    0    0    0    0    205  0    61
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

COORDINATES:    X = 8    Y = 64          GRID AREA:    47 UNITS
LEES:           0    8    0    0    0    0    0    47   0    38
GEOLOGICAL:     0    0    0    0   -.9   0    0    0

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COORDINATES:	X = 18		Y = 15			GRID AREA:			35 UNITS	
LEES:	0	0	17	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	.5	1	0	0	0	0		
COORDINATES:	X = 19		Y = 15			GRID AREA:			22 UNITS	
LEES:	7	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 18		Y = 16			GRID AREA:			383 UNITS	
LEES:	3	0	141	19	0	2	0	0	0	0
GEOLOGICAL:	1	0	.5	0	0	-.5	.1	-.3		
COORDINATES:	X = 19		Y = 16			GRID AREA:			306 UNITS	
LEES:	34	0	79	15	1	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	.1		
COORDINATES:	X = 20		Y = 16			GRID AREA:			232 UNITS	
LEES:	41	0	4	8	1	4	8	114	2	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 21		Y = 16			GRID AREA:			88 UNITS	
LEES:	0	0	17	0	0	5	0	47	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 23		Y = 16			GRID AREA:			101 UNITS	
LEES:	27	0	0	0	2	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 17			GRID AREA:			400 UNITS	
LEES:	3	0	58	0	0	4	2	8	0	0
GEOLOGICAL:	0	1	1	0	0	0	0	.1		
COORDINATES:	X = 19		Y = 17			GRID AREA:			400 UNITS	
LEES:	2	0	321	0	0	0	0	85	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	.1		
COORDINATES:	X = 20		Y = 17			GRID AREA:			400 UNITS	
LEES:	37	0	90	0	0	3	19	187	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.2		
COORDINATES:	X = 21		Y = 17			GRID AREA:			354 UNITS	
LEES:	20	0	38	9	0	1	0	164	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 22		Y = 17			GRID AREA:			340 UNITS	
LEES:	45	0	0	0	6	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 23		Y = 17			GRID AREA:			397 UNITS	
LEES:	43	0	0	20	12	13	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		

COORDINATES:	X = 18		Y = 18			GRID AREA:		400	UNITS	
LEES:	13	0	39	17	0	0	8	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 18			GRID AREA:		400	UNITS	
LEES:	30	0	160	27	0	7	0	129	0	0
GEOLOGICAL:	1	1	0	0	0	0	.5	.1		
COORDINATES:	X = 20		Y = 18			GRID AREA:		400	UNITS	
LEES:	17	0	6	10	0	2	11	270	0	0
GEOLOGICAL:	1	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 18			GRID AREA:		400	UNITS	
LEES:	29	0	48	17	0	6	15	242	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 18			GRID AREA:		400	UNITS	
LEES:	50	0	13	31	5	0	0	94	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 18			GRID AREA:		400	UNITS	
LEES:	11	0	26	51	9	5	0	26	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 19			GRID AREA:		400	UNITS	
LEES:	62	0	30	5	2	1	6	0	0	0
GEOLOGICAL:	1	0	1	0	0	0	.1	-.2		
COORDINATES:	X = 19		Y = 19			GRID AREA:		400	UNITS	
LEES:	27	0	140	24	0	1	7	45	0	0
GEOLOGICAL:	0	0	.5	0	0	0	0	0		
COORDINATES:	X = 20		Y = 19			GRID AREA:		400	UNITS	
LEES:	16	0	55	17	0	0	3	71	0	0
GEOLOGICAL:	0	0	.5	0	0	0	0	0		
COORDINATES:	X = 21		Y = 19			GRID AREA:		400	UNITS	
LEES:	14	0	53	25	0	2	0	49	0	0
GEOLOGICAL:	0	0	1	0	0	0	.1	-.2		
COORDINATES:	X = 22		Y = 19			GRID AREA:		400	UNITS	
LEES:	115	0	6	9	12	2	20	387	6	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 19			GRID AREA:		400	UNITS	
LEES:	2	0	0	24	8	17	0	140	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 12			GRID AREA:		220	UNITS	
LEES:	0	0	220	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 29		Y = 12			GRID AREA:			375	UNITS
LEES:	17	0	308	9	8	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 27		Y = 13			GRID AREA:			116	UNITS
LEES:	0	0	60	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 28		Y = 13			GRID AREA:			400	UNITS
LEES:	0	0	391	0	0	0	0	0	7	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 13			GRID AREA:			400	UNITS
LEES:	0	0	388	0	0	0	0	0	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 14			GRID AREA:			20	UNITS
LEES:	0	0	16	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 27		Y = 14			GRID AREA:			384	UNITS
LEES:	0	0	304	6	0	0	0	0	6	0
GEOLOGICAL:	0	0	.5	0	0	0	0	0		
COORDINATES:	X = 28		Y = 14			GRID AREA:			400	UNITS
LEES:	0	0	400	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 29		Y = 14			GRID AREA:			400	UNITS
LEES:	0	0	352	0	0	0	0	0	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 15			GRID AREA:			125	UNITS
LEES:	19	0	45	0	0	0	0	109	2	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 26		Y = 15			GRID AREA:			315	UNITS
LEES:	19	0	95	8	0	21	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 27		Y = 15			GRID AREA:			400	UNITS
LEES:	39	0	165	14	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 15			GRID AREA:			400	UNITS
LEES:	47	0	215	5	1	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 15			GRID AREA:			400	UNITS
LEES:	28	0	260	0	8	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 24		Y = 16			GRID AREA:			315	UNITS
LEES:	63	0	0	28	50	0	0	10	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 16			GRID AREA:			398	UNITS
LEES:	40	0	71	100	16	12	0	60	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	.2		
COORDINATES:	X = 26		Y = 16			GRID AREA:			400	UNITS
LEES:	48	0	95	16	9	7	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 16			GRID AREA:			400	UNITS
LEES:	31	0	33	35	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 16			GRID AREA:			400	UNITS
LEES:	16	0	35	11	0	44	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 16			GRID AREA:			400	UNITS
LEES:	15	0	166	7	0	0	0	50	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 17			GRID AREA:			400	UNITS
LEES:	41	0	0	74	15	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 17			GRID AREA:			400	UNITS
LEES:	75	0	40	90	0	0	0	0	0	0
GEOLOGICAL:	0	0	1	0	0	0	.1	-.2		
COORDINATES:	X = 26		Y = 17			GRID AREA:			400	UNITS
LEES:	58	0	100	25	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 17			GRID AREA:			400	UNITS
LEES:	21	0	35	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 17			GRID AREA:			400	UNITS
LEES:	0	0	78	30	15	7	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 17			GRID AREA:			400	UNITS
LEES:	41	0	80	17	0	0	0	100	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 18			GRID AREA:			400	UNITS
LEES:	70	0	18	62	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 25		Y = 18			GRID AREA:		400	UNITS	
LEES:	118	0	5	24	18	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 18			GRID AREA:		400	UNITS	
LEES:	96	0	45	38	8	35	0	125	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 18			GRID AREA:		400	UNITS	
LEES:	70	0	73	16	0	0	0	360	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 18			GRID AREA:		400	UNITS	
LEES:	40	0	120	37	0	0	0	18	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 29		Y = 18			GRID AREA:		400	UNITS	
LEES:	40	0	115	60	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 19			GRID AREA:		400	UNITS	
LEES:	21	0	0	55	17	5	0	0	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 25		Y = 19			GRID AREA:		400	UNITS	
LEES:	135	0	2	55	12	0	0	.0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 26		Y = 19			GRID AREA:		400	UNITS	
LEES:	150	0	50	10	0	25	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 19			GRID AREA:		400	UNITS	
LEES:	125	0	20	24	0	0	0	55	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 19			GRID AREA:		400	UNITS	
LEES:	56	0	20	50	0	0	14	3	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 19			GRID AREA:		400	UNITS	
LEES:	65	0	17	81	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 50			GRID AREA:		400	UNITS	
LEES:	2	14	156	0	0	0	0	0	0	154
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19		Y = 50			GRID AREA:		264	UNITS	
LEES:	0	0	34	0	31	0	0	0	0	190
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 20	Y = 50			GRID AREA:				141	UNITS
LEES:	0	0	16	5	8	1	1	0	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18	Y = 51			GRID AREA:				400	UNITS
LEES:	0	0	114	0	0	0	0	0	0	239
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19	Y = 51			GRID AREA:				400	UNITS
LEES:	0	0	0	22	24	0	0	0	0	351
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20	Y = 51			GRID AREA:				340	UNITS
LEES:	32	5	40	72	9	1	0	0	0	78
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18	Y = 52			GRID AREA:				400	UNITS
LEES:	0	0	3	54	30	0	0	0	0	268
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19	Y = 52			GRID AREA:				400	UNITS
LEES:	0	3	0	0	3	0	0	0	0	375
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20	Y = 52			GRID AREA:				356	UNITS
LEES:	59	20	12	0	55	2	0	147	0	31
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18	Y = 53			GRID AREA:				400	UNITS
LEES:	0	0	25	24	0	0	0	0	0	203
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19	Y = 53			GRID AREA:				400	UNITS
LEES:	0	9	2	0	0	0	0	46	0	352
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20	Y = 53			GRID AREA:				380	UNITS
LEES:	28	136	19	22	0	0	0	215	0	10
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18	Y = 54			GRID AREA:				400	UNITS
LEES:	18	0	46	14	0	0	0	0	0	141
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 19	Y = 54			GRID AREA:				400	UNITS
LEES:	1	0	0	0	9	0	0	0	0	377
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20	Y = 54			GRID AREA:				333	UNITS
LEES:	2	10	5	0	27	80	0	25	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 18		Y = 55			GRID AREA:			400	UNITS
LEES:	43	0	24	0	51	1	0	0	0	147
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 19		Y = 55			GRID AREA:			400	UNITS
LEES:	0	19	0	23	0	0	0	0	0	274
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20		Y = 55			GRID AREA:			255	UNITS
LEES:	33	0	2	17	0	45	0	0	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18		Y = 56			GRID AREA:			400	UNITS
LEES:	21	0	11	0	57	0	0	0	0	125
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19		Y = 56			GRID AREA:			400	UNITS
LEES:	0	21	11	2	0	0	0	0	0	343
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20		Y = 56			GRID AREA:			204	UNITS
LEES:	0	60	49	6	0	0	0	0	0	20
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18		Y = 57			GRID AREA:			400	UNITS
LEES:	0	30	46	0	48	0	5	0	0	68
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19		Y = 57			GRID AREA:			400	UNITS
LEES:	0	0	0	0	2	0	0	0	0	398
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20		Y = 57			GRID AREA:			160	UNITS
LEES:	0	0	0	0	0	0	0	0	0	6
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18		Y = 58			GRID AREA:			400	UNITS
LEES:	19	0	19	46	37	0	0	0	0	41
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 19		Y = 58			GRID AREA:			318	UNITS
LEES:	0	0	0	0	0	0	0	0	0	318
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 20		Y = 58			GRID AREA:			35	UNITS
LEES:	6	0	0	0	0	0	0	0	0	19
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18		Y = 59			GRID AREA:			353	UNITS
LEES:	0	0	0	12	70	0	0	0	0	143
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 19		Y = 59			GRID AREA:			40 UNITS	
LEES:	0	0	0	0	0	0	0	0	0	40
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 60			GRID AREA:			253 UNITS	
LEES:	0	0	186	0	0	0	0	0	0	67
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 60			GRID AREA:			400 UNITS	
LEES:	0	0	309	0	21	0	0	0	0	70
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 60			GRID AREA:			400 UNITS	
LEES:	0	0	228	11	0	0	0	0	0	83
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 60			GRID AREA:			400 UNITS	
LEES:	32	7	6	3	47	83	0	0	0	16
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 60			GRID AREA:			320 UNITS	
LEES:	0	2	10	0	2	0	0	0	0	257
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 61			GRID AREA:			168 UNITS	
LEES:	0	0	107	0	0	0	0	0	0	61
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 15		Y = 61			GRID AREA:			400 UNITS	
LEES:	0	0	182	0	113	0	0	0	0	105
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 61			GRID AREA:			400 UNITS	
LEES:	0	0	47	22	20	0	0	0	0	304
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 61			GRID AREA:			400 UNITS	
LEES:	1	2	0	0	4	0	0	0	0	373
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 61			GRID AREA:			190 UNITS	
LEES:	13	7	0	0	0	0	0	0	0	62
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 62			GRID AREA:			12 UNITS	
LEES:	0	0	12	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 15		Y = 62			GRID AREA:			381 UNITS	
LEES:	6	0	54	0	0	0	0	0	0	159
GEOLOGICAL:	0	0	1	0	0	0	.1	0		

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COORDINATES:    X = 16     Y = 62          GRID AREA:      400 UNITS
LEES:           0    0     0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0     0    0    0     0    0    0

COORDINATES:    X = 17     Y = 62          GRID AREA:      400 UNITS
LEES:           0    0     0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0     0    0    0     0    0    0

COORDINATES:    X = 18     Y = 62          GRID AREA:      103 UNITS
LEES:           0    0     0    0    0     0    0    0     0     92
GEOLOGICAL:     0    0     0    0    0     0    0    0

COORDINATES:    X = 15     Y = 63          GRID AREA:      32 UNITS
LEES:           0    0     6    0    8     0    0    0     0     15
GEOLOGICAL:     0    0     1    0    0     0    0    0

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COORDINATES:	X = 33		Y = 10			GRID AREA:			88	UNITS
LEES:	0	0	46	1	0	5	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 34		Y = 10			GRID AREA:			270	UNITS
LEES:	19	0	85	13	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 35		Y = 10			GRID AREA:			400	UNITS
LEES:	84	0	34	65	9	1	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 33		Y = 11			GRID AREA:			170	UNITS
LEES:	0	0	22	38	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 34		Y = 11			GRID AREA:			400	UNITS
LEES:	140	0	60	18	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 11			GRID AREA:			400	UNITS
LEES:	105	0	52	0	9	10	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 30		Y = 12			GRID AREA:			350	UNITS
LEES:	0	0	295	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	.2	1	0	0	0	0		
COORDINATES:	X = 33		Y = 12			GRID AREA:			168	UNITS
LEES:	12	0	68	0	0	0	0	6	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 34		Y = 12			GRID AREA:			400	UNITS
LEES:	76	0	58	5	0	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 12			GRID AREA:			400	UNITS
LEES:	145	0	14	7	13	7	40	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 13			GRID AREA:			388	UNITS
LEES:	33	0	313	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 31		Y = 13			GRID AREA:			304	UNITS
LEES:	13	0	105	2	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 32		Y = 13			GRID AREA:			360	UNITS
LEES:	0	0	253	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		

COORDINATES:	X = 33		Y = 13			GRID AREA:			40 UNITS	
LEES:	53	0	273	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 13			GRID AREA:			400 UNITS	
LEES:	36	0	82	75	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 13			GRID AREA:			400 UNITS	
LEES:	41	0	10	61	3	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 14			GRID AREA:			400 UNITS	
LEES:	53	0	95	5	0	1	14	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 14			GRID AREA:			400 UNITS	
LEES:	19	0	26	28	0	0	2	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 32		Y = 14			GRID AREA:			400 UNITS	
LEES:	30	0	137	42	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 14			GRID AREA:			400 UNITS	
LEES:	100	0	55	50	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 14			GRID AREA:			400 UNITS	
LEES:	7	0	23	14	12	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 14			GRID AREA:			400 UNITS	
LEES:	7	0	23	14	12	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 15			GRID AREA:			400 UNITS	
LEES:	38	0	325	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 15			GRID AREA:			400 UNITS	
LEES:	47	0	19	37	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 15			GRID AREA:			400 UNITS	
LEES:	97	0	23	17	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 15			GRID AREA:			400 UNITS	
LEES:	76	0	10	23	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 34		Y = 15			GRID AREA:		400	UNITS		
LEES:	45	0	2	19	2	1	0	105	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 35		Y = 15			GRID AREA:		400	UNITS		
LEES:	74	0	12	45	11	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 30		Y = 16			GRID AREA:		400	UNITS		
LEES:	80	0	66	13	11	0	4	40	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 31		Y = 16			GRID AREA:		400	UNITS		
LEES:	19	0	71	21	21	2	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 32		Y = 16			GRID AREA:		400	UNITS		
LEES:	45	0	44	80	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 33		Y = 16			GRID AREA:		400	UNITS		
LEES:	16	0	29	0	0	0	6	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 34		Y = 16			GRID AREA:		400	UNITS		
LEES:	43	0	0	21	0	0	47	320	6	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 35		Y = 16			GRID AREA:		400	UNITS		
LEES:	130	0	45	39	2	1	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 30		Y = 17			GRID AREA:		400	UNITS		
LEES:	31	0	85	26	9	0	4	40	2	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 31		Y = 17			GRID AREA:		400	UNITS		
LEES:	22	0	182	7	7	3	0	87	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 32		Y = 17			GRID AREA:		400	UNITS		
LEES:	61	0	125	1	0	3	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 33		Y = 17			GRID AREA:		400	UNITS		
LEES:	118	0	32	37	2	0	0	45	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 34		Y = 17			GRID AREA:		400	UNITS		
LEES:	65	0	0	52	0	0	0	335	2	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			

COORDINATES:	X = 35		Y = 17			GRID AREA:		400	UNITS	
LEES:	95	0	14	0	4	12	0	12	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 18			GRID AREA:		400	UNITS	
LEES:	65	0	11	45	20	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 18			GRID AREA:		400	UNITS	
LEES:	97	0	90	21	0	2	6	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 18			GRID AREA:		400	UNITS	
LEES:	83	0	44	25	0	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.2		
COORDINATES:	X = 33		Y = 18			GRID AREA:		400	UNITS	
LEES:	57	0	6	47	3	0	16	265	3	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 18			GRID AREA:		400	UNITS	
LEES:	72	0	0	15	0	0	2	265	3	0
GEOLOGICAL:	0	0	.5	0	0	0	0	0		
COORDINATES:	X = 35		Y = 18			GRID AREA:		400	UNITS	
LEES:	70	0	0	4	0	60	9	90	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 19			GRID AREA:		400	UNITS	
LEES:	55	0	45	50	8	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 19			GRID AREA:		400	UNITS	
LEES:	95	0	52	50	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 19			GRID AREA:		400	UNITS	
LEES:	52	0	19	32	4	8	0	110	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 19			GRID AREA:		400	UNITS	
LEES:	45	0	30	71	0	0	12	100	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 19			GRID AREA:		400	UNITS	
LEES:	45	0	45	45	0	110	6	135	1	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 19			GRID AREA:		400	UNITS	
LEES:	125	0	0	6	0	35	14	255	0	0
GEOLOGICAL:	0	0	.5	0	0	0	0	0		

COORDINATES:	X = 36		Y = 10			GRID AREA:			210	UNITS
LEES:	53	0	71	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 39		Y = 10			GRID AREA:			192	UNITS
LEES:	37	0	13	46	30	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	1	0	0	0	.1		
COORDINATES:	X = 40		Y = 10			GRID AREA:			400	UNITS
LEES:	130	0	36	3	23	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 41		Y = 10			GRID AREA:			364	UNITS
LEES:	2	0	6	30	11	11	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 11			GRID AREA:			200	UNITS
LEES:	13	0	160	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 11			GRID AREA:			125	UNITS
LEES:	52	0	8	10	0	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 11			GRID AREA:			377	UNITS
LEES:	165	0	42	55	11	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 40		Y = 11			GRID AREA:			400	UNITS
LEES:	145	0	71	16	0	0	5	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 41		Y = 11			GRID AREA:			88	UNITS
LEES:	0	0	30	8	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 12			GRID AREA:			192	UNITS
LEES:	7	0	53	5	0	17	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 37		Y = 12			GRID AREA:			239	UNITS
LEES:	45	0	50	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 38		Y = 12			GRID AREA:			388	UNITS
LEES:	161	0	40	0	0	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 12			GRID AREA:			400	UNITS
LEES:	165	0	28	21	0	2	15	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 40		Y = 12			GRID AREA:			320	UNITS	
LEES:	95	0	94	3	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 36		Y = 13			GRID AREA:			377	UNITS	
LEES:	90	0	70	7	2	7	17	0	0	0	
GEOLOGICAL:	0	0	1	0	0	0	0	0			
COORDINATES:	X = 37		Y = 13			GRID AREA:			400	UNITS	
LEES:	95	0	45	23	0	0	8	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 38		Y = 13			GRID AREA:			400	UNITS	
LEES:	140	0	51	0	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 39		Y = 13			GRID AREA:			400	UNITS	
LEES:	130	0	40	25	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 40		Y = 13			GRID AREA:			200	UNITS	
LEES:	16	0	3	18	5	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 36		Y = 14			GRID AREA:			400	UNITS	
LEES:	80	0	160	2	3	20	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 37		Y = 14			GRID AREA:			400	UNITS	
LEES:	37	0	38	65	0	116	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 38		Y = 14			GRID AREA:			400	UNITS	
LEES:	24	0	150	15	8	20	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 39		Y = 14			GRID AREA:			400	UNITS	
LEES:	103	0	58	47	14	0	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 40		Y = 14			GRID AREA:			115	UNITS	
LEES:	66	0	1	2	0	0	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 36		Y = 15			GRID AREA:			400	UNITS	
LEES:	85	0	81	30	1	30	0	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 37		Y = 15			GRID AREA:			400	UNITS	
LEES:	47	0	33	51	0	63	0	135	2	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			

COORDINATES:	X = 38		Y = 15			GRID AREA:		400	UNITS	
LEES:	24	0	85	33	10	112	2	210	1	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 15			GRID AREA:		391	UNITS	
LEES:	40	0	19	5	14	15	0	50	1	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 40		Y = 15			GRID AREA:		20	UNITS	
LEES:	9	0	3	0	1	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 16			GRID AREA:		400	UNITS	
LEES:	85	0	104	30	0	4	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 16			GRID AREA:		400	UNITS	
LEES:	50	0	125	9	3	55	0	180	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 16			GRID AREA:		400	UNITS	
LEES:	27	0	85	24	4	40	0	220	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 16			GRID AREA:		313	UNITS	
LEES:	48	0	10	7	14	8	4	250	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 17			GRID AREA:		400	UNITS	
LEES:	220	0	62	0	0	4	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 17			GRID AREA:		400	UNITS	
LEES:	53	0	45	32	9	8	5	170	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 17			GRID AREA:		400	UNITS	
LEES:	25	0	14	41	10	75	24	375	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 17			GRID AREA:		250	UNITS	
LEES:	9	0	34	0	2	58	17	70	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 18			GRID AREA:		400	UNITS	
LEES:	326	0	4	2	0	38	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 18			GRID AREA:		400	UNITS	
LEES:	80	0	85	13	7	47	0	125	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

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COORDINATES:    X = 38      Y = 18          GRID AREA:      400 UNITS
LEES:           37   0      125  10   3     31   0      150  4    0
GEOLOGICAL:     0    0      0    0    0     0    0      0

COORDINATES:    X = 39      Y = 18          GRID AREA:      155 UNITS
LEES:           0    0      0    1    0     123  0      19   0    0
GEOLOGICAL:     0    0      0    0    0     0    0      0

COORDINATES:    X = 36      Y = 19          GRID AREA:      400 UNITS
LEES:           198  0      9    0    0     0    2      145  0    0
GEOLOGICAL:     0    0      0    0    0     0    0      0

COORDINATES:    X = 37      Y = 19          GRID AREA:      400 UNITS
LEES:           0    0      83   0    0     0    0      35   0    0
GEOLOGICAL:     0    0      0    0    0     0    0      0

COORDINATES:    X = 38      Y = 19          GRID AREA:      400 UNITS
LEES:           195  0      60   15   3     7    0      393  0    0
GEOLOGICAL:     0    0      0    1    0     0    0      0

COORDINATES:    X = 39      Y = 19          GRID AREA:      50 UNITS
LEES:           15   0      0    0    0     2    0      48   0    0
GEOLOGICAL:     0    0      0    0    0     0    0      0

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NARRAGANNSETT BASIN FILE 4

COORDINATES:	X = 12		Y = 20			GRID AREA:			400	UNITS
LEES:	33	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.2		
COORDINATES:	X = 13		Y = 20			GRID AREA:			400	UNITS
LEES:	0	0	141	42	4	0	0	175	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 14		Y = 20			GRID AREA:			400	UNITS
LEES:	17	0	185	16	7	0	0	65	2	0
GEOLOGICAL:	0	0	1	0	0	0	0	-.3		
COORDINATES:	X = 15		Y = 20			GRID AREA:			400	UNITS
LEES:	35	0	59	0	0	0	0	44	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 16		Y = 20			GRID AREA:			400	UNITS
LEES:	17	0	185	16	7	0	0	65	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 20			GRID AREA:			400	UNITS
LEES:	40	0	42	27	0	9	7	140	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 21			GRID AREA:			400	UNITS
LEES:	17	0	0	10	3	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 13		Y = 21			GRID AREA:			400	UNITS
LEES:	33	0	240	16	0	0	0	16	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 14		Y = 21			GRID AREA:			400	UNITS
LEES:	2	0	258	6	0	0	0	120	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 15		Y = 21			GRID AREA:			400	UNITS
LEES:	15	0	29	26	0	7	0	30	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 16		Y = 21			GRID AREA:			400	UNITS
LEES:	80	0	61	14	8	0	37	320	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 21			GRID AREA:			400	UNITS
LEES:	113	0	0	17	0	0	0	10	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 22			GRID AREA:			400	UNITS
LEES:	3	0	0	4	18	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 13		Y = 22			GRID AREA:		400		UNITS
LEES:	11	0	140	33	10	21	0	100	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 14		Y = 22			GRID AREA:		400		UNITS
LEES:	19	0	204	1	5	42	0	130	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 22			GRID AREA:		400		UNITS
LEES:	22	0	271	12	4	3	0	180	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 22			GRID AREA:		400		UNITS
LEES:	178	0	59	30	2	0	0	350	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 17		Y = 22			GRID AREA:		400		UNITS
LEES:	35	0	11	20	6	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 12		Y = 23			GRID AREA:		400		UNITS
LEES:	0	0	24	29	0	0	9	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 23			GRID AREA:		400		UNITS
LEES:	18	9	59	55	0	2	0	0	0	0
GEOLOGICAL:	0	0	-.5	1	0	0	0	-.3		
COORDINATES:	X = 14		Y = 23			GRID AREA:		400		UNITS
LEES:	38	0	47	9	5	26	0	5	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 15		Y = 23			GRID AREA:		400		UNITS
LEES:	22	0	258	8	0	4	5	62	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 16		Y = 23			GRID AREA:		400		UNITS
LEES:	150	0	176	0	0	0	0	315	5	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 23			GRID AREA:		400		UNITS
LEES:	91	0	93	128	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 24			GRID AREA:		400		UNITS
LEES:	65	0	8	49	0	2	0	16	0	0
GEOLOGICAL:	0	0	-.5	0	0	0	0	-.3		
COORDINATES:	X = 13		Y = 24			GRID AREA:		400		UNITS
LEES:	5	0	90	45	3	13	5	80	0	0
GEOLOGICAL:	0	0	-.5	0	0	0	0	-.3		

COORDINATES:	X = 14		Y = 24			GRID AREA:		400	UNITS			
LEES:	7	0	19	39	10	130	0	24	2	0		
GEOLOGICAL:	0	0	-.5	0	0	0	0	-.3				
COORDINATES:	X = 15		Y = 24			GRID AREA:		400	UNITS			
LEES:	44	0	172	32	0	21	0	361	5	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 16		Y = 24			GRID AREA:		400	UNITS			
LEES:	2	0	379	0	0	0	0	394	9	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 17		Y = 24			GRID AREA:		400	UNITS			
LEES:	100	0	115	4	0	0	0	5	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 12		Y = 25			GRID AREA:		400	UNITS			
LEES:	20	0	44	46	0	0	4	155	0	0		
GEOLOGICAL:	1	0	1	0	0	0	.1	-.3				
COORDINATES:	X = 13		Y = 25			GRID AREA:		400	UNITS			
LEES:	18	0	69	7	1	17	21	160	6	0		
GEOLOGICAL:	0	0	-.5	0	0	0	0	-.3				
COORDINATES:	X = 14		Y = 25			GRID AREA:		400	UNITS			
LEES:	6	0	136	32	4	17	17	145	8	0		
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3				
COORDINATES:	X = 15		Y = 25			GRID AREA:		400	UNITS			
LEES:	5	0	245	5	0	5	7	220	0	0		
GEOLOGICAL:	0	0	1	0	0	0	0	-.3				
COORDINATES:	X = 16		Y = 25			GRID AREA:		400	UNITS			
LEES:	72	0	215	0	4	12	5	400	4	0		
GEOLOGICAL:	0	0	1	0	0	0	0	0				
COORDINATES:	X = 17		Y = 25			GRID AREA:		400	UNITS			
LEES:	210	0	60	7	0	5	0	135	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 12		Y = 26			GRID AREA:		400	UNITS			
LEES:	10	0	110	38	16	0	0	188	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	.1				
COORDINATES:	X = 13		Y = 26			GRID AREA:		400	UNITS			
LEES:	44	0	46	40	9	0	0	8	0	0		
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3				
COORDINATES:	X = 14		Y = 26			GRID AREA:		400	UNITS			
LEES:	23	0	65	18	0	5	10	140	0	0		
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3				

COORDINATES:	X = 15		Y = 26			GRID AREA:		400	UNITS	
LEES:	59	0	88	22	0	19	55	330	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 16		Y = 26			GRID AREA:		400	UNITS	
LEES:	101	0	36	13	23	0	0	302	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 26			GRID AREA:		400	UNITS	
LEES:	95	0	135	0	0	4	0	195	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 27			GRID AREA:		400	UNITS	
LEES:	50	0	336	0	0	0	0	360	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 27			GRID AREA:		400	UNITS	
LEES:	36	0	85	19	5	1	0	380	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 14		Y = 27			GRID AREA:		400	UNITS	
LEES:	36	0	113	19	0	6	0	276	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 27			GRID AREA:		400	UNITS	
LEES:	49	0	56	29	0	7	8	220	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 27			GRID AREA:		400	UNITS	
LEES:	155	0	25	0	0	0	0	385	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 27			GRID AREA:		400	UNITS	
LEES:	120	0	46	46	6	0	36	325	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 28			GRID AREA:		400	UNITS	
LEES:	14	0	368	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 28			GRID AREA:		400	UNITS	
LEES:	23	0	318	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 28			GRID AREA:		400	UNITS	
LEES:	22	0	180	32	6	5	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 15		Y = 28			GRID AREA:		400	UNITS	
LEES:	120	0	3	40	20	0	0	200	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		

COORDINATES:	X = 16		Y = 28			GRID AREA:		400 UNITS		
LEES:	91	0	13/	52	0	2	0	195	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 28			GRID AREA:		400 UNITS		
LEES:	125	0	0	32	9	0	27	356	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 29			GRID AREA:		400 UNITS		
LEES:	0	0	400	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 29			GRID AREA:		400 UNITS		
LEES:	20	0	307	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 29			GRID AREA:		400 UNITS		
LEES:	104	0	39	15	0	0	9	272	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 29			GRID AREA:		400 UNITS		
LEES:	100	0	0	45	0	0	0	18	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 29			GRID AREA:		400 UNITS		
LEES:	135	0	0	30	0	0	0	40	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 29			GRID AREA:		400 UNITS		
LEES:	94	0	0	28	0	0	0	325	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 40			GRID AREA:		400 UNITS		
LEES:	50	0	32	3	0	0	0	185	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 40			GRID AREA:		400 UNITS		
LEES:	18	9	124	6	0	0	40	144	0	2
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 20		Y = 40			GRID AREA:		400 UNITS		
LEES:	0	7	138	11	0	10	12	140	0	22
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 21		Y = 40			GRID AREA:		400 UNITS		
LEES:	12	0	155	8	0	0	0	0	0	7
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 40			GRID AREA:		400 UNITS		
LEES:	0	0	260	0	0	0	0	0	0	0
GEOLOGICAL:	0	1	0	0	0	0	-.2	.1		

COORDINATES:	X = 23	Y = 40			GRID AREA:			400	UNITS	
LEES:	0	0	135	8	0	0	0	0	0	222
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 18	Y = 41			GRID AREA:			400	UNITS	
LEES:	97	0	13	9	6	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 19	Y = 41			GRID AREA:			400	UNITS	
LEES:	8	0	195	15	0	0	0	140	0	115
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 20	Y = 41			GRID AREA:			400	UNITS	
LEES:	0	0	245	18	0	0	0	65	0	61
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21	Y = 41			GRID AREA:			400	UNITS	
LEES:	25	0	170	0	0	0	0	0	0	7
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22	Y = 41			GRID AREA:			400	UNITS	
LEES:	0	0	261	0	0	0	0	0	0	96
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23	Y = 41			GRID AREA:			260	UNITS	
LEES:	0	0	317	0	0	0	0	0	0	70
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 18	Y = 42			GRID AREA:			400	UNITS	
LEES:	3	4	9	2	2	0	0	0	0	28
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19	Y = 42			GRID AREA:			400	UNITS	
LEES:	0	0	90	7	6	0	0	42	0	269
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20	Y = 42			GRID AREA:			400	UNITS	
LEES:	4	14	217	8	4	0	0	9	0	83
GEOLOGICAL:	0	1	0	0	0	0	.2	.1		
COORDINATES:	X = 21	Y = 42			GRID AREA:			400	UNITS	
LEES:	3	21	150	0	0	0	0	0	0	17
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22	Y = 42			GRID AREA:			365	UNITS	
LEES:	0	0	360	0	0	0	0	0	0	135
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 23	Y = 42			GRID AREA:			400	UNITS	
LEES:	25	0	0	25	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 18	Y = 43			GRID AREA:			400	UNITS	
LEES:	0	19	61	16	0	0	0	0	0	160
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19	Y = 43			GRID AREA:			400	UNITS	
LEES:	0	0	12	8	14	0	0	0	0	344
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20	Y = 43			GRID AREA:			400	UNITS	
LEES:	0	0	62	19	8	0	0	0	0	320
GEOLOGICAL:	0	0	1	0	0	0	.2	.1		
COORDINATES:	X = 21	Y = 43			GRID AREA:			400	UNITS	
LEES:	0	7	34	0	0	0	0	0	0	344
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22	Y = 43			GRID AREA:			185	UNITS	
LEES:	0	0	105	0	0	0	0	0	0	80
GEOLOGICAL:	0	1	0	1	0	0	0	0		
COORDINATES:	X = 18	Y = 44			GRID AREA:			400	UNITS	
LEES:	0	0	46	0	20	0	6	0	0	303
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19	Y = 44			GRID AREA:			400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20	Y = 44			GRID AREA:			400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21	Y = 44			GRID AREA:			360	UNITS	
LEES:	0	0	278	0	0	0	0	0	0	118
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 18	Y = 45			GRID AREA:			205	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	152
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 19	Y = 45			GRID AREA:			400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20	Y = 45			GRID AREA:			400	UNITS	
LEES:	0	0	110	0	0	0	0	0	0	290
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21	Y = 45			GRID AREA:			110	UNITS	
LEES:	0	0	110	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

```
COORDINATES:    X = 18      Y = 46          GRID AREA:      145 UNITS
LEES:           0    0      0    0    0     0    0    0     0    141
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 19      Y = 46          GRID AREA:      400 UNITS
LEES:           0    0      0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 20      Y = 46          GRID AREA:      275 UNITS
LEES:           0    0     55    0    0     0    0    0     0    180
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 18      Y = 47          GRID AREA:      320 UNITS
LEES:           0    0      0    0    0     0    0    0     0    320
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 19      Y = 47          GRID AREA:      295 UNITS
LEES:           0    0      0    0    0     0    0    0     0    295
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 20      Y = 47          GRID AREA:      77 UNITS
LEES:           0    0     12    0    0     0    0    0     0    38
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 18      Y = 48          GRID AREA:      400 UNITS
LEES:           0    0     20    6    0     0    0   57     0    337
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 19      Y = 48          GRID AREA:      240 UNITS
LEES:           0    9     71    2    0     0    0   55     0    150
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 20      Y = 48          GRID AREA:      16 UNITS
LEES:           0    0     13    3    0     0    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 18      Y = 49          GRID AREA:      400 UNITS
LEES:           0   47     93    0    0     0    0  260     0    65
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 19      Y = 49          GRID AREA:      250 UNITS
LEES:           0    0     90    0    0     0    0    0     0    150
GEOLOGICAL:     0    0      0    0    0     0    0    0

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NARRAGANNSETT BASIN FILE 5

COORDINATES:	X = 18	Y = 20		GRID AREA:		400 UNITS			
LEES:	101 0	20 35	0	0	5	135	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 19	Y = 20		GRID AREA:		400 UNITS			
LEES:	67 0	7 12	0	9	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 20	Y = 20		GRID AREA:		400 UNITS			
LEES:	30 0	195 2	0	118	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 21	Y = 20		GRID AREA:		400 UNITS			
LEES:	90 0	70 18	2	0	22	150	2	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 22	Y = 20		GRID AREA:		400 UNITS			
LEES:	75 0	22 0	4	0	57	100	2	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 23	Y = 20		GRID AREA:		400 UNITS			
LEES:	35 0	24 0	0	4	0	35	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 18	Y = 21		GRID AREA:		400 UNITS			
LEES:	55 0	7 35	0	2	7	90	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	-.2			
COORDINATES:	X = 19	Y = 21		GRID AREA:		400 UNITS			
LEES:	103 0	25 5	0	1	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 20	Y = 21		GRID AREA:		400 UNITS			
LEES:	3 0	60 25	0	210	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	-.2			
COORDINATES:	X = 21	Y = 21		GRID AREA:		400 UNITS			
LEES:	43 0	7 50	0	3	2	40	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	-.3			
COORDINATES:	X = 22	Y = 21		GRID AREA:		400 UNITS			
LEES:	110 0	45 16	14	0	20	33	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 23	Y = 21		GRID AREA:		400 UNITS			
LEES:	83 0	30 20	31	0	0	75	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 18	Y = 22		GRID AREA:		400 UNITS			
LEES:	85 0	40 17	9	0	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			

COORDINATES:	X = 19		Y = 22		GRID AREA:			400	UNITS
LEES:	170	0	0	7	11	0	6	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 20		Y = 22		GRID AREA:			400	UNITS
LEES:	97	0	85	20	0	22	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 21		Y = 22		GRID AREA:			400	UNITS
LEES:	45	0	75	32	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 22		Y = 22		GRID AREA:			400	UNITS
LEES:	70	0	30	45	2	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 22		GRID AREA:			400	UNITS
LEES:	70	0	60	15	4	100	0	300	3	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 23		GRID AREA:			400	UNITS
LEES:	70	0	45	25	15	0	0	25	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 23		GRID AREA:			400	UNITS
LEES:	70	0	65	6	0	6	2	85	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 20		Y = 23		GRID AREA:			400	UNITS
LEES:	75	0	32	8	30	0	0	40	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 23		GRID AREA:			400	UNITS
LEES:	30	0	7	11	11	0	6	18	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 23		GRID AREA:			400	UNITS
LEES:	61	0	1	17	0	5	8	120	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 23		GRID AREA:			400	UNITS
LEES:	61	0	17	0	0	0	0	160	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 24		GRID AREA:			400	UNITS
LEES:	157	0	30	7	0	45	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 24		GRID AREA:			400	UNITS
LEES:	80	0	66	19	5	4	2	50	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 20		Y = 24			GRID AREA:		400	UNITS
LEES:	38	0	40	25	13	9	4	15	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 24			GRID AREA:		400	UNITS
LEES:	70	0	15	17	0	0	7	18	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 24			GRID AREA:		400	UNITS
LEES:	160	0	0	22	11	0	0	220	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 24			GRID AREA:		400	UNITS
LEES:	62	0	75	3	0	0	0	35	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 25			GRID AREA:		400	UNITS
LEES:	200	0	50	35	0	1	10	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 25			GRID AREA:		400	UNITS
LEES:	70	0	0	21	0	0	30	9	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 20		Y = 25			GRID AREA:		400	UNITS
LEES:	130	0	9	22	0	0	8	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 25			GRID AREA:		400	UNITS
LEES:	150	0	1	5	7	0	8	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 25			GRID AREA:		400	UNITS
LEES:	30	0	10	20	4	0	0	95	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 25			GRID AREA:		400	UNITS
LEES:	70	0	40	10	0	0	8	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 26			GRID AREA:		400	UNITS
LEES:	125	0	32	15	0	0	22	0	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	.1		
COORDINATES:	X = 19		Y = 26			GRID AREA:		400	UNITS
LEES:	240	0	31	0	0	0	0	125	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 26			GRID AREA:		400	UNITS
LEES:	195	0	0	25	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 21		Y = 26			GRID AREA:			400	UNITS
LEES:	95	0	7	24	0	0	10	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 26			GRID AREA:			400	UNITS
LEES:	105	0	21	35	0	0	15	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 26			GRID AREA:			400	UNITS
LEES:	15	0	40	22	28	40	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 27			GRID AREA:			400	UNITS
LEES:	65	0	7	8	0	0	10	215	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 27			GRID AREA:			400	UNITS
LEES:	105	0	12	21	7	0	8	100	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 27			GRID AREA:			400	UNITS
LEES:	95	0	3	45	4	0	6	75	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 27			GRID AREA:			400	UNITS
LEES:	201	0	0	12	15	0	0	0	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 22		Y = 27			GRID AREA:			400	UNITS
LEES:	200	0	0	35	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 27			GRID AREA:			400	UNITS
LEES:	95	0	95	10	10	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 28			GRID AREA:			400	UNITS
LEES:	155	0	0	3	1	0	0	225	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 28			GRID AREA:			400	UNITS
LEES:	140	0	5	20	17	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 28			GRID AREA:			400	UNITS
LEES:	40	0	7	3	10	5	18	115	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	.1		
COORDINATES:	X = 21		Y = 28			GRID AREA:			400	UNITS
LEES:	85	0	21	5	2	8	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		

COORDINATES:	X = 22	Y = 28			GRID AREA:		400 UNITS		
LEES:	70 0	1 0	0	0	0	0	0	0	0
GEOLOGICAL:	0 0	1 0	0	0	0	0	.1		
COORDINATES:	X = 23	Y = 28			GRID AREA:		400 UNITS		
LEES:	101 0	13 10	0	0	0	0	0	0	0
GEOLOGICAL:	0 0	0 0	0	0	0	0	-.3		
COORDINATES:	X = 18	Y = 29			GRID AREA:		400 UNITS		
LEES:	76 0	0 18	16	0	0	42	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 19	Y = 29			GRID AREA:		400 UNITS		
LEES:	155 0	10 8	1	0	0	300	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 20	Y = 29			GRID AREA:		400 UNITS		
LEES:	35 0	12 0	18	0	0	42	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 21	Y = 29			GRID AREA:		400 UNITS		
LEES:	41 0	9 15	0	7	12	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	.1			
COORDINATES:	X = 22	Y = 29			GRID AREA:		400 UNITS		
LEES:	70 0	25 20	0	0	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	.1			
COORDINATES:	X = 23	Y = 29			GRID AREA:		400 UNITS		
LEES:	35 0	50 9	0	12	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 9	Y = 30			GRID AREA:		220 UNITS		
LEES:	6 0	203 0	0	0	0	143	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 10	Y = 30			GRID AREA:		400 UNITS		
LEES:	2 0	368 0	0	0	0	379	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 11	Y = 30			GRID AREA:		400 UNITS		
LEES:	0 0	376 0	0	0	0	292	0	24	
GEOLOGICAL:	0 0	1 0	0	0	.1	0			
COORDINATES:	X = 8	Y = 31			GRID AREA:		49 UNITS		
LEES:	0 0	49 0	0	0	0	23	0	0	
GEOLOGICAL:	0 0	0 1	0	0	0	0			
COORDINATES:	X = 9	Y = 31			GRID AREA:		366 UNITS		
LEES:	0 0	340 0	0	10	0	256	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			

COORDINATES:	X = 10		Y = 31			GRID AREA:		400 UNITS			
LEES:	0	0	397	0	0	0	0	288	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 11		Y = 31			GRID AREA:		400 UNITS			
LEES:	0	0	311	0	0	0	0	219	0	89	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 8		Y = 32			GRID AREA:		226 UNITS			
LEES:	0	0	226	0	0	0	0	41	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 9		Y = 32			GRID AREA:		400 UNITS			
LEES:	0	0	400	0	0	0	0	265	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 32			GRID AREA:		400 UNITS			
LEES:	0	0	400	0	0	0	0	203	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 11		Y = 32			GRID AREA:		400 UNITS			
LEES:	0	5	317	0	0	0	0	157	0	78	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 8		Y = 33			GRID AREA:		317 UNITS			
LEES:	0	0	317	0	0	0	0	159	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 9		Y = 33			GRID AREA:		400 UNITS			
LEES:	0	0	392	0	0	8	0	399	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 10		Y = 33			GRID AREA:		400 UNITS			
LEES:	0	0	400	0	0	0	0	148	0	0	
GEOLOGICAL:	1	0	0	0	0	0	0	0			
COORDINATES:	X = 11		Y = 33			GRID AREA:		400 UNITS			
LEES:	0	0	328	0	0	0	0	140	0	72	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 7		Y = 34			GRID AREA:		10 UNITS			
LEES:	0	0	10	0	0	0	0	10	0	0	
GEOLOGICAL:	0	0	1	1	0	0	.1	0			
COORDINATES:	X = 8		Y = 34			GRID AREA:		378 UNITS			
LEES:	0	0	373	0	0	5	0	364	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 9		Y = 34			GRID AREA:		400 UNITS			
LEES:	0	0	400	0	0	0	0	400	0	0	
GEOLOGICAL:	0	0	1	0	0	0	.1	0			

COORDINATES:	X = 10	Y = 34		GRID AREA:	400 UNITS			
LEES:	0 0	346 0	0	0 0	351 0	54		
GEOLOGICAL:	0 0	1 0	0	0 .1	0			
COORDINATES:	X = 11	Y = 34		GRID AREA:	400 UNITS			
LEES:	0 0	315 0	0	0 0	204 0	85		
GEOLOGICAL:	0 0	1 0	0	0 .1	0			
COORDINATES:	X = 7	Y = 35		GRID AREA:	120 UNITS			
LEES:	0 0	104 0	0	16 0	120 0	0		
GEOLOGICAL:	0 0	1 1	-.5	0 .1	0			
COORDINATES:	X = 8	Y = 35		GRID AREA:	400 UNITS			
LEES:	0 0	400 0	0	0 0	120 0	0		
GEOLOGICAL:	1 0	1 0	-.5	0 .1	0			
COORDINATES:	X = 9	Y = 35		GRID AREA:	400 UNITS			
LEES:	0 0	400 0	0	0 0	400 0	0		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 10	Y = 35		GRID AREA:	400 UNITS			
LEES:	0 0	330 0	0	0 0	332 2	68		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 11	Y = 35		GRID AREA:	400 UNITS			
LEES:	0 3	219 0	0	0 0	222 0	181		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 7	Y = 36		GRID AREA:	252 UNITS			
LEES:	39 0	128 0	0	36 0	252 0	0		
GEOLOGICAL:	0 0	1 1	-.5	0 .1	0			
COORDINATES:	X = 8	Y = 36		GRID AREA:	400 UNITS			
LEES:	0 0	335 0	0	30 0	326 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 9	Y = 36		GRID AREA:	400 UNITS			
LEES:	0 0	342 0	0	47 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 10	Y = 36		GRID AREA:	400 UNITS			
LEES:	0 0	400 0	0	0 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 11	Y = 36		GRID AREA:	400 UNITS			
LEES:	0 0	231 0	0	0 0	235 4	165		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 7	Y = 37		GRID AREA:	332 UNITS			
LEES:	7 0	305 0	0	5 0	297 0	0		
GEOLOGICAL:	0 0	0 1	-.5	0 0	0			

COORDINATES:	X = 8	Y = 37		GRID AREA:	400 UNITS			
LEES:	17 0	350 0	0	5 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 9	Y = 37		GRID AREA:	400 UNITS			
LEES:	0 0	400 0	0	0 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 10	Y = 37		GRID AREA:	400 UNITS			
LEES:	0 0	343 0	0	57 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 11	Y = 37		GRID AREA:	400 UNITS			
LEES:	0 0	130 0	0	0 0	130 0	270		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 6	Y = 38		GRID AREA:	37 UNITS			
LEES:	14 0	16 0	0	0 0	37 0	0		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 7	Y = 38		GRID AREA:	400 UNITS			
LEES:	4 0	331 0	0	15 0	153 0	0		
GEOLOGICAL:	1 0	1 1	-.5	0 .1	0			
COORDINATES:	X = 8	Y = 38		GRID AREA:	400 UNITS			
LEES:	30 0	326 0	0	9 0	326 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 9	Y = 38		GRID AREA:	400 UNITS			
LEES:	0 0	376 0	0	10 0	376 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 10	Y = 38		GRID AREA:	400 UNITS			
LEES:	13 0	300 0	0	8 0	400 0	0		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 11	Y = 38		GRID AREA:	400 UNITS			
LEES:	0 4	133 0	0	0 0	146 0	254		
GEOLOGICAL:	0 0	0 0	-.5	0 0	0			
COORDINATES:	X = 6	Y = 39		GRID AREA:	162 UNITS			
LEES:	3 0	135 0	0	0 5	162 0	0		
GEOLOGICAL:	0 0	0 0	0	0 0	0			
COORDINATES:	X = 7	Y = 39		GRID AREA:	400 UNITS			
LEES:	14 0	327 0	0	0 0	82 0	0		
GEOLOGICAL:	0 0	1 0	-.5	0 .1	0			
COORDINATES:	X = 8	Y = 39		GRID AREA:	400 UNITS			
LEES:	33 0	318 0	0	0 0	400 0	0		
GEOLOGICAL:	0 0	0 1	-.5	0 0	0			

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COORDINATES:    X = 9     Y = 39          GRID AREA:     400 UNITS
LEES:           37    0    313   0     0     0     0     400   0     0
GEOLOGICAL:     0     0    0     0    -.5    0     0     0

COORDINATES:    X = 10    Y = 39          GRID AREA:     400 UNITS
LEES:           9     0    370   0     0     0     0     400   0     0
GEOLOGICAL:     0     0    0     0    -.5    0     0     0

COORDINATES:    X = 11    Y = 39          GRID AREA:     400 UNITS
LEES:           0     0    196   0     0     0     0     196   0     204
GEOLOGICAL:     0     0    0     0    -.5    0     0     0

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Ready
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COORDINATES:	X = 30		Y = 30			GRID AREA:		400	UNITS		
LEES:	44	0	0	3	10	64	0	303	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 31		Y = 30			GRID AREA:		400	UNITS		
LEES:	66	0	4	2	0	3	8	132	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 32		Y = 30			GRID AREA:		382	UNITS		
LEES:	59	0	38	30	0	24	0	164	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 33		Y = 30			GRID AREA:		400	UNITS		
LEES:	6	0	71	60	0	0	0	37	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 34		Y = 30			GRID AREA:		400	UNITS		
LEES:	190	0	54	6	9	7	0	286	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 35		Y = 30			GRID AREA:		259	UNITS		
LEES:	11	0	22	14	0	0	7	32	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 30		Y = 31			GRID AREA:		372	UNITS		
LEES:	9	0	10	45	0	3	0	118	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 31		Y = 31			GRID AREA:		96	UNITS		
LEES:	17	0	0	25	0	0	14	83	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 32		Y = 31			GRID AREA:		160	UNITS		
LEES:	9	0	6	27	0	0	0	69	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 33		Y = 31			GRID AREA:		400	UNITS		
LEES:	76	0	11	2	0	48	0	5	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 34		Y = 31			GRID AREA:		400	UNITS		
LEES:	79	0	4	0	0	32	3	218	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 35		Y = 31			GRID AREA:		242	UNITS		
LEES:	52	0	0	9	0	1	0	0	0	0	
GEOLOGICAL:	0	0	0	1	0	0	0	0			
COORDINATES:	X = 30		Y = 32			GRID AREA:		83	UNITS		
LEES:	3	0	12	0	0	0	2	0	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			

COORDINATES:	X = 32		Y = 32			GRID AREA:			160	UNITS
LEES:	44	0	7	0	0	90	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 32			GRID AREA:			400	UNITS
LEES:	44	0	8	0	0	341	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 32			GRID AREA:			400	UNITS
LEES:	28	0	0	0	0	288	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 32			GRID AREA:			207	UNITS
LEES:	63	0	0	2	0	54	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 33			GRID AREA:			155	UNITS
LEES:	61	0	5	2	0	68	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 33		Y = 33			GRID AREA:			400	UNITS
LEES:	21	0	0	31	0	307	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 33			GRID AREA:			400	UNITS
LEES:	7	0	0	0	0	289	0	111	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 35		Y = 33			GRID AREA:			187	UNITS
LEES:	14	0	0	0	2	92	0	1	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 34			GRID AREA:			140	UNITS
LEES:	0	0	23	0	0	89	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 34			GRID AREA:			400	UNITS
LEES:	31	0	0	40	4	9	41	142	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 34			GRID AREA:			400	UNITS
LEES:	88	0	0	7	0	79	35	321	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 34			GRID AREA:			172	UNITS
LEES:	9	0	0	2	0	100	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 35			GRID AREA:			120	UNITS
LEES:	0	0	12	6	2	68	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 33		Y = 35			GRID AREA:			327 UNITS	
LEES:	22	0	0	21	0	2	0	74	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 35			GRID AREA:			183 UNITS	
LEES:	10	0	0	9	0	49	2	134	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 35			GRID AREA:			55 UNITS	
LEES:	0	0	0	0	0	48	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 36			GRID AREA:			25 UNITS	
LEES:	0	0	0	3	0	16	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	0		
COORDINATES:	X = 33		Y = 36			GRID AREA:			3 UNITS	
LEES:	0	0	0	0	2	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 24		Y = 20			GRID AREA:			400 UNITS	
LEES:	83	0	0	22	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 25		Y = 20			GRID AREA:			400 UNITS	
LEES:	265	0	0	7	12	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 26		Y = 20			GRID AREA:			400 UNITS	
LEES:	386	0	0	4	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 20			GRID AREA:			400 UNITS	
LEES:	370	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 20			GRID AREA:			400 UNITS	
LEES:	130	0	27	0	5	0	0	0	0	0
GEOLOGICAL:	0	1	1	0	0	0	.2	.1		
COORDINATES:	X = 29		Y = 20			GRID AREA:			400 UNITS	
LEES:	265	0	0	39	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 21			GRID AREA:			400 UNITS	
LEES:	123	0	0	8	5	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 21			GRID AREA:			400 UNITS	
LEES:	340	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 26		Y = 21			GRID AREA:			400	UNITS
LEES:	130	0	62	13	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.2		
COORDINATES:	X = 27		Y = 21			GRID AREA:			400	UNITS
LEES:	300	0	0	10	0	43	0	75	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 21			GRID AREA:			400	UNITS
LEES:	270	0	20	3	3	15	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 21			GRID AREA:			400	UNITS
LEES:	270	0	3	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 22			GRID AREA:			400	UNITS
LEES:	225	0	7	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 22			GRID AREA:			400	UNITS
LEES:	290	0	0	4	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 22			GRID AREA:			400	UNITS
LEES:	20	0	32	39	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 22			GRID AREA:			400	UNITS
LEES:	110	0	30	32	0	80	0	161	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 22			GRID AREA:			400	UNITS
LEES:	90	0	55	25	0	90	0	27	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 29		Y = 22			GRID AREA:			400	UNITS
LEES:	50	0	20	65	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 23			GRID AREA:			400	UNITS
LEES:	57	0	45	0	45	38	0	118	5	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 23			GRID AREA:			400	UNITS
LEES:	123	0	39	7	16	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 23			GRID AREA:			400	UNITS
LEES:	30	0	110	38	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 27		Y = 23			GRID AREA:		400 UNITS	
LEES:	135	0	43	12	6	9	0	30	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 23			GRID AREA:		400 UNITS	
LEES:	145	0	81	25	0	3	0	350	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 23			GRID AREA:		400 UNITS	
LEES:	50	0	33	8	11	0	8	125	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 24		Y = 24			GRID AREA:		400 UNITS	
LEES:	14	0	142	2	8	130	0	95	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 24			GRID AREA:		400 UNITS	
LEES:	71	0	50	7	4	22	21	135	1	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 24			GRID AREA:		400 UNITS	
LEES:	33	0	120	0	0	6	4	210	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 24			GRID AREA:		400 UNITS	
LEES:	120	0	30	28	0	0	0	36	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 24			GRID AREA:		400 UNITS	
LEES:	95	0	85	0	0	14	56	100	0	0
GEOLOGICAL:	0	0	1	0	0	0	.1	0		
COORDINATES:	X = 29		Y = 24			GRID AREA:		400 UNITS	
LEES:	0	0	30	0	23	0	15	42	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 25			GRID AREA:		400 UNITS	
LEES:	56	0	50	34	0	24	3	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 25			GRID AREA:		400 UNITS	
LEES:	78	0	150	10	0	24	13	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 25			GRID AREA:		400 UNITS	
LEES:	280	0	23	4	0	0	16	125	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 25			GRID AREA:		400 UNITS	
LEES:	9	0	65	41	7	20	45	50	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 28		Y = 25			GRID AREA:			400	UNITS
LEES:	2	0	135	18	0	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 25			GRID AREA:			400	UNITS
LEES:	31	0	23	3	3	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 26			GRID AREA:			400	UNITS
LEES:	105	0	130	0	2	3	11	0	0	0
GEOLOGICAL:	1	1	1	0	0	0	0	.2		
COORDINATES:	X = 25		Y = 26			GRID AREA:			400	UNITS
LEES:	14	0	270	0	0	0	0	100	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 26		Y = 26			GRID AREA:			400	UNITS
LEES:	65	0	47	4	0	0	3	3	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 26			GRID AREA:			400	UNITS
LEES:	1	0	30	85	0	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 26			GRID AREA:			400	UNITS
LEES:	8	0	21	11	0	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 26			GRID AREA:			400	UNITS
LEES:	10	0	0	10	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 24		Y = 27			GRID AREA:			400	UNITS
LEES:	26	0	250	0	2	0	0	0	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	.1		
COORDINATES:	X = 25		Y = 27			GRID AREA:			400	UNITS
LEES:	0	0	290	0	0	2	0	50	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 26		Y = 27			GRID AREA:			400	UNITS
LEES:	6	0	100	26	0	10	0	0	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 27		Y = 27			GRID AREA:			400	UNITS
LEES:	19	0	105	14	0	6	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 27			GRID AREA:			400	UNITS
LEES:	0	0	65	11	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 29		Y = 27			GRID AREA:			400	UNITS
LEES:	25	0	18	24	0	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 24		Y = 28			GRID AREA:			400	UNITS
LEES:	2	0	340	0	0	0	0	65	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 28			GRID AREA:			400	UNITS
LEES:	0	0	375	0	0	0	0	100	5	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 26		Y = 28			GRID AREA:			400	UNITS
LEES:	0	0	85	24	6	25	0	10	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	-.2		
COORDINATES:	X = 27		Y = 28			GRID AREA:			400	UNITS
LEES:	10	0	18	45	0	3	0	45	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 28			GRID AREA:			400	UNITS
LEES:	17	0	61	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 28			GRID AREA:			400	UNITS
LEES:	37	0	13	13	3	8	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.2		
COORDINATES:	X = 24		Y = 29			GRID AREA:			400	UNITS
LEES:	30	0	145	0	0	0	5	55	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 29			GRID AREA:			400	UNITS
LEES:	0	0	348	0	0	13	8	55	7	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 29			GRID AREA:			400	UNITS
LEES:	25	0	145	10	0	5	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		
COORDINATES:	X = 27		Y = 29			GRID AREA:			400	UNITS
LEES:	0	0	135	2	0	7	34	59	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 29			GRID AREA:			400	UNITS
LEES:	25	0	213	2	2	7	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 29			GRID AREA:			400	UNITS
LEES:	60	0	74	0	0	5	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

NARRAGANNSETT BASIN FILE 7

COORDINATES:	X = 30	Y = 20		GRID AREA:			400	UNITS	
LEES:	40 0	158 5	0	0	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 31	Y = 20		GRID AREA:			400	UNITS	
LEES:	45 0	175 4	0	0	9	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 32	Y = 20		GRID AREA:			400	UNITS	
LEES:	25 0	17 73	8	25	0	50	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 33	Y = 20		GRID AREA:			400	UNITS	
LEES:	33 0	3 66	0	10	38	43	2	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 34	Y = 20		GRID AREA:			400	UNITS	
LEES:	44 0	0 5	22	20	70	50	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 35	Y = 20		GRID AREA:			400	UNITS	
LEES:	45 0	0 50	0	25	20	265	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 30	Y = 21		GRID AREA:			400	UNITS	
LEES:	7 0	125 30	0	0	3	10	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 31	Y = 21		GRID AREA:			400	UNITS	
LEES:	20 0	145 13	0	12	3	175	2	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 32	Y = 21		GRID AREA:			400	UNITS	
LEES:	67 0	0 52	0	4	0	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 33	Y = 21		GRID AREA:			400	UNITS	
LEES:	13 0	7 25	3	6	4	0	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 34	Y = 21		GRID AREA:			400	UNITS	
LEES:	70 0	7 0	3	6	0	35	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 35	Y = 21		GRID AREA:			400	UNITS	
LEES:	93 0	0 0	8	0	4	185	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			
COORDINATES:	X = 30	Y = 22		GRID AREA:			400	UNITS	
LEES:	68 0	31 16	0	0	0	40	0	0	
GEOLOGICAL:	0 0	0 0	0	0	0	0			

COORDINATES:	X = 31		Y = 22			GRID AREA:			400	UNITS
LEES:	30	0	23	47	0	0	0	155	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 22			GRID AREA:			400	UNITS
LEES:	13	0	45	38	13	0	4	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 22			GRID AREA:			400	UNITS
LEES:	76	0	7	3	7	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 22			GRID AREA:			400	UNITS
LEES:	80	0	0	0	0	1	7	46	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 22			GRID AREA:			400	UNITS
LEES:	103	0	3	5	0	5	0	80	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 23			GRID AREA:			400	UNITS
LEES:	53	0	5	30	6	1	0	15	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 23			GRID AREA:			400	UNITS
LEES:	88	0	15	6	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 23			GRID AREA:			400	UNITS
LEES:	6	0	8	0	0	4	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 23			GRID AREA:			400	UNITS
LEES:	46	0	0	6	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 23			GRID AREA:			400	UNITS
LEES:	0	0	23	0	0	0	8	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 23			GRID AREA:			400	UNITS
LEES:	205	0	3	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 24			GRID AREA:			400	UNITS
LEES:	65	0	55	20	4	0	8	7	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 24			GRID AREA:			400	UNITS
LEES:	83	0	3	3	0	9	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 32		Y = 24			GRID AREA:			400	UNITS
LEES:	17	0	95	5	0	1	5	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 24			GRID AREA:			400	UNITS
LEES:	40	0	4	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 24			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 24			GRID AREA:			400	UNITS
LEES:	218	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 25			GRID AREA:			400	UNITS
LEES:	46	0	13	43	3	3	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 31		Y = 25			GRID AREA:			400	UNITS
LEES:	35	0	33	6	18	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 32		Y = 25			GRID AREA:			400	UNITS
LEES:	75	0	7	35	0	8	8	145	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 25			GRID AREA:			400	UNITS
LEES:	47	0	16	24	7	16	0	35	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 25			GRID AREA:			400	UNITS
LEES:	125	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 35		Y = 25			GRID AREA:			400	UNITS
LEES:	135	0	0	3	16	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 26			GRID AREA:			400	UNITS
LEES:	44	0	33	19	3	0	2	26	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 26			GRID AREA:			400	UNITS
LEES:	78	0	9	32	1	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 26			GRID AREA:			400	UNITS
LEES:	95	0	0	5	0	0	0	9	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 33		Y = 26			GRID AREA:		400	UNITS	
LEES:	88	0	12	29	12	11	0	200	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 26			GRID AREA:		225	UNITS	
LEES:	11	0	0	0	20	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	-.2		
COORDINATES:	X = 35		Y = 26			GRID AREA:		235	UNITS	
LEES:	54	0	0	8	18	3	0	25	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 27			GRID AREA:		400	UNITS	
LEES:	90	0	6	4	0	0	15	37	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 27			GRID AREA:		400	UNITS	
LEES:	17	0	67	24	0	0	0	15	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 27			GRID AREA:		400	UNITS	
LEES:	125	0	1	13	7	5	0	150	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 27			GRID AREA:		400	UNITS	
LEES:	37	0	43	33	0	10	28	300	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 27			GRID AREA:		200	UNITS	
LEES:	27	0	51	5	7	3	0	3	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 27			GRID AREA:		92	UNITS	
LEES:	2	0	8	6	14	0	0	36	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 28			GRID AREA:		400	UNITS	
LEES:	54	0	0	7	41	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 31		Y = 28			GRID AREA:		400	UNITS	
LEES:	31	0	20	32	1	18	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 28			GRID AREA:		400	UNITS	
LEES:	76	0	83	15	6	4	7	385	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 28			GRID AREA:		400	UNITS	
LEES:	42	0	223	0	5	10	6	180	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.2		

COORDINATES:	X = 34		Y = 28			GRID AREA:			345	UNITS
LEES:	0	0	260	15	0	5	0	45	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 28			GRID AREA:			25	UNITS
LEES:	0	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 30		Y = 29			GRID AREA:			400	UNITS
LEES:	32	0	0	18	2	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 31		Y = 29			GRID AREA:			400	UNITS
LEES:	28	0	0	31	0	3	15	25	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 32		Y = 29			GRID AREA:			400	UNITS
LEES:	62	0	0	10	14	15	8	375	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 33		Y = 29			GRID AREA:			400	UNITS
LEES:	26	0	85	54	0	2	27	290	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 34		Y = 29			GRID AREA:			400	UNITS
LEES:	41	0	125	30	4	4	7	245	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 35		Y = 29			GRID AREA:			135	UNITS
LEES:	3	0	17	33	0	2	0	110	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 30			GRID AREA:			400	UNITS
LEES:	31	0	136	10	0	4	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 25		Y = 30			GRID AREA:			400	UNITS
LEES:	75	0	41	27	0	8	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 30			GRID AREA:			400	UNITS
LEES:	113	0	17	24	0	0	12	5	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 30			GRID AREA:			400	UNITS
LEES:	9	0	91	16	0	3	0	35	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 30			GRID AREA:			400	UNITS
LEES:	31	0	30	15	3	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 29		Y = 30			GRID AREA:		400	UNITS	
LEES:	81	0	63	4	5	13	0	174	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 31			GRID AREA:		400	UNITS	
LEES:	62	0	111	0	0	24	0	0	2	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 25		Y = 31			GRID AREA:		400	UNITS	
LEES:	58	0	3	36	0	1	18	184	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 31			GRID AREA:		400	UNITS	
LEES:	112	0	3	65	0	0	3	64	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 31			GRID AREA:		400	UNITS	
LEES:	91	0	19	14	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 31			GRID AREA:		400	UNITS	
LEES:	11	0	34	30	0	2	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 31			GRID AREA:		400	UNITS	
LEES:	71	0	2	30	0	9	2	237	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 24		Y = 32			GRID AREA:		400	UNITS	
LEES:	47	0	18	25	0	19	0	109	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 25		Y = 32			GRID AREA:		400	UNITS	
LEES:	93	0	5	20	3	0	0	329	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 32			GRID AREA:		400	UNITS	
LEES:	113	0	25	9	16	0	0	41	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 32			GRID AREA:		400	UNITS	
LEES:	102	0	4	17	6	12	12	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 32			GRID AREA:		400	UNITS	
LEES:	60	0	6	43	5	0	1	18	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 32			GRID AREA:		389	UNITS	
LEES:	72	0	67	17	4	1	29	173	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 24		Y = 33			GRID AREA:			400	UNITS
LEES:	65	0	51	38	6	31	0	158	2	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 25		Y = 33			GRID AREA:			400	UNITS
LEES:	11	0	6	16	4	0	1	56	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 26		Y = 33			GRID AREA:			400	UNITS
LEES:	69	0	21	7	6	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 33			GRID AREA:			400	UNITS
LEES:	44	0	0	0	13	0	2	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 28		Y = 33			GRID AREA:			400	UNITS
LEES:	82	0	14	38	0	0	9	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 33			GRID AREA:			237	UNITS
LEES:	17	0	0	7	0	0	0	0	0	0
GEOLOGICAL:	0	0	.2	1	0	0	0	0		
COORDINATES:	X = 24		Y = 34			GRID AREA:			400	UNITS
LEES:	76	0	45	25	5	95	0	4	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 25		Y = 34			GRID AREA:			400	UNITS
LEES:	39	0	11	5	1	3	0	42	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 26		Y = 34			GRID AREA:			400	UNITS
LEES:	53	0	15	15	10	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 27		Y = 34			GRID AREA:			399	UNITS
LEES:	99	0	0	28	6	0	8	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 28		Y = 34			GRID AREA:			318	UNITS
LEES:	99	0	0	16	0	0	6	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 29		Y = 34			GRID AREA:			98	UNITS
LEES:	63	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 24		Y = 35			GRID AREA:			400	UNITS
LEES:	18	0	16	43	0	88	0	0	2	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		

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COORDINATES:    X = 25      Y = 35          GRID AREA:      400 UNITS
LEES:           104  0      0    0    6     90   0    0     0    0
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 26      Y = 35          GRID AREA:      400 UNITS
LEES:           62   0      29   22   6     3    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 27      Y = 35          GRID AREA:      183 UNITS
LEES:           29   0      0    48   8     12   0    0     0    0
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 28      Y = 35          GRID AREA:      29 UNITS
LEES:           12   0      0    0    0     0    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 29      Y = 35          GRID AREA:      7 UNITS
LEES:           7    0      0    0    0     0    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 24      Y = 36          GRID AREA:      400 UNITS
LEES:           25   0      19   21   6     125  0    0     0    0
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 25      Y = 36          GRID AREA:      400 UNITS
LEES:           35   0      81   3    11    122  14   0     4    0
GEOLOGICAL:     0    0      .2   0    0     0    0    0

COORDINATES:    X = 26      Y = 36          GRID AREA:      191 UNITS
LEES:           3    0      13   29   11    77   8    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 24      Y = 37          GRID AREA:      400 UNITS
LEES:           9    0      65   0    16    217  0    0     0    0
GEOLOGICAL:     0    0      0    0    0     0    0    0

COORDINATES:    X = 25      Y = 37          GRID AREA:      190 UNITS
LEES:           5    0      27   0    7     0    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 24      Y = 38          GRID AREA:      198 UNITS
LEES:           0    0      10   0    6     153  0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

COORDINATES:    X = 24      Y = 39          GRID AREA:      80 UNITS
LEES:           0    0      0    3    0     2    0    0     0    0
GEOLOGICAL:     0    0      0    1    0     0    0    0

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COORDINATES:	X = 30		Y = 20			GRID AREA:		400	UNITS	
LEES:	115	0	52	15	0	0	0	307	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 20			GRID AREA:		400	UNITS	
LEES:	62	0	57	16	13	24	0	148	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 20			GRID AREA:		320	UNITS	
LEES:	89	0	0	0	29	9	0	180	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 21			GRID AREA:		400	UNITS	
LEES:	41	0	0	31	0	0	0	165	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 21			GRID AREA:		400	UNITS	
LEES:	70	0	0	7	0	4	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 21			GRID AREA:		395	UNITS	
LEES:	245	0	0	19	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 39		Y = 21			GRID AREA:		70	UNITS	
LEES:	55	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 36		Y = 22			GRID AREA:		400	UNITS	
LEES:	92	0	0	11	0	0	0	0	0	0
GEOLOGICAL:	1	0	0	0	0	0	0	-.2		
COORDINATES:	X = 37		Y = 22			GRID AREA:		400	UNITS	
LEES:	130	0	6	6	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 22			GRID AREA:		400	UNITS	
LEES:	160	0	4	38	6	4	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 39		Y = 22			GRID AREA:		28	UNITS	
LEES:	15	0	0	6	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 23			GRID AREA:		400	UNITS	
LEES:	151	0	0	0	0	1	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 23			GRID AREA:		400	UNITS	
LEES:	131	0	2	8	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 38		Y = 23			GRID AREA:			380	UNITS
LEES:	78	0	19	45	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 24			GRID AREA:			400	UNITS
LEES:	290	0	0	0	5	0	0	30	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 24			GRID AREA:			400	UNITS
LEES:	90	0	0	0	0	0	0	145	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 24			GRID AREA:			335	UNITS
LEES:	22	0	0	37	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 25			GRID AREA:			400	UNITS
LEES:	136	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 25			GRID AREA:			400	UNITS
LEES:	85	0	0	0	2	0	0	150	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 25			GRID AREA:			280	UNITS
LEES:	45	0	0	5	0	4	5	140	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 26			GRID AREA:			400	UNITS
LEES:	31	0	2	0	17	7	0	200	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 26			GRID AREA:			400	UNITS
LEES:	18	0	44	38	12	11	0	90	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 26			GRID AREA:			240	UNITS
LEES:	17	0	29	0	0	0	0	120	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 36		Y = 27			GRID AREA:			400	UNITS
LEES:	25	0	20	41	13	0	0	80	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 37		Y = 27			GRID AREA:			400	UNITS
LEES:	65	0	0	14	8	4	0	40	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 38		Y = 27			GRID AREA:			180	UNITS
LEES:	30	0	0	0	0	0	0	60	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 36	Y = 28			GRID AREA:			375 UNITS	
LEES:	5 0	0	11	0	0	0	0	0	0
GEOLOGICAL:	0 0	0	0	0	0	0	0		
COORDINATES:	X = 37	Y = 28			GRID AREA:			400 UNITS	
LEES:	132 0	20	0	0	30	0	125	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 38	Y = 28			GRID AREA:			115 UNITS	
LEES:	4 0	0	0	0	8	0	40	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 36	Y = 29			GRID AREA:			235 UNITS	
LEES:	21 0	0	15	0	0	0	36	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 37	Y = 29			GRID AREA:			400 UNITS	
LEES:	95 0	5	9	0	4	0	165	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 38	Y = 29			GRID AREA:			50 UNITS	
LEES:	20 0	0	0	0	0	0	47	0	0
GEOLOGICAL:	0 0	0	0	0	0	0	0		
COORDINATES:	X = 36	Y = 30			GRID AREA:			8 UNITS	
LEES:	4 0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 36	Y = 31			GRID AREA:			38 UNITS	
LEES:	6 0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0 0	0	1	0	0	0	0		
COORDINATES:	X = 12	Y = 30			GRID AREA:			400 UNITS	
LEES:	0 0	400	0	0	0	0	400	0	0
GEOLOGICAL:	0 0	0	0	0	0	0	0		
COORDINATES:	X = 13	Y = 30			GRID AREA:			400 UNITS	
LEES:	22 0	305	0	0	3	1	400	0	0
GEOLOGICAL:	0 0	0	0	0	0	0	0		
COORDINATES:	X = 14	Y = 30			GRID AREA:			400 UNITS	
LEES:	52 0	38	10	10	14	8	277	2	0
GEOLOGICAL:	0 0	-.2	0	0	0	0	.2		
COORDINATES:	X = 15	Y = 30			GRID AREA:			400 UNITS	
LEES:	67 0	0	13	13	0	0	0	0	0
GEOLOGICAL:	0 0	-.2	0	0	0	0	.2		
COORDINATES:	X = 16	Y = 30			GRID AREA:			400 UNITS	
LEES:	115 0	0	0	0	0	0	8	0	0
GEOLOGICAL:	0 0	-.2	0	0	0	0	.1		

COORDINATES:	X = 17		Y = 30			GRID AREA:		400	UNITS		
LEES:	36	0	0	12	0	7	0	377	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 12		Y = 31			GRID AREA:		400	UNITS		
LEES:	0	0	352	0	0	0	13	365	0	35	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 13		Y = 31			GRID AREA:		400	UNITS		
LEES:	12	0	255	0	0	62	3	338	4	0	
GEOLOGICAL:	0	0	1	0	0	0	0	0			
COORDINATES:	X = 14		Y = 31			GRID AREA:		400	UNITS		
LEES:	42	0	35	55	0	2	14	245	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1			
COORDINATES:	X = 15		Y = 31			GRID AREA:		400	UNITS		
LEES:	105	0	0	2	0	0	0	0	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1			
COORDINATES:	X = 16		Y = 31			GRID AREA:		400	UNITS		
LEES:	35	0	0	5	0	0	0	13	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1			
COORDINATES:	X = 17		Y = 31			GRID AREA:		400	UNITS		
LEES:	23	0	0	55	13	2	0	315	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1			
COORDINATES:	X = 12		Y = 32			GRID AREA:		400	UNITS		
LEES:	0	0	315	0	0	0	0	315	0	85	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 13		Y = 32			GRID AREA:		400	UNITS		
LEES:	0	0	318	0	0	75	0	325	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 14		Y = 32			GRID AREA:		400	UNITS		
LEES:	110	0	55	15	0	0	0	380	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.2			
COORDINATES:	X = 15		Y = 32			GRID AREA:		400	UNITS		
LEES:	105	0	2	22	0	0	0	0	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1			
COORDINATES:	X = 16		Y = 32			GRID AREA:		400	UNITS		
LEES:	50	0	16	32	3	0	0	145	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 17		Y = 32			GRID AREA:		400	UNITS		
LEES:	83	0	32	33	1	0	4	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			

COORDINATES:	X = 12		Y = 33			GRID AREA:		400	UNITS		
LEES:	0	0	360	0	0	0	0	360	0	40	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 13		Y = 33			GRID AREA:		400	UNITS		
LEES:	39	0	255	0	0	41	0	359	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	.1			
COORDINATES:	X = 14		Y = 33			GRID AREA:		400	UNITS		
LEES:	55	0	23	130	3	0	0	270	0	0	
GEOLOGICAL:	0	0	.2	0	0	0	0	.1			
COORDINATES:	X = 15		Y = 33			GRID AREA:		400	UNITS		
LEES:	45	0	36	52	0	0	0	22	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 16		Y = 33			GRID AREA:		400	UNITS		
LEES:	64	0	18	31	0	6	10	315	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 17		Y = 33			GRID AREA:		400	UNITS		
LEES:	95	0	17	14	28	0	8	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 12		Y = 34			GRID AREA:		400	UNITS		
LEES:	0	0	400	0	0	0	0	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 13		Y = 34			GRID AREA:		400	UNITS		
LEES:	30	0	155	0	0	7	72	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 14		Y = 34			GRID AREA:		400	UNITS		
LEES:	127	0	30	25	1	0	0	280	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 15		Y = 34			GRID AREA:		400	UNITS		
LEES:	28	0	5	40	4	0	0	280	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 16		Y = 34			GRID AREA:		400	UNITS		
LEES:	81	0	0	20	3	5	0	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 17		Y = 34			GRID AREA:		400	UNITS		
LEES:	130	0	0	12	0	0	0	400	0	0	
GEOLOGICAL:	0	0	0	0	0	0	0	0			
COORDINATES:	X = 12		Y = 35			GRID AREA:		400	UNITS		
LEES:	1	0	394	0	0	0	0	195	0	0	
GEOLOGICAL:	0	0	-.2	0	0	0	0	0			

COORDINATES:	X = 13		Y = 35			GRID AREA:		400	UNITS			
LEES:	38	0	230	7	0	0	0	365	0	0		
GEOLOGICAL:	0	0	1	0	0	0	0	0				
COORDINATES:	X = 14		Y = 35			GRID AREA:		400	UNITS			
LEES:	19	0	115	50	0	5	25	375	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 15		Y = 35			GRID AREA:		400	UNITS			
LEES:	59	0	16	18	3	0	9	270	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 16		Y = 35			GRID AREA:		400	UNITS			
LEES:	31	0	0	16	8	25	11	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 17		Y = 35			GRID AREA:		400	UNITS			
LEES:	117	0	2	14	0	3	8	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 12		Y = 36			GRID AREA:		400	UNITS			
LEES:	17	0	340	0	0	0	0	157	0	13		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 13		Y = 36			GRID AREA:		400	UNITS			
LEES:	85	0	190	0	0	1	12	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 14		Y = 36			GRID AREA:		400	UNITS			
LEES:	26	0	195	5	0	0	9	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 15		Y = 36			GRID AREA:		400	UNITS			
LEES:	58	0	40	17	6	1	5	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 16		Y = 36			GRID AREA:		400	UNITS			
LEES:	68	0	0	4	0	0	14	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 17		Y = 36			GRID AREA:		400	UNITS			
LEES:	55	0	25	0	0	0	0	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				
COORDINATES:	X = 12		Y = 37			GRID AREA:		400	UNITS			
LEES:	30	0	284	0	0	4	0	382	0	100		
GEOLOGICAL:	0	0	.2	0	0	0	0	0				
COORDINATES:	X = 13		Y = 37			GRID AREA:		400	UNITS			
LEES:	70	0	115	7	0	3	5	400	0	0		
GEOLOGICAL:	0	0	0	0	0	0	0	0				

COORDINATES:	X = 14		Y = 37			GRID AREA:		400		UNITS
LEES:	70	28	85	0	0	0	0	400	0	4
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 37			GRID AREA:		400		UNITS
LEES:	63	0	71	4	3	0	1	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 37			GRID AREA:		400		UNITS
LEES:	75	0	55	17	0	10	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 37			GRID AREA:		400		UNITS
LEES:	70	0	19	10	0	1	0	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 38			GRID AREA:		400		UNITS
LEES:	0	0	245	0	0	0	0	245	0	155
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 13		Y = 38			GRID AREA:		400		UNITS
LEES:	65	3	295	6	0	0	0	335	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 38			GRID AREA:		400		UNITS
LEES:	20	66	88	14	0	0	0	330	0	70
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 38			GRID AREA:		400		UNITS
LEES:	45	70	23	44	0	0	0	361	0	39
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 38			GRID AREA:		400		UNITS
LEES:	110	5	29	8	6	4	0	351	0	45
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 38			GRID AREA:		400		UNITS
LEES:	9	0	116	41	6	0	0	400	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	0		
COORDINATES:	X = 12		Y = 39			GRID AREA:		400		UNITS
LEES:	0	0	115	0	0	0	0	115	0	285
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 13		Y = 39			GRID AREA:		400		UNITS
LEES:	14	0	350	0	0	0	0	341	0	19
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 14		Y = 39			GRID AREA:		400		UNITS
LEES:	3	38	195	5	0	0	0	260	0	115
GEOLOGICAL:	0	0	0	0	0	0	0	0		

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COORDINATES:    X = 15      Y = 39          GRID AREA:      400 UNITS
LEES:           6    3      234  17    0     0    0      335  0      65
GEOLOGICAL:     0    0      0    0     0     0    0      0

COORDINATES:    X = 16      Y = 39          GRID AREA:      400 UNITS
LEES:           4    82     11   10    0     0    0      240  0      125
GEOLOGICAL:     0    0      0    0     0     0    0      0

COORDINATES:    X = 17      Y = 39          GRID AREA:      400 UNITS
LEES:           40   0      15   7     0     0    5      362  5      0
GEOLOGICAL:     0    0      0    0     0     0    0      0

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COORDINATES:	X = 12		Y = 50			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 50			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 50			GRID AREA:			400	UNITS
LEES:	23	8	0	0	0	0	0	0	0	114
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 15		Y = 50			GRID AREA:			400	UNITS
LEES:	2	0	52	0	0	0	0	0	0	264
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 16		Y = 50			GRID AREA:			400	UNITS
LEES:	0	0	17	0	0	0	15	0	0	340
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 50			GRID AREA:			400	UNITS
LEES:	0	0	134	31	0	6	0	0	0	2
GEOLOGICAL:	1	1	1	0	0	0	.1	.2		
COORDINATES:	X = 12		Y = 51			GRID AREA:			400	UNITS
LEES:	0	0	4	0	0	0	0	0	0	364
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 51			GRID AREA:			400	UNITS
LEES:	3	0	0	0	3	0	0	0	0	389
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 51			GRID AREA:			400	UNITS
LEES:	89	0	11	0	9	0	0	0	0	26
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 15		Y = 51			GRID AREA:			400	UNITS
LEES:	14	0	34	0	0	0	0	0	0	253
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 16		Y = 51			GRID AREA:			400	UNITS
LEES:	0	0	25	0	6	0	0	0	0	323
GEOLOGICAL:	0	1	1	0	0	0	.1	.2		
COORDINATES:	X = 17		Y = 51			GRID AREA:			400	UNITS
LEES:	12	0	127	0	0	2	0	0	0	0
GEOLOGICAL:	1	1	1	0	0	0	.1	.2		
COORDINATES:	X = 12		Y = 52			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	389
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 13		Y = 52			GRID AREA:			400	UNITS
LEES:	27	0	0	0	0	0	0	0	0	329
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 52			GRID AREA:			400	UNITS
LEES:	125	0	11	11	0	0	0	0	0	3
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 15		Y = 52			GRID AREA:			400	UNITS
LEES:	0	0	9	0	0	0	0	0	0	365
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 16		Y = 52			GRID AREA:			400	UNITS
LEES:	6	0	53	11	6	3	0	0	0	163
GEOLOGICAL:	1	0	1	0	0	0	.1	0		
COORDINATES:	X = 17		Y = 52			GRID AREA:			400	UNITS
LEES:	20	0	66	36	5	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	.0	0	0	0		
COORDINATES:	X = 12		Y = 53			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 53			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	386
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 53			GRID AREA:			400	UNITS
LEES:	21	0	0	0	0	0	0	0	0	223
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 15		Y = 53			GRID AREA:			400	UNITS
LEES:	5	0	0	0	0	0	0	0	0	380
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 16		Y = 53			GRID AREA:			400	UNITS
LEES:	13	0	119	0	0	4	0	0	0	87
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 53			GRID AREA:			400	UNITS
LEES:	5	0	105	25	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 54			GRID AREA:			400	UNITS
LEES:	19	0	17	14	48	0	0	0	0	229
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 54			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 14		Y = 54			GRID AREA:			400 UNITS
LEES:	0	0	0	0	0	0	0	0	0 400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 15		Y = 54			GRID AREA:			400 UNITS
LEES:	4	0	1	0	0	0	0	0	0 319
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 16		Y = 54			GRID AREA:			400 UNITS
LEES:	4	0	73	0	3	51	0	0	0 0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 17		Y = 54			GRID AREA:			400 UNITS
LEES:	23	0	78	10	0	0	0	0	0 0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 12		Y = 55			GRID AREA:			400 UNITS
LEES:	25	0	15	5	9	0	6	0	0 124
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 13		Y = 55			GRID AREA:			400 UNITS
LEES:	0	0	0	0	0	0	0	0	0 400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 14		Y = 55			GRID AREA:			400 UNITS
LEES:	0	0	0	0	0	0	0	0	0 400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 15		Y = 55			GRID AREA:			400 UNITS
LEES:	13	0	56	0	0	0	0	0	0 260
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 16		Y = 55			GRID AREA:			400 UNITS
LEES:	16	0	42	5	8	76	0	0	0 0
GEOLOGICAL:	0	0	1	0	0	0	0	0	
COORDINATES:	X = 17		Y = 55			GRID AREA:			400 UNITS
LEES:	9	0	40	1	0	39	0	0	0 0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 12		Y = 56			GRID AREA:			400 UNITS
LEES:	16	0	10	18	0	0	0	0	0 172
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 13		Y = 56			GRID AREA:			400 UNITS
LEES:	0	0	5	0	0	0	0	0	0 395
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 14		Y = 56			GRID AREA:			400 UNITS
LEES:	0	0	0	0	0	0	0	0	0 400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	

COORDINATES:	X = 15		Y = 56			GRID AREA:			400	UNITS
LEES:	8	0	122	11	24	0	0	0	0	55
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 56			GRID AREA:			400	UNITS
LEES:	15	0	19	23	0	14	0	0	0	0
GEOLOGICAL:	0	0	1	0	0	0	0	0		
COORDINATES:	X = 17		Y = 56			GRID AREA:			400	UNITS
LEES:	37	0	72	3	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 57			GRID AREA:			400	UNITS
LEES:	29	0	20	16	6	16	0	0	0	165
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 57			GRID AREA:			400	UNITS
LEES:	0	0	33	0	0	0	0	0	0	367
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 57			GRID AREA:			400	UNITS
LEES:	0	0	27	0	0	0	0	0	0	373
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 57			GRID AREA:			400	UNITS
LEES:	1	0	263	0	0	0	0	0	0	1
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 57			GRID AREA:			400	UNITS
LEES:	18	0	128	12	0	0	5	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 57			GRID AREA:			400	UNITS
LEES:	36	0	13	17	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 58			GRID AREA:			125	UNITS
LEES:	5	0	2	7	3	0	0	0	0	73
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 13		Y = 58			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 14		Y = 58			GRID AREA:			400	UNITS
LEES:	0	0	180	0	0	0	0	0	0	215
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 58			GRID AREA:			400	UNITS
LEES:	0	0	336	0	0	0	0	0	0	1
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 16	Y = 58		GRID AREA:		400 UNITS			
LEES:	0	0	125	50	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 17	Y = 58		GRID AREA:		400 UNITS			
LEES:	8	0	28	54	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 13	Y = 59		GRID AREA:		200 UNITS			
LEES:	0	0	0	0	0	0	0	0	200
GEOLOGICAL:	0	0	0	0	-.9	0	0	0	
COORDINATES:	X = 14	Y = 59		GRID AREA:		400 UNITS			
LEES:	0	0	298	0	10	0	0	0	92
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 15	Y = 59		GRID AREA:		400 UNITS			
LEES:	0	0	328	15	12	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 16	Y = 59		GRID AREA:		400 UNITS			
LEES:	0	0	105	20	0	18	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 17	Y = 59		GRID AREA:		400 UNITS			
LEES:	15	0	56	68	0	0	5	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 18	Y = 30		GRID AREA:		400 UNITS			
LEES:	28	0	0	23	24	0	0	175	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0	
COORDINATES:	X = 19	Y = 30		GRID AREA:		400 UNITS			
LEES:	70	0	4	40	0	0	0	240	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.2		
COORDINATES:	X = 20	Y = 30		GRID AREA:		400 UNITS			
LEES:	40	0	0	32	33	0	0	16	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.2		
COORDINATES:	X = 21	Y = 30		GRID AREA:		400 UNITS			
LEES:	70	0	0	50	0	2	9	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 22	Y = 30		GRID AREA:		400 UNITS			
LEES:	77	0	35	17	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23	Y = 30		GRID AREA:		400 UNITS			
LEES:	21	0	135	17	0	9	4	35	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	.1		

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COORDINATES:    X = 18      Y = 31          GRID AREA:      400 UNITS
LEES:           40   0      25   20   27    0    0     37   0    0
GEOLOGICAL:     0    0      -.2  0    0     0    0     -.3

COORDINATES:    X = 19      Y = 31          GRID AREA:      400 UNITS
LEES:           185  0      0    4    0     0    0     190  0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 20      Y = 31          GRID AREA:      400 UNITS
LEES:           85   0      0    36   7     0    0     81   0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 21      Y = 31          GRID AREA:      400 UNITS
LEES:           44   0      0    10   0     0    0     0    0    0
GEOLOGICAL:     0    0      -.2  0    0     0    0     -.3

COORDINATES:    X = 22      Y = 31          GRID AREA:      400 UNITS
LEES:           58   0      3    20   0     0    0     0    0    0
GEOLOGICAL:     0    0      .2   0    0     0    0     -.3

COORDINATES:    X = 23      Y = 31          GRID AREA:      400 UNITS
LEES:           60   0      29   13   6     0    7     0    0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 18      Y = 32          GRID AREA:      400 UNITS
LEES:           62   0      9    51   11    1    0     400  0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 19      Y = 32          GRID AREA:      400 UNITS
LEES:           132  0      0    24   0     0    0     240  0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 20      Y = 32          GRID AREA:      400 UNITS
LEES:           55   0      0    43   7     0    5     40   0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 21      Y = 32          GRID AREA:      400 UNITS
LEES:           77   0      0    17   0     0    16    6    0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 22      Y = 32          GRID AREA:      400 UNITS
LEES:           78   0      10   25   0     0    0     0    0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

COORDINATES:    X = 23      Y = 32          GRID AREA:      400 UNITS
LEES:           71   0      25   20   0     0    0     0    0    0
GEOLOGICAL:     0    0      0    0    0     0    0     0

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NARRAGANNSETT BASIN FILE 10

COORDINATES:	X = 6	Y = 50		GRID AREA:	254 UNITS				
LEES:	46 0	77 0	0	0	26	254	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 7	Y = 50		GRID AREA:	400 UNITS				
LEES:	39 0	183 0	3	6	9	395	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 8	Y = 50		GRID AREA:	400 UNITS				
LEES:	97 0	127 26	7	0	0	337	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 9	Y = 50		GRID AREA:	400 UNITS				
LEES:	39 4	171 0	10	0	17	0	0	4	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 10	Y = 50		GRID AREA:	400 UNITS				
LEES:	0 0	141 0	0	0	0	0	0	259	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 11	Y = 50		GRID AREA:	400 UNITS				
LEES:	0 0	0 0	0	0	0	0	0	400	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 6	Y = 51		GRID AREA:	356 UNITS				
LEES:	90 0	57 0	8	0	17	356	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 7	Y = 51		GRID AREA:	400 UNITS				
LEES:	31 0	178 0	3	0	9	290	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 8	Y = 51		GRID AREA:	400 UNITS				
LEES:	42 0	237 0	0	0	1	114	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 9	Y = 51		GRID AREA:	400 UNITS				
LEES:	0 0	327 0	0	16	0	0	0	2	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 10	Y = 51		GRID AREA:	400 UNITS				
LEES:	0 0	78 0	0	0	0	0	0	322	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 11	Y = 51		GRID AREA:	400 UNITS				
LEES:	0 0	0 0	0	0	0	0	0	400	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			
COORDINATES:	X = 5	Y = 52		GRID AREA:	53 UNITS				
LEES:	1 0	0 15	0	0	4	53	0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0			

COORDINATES:	X = 6	Y = 52		GRID AREA:	400 UNITS			
LEES:	109 0	31 21	0	0	0	400 0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 52		GRID AREA:	400 UNITS			
LEES:	102 0	25 0	0	0	0	195 0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 52		GRID AREA:	400 UNITS			
LEES:	40 5	155 0	0	2	0	0	0	7
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 52		GRID AREA:	400 UNITS			
LEES:	0 0	363 0	0	0	0	0	3	0
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 10	Y = 52		GRID AREA:	400 UNITS			
LEES:	0 0	168 0	0	0	0	0	4	228
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 11	Y = 52		GRID AREA:	400 UNITS			
LEES:	0 0	0 0	0	0	0	0	0	400
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 5	Y = 53		GRID AREA:	87 UNITS			
LEES:	8 0	10 8	0	0	0	87 0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 6	Y = 53		GRID AREA:	400 UNITS			
LEES:	117 0	73 0	0	0	0	400 0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 53		GRID AREA:	400 UNITS			
LEES:	103 0	80 0	0	0	0	18 0	0	
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 53		GRID AREA:	400 UNITS			
LEES:	5 15	66 0	0	0	0	0	0	184
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 53		GRID AREA:	400 UNITS			
LEES:	0 0	98 0	0	0	0	0	0	285
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 10	Y = 53		GRID AREA:	400 UNITS			
LEES:	0 0	6 0	0	0	0	0	0	394
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		
COORDINATES:	X = 11	Y = 53		GRID AREA:	400 UNITS			
LEES:	0 0	0 0	0	0	0	0	0	400
GEOLOGICAL:	0 0	0 0	-.9	0	0	0		

COORDINATES:	X = 5	Y = 54			GRID AREA:	176 UNITS				
LEES:	40	0	0	0	0	0	0	80	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 6	Y = 54			GRID AREA:	400 UNITS				
LEES:	87	0	85	18	0	42	30	364	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 54			GRID AREA:	400 UNITS				
LEES:	19	0	191	5	0	3	0	160	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 54			GRID AREA:	400 UNITS				
LEES:	0	15	210	0	0	0	0	0	0	140
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 54			GRID AREA:	400 UNITS				
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10	Y = 54			GRID AREA:	400 UNITS				
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11	Y = 54			GRID AREA:	400 UNITS				
LEES:	0	0	0	5	0	0	0	0	0	336
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 5	Y = 55			GRID AREA:	145 UNITS				
LEES:	21	0	0	0	0	2	0	25	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 6	Y = 55			GRID AREA:	400 UNITS				
LEES:	90	0	24	7	0	37	24	25	6	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 55			GRID AREA:	400 UNITS				
LEES:	56	0	108	5	0	35	5	135	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 55			GRID AREA:	400 UNITS				
LEES:	61	8	142	0	0	11	0	10	0	12
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 55			GRID AREA:	400 UNITS				
LEES:	9	9	64	0	0	0	0	0	0	300
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10	Y = 55			GRID AREA:	400 UNITS				
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 11		Y = 55			GRID AREA:		400 UNITS		
LEES:	76	0	0	3	0	0	0	0	0	212
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 5		Y = 56			GRID AREA:		5 UNITS		
LEES:	0	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 6		Y = 56			GRID AREA:		360 UNITS		
LEES:	41	0	27	6	0	5	0	250	2	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7		Y = 56			GRID AREA:		400 UNITS		
LEES:	83	0	102	7	0	8	0	200	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 56			GRID AREA:		400 UNITS		
LEES:	87	0	63	0	0	0	0	240	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 56			GRID AREA:		400 UNITS		
LEES:	10	11	14	0	3	0	0	0	0	225
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 56			GRID AREA:		400 UNITS		
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 56			GRID AREA:		400 UNITS		
LEES:	22	0	33	53	0	0	0	0	0	173
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 6		Y = 57			GRID AREA:		150 UNITS		
LEES:	25	0	0	0	1	0	0	125	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7		Y = 57			GRID AREA:		360 UNITS		
LEES:	72	0	94	5	0	5	0	300	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 57			GRID AREA:		399 UNITS		
LEES:	111	0	20	0	0	5	0	259	4	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 57			GRID AREA:		400 UNITS		
LEES:	21	7	89	4	0	5	0	18	0	24
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 57			GRID AREA:		400 UNITS		
LEES:	0	0	0	0	0	0	0	0	0	398
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 11		Y = 57			GRID AREA:			400 UNITS	
LEES:	18	0	5	137	0	0	0	0	0	102
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 58			GRID AREA:			280 UNITS	
LEES:	65	0	12	0	0	41	0	0	0	41
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 58			GRID AREA:			400 UNITS	
LEES:	44	0	102	5	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 58			GRID AREA:			400 UNITS	
LEES:	0	0	0	0	0	0	0	0	0	388
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 58			GRID AREA:			333 UNITS	
LEES:	30	0	0	52	0	0	0	0	0	72
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 59			GRID AREA:			365 UNITS	
LEES:	31	0	27	10	0	0	0	0	0	72
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 59			GRID AREA:			400 UNITS	
LEES:	38	0	90	0	0	0	0	0	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 59			GRID AREA:			400 UNITS	
LEES:	0	0	0	0	0	0	0	0	0	348
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 59			GRID AREA:			176 UNITS	
LEES:	6	0	0	0	0	0	0	0	0	168
GEOLOCICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 18		Y = 33			GRID AREA:			400 UNITS	
LEES:	115	0	12	18	0	0	5	400	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 33			GRID AREA:			400 UNITS	
LEES:	75	0	0	3	3	75	0	355	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 33			GRID AREA:			400 UNITS	
LEES:	55	0	0	32	0	0	0	23	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 33			GRID AREA:			400 UNITS	
LEES:	110	0	0	14	0	0	0	135	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 22		Y = 33			GRID AREA:			400	UNITS
LEES:	35	0	0	35	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 33			GRID AREA:			400	UNITS
LEES:	37	0	5	25	0	0	17	55	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 34			GRID AREA:			400	UNITS
LEES:	90	0	10	18	1	0	6	399	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 34			GRID AREA:			400	UNITS
LEES:	85	0	1	16	3	4	0	400	0	0
GEOLOGICAL:	0	0	.2	0	0	0	0	-.3		
COORDINATES:	X = 20		Y = 34			GRID AREA:			400	UNITS
LEES:	30	0	0	8	0	0	0	60	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 34			GRID AREA:			400	UNITS
LEES:	135	0	0	8	0	0	0	200	2	
GEOLOGICAL:	0	0	0	0	0	0	0	.1		
COORDINATES:	X = 22		Y = 34			GRID AREA:			400	UNITS
LEES:	75	0	0	[illegible]	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 34			GRID AREA:			400	UNITS
LEES:	27	0	55	20	0	15	24	85	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 35			GRID AREA:			400	UNITS
LEES:	20		8	42	0	0	30	240	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 35			GRID AREA:			400	UNITS
LEES:	300	0	0	15	0	0	0	380	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X =		Y = 35			GRID AREA:			400	UNITS
LEES:	65	0	0	5	0	0	0	65	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 35			GRID AREA:			400	UNITS
LEES:	185	0	1		0	0	0	290	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 35			GRID AREA:			400	UNIT
LEES:	55	0	6	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

```
COORDINATES:     X = 23     Y = 35          GRID AREA:      400 UNITS
LEES:            3    0     0    19   2     0    0    0     0    0
GEOLOGICAL:      0    0    -.2   0    0     0    0    .1
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Ready

NARRAGANNSETT BASIN FILE 11

[illegible]:	X = 12		Y = 40			GRID AREA:		400	UNITS	
LEES:	0	0	30	0	0	0	0	34	0	-366
GEOLOGICAL:		0	0	0	-.5	0	0	0		
COORDINATES:	X = 1[illegible]		Y = 40			GRID AREA:		400	UNITS	
LEES:	5	11	256		0	1	0	338	2	62
GEOLOGICAL:	0	0	0	0	-.5	[illegible]	0	0		
COORDINATES:	X = 14		Y = 40			GRID [illegible]		400	UNITS	
LEES:	6	0	182	16	0	2	29	360		10
[illegible]LOGICAL:	0	0	0	0	0	0	0	0		
[illegible]:	X = 15		Y = 40			GRID AREA:		400	UNITS	
LEES:	[illegible]	11	232	0	0	0	0	286	0	64
GEOLOGICAL:	0		0	0	0	0	0	0		
COORDINATES:	X = 16		Y [illegible]			GRID AREA:		400	UNITS	
LEES:	13	32	62	0	7	[illegible]	0	198	0	157
GEOLOGICAL:	0	0	0	0	0	0		[illegible]		
COORDINATES:	X = 17		Y = 40			GRID AREA:			[illegible]ITS	
[illegible]EES:	42	0	0	42	10	11	0	306	0	0
[illegible]:	0	0	0	0	0	0	0	-.3		
COORDINATES:	Y = 12		[illegible] = 41			GRID AREA:		400	UNITS	
LEES:	0		0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0		0	0	0	0		
COORDINATES:	X = 13		Y = 41			[illegible]RID AREA:		400	UNITS	
LEES:	0	12	7	16	57	13	[illegible]	166	0	234
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 14		Y = 41			GRID AREA:		400	UNIT[illegible]	
LEES:	5	27	109	10	33	1	0	400	4	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = [illegible]		Y = 41			GRID AREA:		400	UNITS	
LEES:	17	2	2[illegible]	[illegible]	5	0	0	329	0	28
GEOLOGICAL:	0	0	0	0		0	0	0		
COORDINATES:	X = 16		Y = 41			GRI[illegible] AREA:		400	UNITS	
LEES:	0	28	266	0	0	0	0	[illegible]		79
GEOLOGICAL:	0	0	0	0	0	0	0	0		
[illegible]:	X = 17		Y = 41			GRID AREA:		400	UNITS	
LEES:	12	10	163	2	4	14	0	300	0	7
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 42			GRID AREA:		400	UNITS	
LEES:	0	5	71	0	0	0	0	187	0	213
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 13		Y = 42			GRID AREA:		400	UNITS	
LEES:	0	0	0	0	0	0	0	4	0	394
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 14		Y = 42			GRID AREA:		400	UNITS	
LEES:	0	0	6	0	0	0	0	16	0	384
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 42			GRID AREA:		400	UNITS	
LEES:	0	31	43	24	86	0	0	127	0	150
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 42			GRID AREA:		400	UNITS	
LEES:	6	10	260	0	13	0	0	229	0	95
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 42			GRID AREA:		400	UNITS	
LEES:	0	35	157	4	1	4	0	38	0	133
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	0	155	0	0	0	0	100	0	231
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	39	2	0	30	0	0	2	0	355
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 16		Y = 43			GRID AREA:		400	UNITS	
LEES:	2	31	113	8	7	0	0	104	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 17		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	0	91	32	4	0	4	0	0	48
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 12		Y = 44			GRID AREA:		400	UNITS	
LEES:	2	0	94	9	0	0	0	0	0	229
GEOLOGICAL:	0	0	0	0	0	0	0	-.3		
COORDINATES:	X = 13		Y = 44			GRID AREA:		400	UNITS	
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 14		Y = 44			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 44			GRID AREA:			400	UNITS
LEES:	0	0	33	0	0	0	0	0	0	365
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 44			GRID AREA:			400	UNITS
LEES:	6	0	271	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 44			GRID AREA:			254	UNITS
LEES:	14	0	41	0	3	1	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 12		Y = 45			GRID AREA:			400	UNITS
LEES:	0	0	1	0	0	1	0	0	0	363
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 45			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 45			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 45			GRID AREA:			400	UNITS
LEES:	0	45	2	0	5	0	0	0	0	248
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 45			GRID AREA:			360	UNITS
LEES:	0	18	104	8	3	1	0	0	0	93
GEOLOGICAL:	0	1	0	1	0	0	.1	.3		
COORDINATES:	X = 17		Y = 45			GRID AREA:			1	UNITS
LEES:	0	0	0	0	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	1	0	0	0	0		
COORDINATES:	X = 12		Y = 46			GRID AREA:			400	UNITS
LEES:	0	0	1	0	0	0	0	0	0	394
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 46			GRID AREA:			400	UNITS
LEES:	0	7	0	0	0	0	0	0	0	379
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 46			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 15		Y = 46			GRID AREA:			400	UNITS
LEES:	40	7	9	0	28	0	0	0	0	118
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 46			GRID AREA:			256	UNITS
LEES:	0	0	32	0	9	0	0	0	0	193
GEOLOGICAL:	1	1	1	1	0	0	.1	-.3		
COORDINATES:	X = 12		Y = 47			GRID AREA:			400	UNITS
LEES:	0	8	0	0	13	0	0	0	0	255
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 47			GRID AREA:			400	UNITS
LEES:	0	50	0	0	5	0	0	0	0	224
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 47			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 47			GRID AREA:			400	UNITS
LEES:	0	0	0	0	35	0	0	0	0	270
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 47			GRID AREA:			255	UNITS
LEES:	0	0	0	0	0	0	0	0	0	255
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 12		Y = 48			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 48			GRID AREA:			400	UNITS
LEES:	15	35	14	3	0	3	0	0	0	147
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 48			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 48			GRID AREA:			400	UNITS
LEES:	0	0	0	0	3	0	0	0	0	397
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 48			GRID AREA:			368	UNITS
LEES:	0	23	22	10	0	0	0	0	0	238
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 48			GRID AREA:			135	UNITS
LEES:	0	0	0	6	0	0	0	0	0	129
GEOLOGICAL:	0	0	0	1	0	0	0	0		

COORDINATES:	X = 12		Y = 49			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	400
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 13		Y = 49			GRID AREA:			400	UNITS
LEES:	0	23	4	3	0	0	0	0	0	239
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 14		Y = 49			GRID AREA:			400	UNITS
LEES:	0	63	13	8	5	0	0	0	0	223
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 15		Y = 49			GRID AREA:			400	UNITS
LEES:	0	0	7	0	0	0	0	0	0	390
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 16		Y = 49			GRID AREA:			400	UNITS
LEES:	0	0	0	0	0	0	0	0	0	377
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 17		Y = 49			GRID AREA:			400	UNITS
LEES:	0	13	51	46	0	0	0	0	0	205
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 18		Y = 36			GRID AREA:			400	UNITS
LEES:	3	0	0	15	8	0	0	200	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 36			GRID AREA:			400	UNITS
LEES:	99	0	0	20	4	0	0	240	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 36			GRID AREA:			400	UNITS
LEES:	70	0	0	25	0	0	0	105	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 36			GRID AREA:			400	UNITS
LEES:	98	0	3	11	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 36			GRID AREA:			400	UNITS
LEES:	33	0	4	4	0	0	0	0	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 23		Y = 36			GRID AREA:			400	UNITS
LEES:	70	0	31	23	0	45	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.2		
COORDINATES:	X = 18		Y = 37			GRID AREA:			400	UNITS
LEES:	30	0	0	19	0	0	16	265	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

COORDINATES:	X = 19		Y = 37			GRID AREA:		400 UNITS		
LEES:	75	0	9	16	3	0	17	320	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 37			GRID AREA:		400 UNITS		
LEES:	98	0	24	11	0	0	5	255	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 21		Y = 37			GRID AREA:		400 UNITS		
LEES:	65	0	14	28	3	0	0	85	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 22		Y = 37			GRID AREA:		400 UNITS		
LEES:	23	0	40	1	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 23		Y = 37			GRID AREA:		400 UNITS		
LEES:	3	0	90	5	0	110	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 18		Y = 38			GRID AREA:		400 UNITS		
LEES:	62	0	55	4	0	44	0	320	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 19		Y = 38			GRID AREA:		400 UNITS		
LEES:	35	0	22	16	2	6	0	195	2	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		
COORDINATES:	X = 20		Y = 38			GRID AREA:		400 UNITS		
LEES:	35	0	31	18	0	0	6	365	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 21		Y = 38			GRID AREA:		400 UNITS		
LEES:	30	0	4	25	3	0	0	5	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 22		Y = 38			GRID AREA:		400 UNITS		
LEES:	59	0	165	9	0	0	0	0	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	-.3		
COORDINATES:	X = 23		Y = 38			GRID AREA:		400 UNITS		
LEES:	23	0	195	0	0	40	0	0	4	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.1		
COORDINATES:	X = 18		Y = 39			GRID AREA:		400 UNITS		
LEES:	37	0	75	8	0	0	0	400	0	0
GEOLOGICAL:	0	0	-.2	0	0	0	0	.2		
COORDINATES:	X = 19		Y = 39			GRID AREA:		400 UNITS		
LEES:	20	0	125	0	0	21	0	190	0	0
GEOLOGICAL:	0	0	0	0	0	0	0	0		

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COORDINATES:    X = 20     Y = 39          GRID AREA:      400 UNITS
LEES:           10   0     37   40    0     8    0     265  0     0
GEOLOGICAL:     0    0     -.2  0     0     0    0     -.2

COORDINATES:    X = 21     Y = 39          GRID AREA:      400 UNITS
LEES:           20   0     7    37    0     0    0     0    0     0
GEOLOGICAL:     0    0     -.2  0     0     0    0     .1

COORDINATES:    X = 22     Y = 39          GRID AREA:      400 UNITS
LEES:           1    0     160  15    0     0    0     0    0     0
GEOLOGICAL:     0    0     -.2  0     0     0    0     .1

COORDINATES:    X = 23     Y = 39          GRID AREA:      400 UNITS
LEES:           20   0     200  0     0     145  0     0    0     0
GEOLOGICAL:     0    0     0    0     0     0    0     0

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Ready
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NARRAGANNSETT BASIN FILE 12

COORDINATES:	X = 6	Y = 40		GRID AREA:	235 UNITS				
LEES:	17	0	130	6	0	0	16	235	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 40		GRID AREA:	400 UNITS				
LEES:	10	0	300	0	0	0	0	25	0	0
GEOLOGICAL:	1	0	0	0	-.5	0	.1	0		
COORDINATES:	X = 8	Y = 40		GRID AREA:	400 UNITS				
LEES:	0	0	275	0	0	0	6	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 9	Y = 40		GRID AREA:	400 UNITS				
LEES:	36	0	329	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 10	Y = 40		GRID AREA:	400 UNITS				
LEES:	4	0	386	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11	Y = 40		GRID AREA:	400 UNITS				
LEES:	0	18	194	0	0	0	0	295	0	155
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 6	Y = 41		GRID AREA:	400 UNITS				
LEES:	0	18	194	0	0	0	0	295	0	155
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 41		GRID AREA:	400 UNITS				
LEES:	13	0	285	6	0	17	4	315	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 41		GRID AREA:	400 UNITS				
LEES:	10	0	235	0	0	17	.42	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 41		GRID AREA:	400 UNITS				
LEES:	3	0	330	0	0	0	5	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 10	Y = 41		GRID AREA:	400 UNITS				
LEES:	11	4	275	0	0	38	3	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11	Y = 41		GRID AREA:	400 UNITS				
LEES:	0	12	140	0	0	0	0	185	0	215
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 6	Y = 42		GRID AREA:	140 UNITS				
LEES:	0	0	125	0	0	0	0	140	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 7		Y = 42			GRID AREA:		400 UNITS		
LEES:	10	0	245	3	0	8	13	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 42			GRID AREA:		400 UNITS		
LEES:	18	0	103	0	0	0	58	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 42			GRID AREA:		400 UNITS		
LEES:	32	0	145	0	0	0	32	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 42			GRID AREA:		400 UNITS		
LEES:	40	0	285	0	0	45	7	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11		Y = 42			GRID AREA:		400 UNITS		
LEES:	9	0	290	0	0	20	0	380	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 7		Y = 43			GRID AREA:		166 UNITS		
LEES:	15	0	98	0	0	27	0	166	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 43			GRID AREA:		400 UNITS		
LEES:	7	0	360	0	0	13	0	387	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 43			GRID AREA:		400 UNITS		
LEES:	2	3	340	0	0	10	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 43			GRID AREA:		400 UNITS		
LEES:	0	0	265	15	0	14	28	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11		Y = 43			GRID AREA:		400 UNITS		
LEES:	12	13	248	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 7		Y = 44			GRID AREA:		100 UNITS		
LEES:	10	0	76	0	0	0	0	80	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 44			GRID AREA:		400 UNITS		
LEES:	0	10	255	12	8	0	0	316	0	78
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 44			GRID AREA:		400 UNITS		
LEES:	3	26	248	4	0	0	0	400	0	1
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 10		Y = 44			GRID AREA:		400 UNITS		
LEES:	0	0	218	2	0	0	0	348	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 44			GRID AREA:		400 UNITS		
LEES:	3	3	265	0	0	0	0	133	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 45			GRID AREA:		290 UNITS		
LEES:	0	4	50	3	0	0	0	5	0	315
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 45			GRID AREA:		400 UNITS		
LEES:	1	4	36	0	0	0	0	60	0	340
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 45			GRID AREA:		400 UNITS		
LEES:	0	0	60	9	0	0	0	66	0	325
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 45			GRID AREA:		400 UNITS		
LEES:	0	0	60	77	4	0	0	12	3	78
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 46			GRID AREA:		250 UNITS		
LEES:	0	0	65	25	0	0	0	40	3	127
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	45	0	0	0	0	0	0	243
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	13	0	0	0	0	0	0	387
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	11	14	60	0	0	0	0	237
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 47			GRID AREA:		280 UNITS		
LEES:	0	0	52	0	5	0	0	265	2	85
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 47			GRID AREA:		400 UNITS		
LEES:	0	4	45	4	25	0	0	8	5	65
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 47			GRID AREA:		400 UNITS		
LEES:	0	30	23	0	2	0	0	0	0	313
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

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COORDINATES:    X = 11     Y = 47          GRID AREA:     400 UNITS
LEES:           0    0     0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 7      Y = 48          GRID AREA:     105 UNITS
LEES:           22   0     28   0    7     0    0    105   2    0
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 8      Y = 48          GRID AREA:     400 UNITS
LEES:           10   0     50   15   40    12   0    325   0    14
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 9      Y = 48          GRID AREA:     400 UNITS
LEES:           10   0     0    54   20    3    0    22    0    5
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 10     Y = 48          GRID AREA:     400 UNITS
LEES:           0    13    1    0    12    3    8    0     0    240
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 11     Y = 48          GRID AREA:     400 UNITS
LEES:           0    0     0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 6      Y = 49          GRID AREA:     35 UNITS
LEES:           0    0     0    0    0     0    9    35    0    0
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 7      Y = 49          GRID AREA:     342 UNITS
LEES:           15   0     121  37   0     0    14   342   2    0
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 8      Y = 49          GRID AREA:     400 UNITS
LEES:           43   0     11   70   17    7    0    256   0    0
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 9      Y = 49          GRID AREA:     400 UNITS
LEES:           61   0     6    17   42    0    0    0     0    0
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 10     Y = 49          GRID AREA:     400 UNITS
LEES:           9    0     175  0    0     0    0    0     0    200
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

COORDINATES:    X = 11     Y = 49          GRID AREA:     400 UNITS
LEES:           0    0     0    0    0     0    0    0     0    400
GEOLOGICAL:     0    0     0    0   -.9    0    0    0

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APPENDIX K

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA COMPUTER MAPS

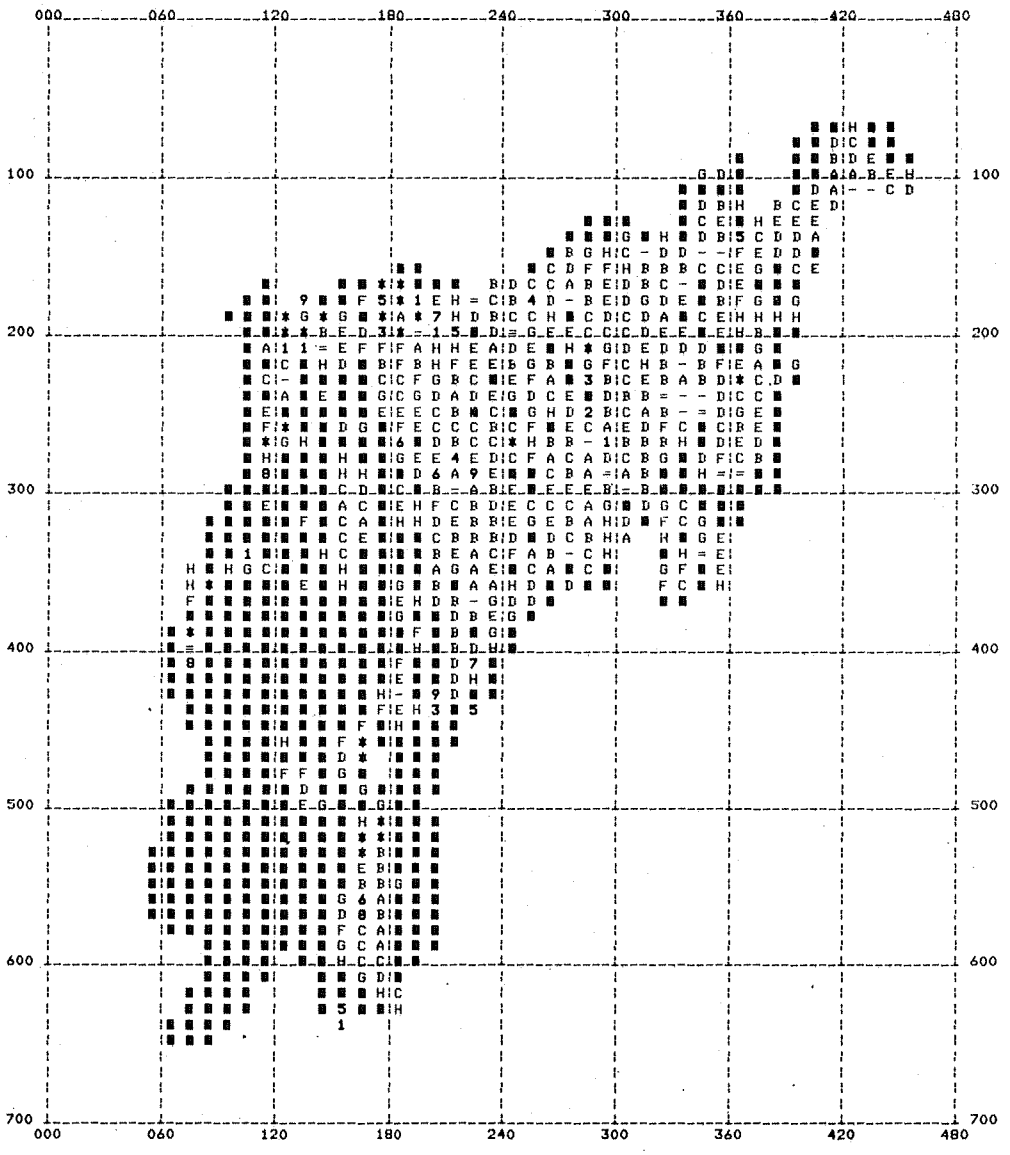
NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP;
DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS YOU PLACE ON THE FOLLOWING FACTORS.

INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 10,10
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 10,10,10
FRESH AND OCEAN WATER BODY WEIGHTS	? 10,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 10,10
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,10
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,10,10
DEPTH AND DIP WEIGHTS	? 10,10



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
								SLIGHTLY	?	SLIGHTLY										
WORST CASE		VERY BAD			BAD			BAD		GOOD			GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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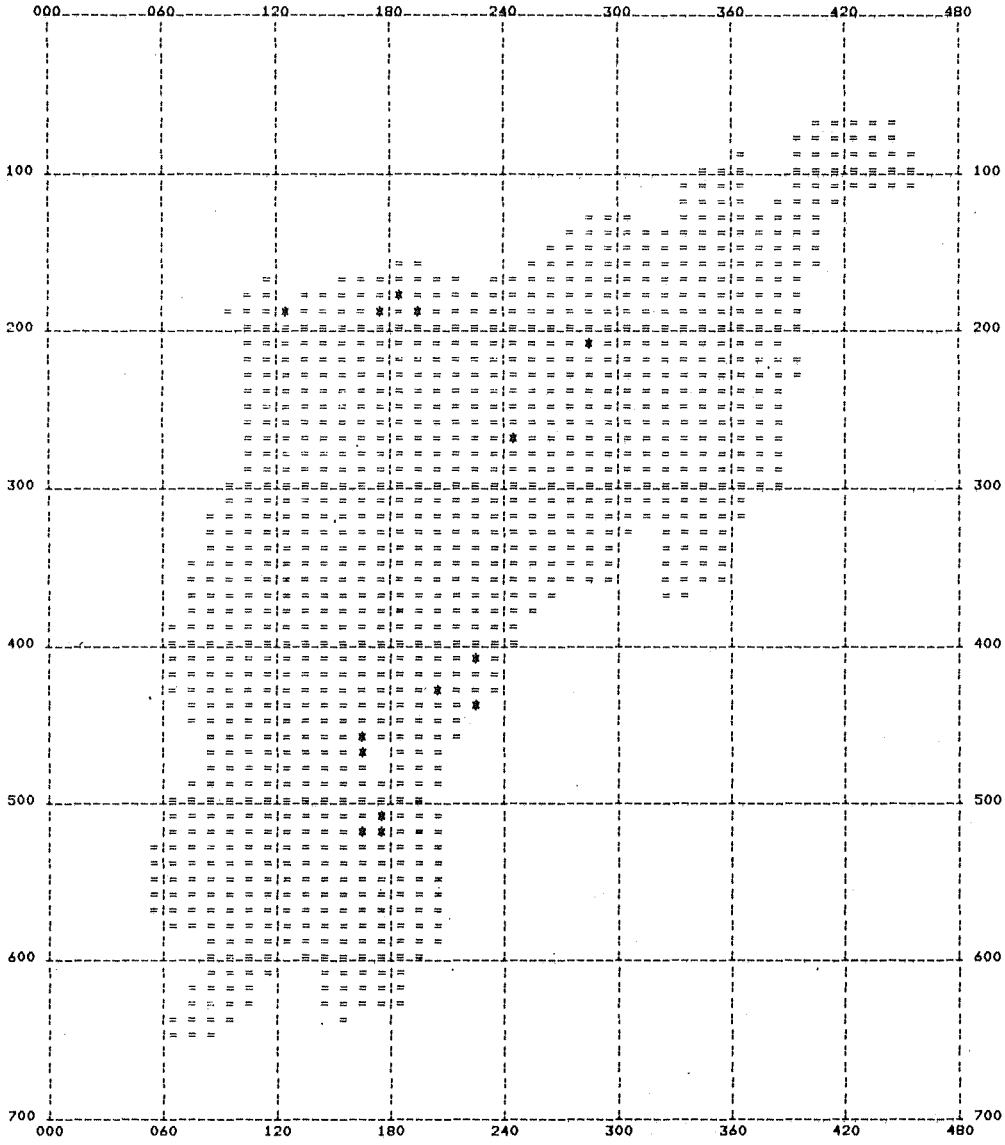
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

#	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP;
DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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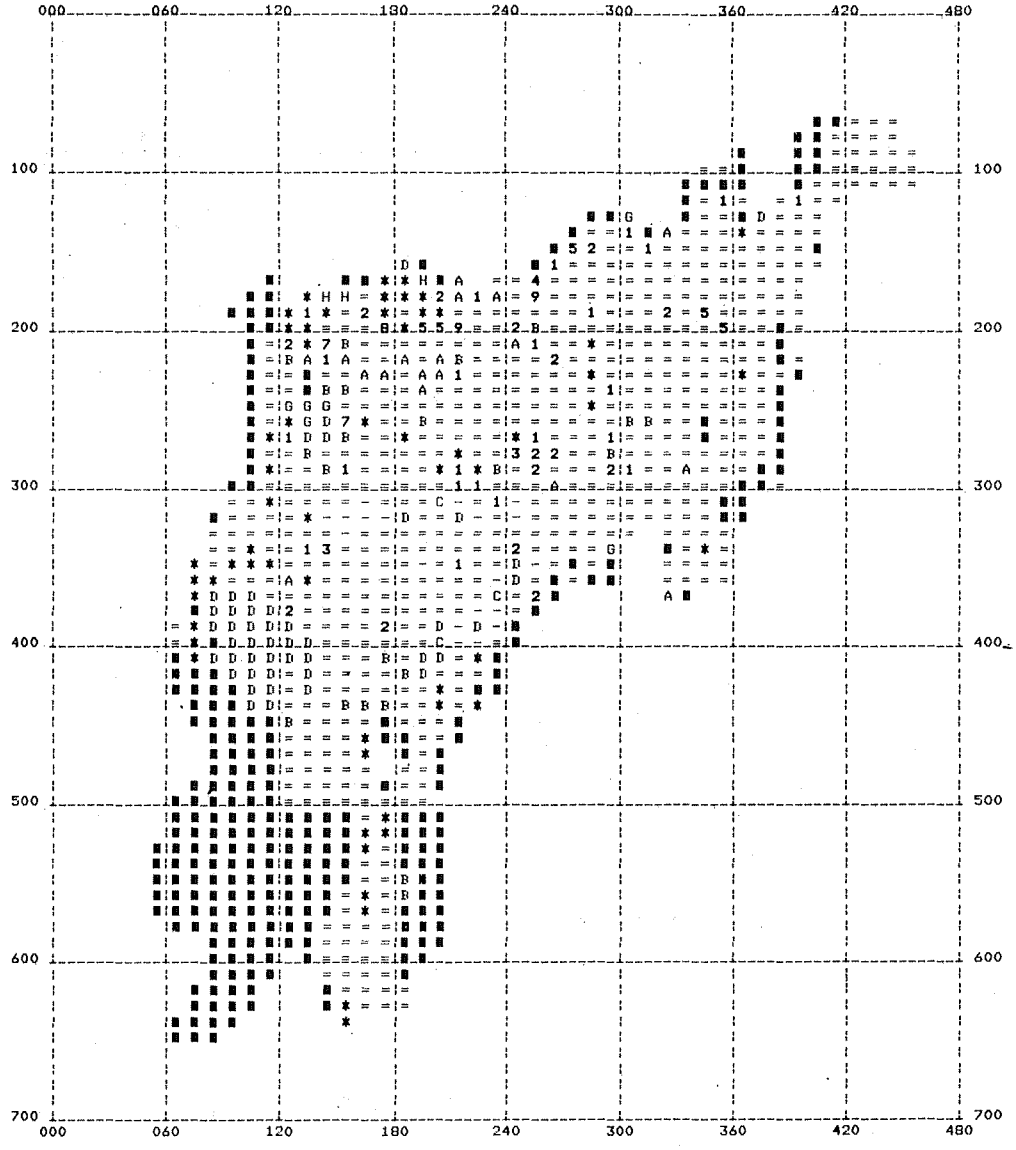
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,10
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,10,10
DEPTH AND DIP WEIGHTS	? 10,10



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP;
DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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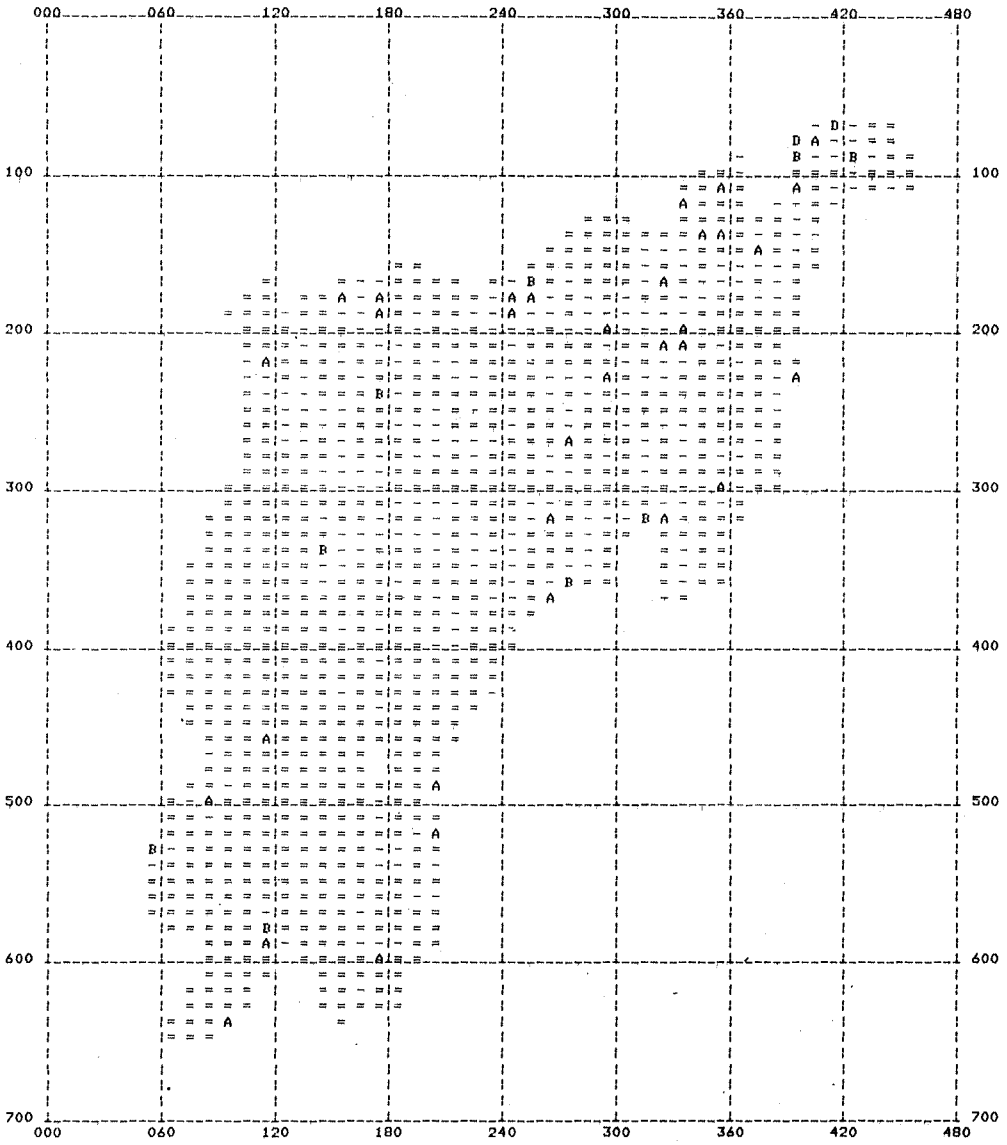
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,10,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE — VERY BAD — BAD — SLIGHTLY BAD — ? — SLIGHTLY GOOD — GOOD — VERY GOOD — BEST CASE

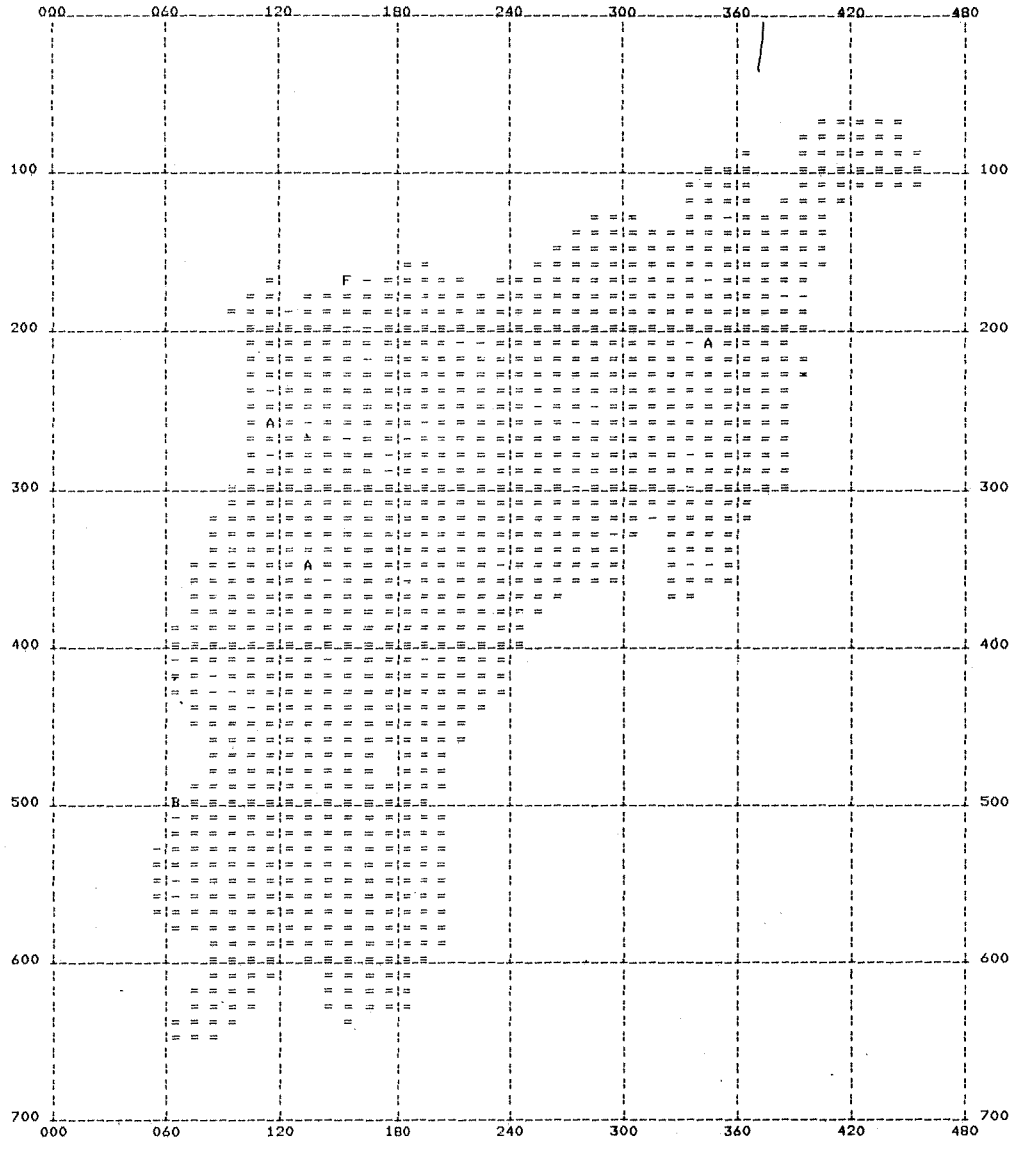
NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS YOU PLACE ON THE FOLLOWING FACTORS.

INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE | VERY BAD | BAD | SLIGHTLY BAD | ? | SLIGHTLY GOOD | GOOD | VERY GOOD | BEST CASE

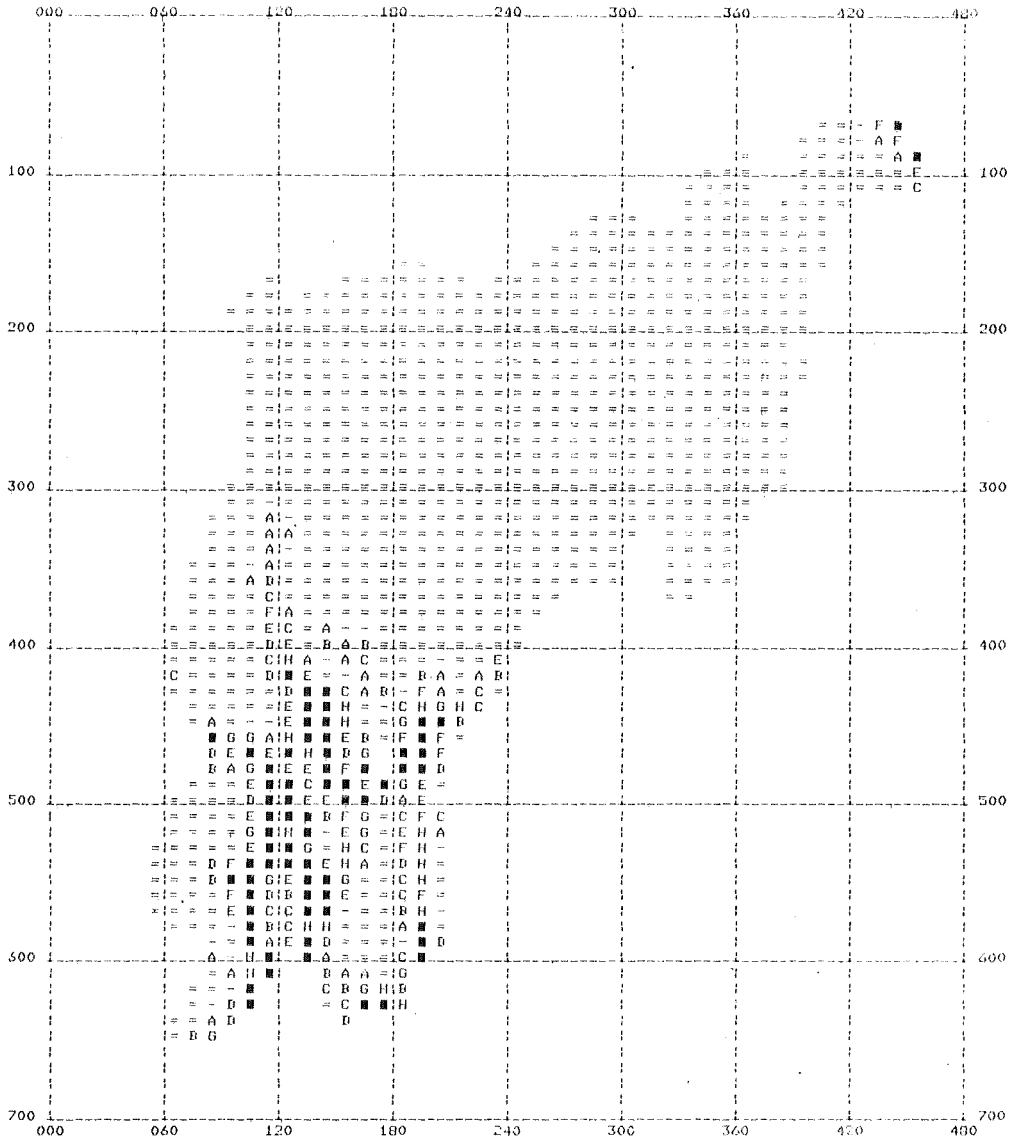
NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP;
DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS YOU PLACE ON THE FOLLOWING FACTORS.

INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIF WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE			VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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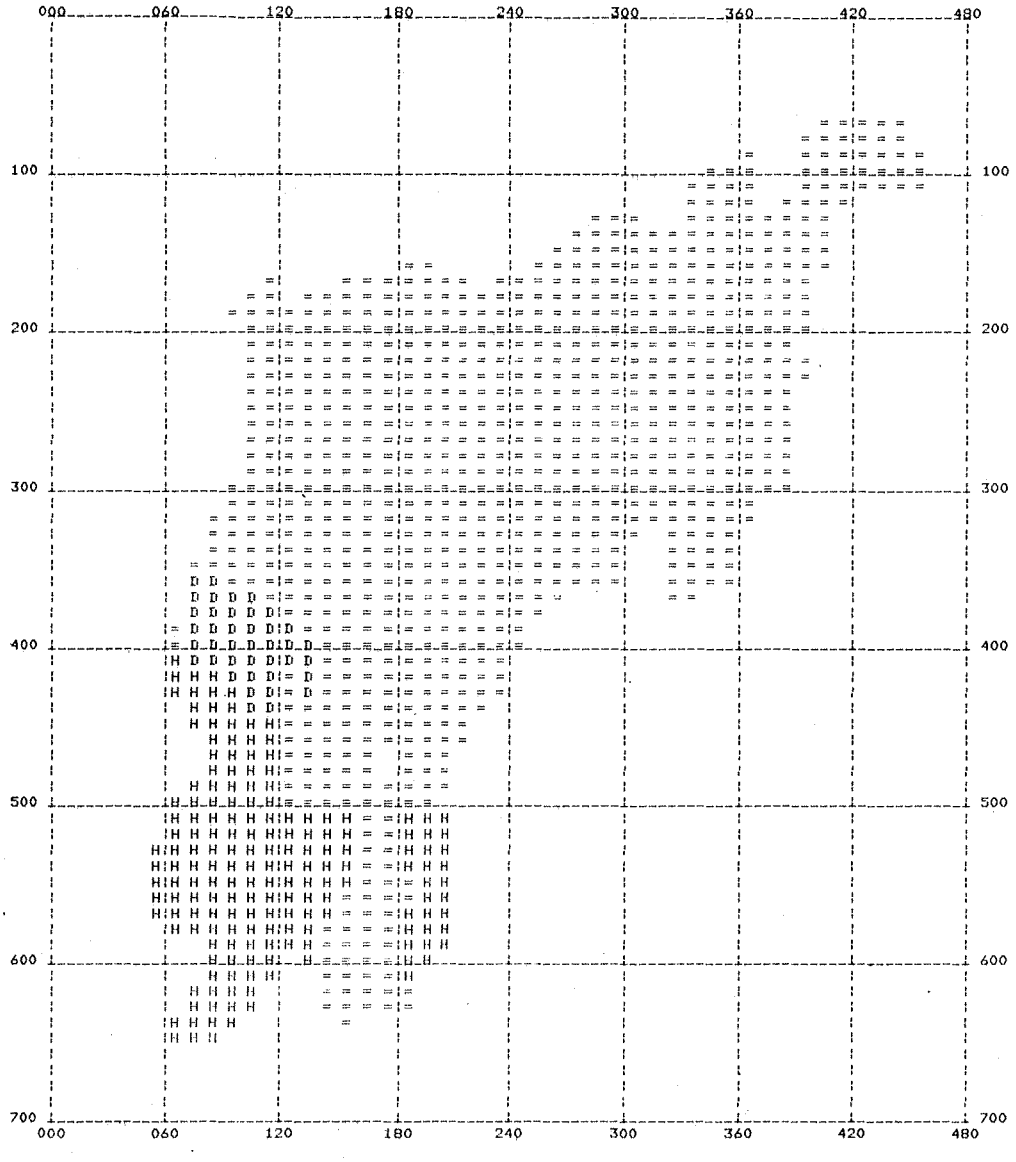
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,10,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD		GOOD			VERY GOOD			BEST CASE		

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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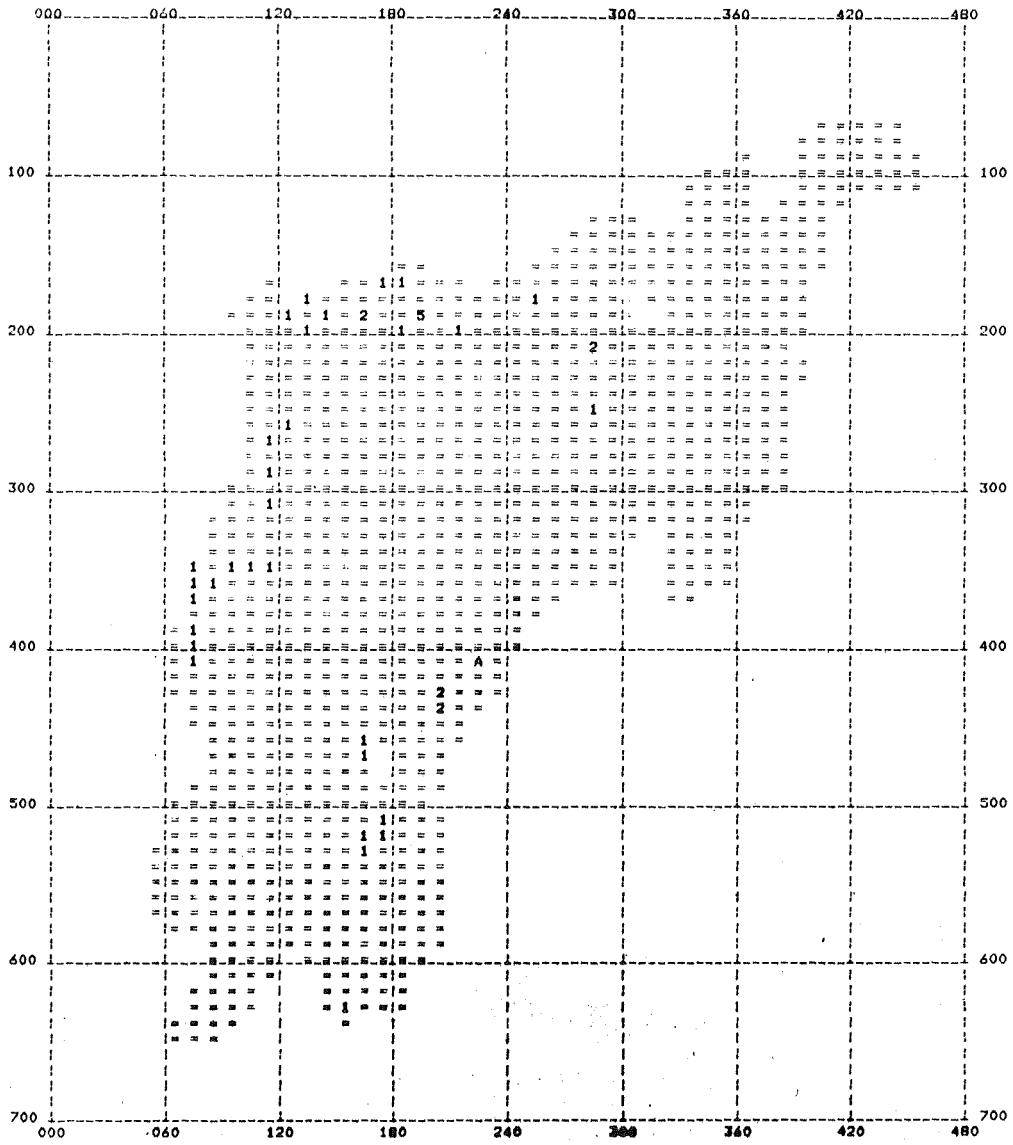
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 10,0



EXPLANATION OF SYMBOLS.

G	H	O	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		9	SLIGHTLY GOOD		GOOD			VERY GOOD				BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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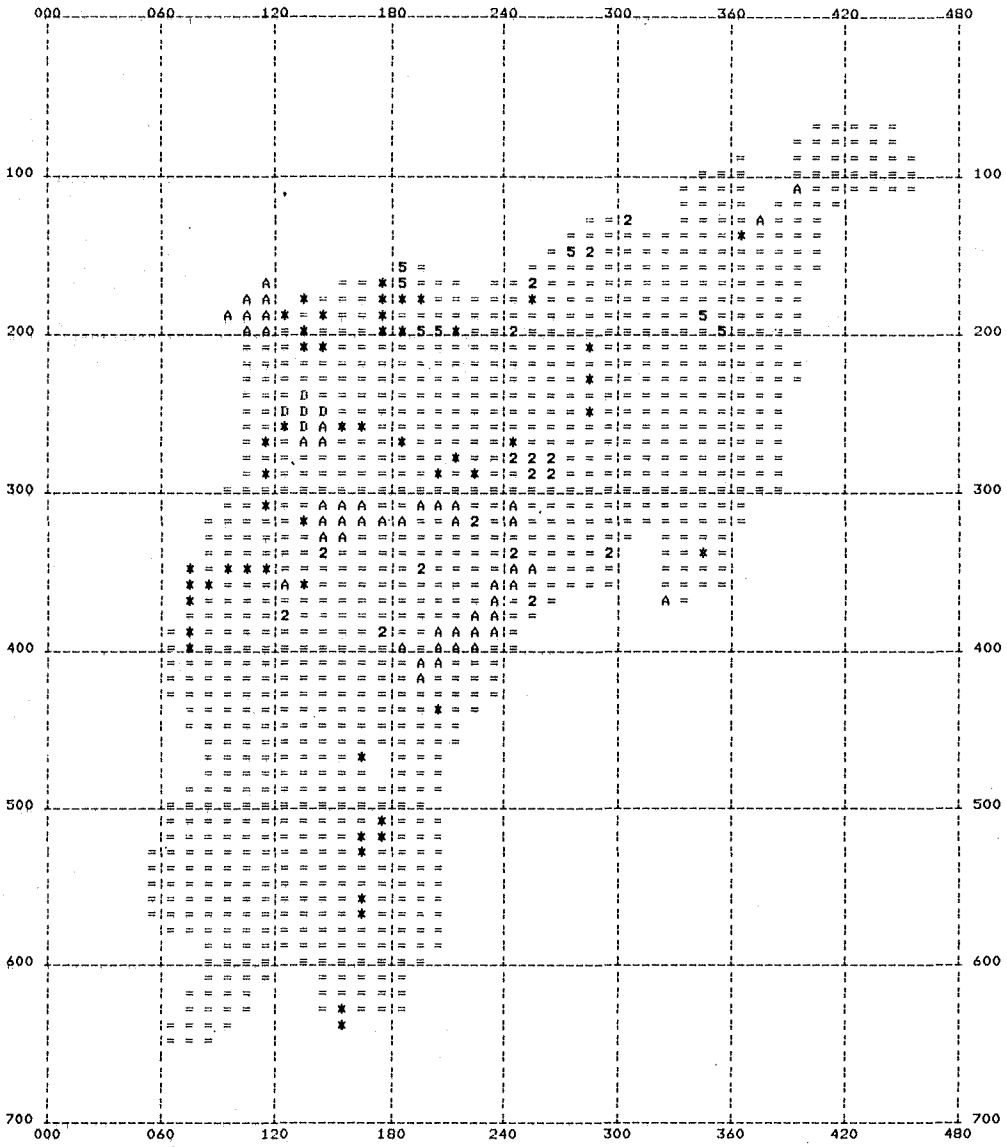
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE | VERY BAD | BAD | SLIGHTLY BAD | ? | SLIGHTLY GOOD | GOOD | VERY GOOD | BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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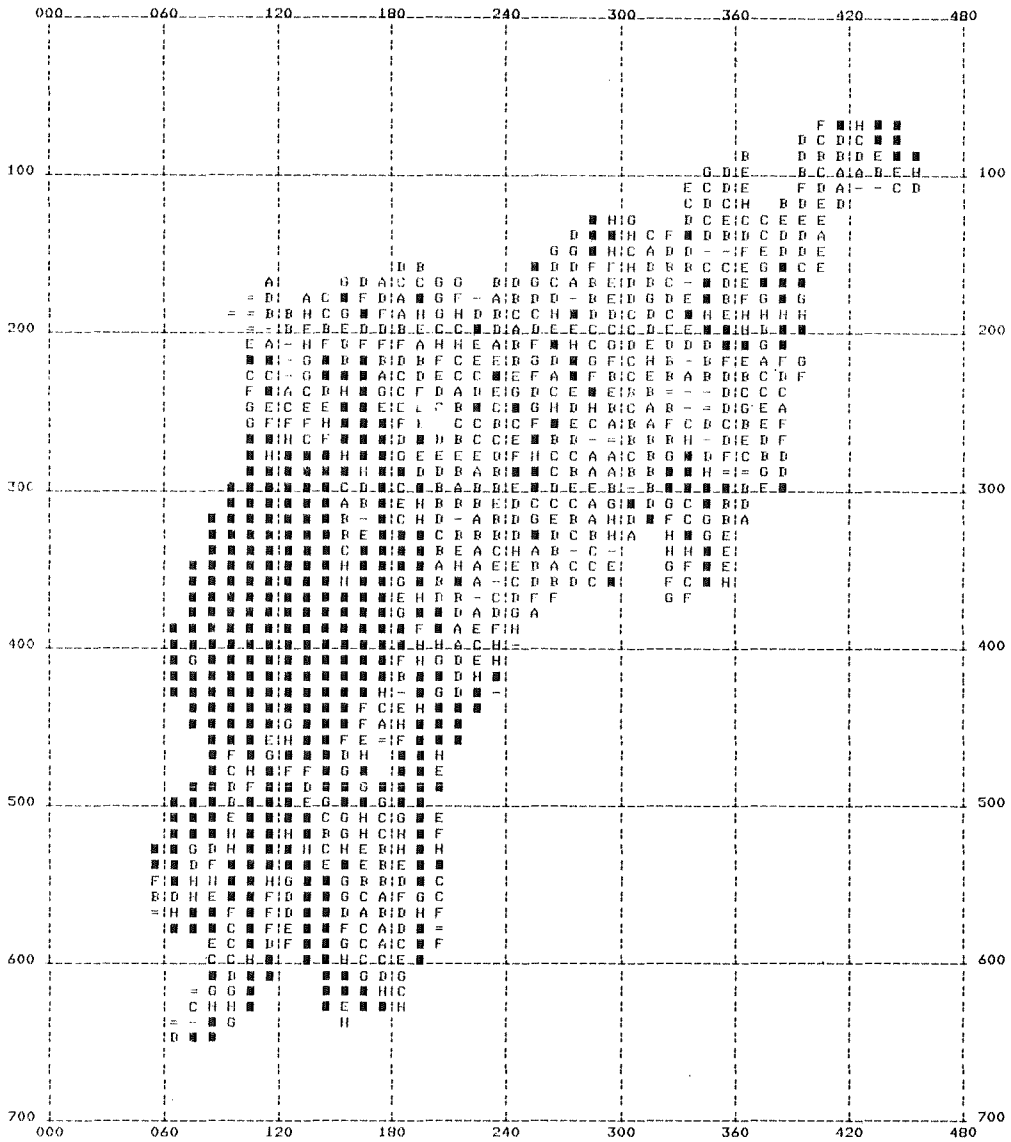
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 10,10
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 10,10,10
FRESH AND OCEAN WATER BODY WEIGHTS	? 10,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 10,10
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,10\01\0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DTF WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	N	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD		GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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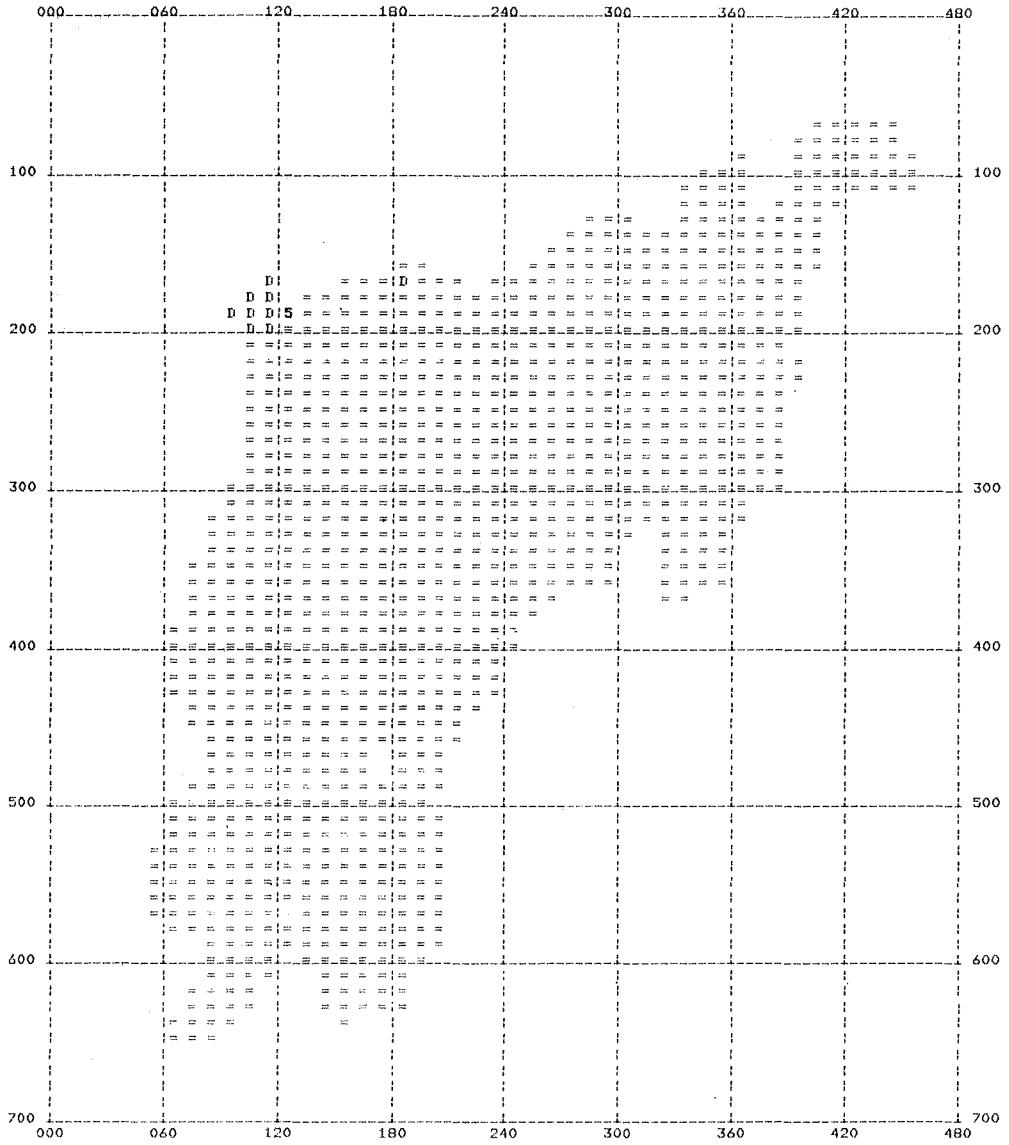
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,10
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	~	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE	

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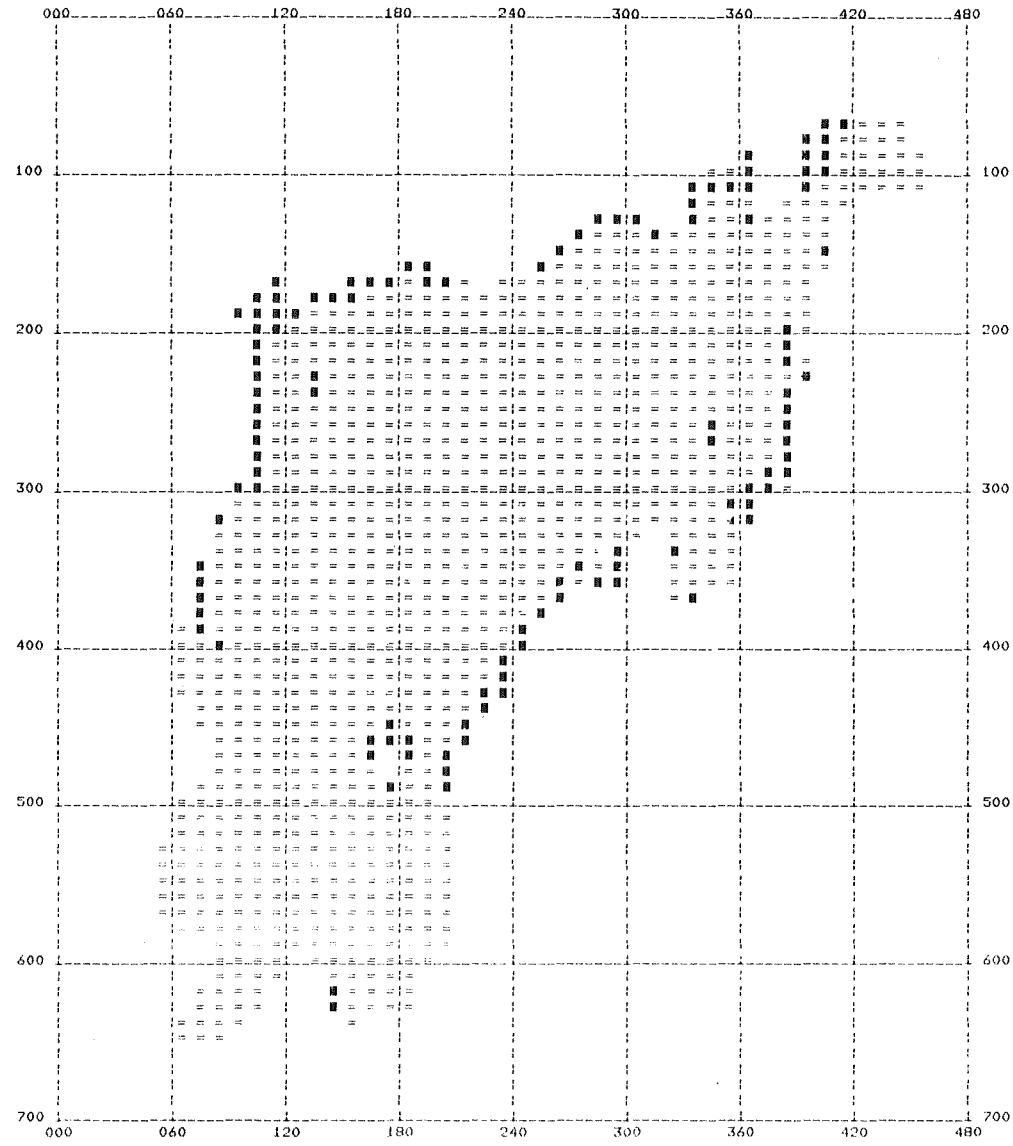
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

#	H	G	F	E	D	C	B	A	-	:	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD		GOOD			VERY GOOD			BEST CASE		

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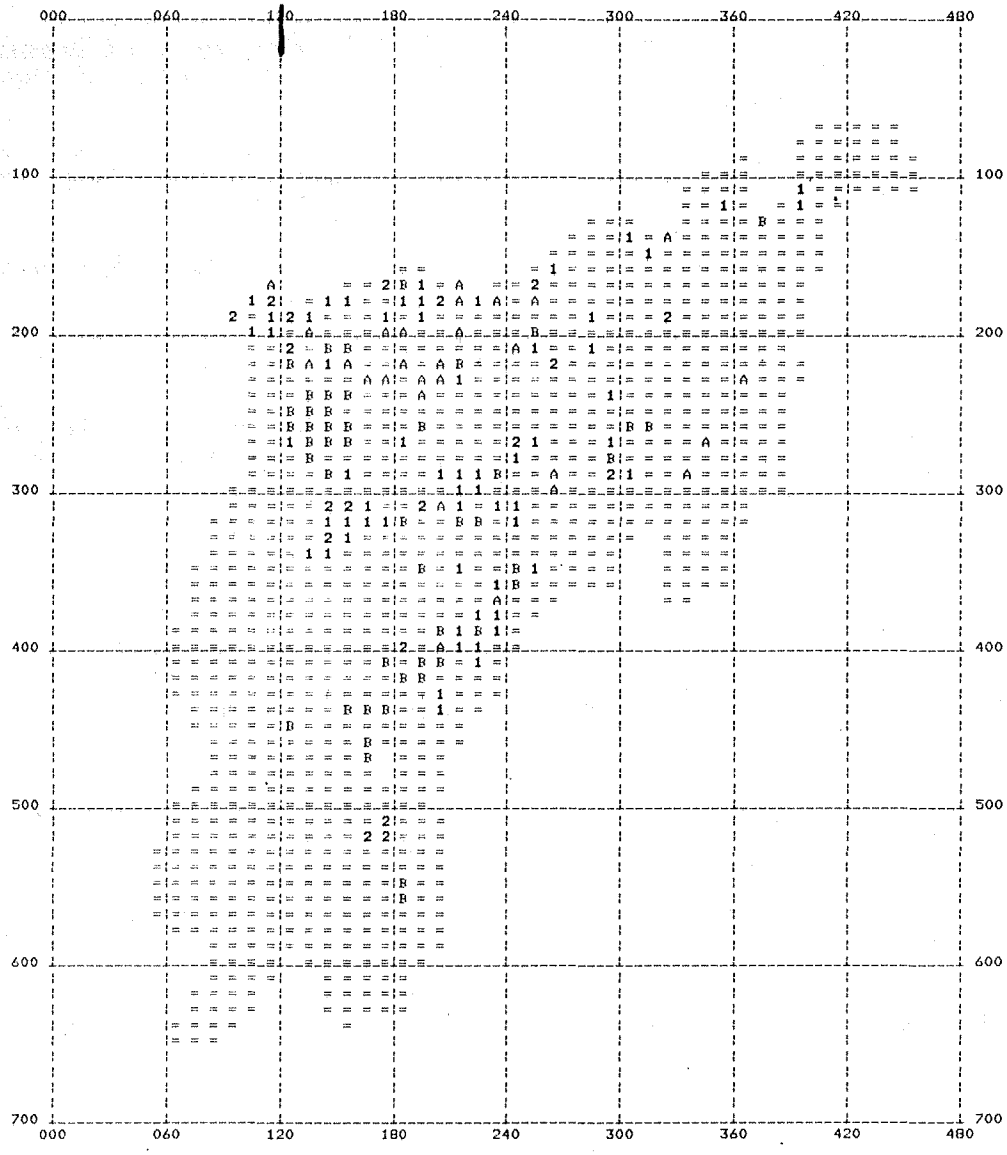
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS ? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS ? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS ? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS ? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS ? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS ? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS ? 0,0,0
DEPTH AND DIP WEIGHTS ? 0,10



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE VERY BAD BAD SLIGHTLY BAD ? SLIGHTLY GOOD GOOD VERY GOOD BEST CASE

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The asterisk (*) before each reference indicates those completed during NSF funding of the Narragansett Basin Project.

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```
COORDINATES:    X = 20      Y = 39          GRID AREA:      400 UNITS
LEES:           10   0      37   40    0     8    0     265  0     0
GEOLOGICAL:     0    0      -.2  0     0     0    0     -.2

COORDINATES:    X = 21      Y = 39          GRID AREA:      400 UNITS
LEES:           20   0      7    37    0     0    0     0    0     0
GEOLOGICAL:     0    0      -.2  0     0     0    0     .1

COORDINATES:    X = 22      Y = 39          GRID AREA:      400 UNITS
LEES:           1    0      160  15    0     0    0     0    0     0
GEOLOGICAL:     0    0      -.2  0     0     0    0     .1

COORDINATES:    X = 23      Y = 39          GRID AREA:      400 UNITS
LEES:           20   0      200  0     0     145  0     0    0     0
GEOLOGICAL:     0    0      0    0     0     0    0     0

 999

Ready
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NARRAGANNSETT BASIN FILE 12

COORDINATES:	X = 6	Y = 40		GRID AREA:	235 UNITS				
LEES:	17	0	130	6	0	0	16	235	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 40		GRID AREA:	400 UNITS				
LEES:	10	0	300	0	0	0	0	25	0	0
GEOLOGICAL:	1	0	0	0	-.5	0	.1	0		
COORDINATES:	X = 8	Y = 40		GRID AREA:	400 UNITS				
LEES:	0	0	275	0	0	0	6	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 9	Y = 40		GRID AREA:	400 UNITS				
LEES:	36	0	329	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 10	Y = 40		GRID AREA:	400 UNITS				
LEES:	4	0	386	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11	Y = 40		GRID AREA:	400 UNITS				
LEES:	0	18	194	0	0	0	0	295	0	155
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 6	Y = 41		GRID AREA:	400 UNITS				
LEES:	0	18	194	0	0	0	0	295	0	155
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 7	Y = 41		GRID AREA:	400 UNITS				
LEES:	13	0	285	6	0	17	4	315	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8	Y = 41		GRID AREA:	400 UNITS				
LEES:	10	0	235	0	0	17	.42	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9	Y = 41		GRID AREA:	400 UNITS				
LEES:	3	0	330	0	0	0	5	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 10	Y = 41		GRID AREA:	400 UNITS				
LEES:	11	4	275	0	0	38	3	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11	Y = 41		GRID AREA:	400 UNITS				
LEES:	0	12	140	0	0	0	0	185	0	215
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 6	Y = 42		GRID AREA:	140 UNITS				
LEES:	0	0	125	0	0	0	0	140	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 7		Y = 42			GRID AREA:		400	UNITS	
LEES:	10	0	245	3	0	8	13	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 42			GRID AREA:		400	UNITS	
LEES:	18	0	103	0	0	0	58	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 42			GRID AREA:		400	UNITS	
LEES:	32	0	145	0	0	0	32	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 42			GRID AREA:		400	UNITS	
LEES:	40	0	285	0	0	45	7	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11		Y = 42			GRID AREA:		400	UNITS	
LEES:	9	0	290	0	0	20	0	380	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 7		Y = 43			GRID AREA:		166	UNITS	
LEES:	15	0	98	0	0	27	0	166	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 43			GRID AREA:		400	UNITS	
LEES:	7	0	360	0	0	13	0	387	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 43			GRID AREA:		400	UNITS	
LEES:	2	3	340	0	0	10	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 43			GRID AREA:		400	UNITS	
LEES:	0	0	265	15	0	14	28	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 11		Y = 43			GRID AREA:		400	UNITS	
LEES:	12	13	248	0	0	0	0	400	0	0
GEOLOGICAL:	0	0	0	0	-.5	0	0	0		
COORDINATES:	X = 7		Y = 44			GRID AREA:		100	UNITS	
LEES:	10	0	76	0	0	0	0	80	0	0
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 44			GRID AREA:		400	UNITS	
LEES:	0	10	255	12	8	0	0	316	0	78
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 44			GRID AREA:		400	UNITS	
LEES:	3	26	248	4	0	0	0	400	0	1
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

COORDINATES:	X = 10		Y = 44			GRID AREA:		400 UNITS		
LEES:	0	0	218	2	0	0	0	348	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 44			GRID AREA:		400 UNITS		
LEES:	3	3	265	0	0	0	0	133	0	52
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 45			GRID AREA:		290 UNITS		
LEES:	0	4	50	3	0	0	0	5	0	315
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 45			GRID AREA:		400 UNITS		
LEES:	1	4	36	0	0	0	0	60	0	340
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 45			GRID AREA:		400 UNITS		
LEES:	0	0	60	9	0	0	0	66	0	325
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 45			GRID AREA:		400 UNITS		
LEES:	0	0	60	77	4	0	0	12	3	78
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 46			GRID AREA:		250 UNITS		
LEES:	0	0	65	25	0	0	0	40	3	127
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	45	0	0	0	0	0	0	243
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	13	0	0	0	0	0	0	387
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 11		Y = 46			GRID AREA:		400 UNITS		
LEES:	0	0	11	14	60	0	0	0	0	237
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 8		Y = 47			GRID AREA:		290 UNITS		
LEES:	0	0	52	0	5	0	0	265	2	85
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 9		Y = 47			GRID AREA:		400 UNITS		
LEES:	0	4	45	4	25	0	0	8	5	65
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		
COORDINATES:	X = 10		Y = 47			GRID AREA:		400 UNITS		
LEES:	0	30	23	0	2	0	0	0	0	313
GEOLOGICAL:	0	0	0	0	-.9	0	0	0		

```
COORDINATES:    X = 11      Y = 47          GRID AREA:      400 UNITS
LEES:           0    0      0    0     0     0    0     0     0     400
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 7       Y = 48          GRID AREA:      105 UNITS
LEES:           22   0      28   0     7     0    0     105   2     0
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 8       Y = 48          GRID AREA:      400 UNITS
LEES:           10   0      50   15    40    12   0     325   0     14
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 9       Y = 48          GRID AREA:      400 UNITS
LEES:           10   0      0    54    20    3    0     22    0     5
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 10      Y = 48          GRID AREA:      400 UNITS
LEES:           0    13     1    0     12    3    8     0     0     240
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 11      Y = 48          GRID AREA:      400 UNITS
LEES:           0    0      0    0     0     0    0     0     0     400
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 6       Y = 49          GRID AREA:      35 UNITS
LEES:           0    0      0    0     0     0    9     35    0     0
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 7       Y = 49          GRID AREA:      342 UNITS
LEES:           15   0      121  37    0     0    14    342   2     0
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 8       Y = 49          GRID AREA:      400 UNITS
LEES:           43   0      11   70    17    7    0     256   0     0
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 9       Y = 49          GRID AREA:      400 UNITS
LEES:           61   0      6    17    42    0    0     0     0     0
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 10      Y = 49          GRID AREA:      400 UNITS
LEES:           9    0      175  0     0     0    0     0     0     200
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

COORDINATES:    X = 11      Y = 49          GRID AREA:      400 UNITS
LEES:           0    0      0    0     0     0    0     0     0     400
GEOLOGICAL:     0    0      0    0    -.9    0    0     0

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Ready
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APPENDIX K

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA COMPUTER MAPS

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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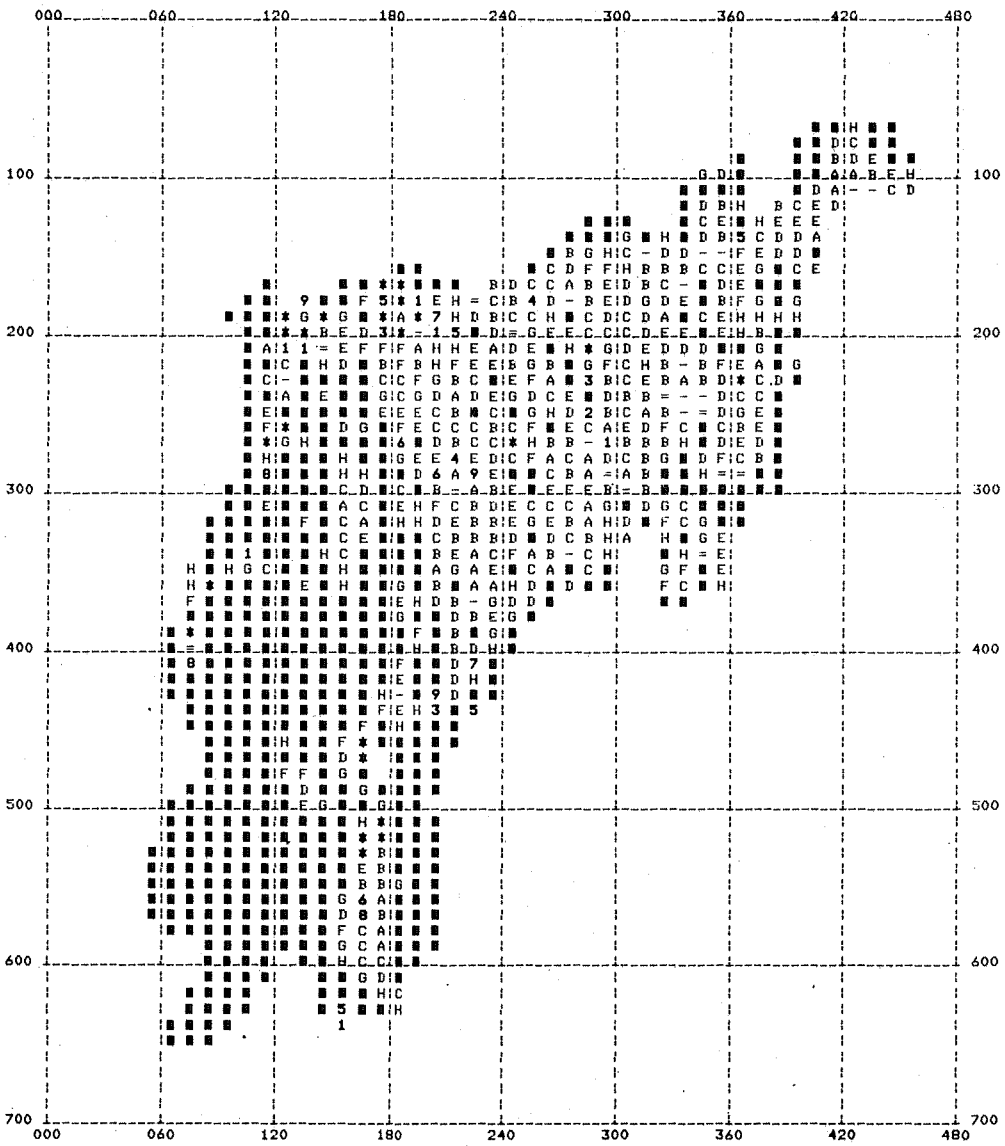
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 10,10
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 10,10,10
FRESH AND OCEAN WATER BODY WEIGHTS	? 10,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 10,10
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,10
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,10,10
DEPTH AND DIP WEIGHTS	? 10,10



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD		GOOD			VERY GOOD				BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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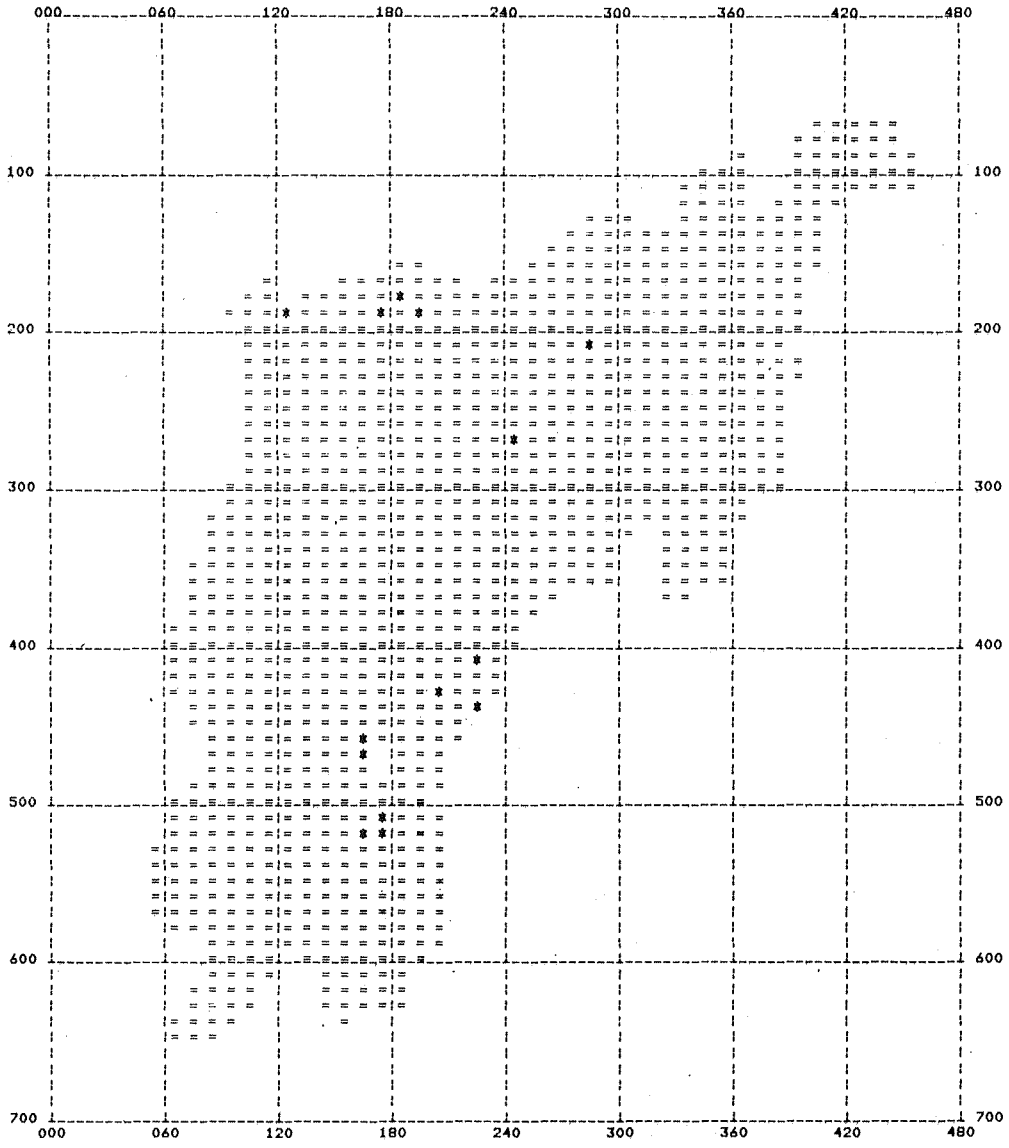
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?		SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

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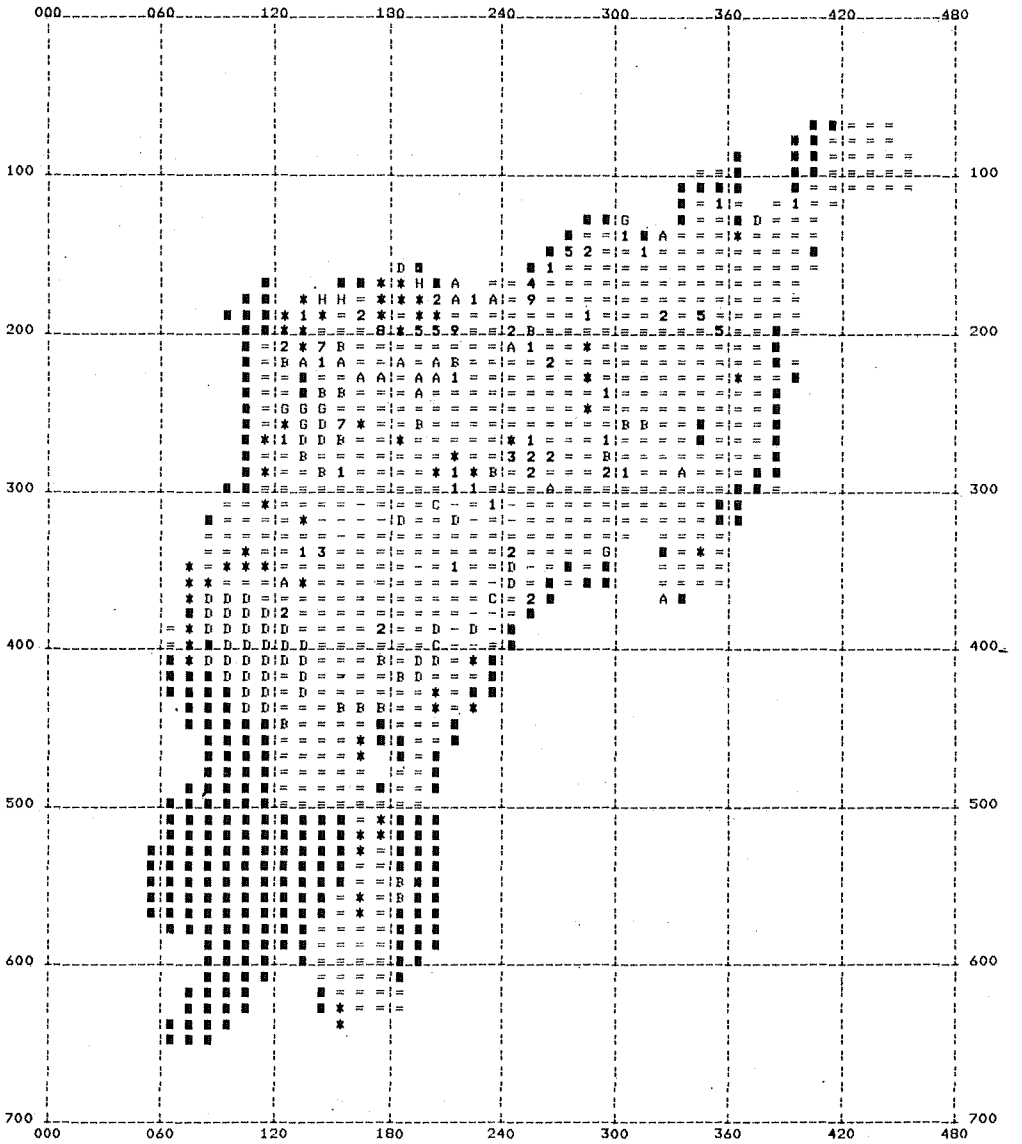
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,10
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 10,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,10,10
DEPTH AND DIP WEIGHTS	? 10,10



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE — VERY BAD — BAD — SLIGHTLY BAD — ? — SLIGHTLY GOOD — GOOD — VERY GOOD — BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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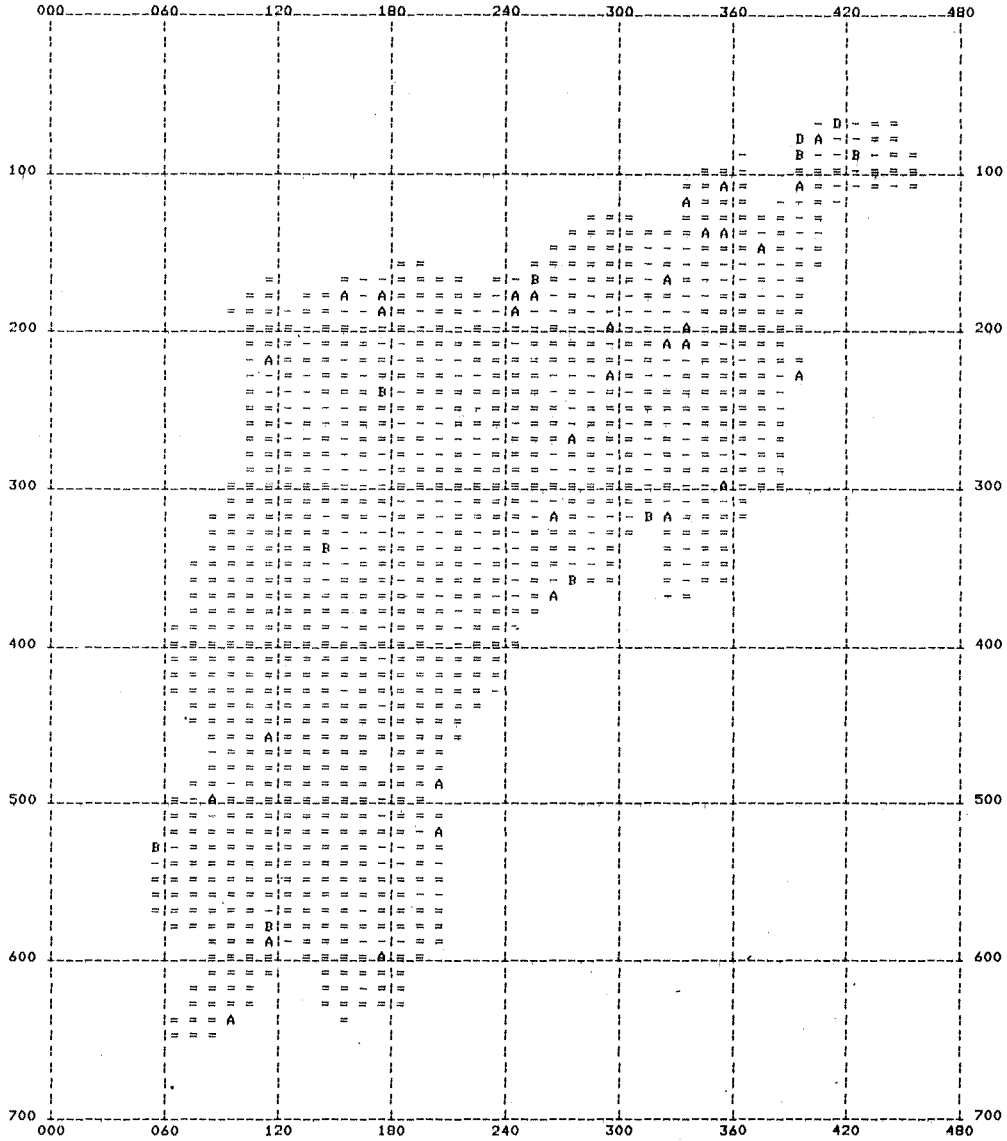
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,10,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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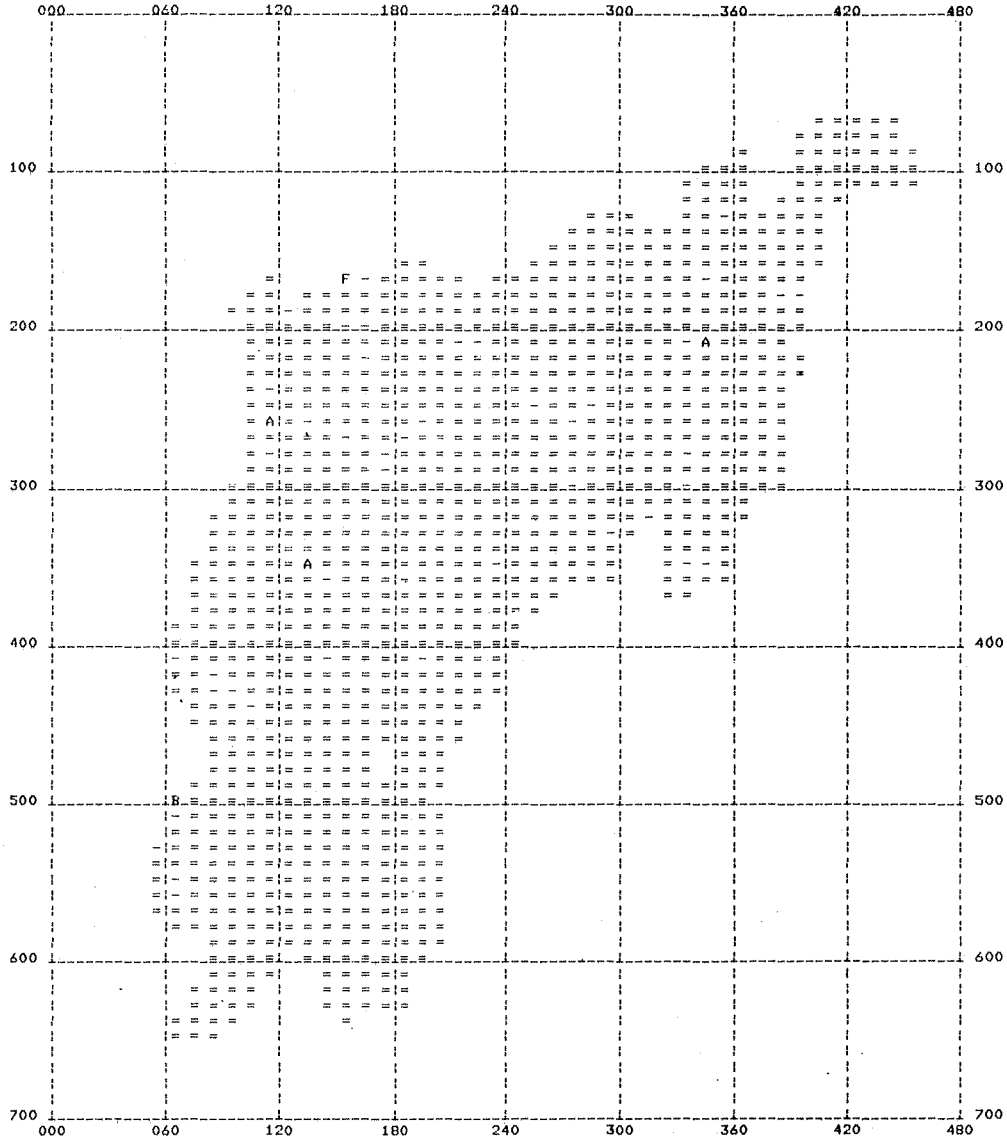
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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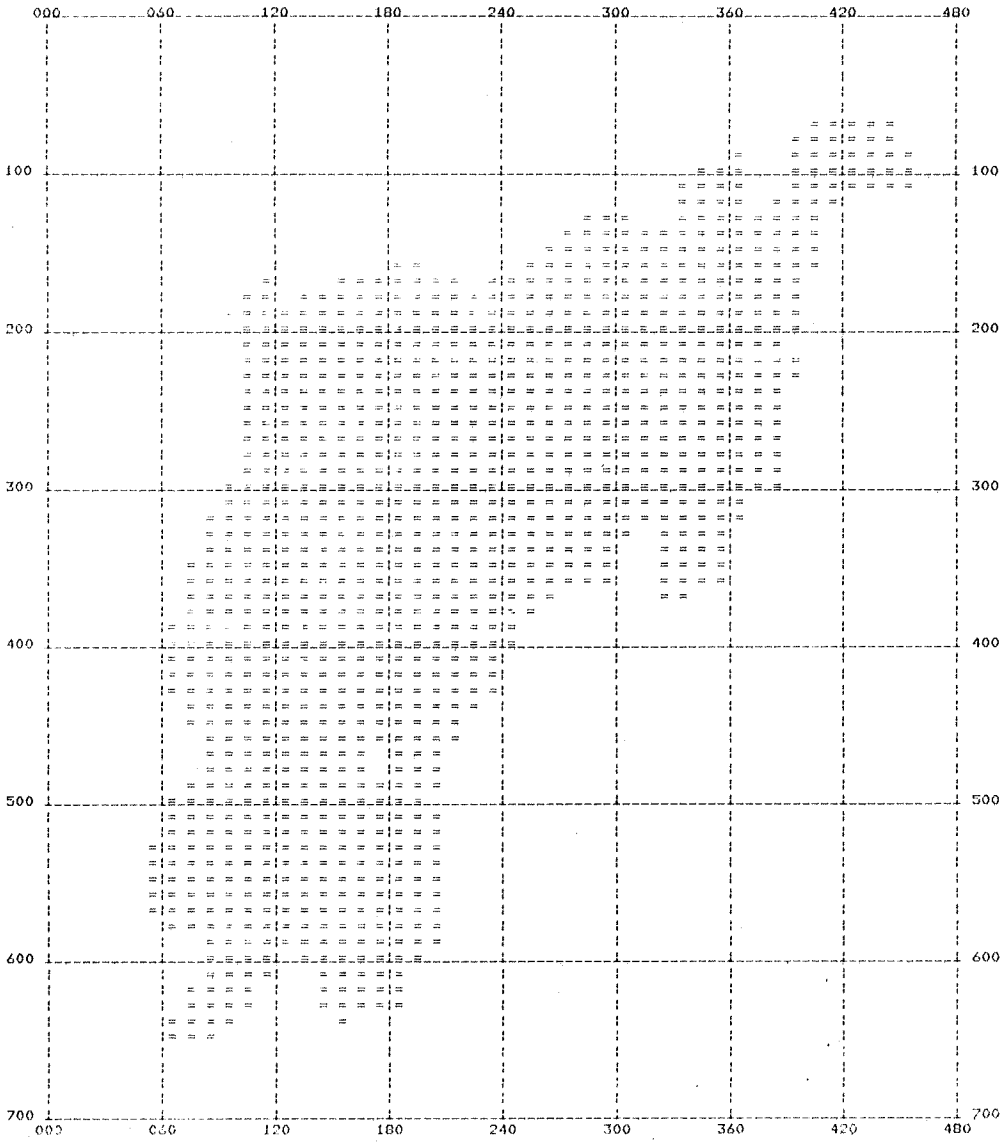
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS ? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS ? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS ? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS ? 0,10
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS ? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS ? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS ? 0,0,0
DEPTH AND DIP WEIGHTS ? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE VERY BAD BAD SLIGHTLY BAD ? SLIGHTLY GOOD GOOD VERY GOOD BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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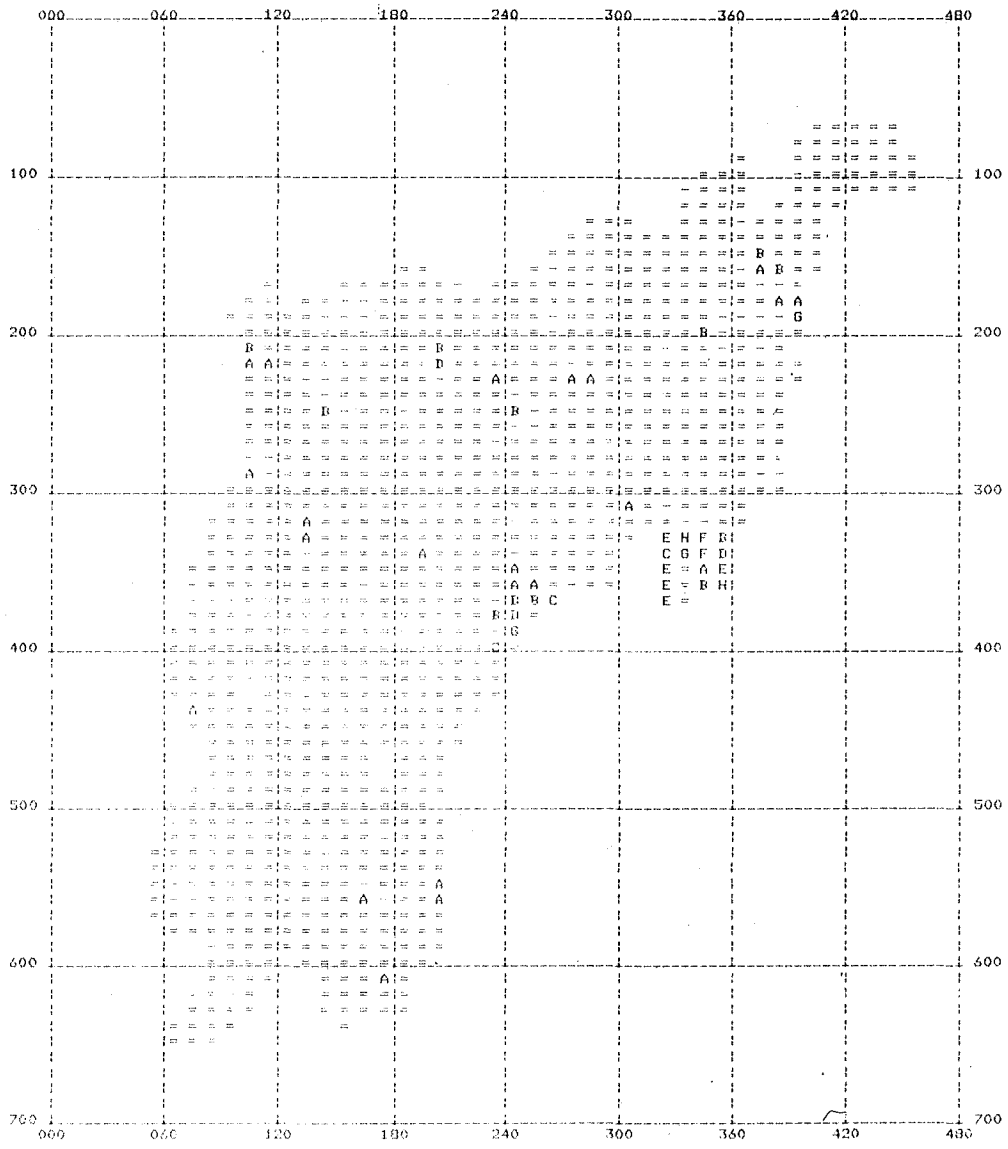
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 10,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - . 1 2 3 4 5 6 7 8 9 #

WORST CASE — VERY BAD — BAD — SLIGHTLY BAD — ? — SLIGHTLY GOOD — GOOD — VERY GOOD — BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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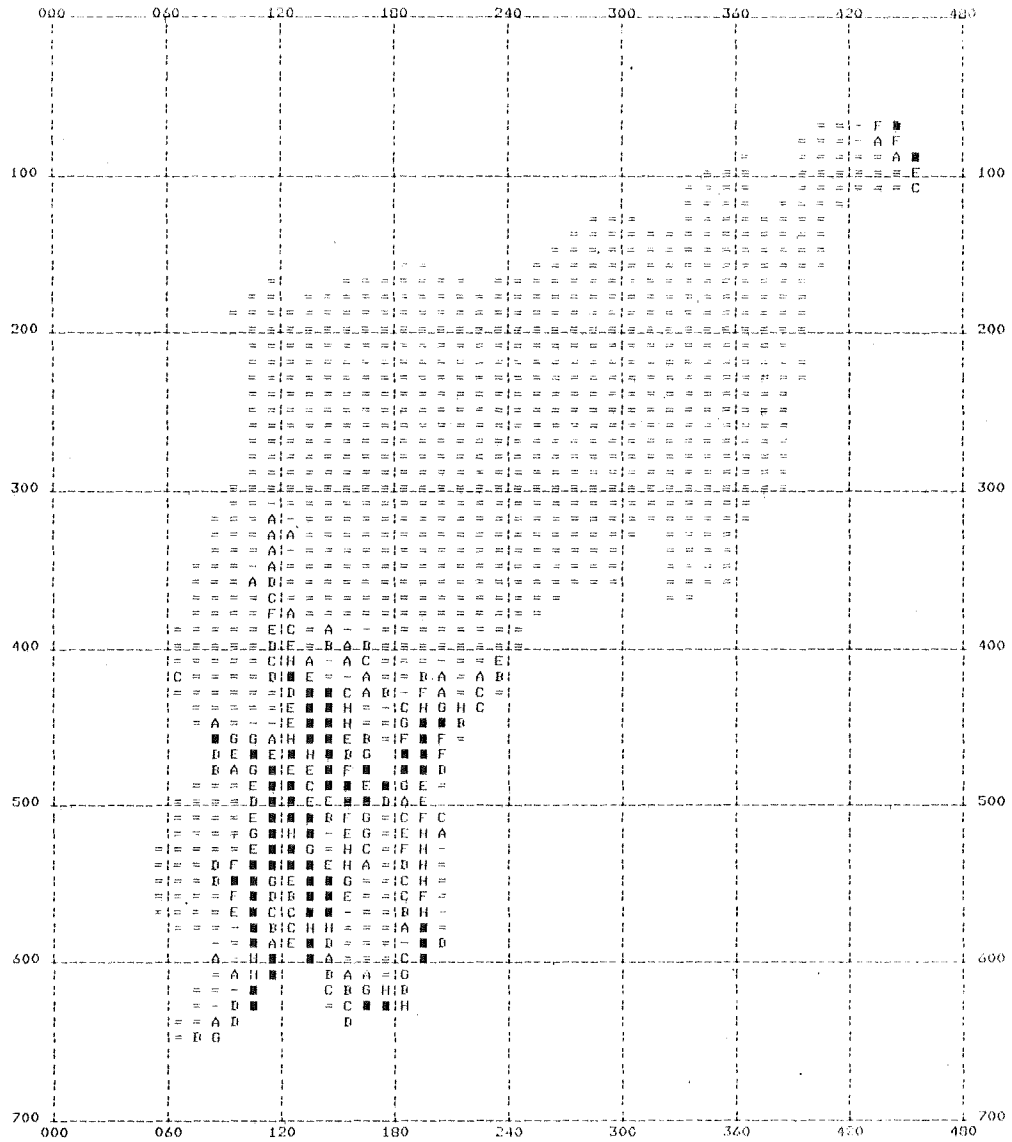
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

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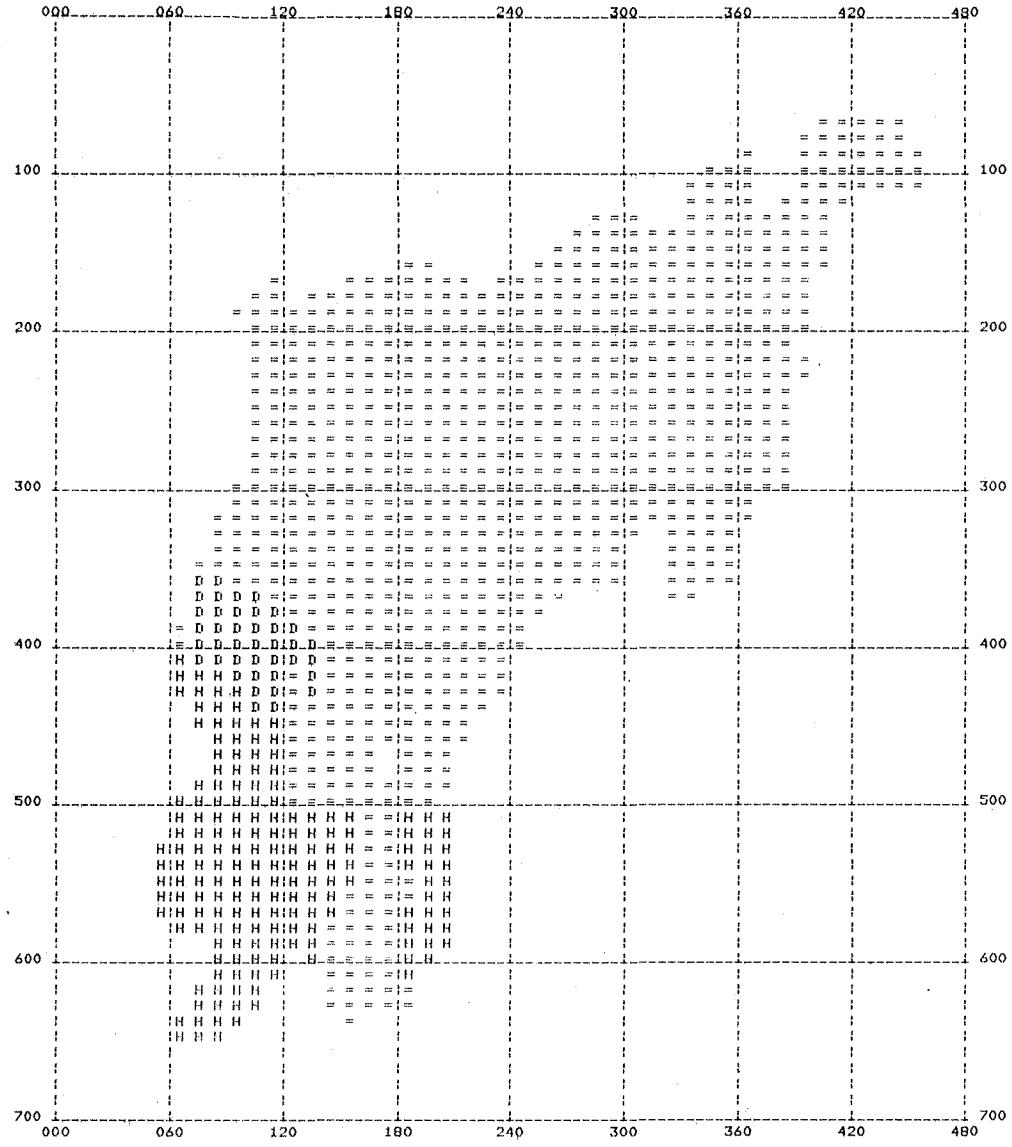
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,10,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
									SLIGHTLY BAD	?	SLIGHTLY GOOD									
WORST CASE			VERY BAD			BAD							GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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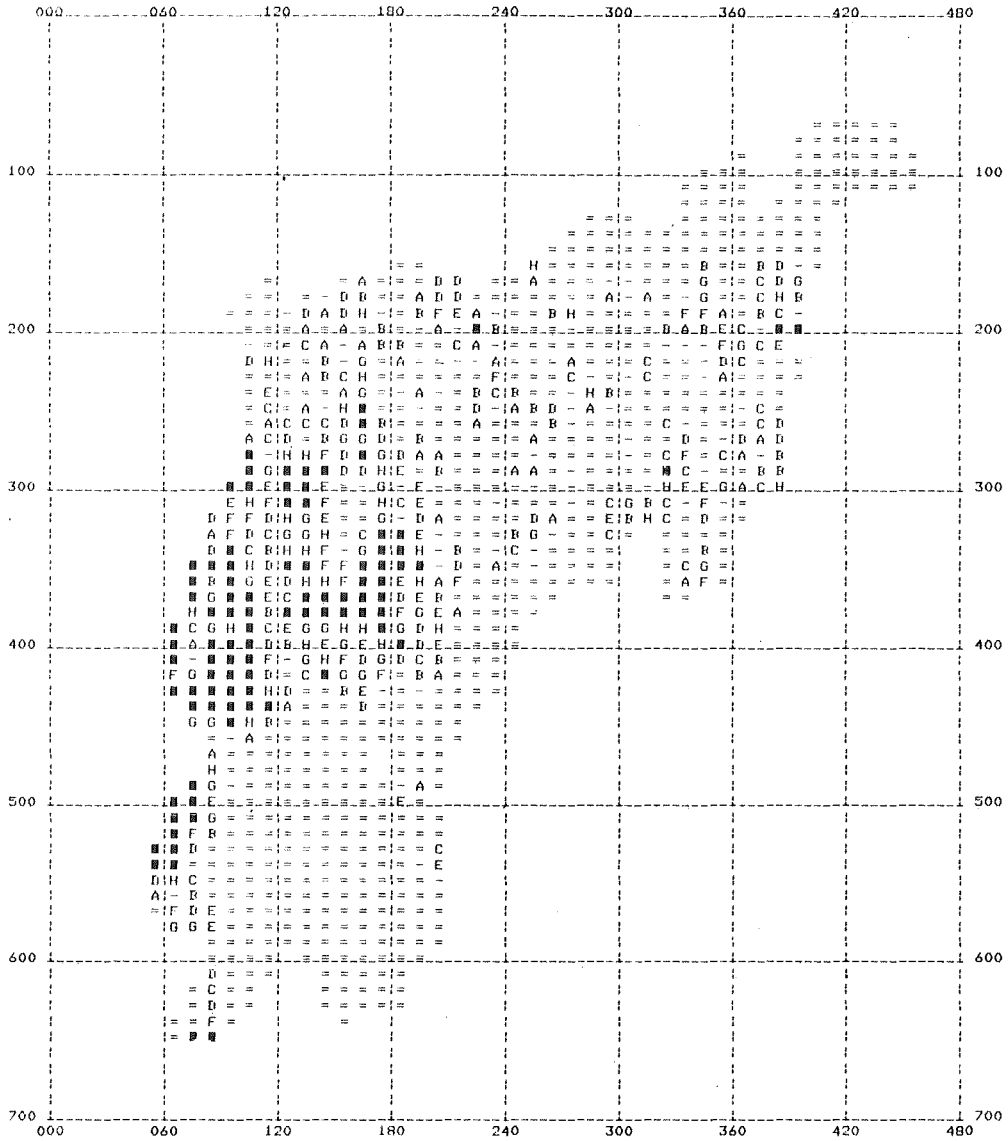
INPUT L,E,E,S, AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 10,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? OP,\,PO\0,0



EXPLANATION OF SYMBOLS

A	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD		GOOD			VERY GOOD				BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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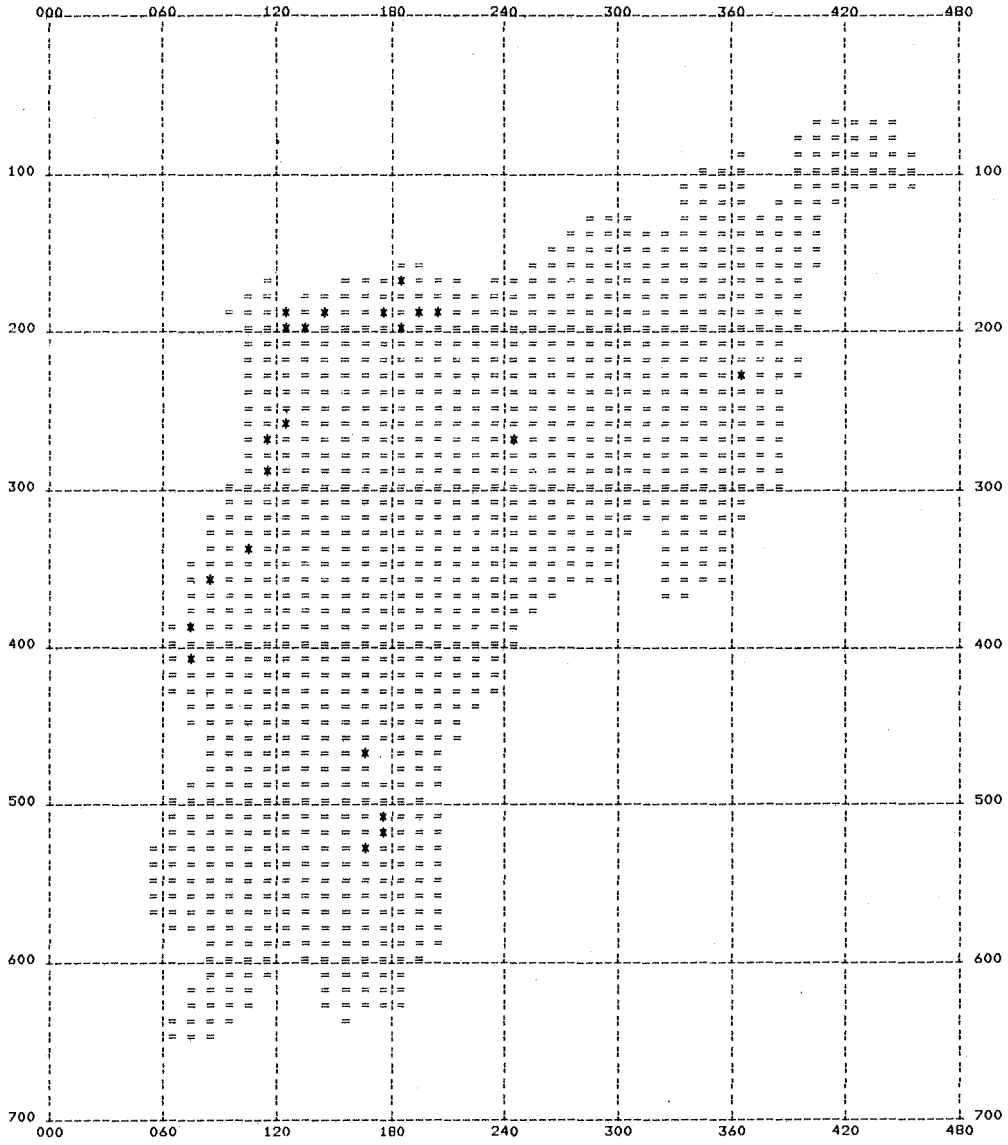
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,10
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
								SLIGHTLY BAD		?	SLIGHTLY GOOD									
WORST CASE			VERY BAD			BAD						GOOD			VERY GOOD				BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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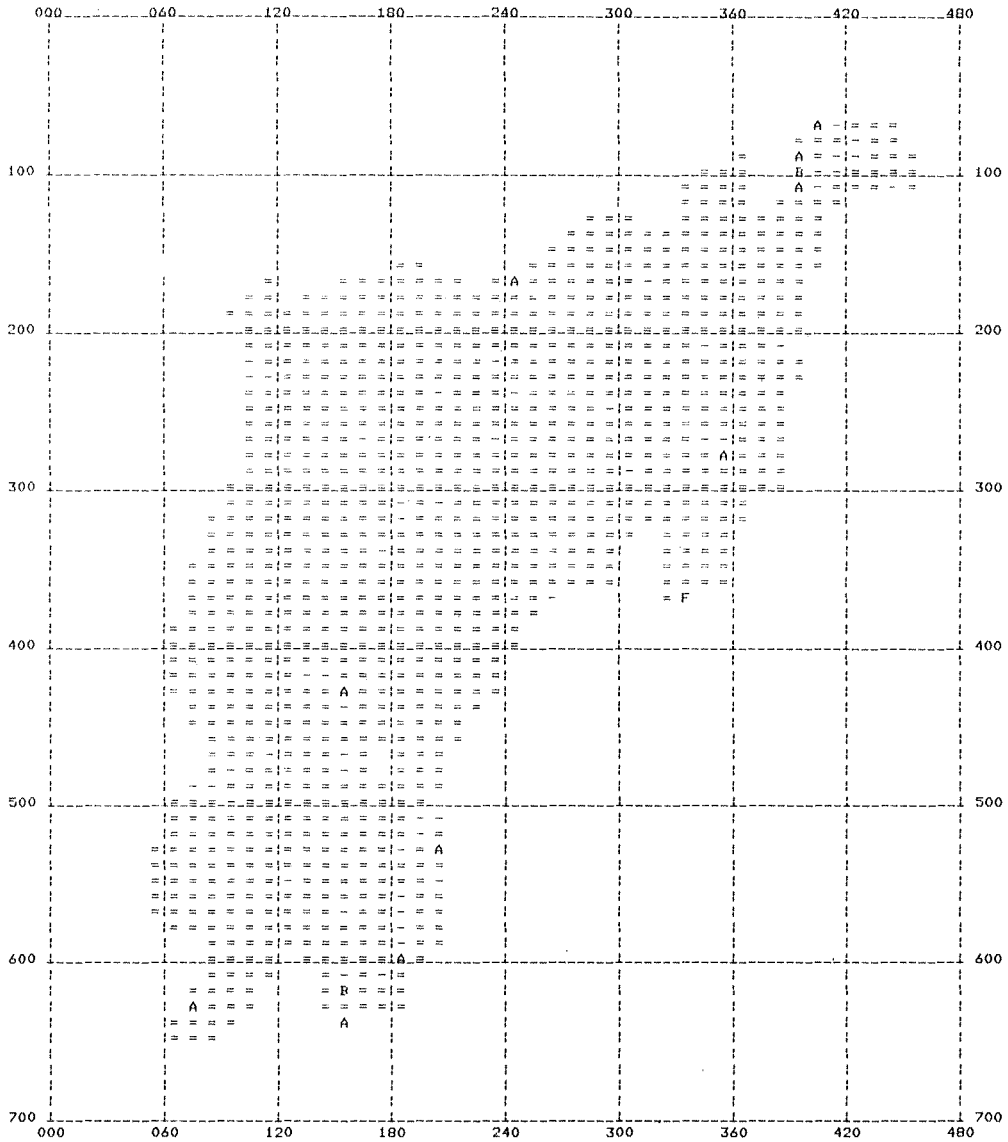
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,10
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

#	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?		SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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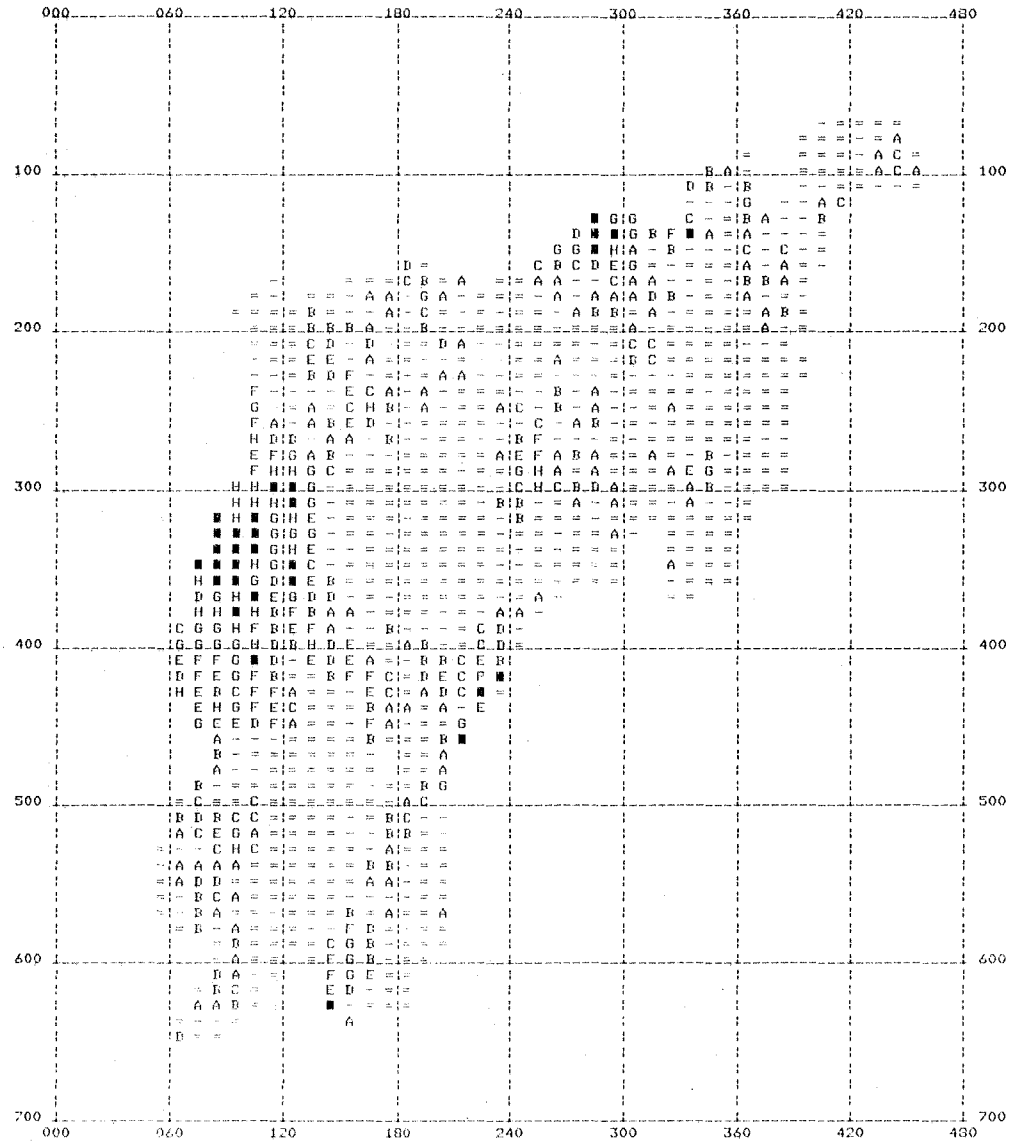
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 10,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE VERY BAD BAD SLIGHTLY BAD ? SLIGHTLY GOOD GOOD VERY GOOD BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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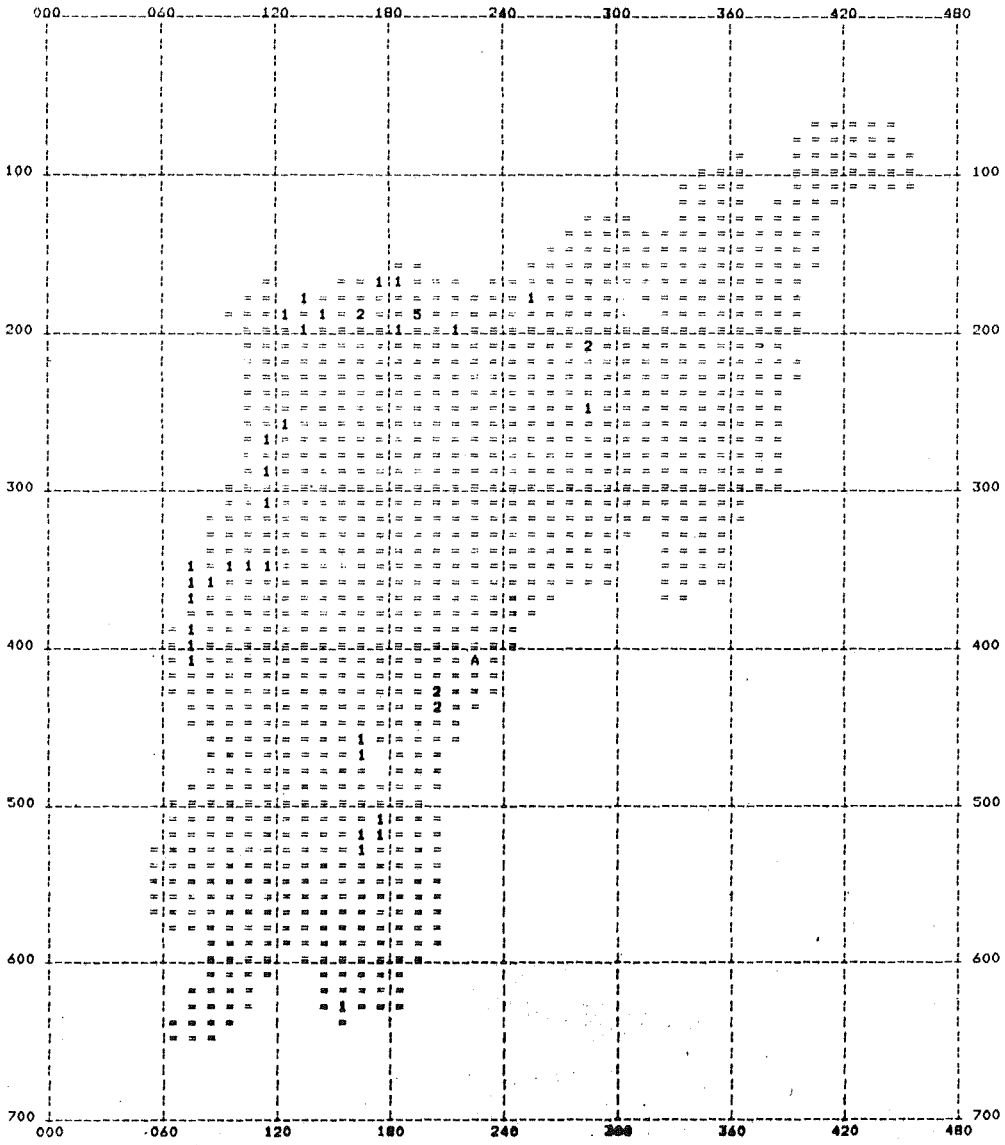
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 10,0



EXPLANATION OF SYMBOLS.

| | | |

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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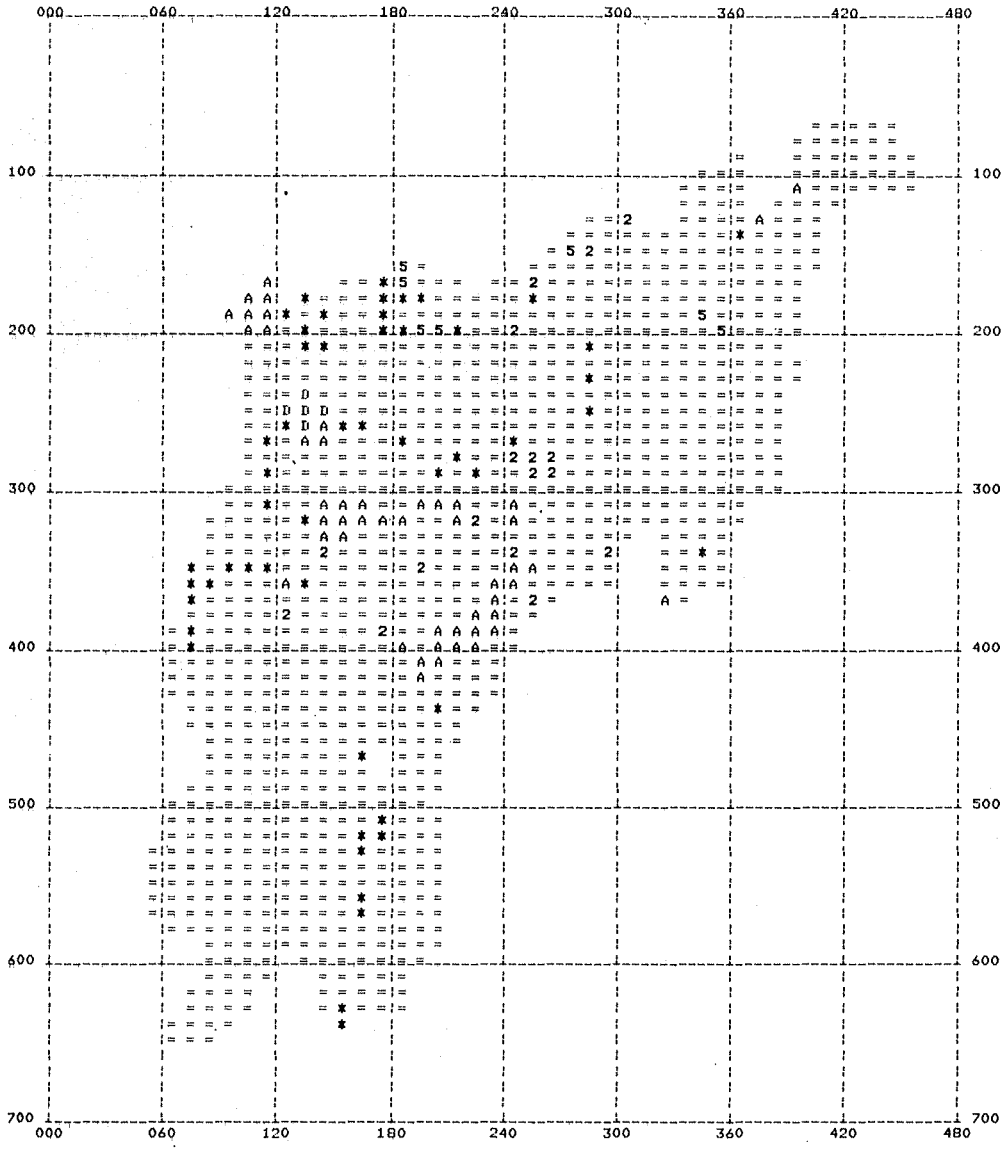
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,10
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD		GOOD			VERY GOOD			BEST CASE	

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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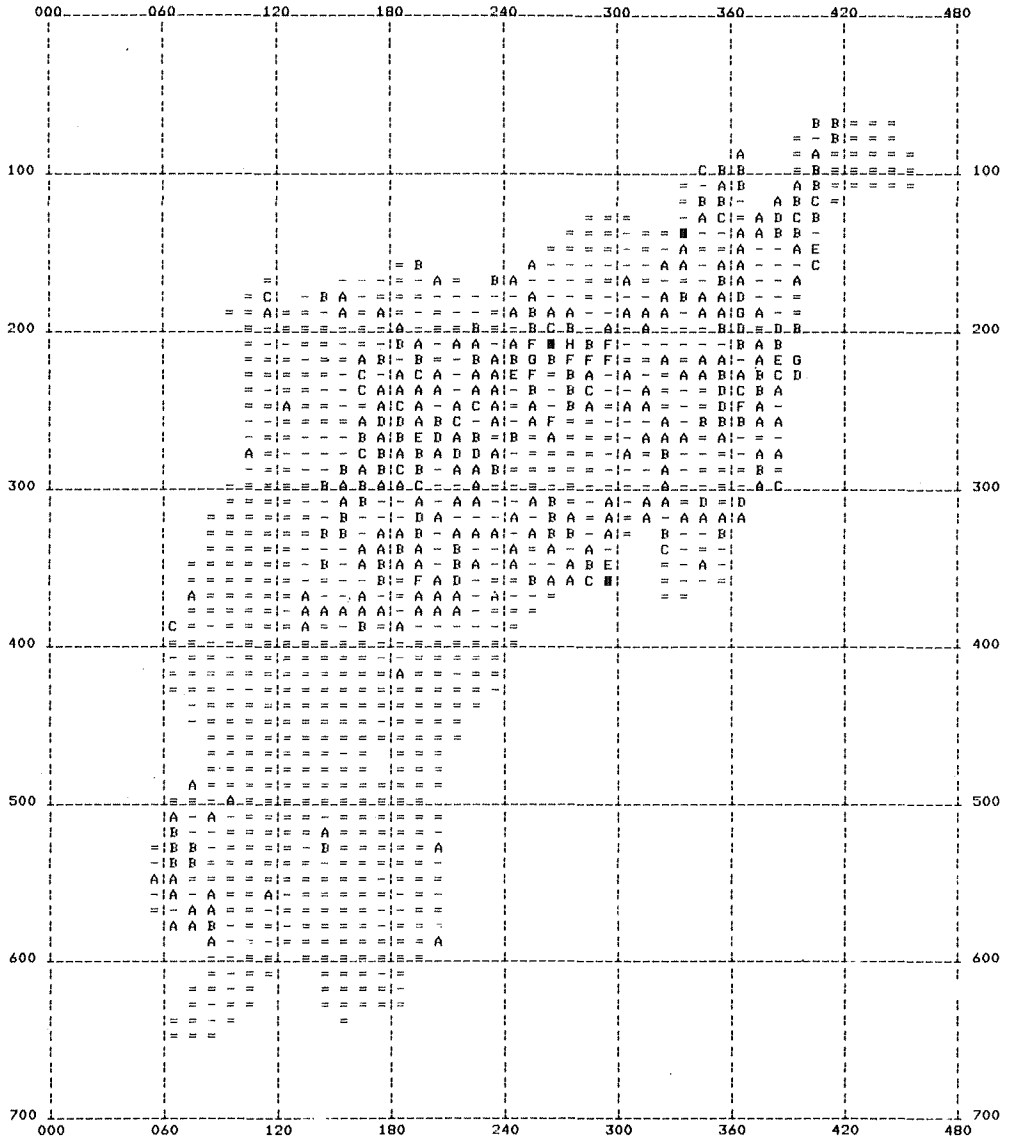
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 10,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE | VERY BAD | BAD | SLIGHTLY BAD | ? | SLIGHTLY GOOD | GOOD | VERY GOOD | BEST CASE

NARRAGANSETT BASIN DRILL SITE S[illegible]TION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. [illegible]ER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. [illegible]REW SMITH.

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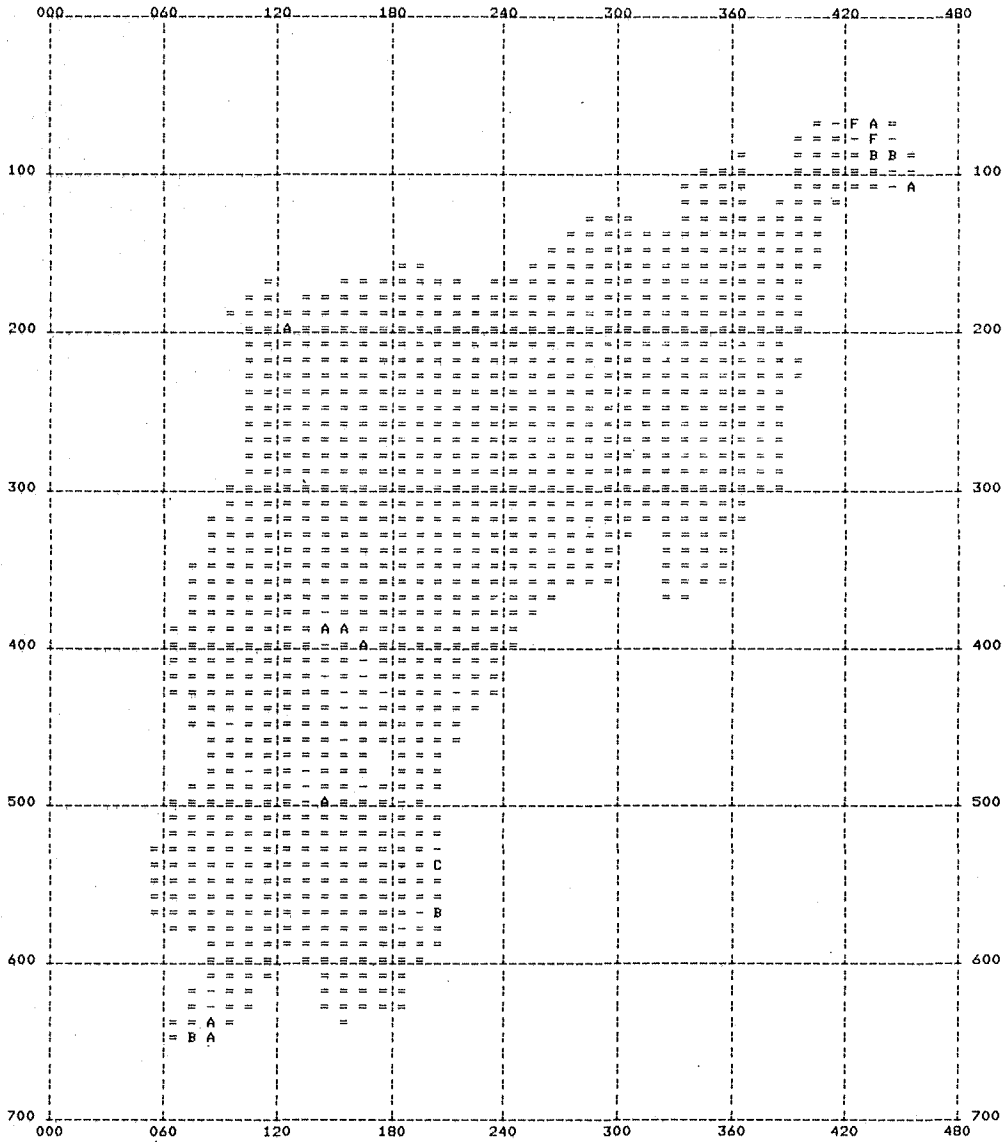
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,10
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
									SLIGHTLY	?	SLIGHTLY									
WORST CASE			VERY BAD			BAD			BAD		GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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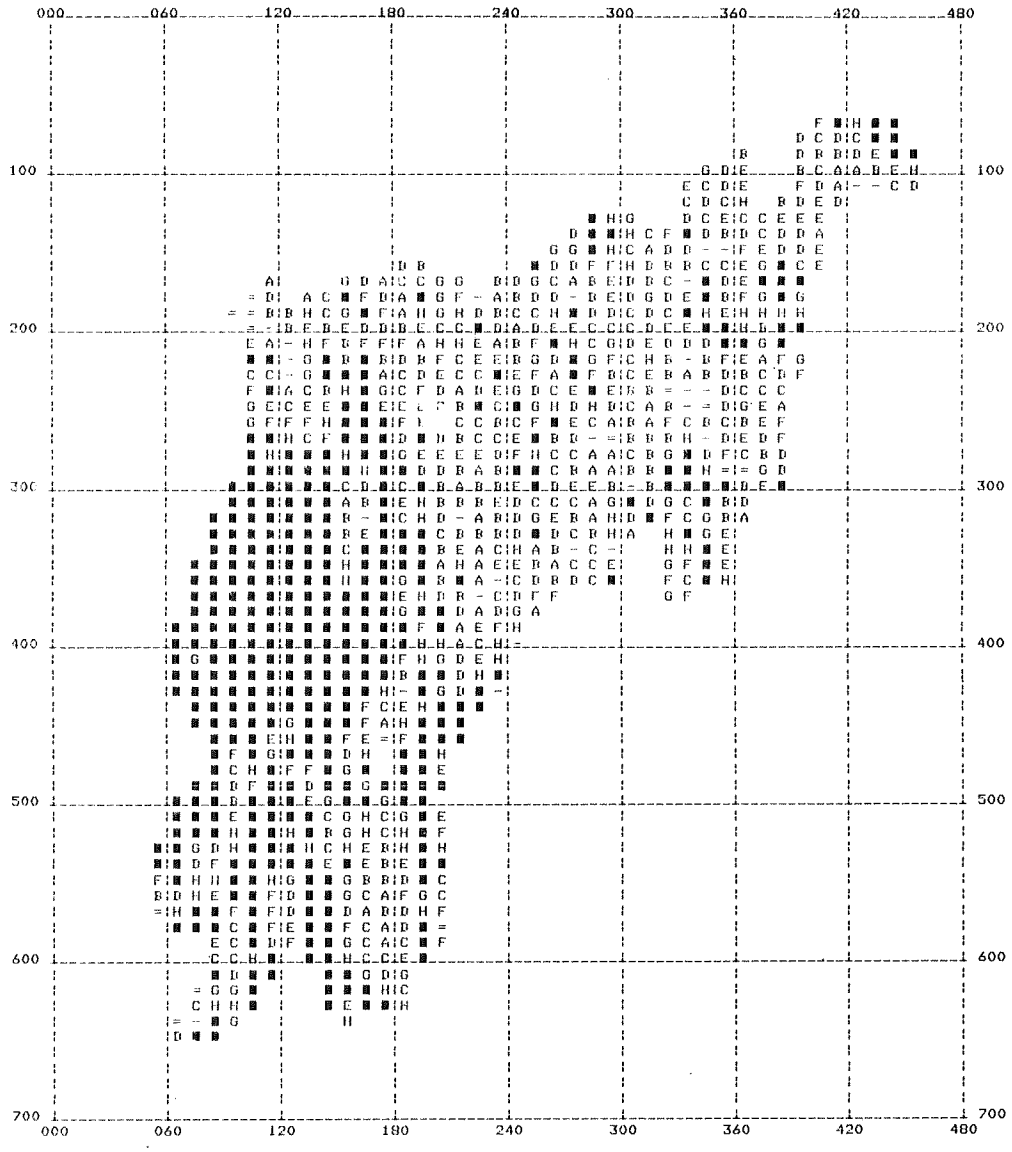
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 10,10
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 10,10,10
FRESH AND OCEAN WATER BODY WEIGHTS	? 10,10
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 10,10
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 10,10\01\0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?		SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

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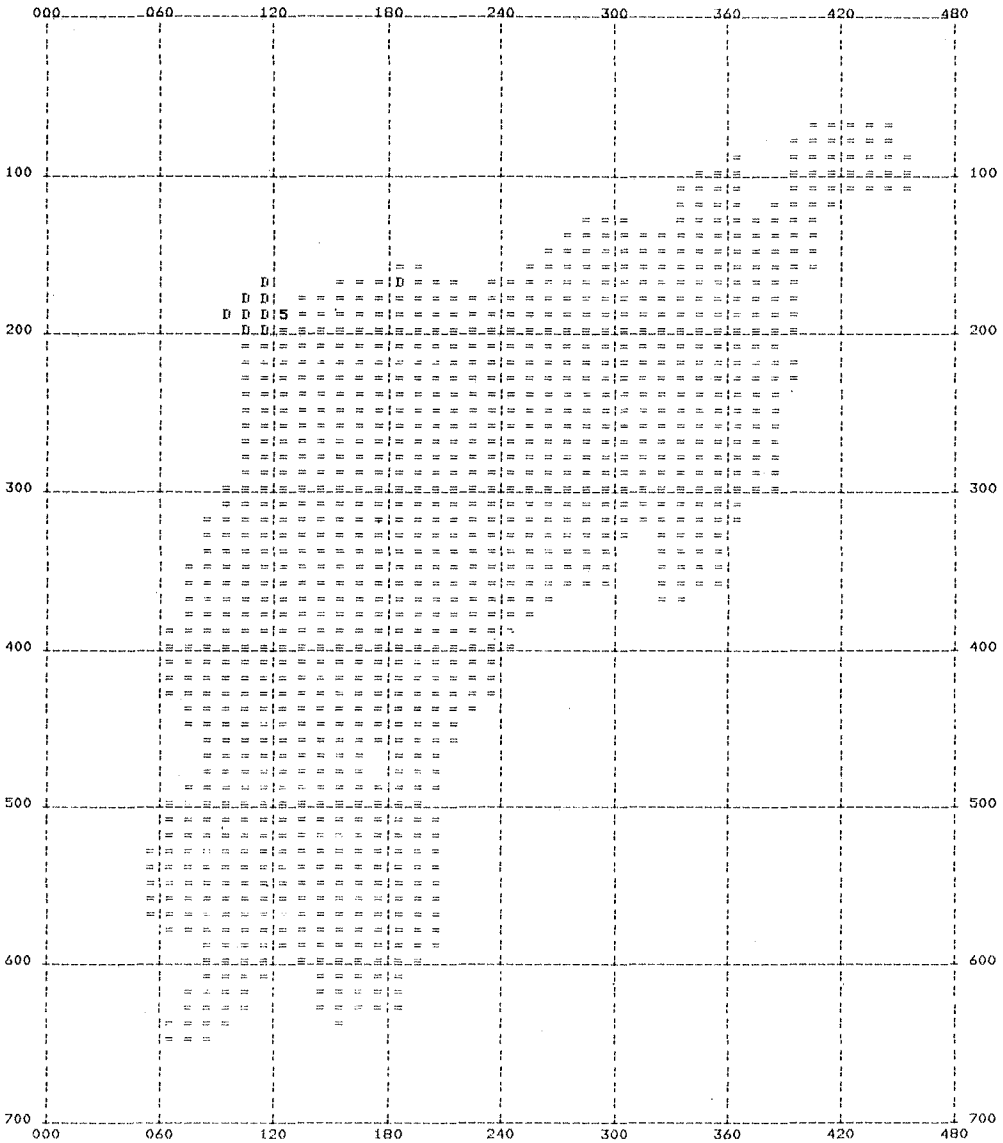
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,10
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD	?	SLIGHTLY GOOD		GOOD			VERY GOOD			BEST CASE		

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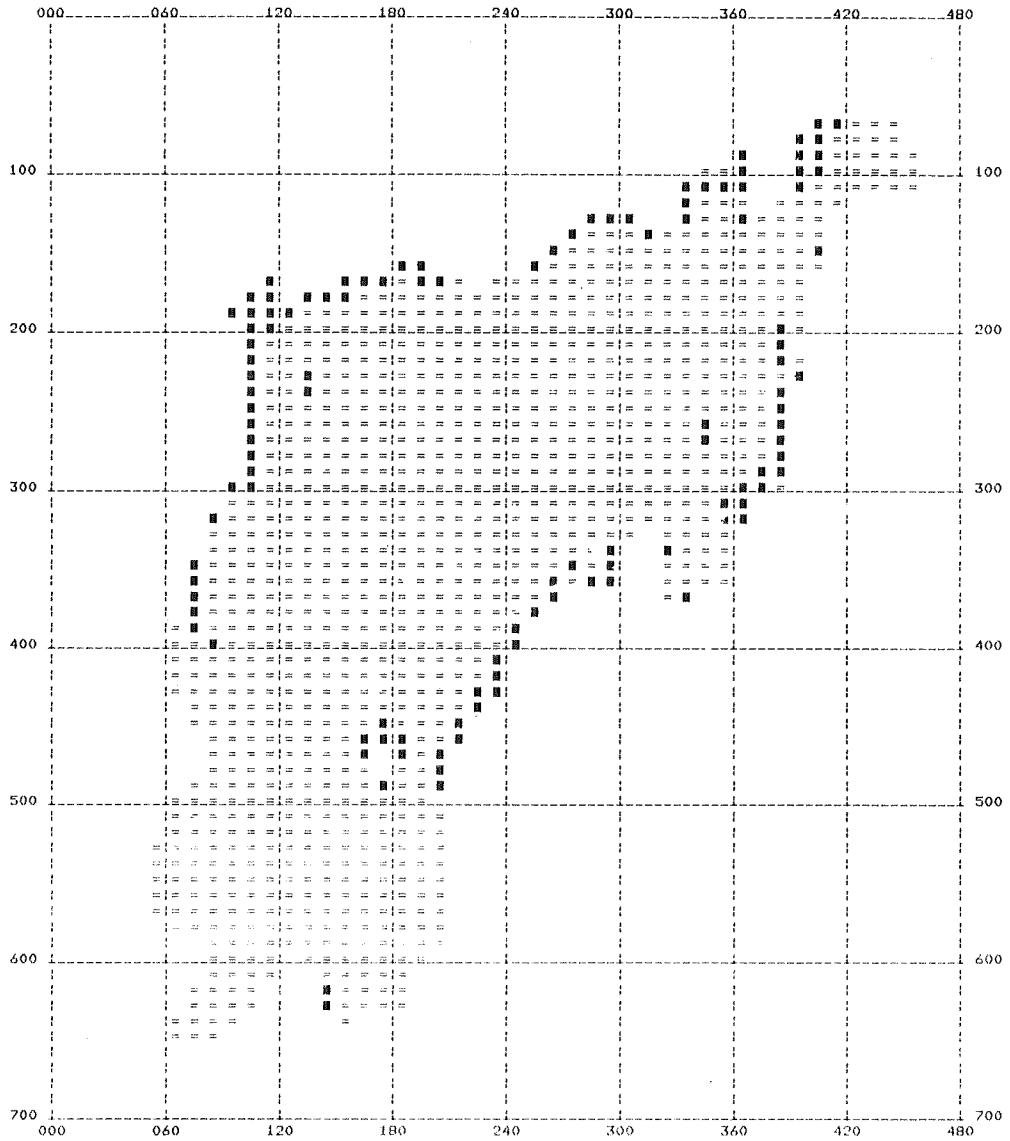
INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 10,0,0
DEPTH AND DIP WEIGHTS	? 0,0



EXPLANATION OF SYMBOLS

■	H	G	F	E	D	C	B	A	-	=	1	2	3	4	5	6	7	8	9	*
WORST CASE		VERY BAD			BAD			SLIGHTLY BAD		?	SLIGHTLY GOOD			GOOD			VERY GOOD			BEST CASE

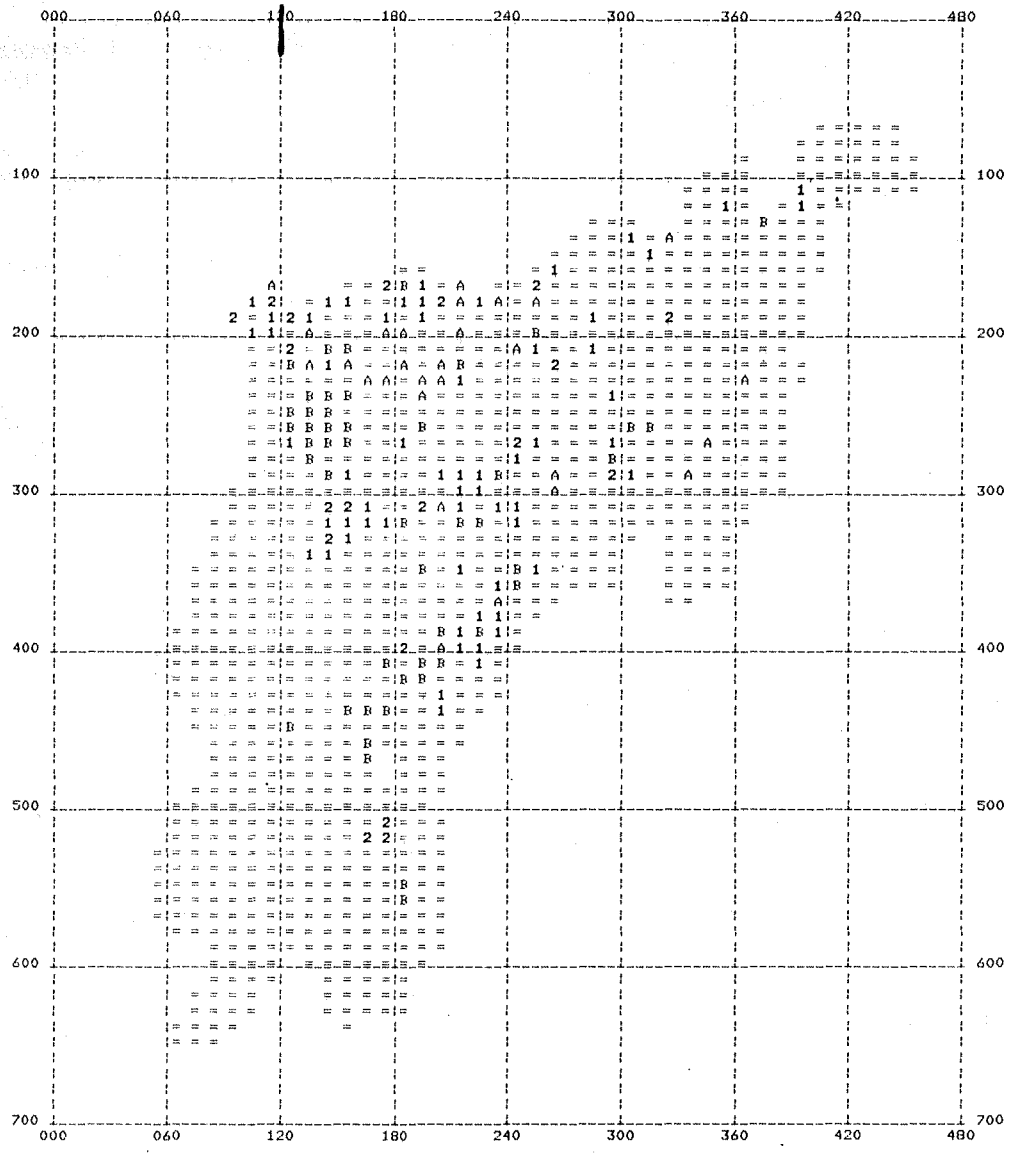
NARRAGANSETT BASIN DRILL SITE SELECTION CRITERIA MAP

CREATED FOR THE BUREAU OF MINES, CONT. #J0188022, 1978, BY T. H. RIDER, MANAGING DIRECTOR, NECEP; DEVELOPED & EDITED BY E. WINN DAVIS, NECEP; SPECIAL COMPUTER ASSISTANCE FROM J. ANDREW SMITH.

THIS PROGRAM WILL DEPICT THE NARRAGANSETT BASIN USING ALPHANUMERIC CHARACTERS TO REPRESENT EVERY SQUARE MILE WITHIN THE BASIN. EACH CHARACTER REPRESENTS AN EVALUATION OF LAND USE AND GEOLOGICAL PARAMETERS, AND EACH WILL VARY ACCORDING TO THE EMPHASIS YOU PLACE ON THE FOLLOWING FACTORS.

INPUT L.E.E.S. AND GEOLOGICAL WEIGHTS:

INLAND AND COASTAL WETLANDS WEIGHTS	? 0,0
HIGH, MEDIUM, AND LOW DENSITY DEVELOPMENT WEIGHTS	? 0,0,0
FRESH AND OCEAN WATER BODY WEIGHTS	? 0,0
GROUND WATER RESERVE AND TOWN WELL WEIGHTS	? 0,0
SURFACE MINING AND PREVIOUS COAL MINING ACTIVITY WEIGHTS	? 0,0
DRILLING ACTIVITY AND FIELD RESEARCH WEIGHTS	? 0,0
NON-PENNSYLVANIAN FORMATION, METAMORPHIC ANALYSIS, AND STRUCTURAL COMPLEXITY WEIGHTS	? 0,0,0
DEPTH AND DIP WEIGHTS	? 0,10



EXPLANATION OF SYMBOLS

■ H G F E D C B A - = 1 2 3 4 5 6 7 8 9 *

WORST CASE VERY BAD BAD SLIGHTLY BAD ? SLIGHTLY GOOD GOOD VERY GOOD BEST CASE

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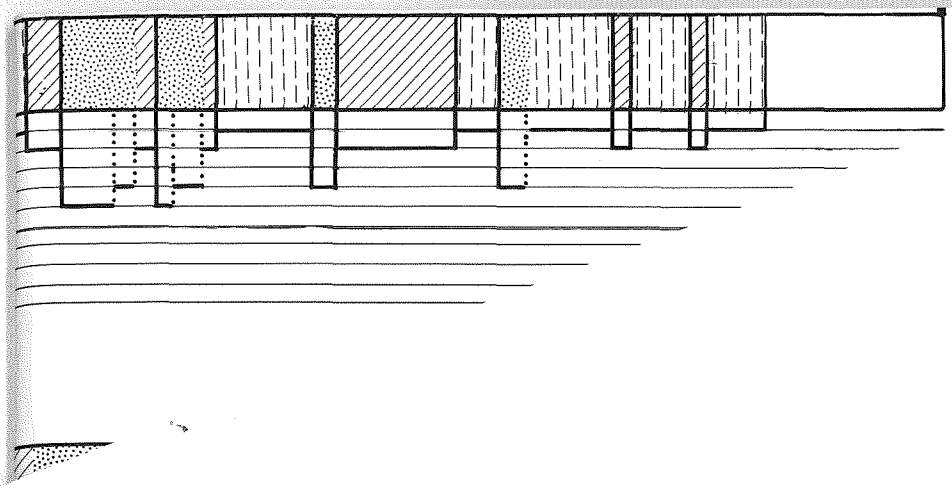

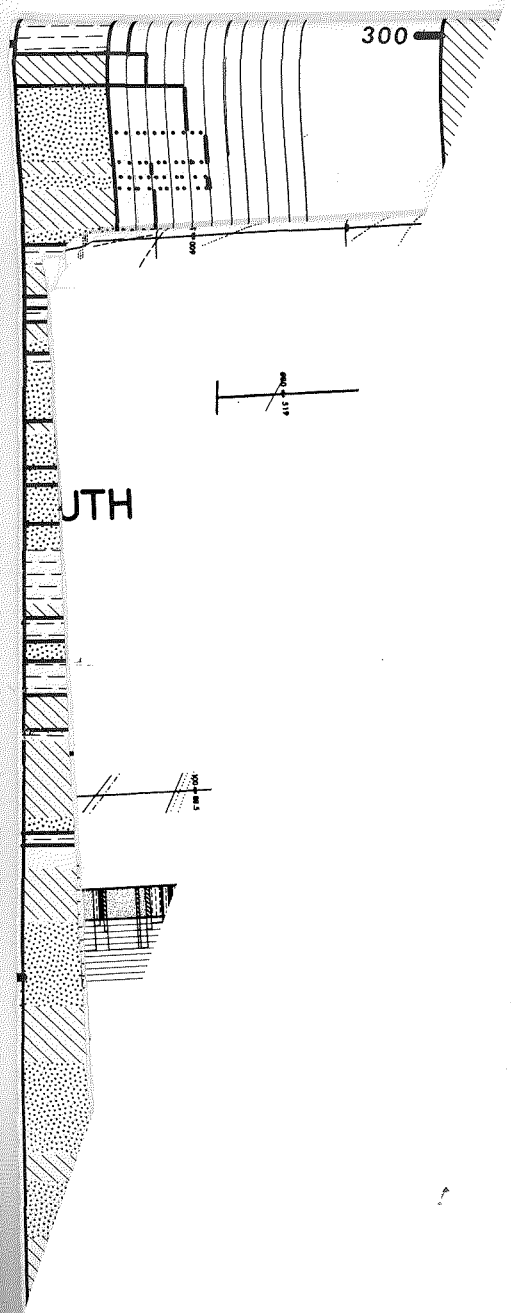
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