LOCKHEED SPACE OPERATIONS COMPANY
KENNEDY SPACE CENTER , FLORIDA

BANANA RIVER DREDGING - SPOIL SITES ENVIRONMENTAL ASSESSMENT

APRIL , 1991

GEE & JENSON
Engineers-Architects-
Planners, Inc.

April 12, 1991

GEE & JENSON

Lockheed Space Operations Company
Modification Management
P.O. Box 21166
Kennedy Space Center, FL 32815

Attn: Tom Smith, LSO-084

Re: Banana River Dredging Spoil Sites
Environmental Assessment

Gentlemen:

Gee & Jenson is pleased to submit herewith six (6) copies of the BANANA RIVER DREDGING SPOIL SITES ENVIRONMENTAL ASSESSMENT. The report is divided into three phases, including:

PHASE I - ENVIRONMENTAL ANALYSIS
(Alternative Sites Selection)

PHASE II - ENVIRONMENTAL ASSESSMENT

PHASE III - PRELIMINARY ENGINEERING
(Selected Sites)

The Environmental Assessment (EA) in Phase II was prepared under the guidelines of KHB 1200.1A, Chapter 18, Section 19, and NHB 8800.11 and may be extracted from this report as a complete document within the overall report. Base maps included in the geographic analysis of Phase I (Alternative Sites Selection), should be attached as an Appendix to the EA if separate reproduction is required.

We appreciate the opportunity to have been of service to Lockheed Space Operations Company in the early considerations of this work, and look forward to providing future assistance on this project.

Very truly yours,

Peter J. Krinsky, C.E.P.
Project Manager

John S. Yeend, P.E.
Vice President

PJK/JSY:cw
Enc. as stated
90-379

One Harvard Circle • West Palm Beach, Florida 33409-1923 • 407/683-3301 • FAX 407/686-7446

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd.)

LIST OF TABLES AND PLATES

List of Tables and Plates (cont'd.)

EXECUTIVE SUMMARY

Dredge spoil disposal areas are required in support of Banana River channel maintenance dredging. Solid rocket booster retrieval ships, and external tank barges travel the river in support of the Shuttle Program. Based on an analysis of design constraints, costs, and environmental sensitivities, five sites were selected to retain 1,200,000 cubic yards of hydraulic dredge material. Two of the sites are existing mosquito impoundment areas (2C and 3A) and two are expansions of existing dredge spoil disposal areas (4 and 5). A fifth site on the Air Force side is a disturbed ruderal area. It has not been released for use, but will be included for the purposes of this study as an alternate site.

The estimated cumulative aerial coverage of the five sites is 205 acres. This area will adequately store 1,200,000 cubic yards of dredged material. Schematics for each site are contained within this report. It is estimated that there will be a 4.8 day average retention time for the five sites. Effluent quality needs to meet discharge standards of "Outstanding Florida Waters" (OFW) or ambient river water quality. It is recommended that "bench scale" settleability work be undertaken so that minimum detention times for each basin can be established. Due to the OFW designation of receiving waters, it may be necessary to apply to Tallahassee for a "mixing zone variance" to meet water quality criteria.

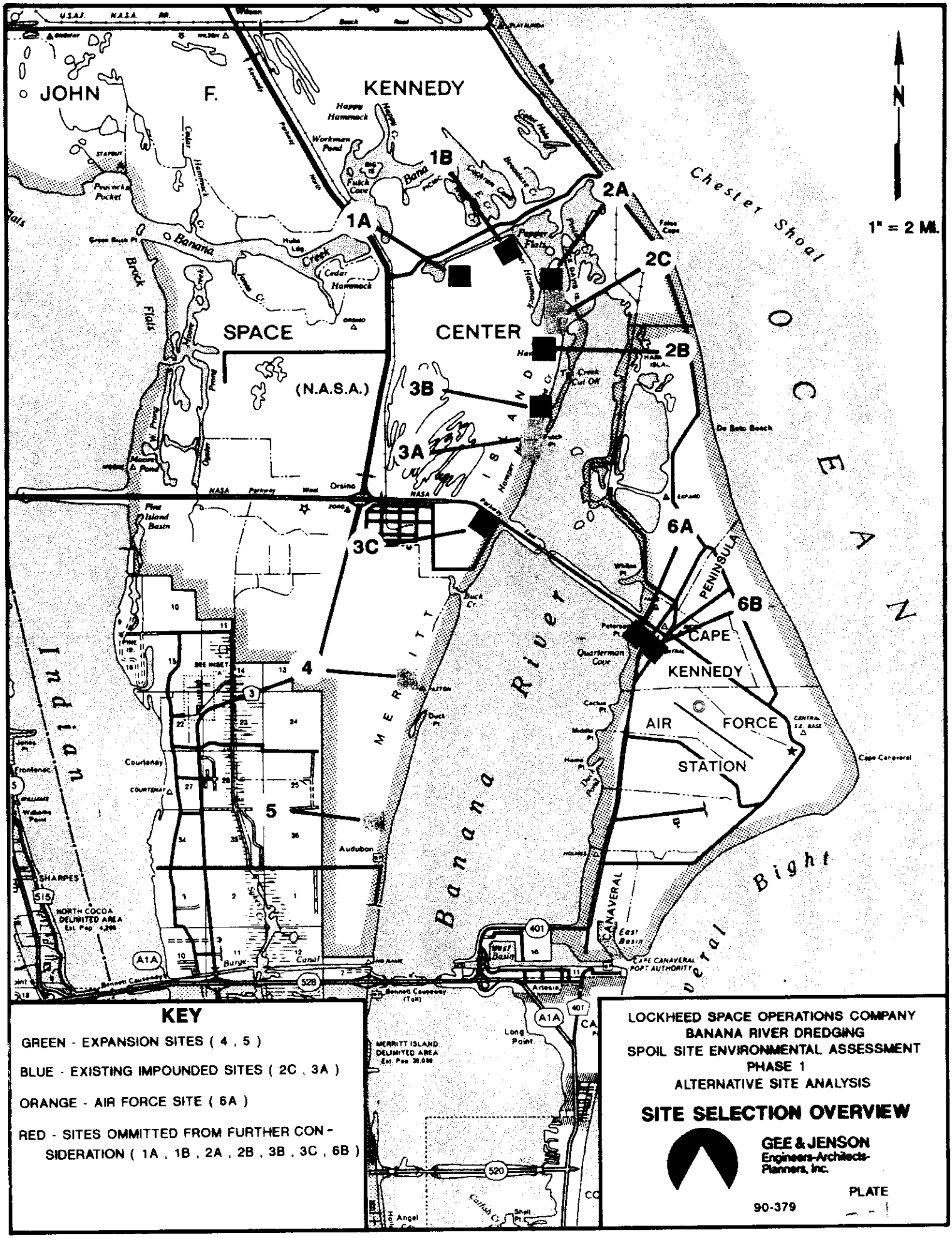
Berms have been designed to be 10 ft. high with depths of solids reaching about 4 ft. in each basin. The remaining depth will be for retention of water to achieve desired effluent quality with 2 ft. of freeboard. It has been estimated that approximately 1 ft. or less of excavation will be required on the average site for construction of berms. Soils borings indicate that "in-situ" material is acceptable as construction material for an estimated 19,500 ft. of new berm which will be required for these sites.

Cost estimates indicate $1,500,000 for construction of these facilities or $1.25/cubic yard of dredged material.

Plate A-1 is a site selection overview illustrating the approximate locations of the five sites, as well as an additional seven sites which were analyzed and omitted from further consideration, based on the Phase I Alternative Sites Analysis. The results of the EA state that there will be some impacts to biotic resources, in particular wetlands and some native uplands. Some of these areas have previously been disturbed/impacted (fair quality), while others may be considered higher quality.

As appropriate mitigation is feasible and cost-effective (and will be addressed during the regulatory permitting process), this study recommends a "finding of no <u>significant</u> impact" (FONSI).

Permitting agencies include the Florida Department of Environmental Regulation (DER), the St. Johns River Water Management District (SJRWMD), the U.S. Army Corps of Engineers (COE), and the Florida Game & Freshwater Fish Commission (FGFWFC). The issues raised in this assessment will be undertaken and addressed in detail during the regulatory permitting process with each of the agencies. The purpose of this EA is to summarize and identify these issues.



KEY

GREEN - EXPANSION SITES (4 , 5)

BLUE - EXISTING IMPOUNDED SITES (2C , 3A)

ORANGE - AIR FORCE SITE (6A)

RED - SITES OMMITTED FROM FURTHER CONSIDERATION (1A , 1B , 2A , 2B , 3B , 3C , 6B)

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SITE SELECTION OVERVIEW

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PLATE

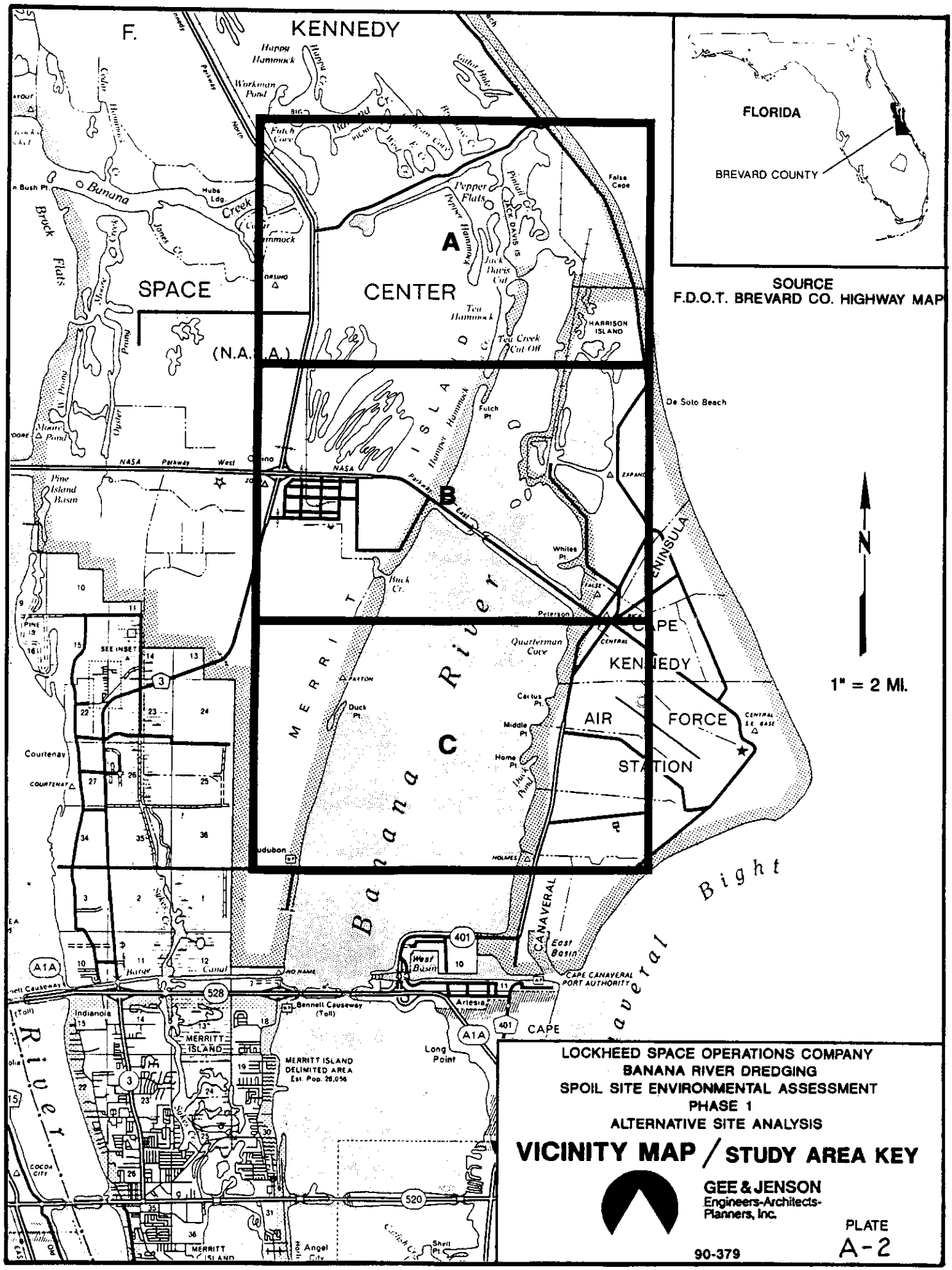
90-379

INTRODUCTION

The Banana River channel is accumulating deposits at a rate of approximately .2 ft. per year. This requires channel maintenance dredging to be performed every 5 to 7 years. As a result, LSOC contracted (PO #147348) with Gee & Jenson (7/27/90) to make an analysis of existing and potential sites (Phase I); perform an Environmental Assessment (EA) in accordance with recommended guidelines (Phase II), and undertake the preliminary engineering on selected sites (Phase III). As a result, this report is divided into three sections or phases.

Phase I is an environmental analysis for alternative sites selection based primarily on environmental considerations, as well as engineering constraints and costs. A ranking methodology is used in final selection of the sites to be proposed for spoils disposal.

Plate A-2 is a vicinity map and study area key used in assessing the geographical information compiled on a set of base maps developed during the Phase I study. The study area ranges from the northern limits of the Merritt Island National Wildlife Refuge (MINWR) to approximately Hall Road and Audubon to the south. The areas contiguous to the western shore of the Banana River were the western limits of the study area; while the Cape Canaveral Air Force Station, particularly the areas contiguous to the Banana River north and south of NASA Parkway East, were the eastern limits of the study area.


F. KENNEDY SPACE CENTER
(N.A.S.A.)
A
B
C
FLORIDA
BREVARD COUNTY
SOURCE
F.D.O.T. BREVARD CO. HIGHWAY MAP
N
1" = 2 MI.
Banana River
Indian River
Merritt Island
Cape Canaveral
Cape Kennedy
Air Force Station
Pepper Flats
Tee Hammock
Harrison Island
De Soto Beach
Courtenay
Indianola
Long Point
Bennett Causeway (Toll)
NASA Parkway West
NASA Parkway East
MERRITT ISLAND DELIMITED AREA
Est. Pop. 26,056
LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS
VICINITY MAP / STUDY AREA KEY
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90-379
PLATE
A-2

In preparing the base maps which illustrate the majority of geographical information considered during the Phase I analysis, it was necessary, for report purposes and data presentation, to divide the study area into three sections designated as Study Areas A, B and C, respectively (Plate A-2).

Once the Phase I analysis was completed and final sites were delineated, **Phase II** was developed which is an EA for the five sites.

Phase III is preliminary engineering of these sites, consisting of plan view schematics for each site, typical cross sections supporting engineering computations, and a brief engineering report.

PHASE I

ENVIRONMENTAL ANALYSIS

ALTERNATIVE SITES SELECTION

I. PHASE I - ENVIRONMENTAL ANALYSIS (ALTERNATIVE SITES SELECTION)

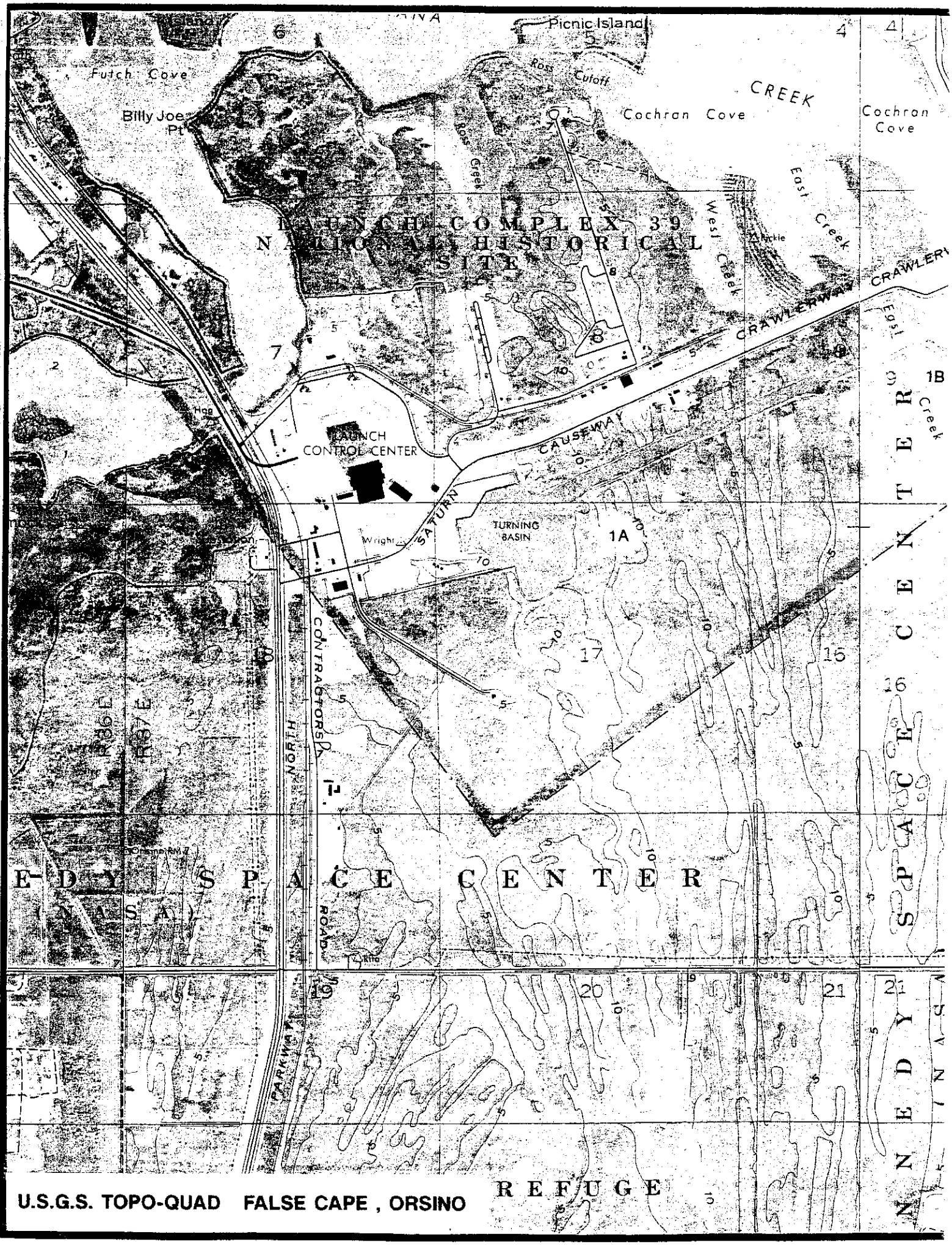
A. Geographic Analysis

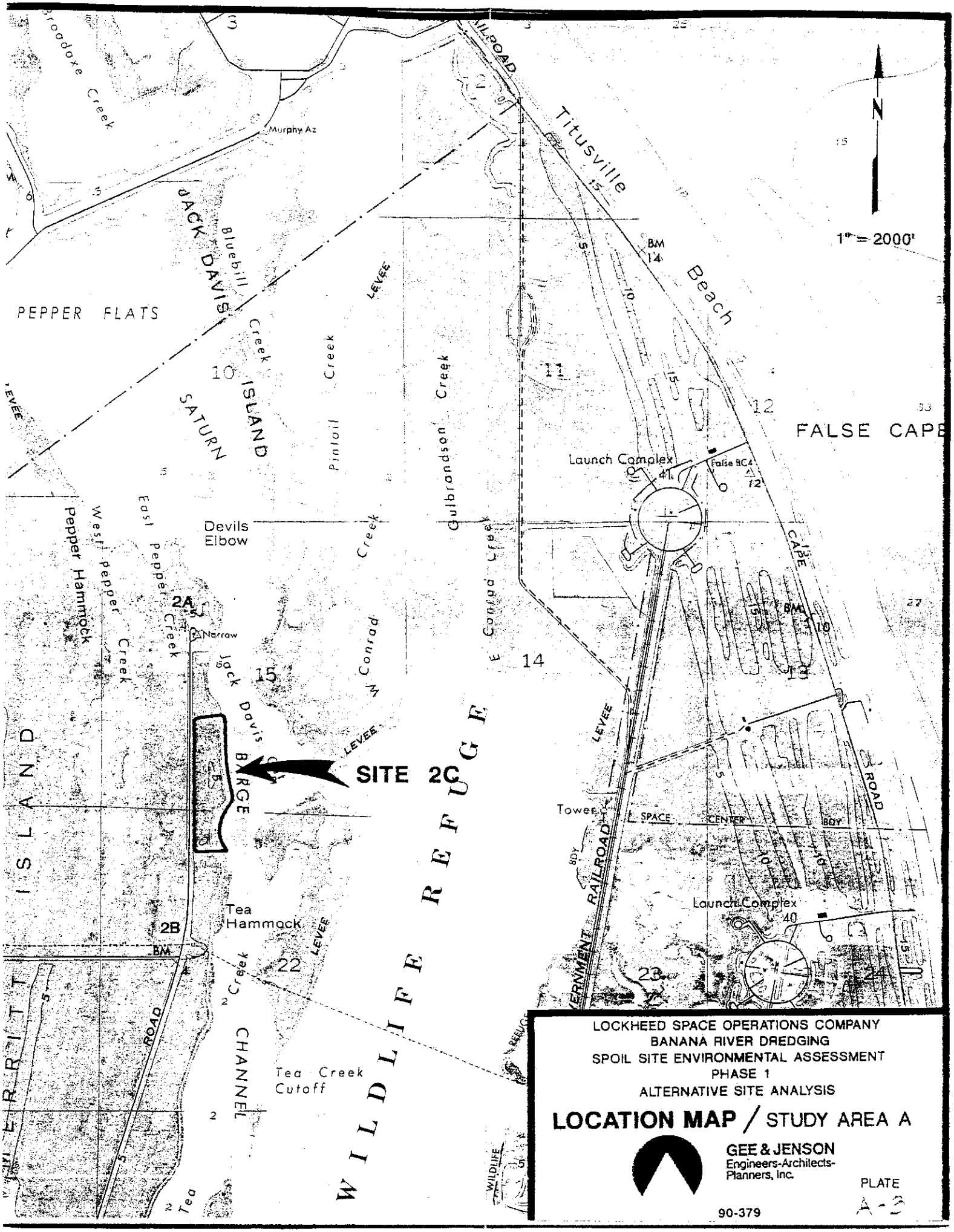
This analysis was accomplished utilizing infrared aerial photographs supplied by NASA at a scale of approximately 1" = 350' in conjunction with information extracted from four sets of base maps. Due to the large nature of the study area, the four sets of geographic base maps were divided into three segments, namely, Study Areas A, B and C. The base maps were USGS quadrangles for the area (Plate A-3); color I.R. photography/mapping indicating vegetative associations of the KSC property (Plate A-4); the Brevard County soils survey (Plate A-5); and flood zone information (Plate A-6). This information was critical in making the initial analysis and an attempt at identifying prospective spoil disposal sites in strategic locations to the dredging project area.

In analyzing the above data, 12 prospective sites were initially identified. These sites were identified after scrutinizing the aerial and base maps for areas of previous disturbance, suitable soils (non-hydric if possible), impacted upland areas and vegetation, minimum wetlands involvement (if possible), and engineering constraints and costs. The topo quads (Plate A-3) were initially used in conjunction with the 1" = 350' NASA aerials to locate prospective sites. This plate (see A-3) contains "boldfaced" perimeters for the selected sites as well as an overview of eliminated sites. Plate A-3 also indicates the topographical nature of each site. Once the prospective sites were identified off the aerials and onto the topo quads, the review was cross referenced to Plates A-4 and A-5 for major vegetation types and soils indications. The final sites were selected in an attempt to be located in impacted uplands with non-hydric soils. The sites were also strategically selected in an effort to space the spoil disposal facilities along the entire length of the channel. The

sites also require close proximity to the river to minimize actual pumping distances of dredged material.

Habitat constraints were also considered. Plate A-7 is a grid example which was superimposed on the NASA aerials at each proposed site. The grid represents a "Simplified Habitat Evaluation" (S.H.E.) process to determine which habitats had the least diversity based on the least number of features and interfaces between habitat types (Atkinson, 1990). The higher the number as a result of the analysis, the greater the potential habitat diversity for the site. The number itself has no significance; however, in comparing one site to another, the higher the number the more habitat sensitive the site may be. Results of these analyses may be found in Appendix A. These results were included in the following ranking methodology.


Picnic Island
Futch Cove
Billy Joe Pt
Ross Cutoff
CREEK
Cochran Cove
Cochran Cove
Ross Creek
West Creek
East Creek
Tickle
LAUNCH COMPLEX 39
NATIONAL HISTORICAL
SITE
CRAWLERWAY
CRAWLERWAY
East
1B
Hog
LAUNCH
CONTROL CENTER
CAUSEWAY
Creek
Wright
SATURN
TURNING
BASIN
1A
CONTRACTORS
NORTH
ROAD
Orsino RM 7
E D Y S P A C E C E N T E R
(N A S A)
PARKWAY
R E F U G E
U.S.G.S. TOPO-QUAD FALSE CAPE , ORSINO



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BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

LOCATION MAP / STUDY AREA A

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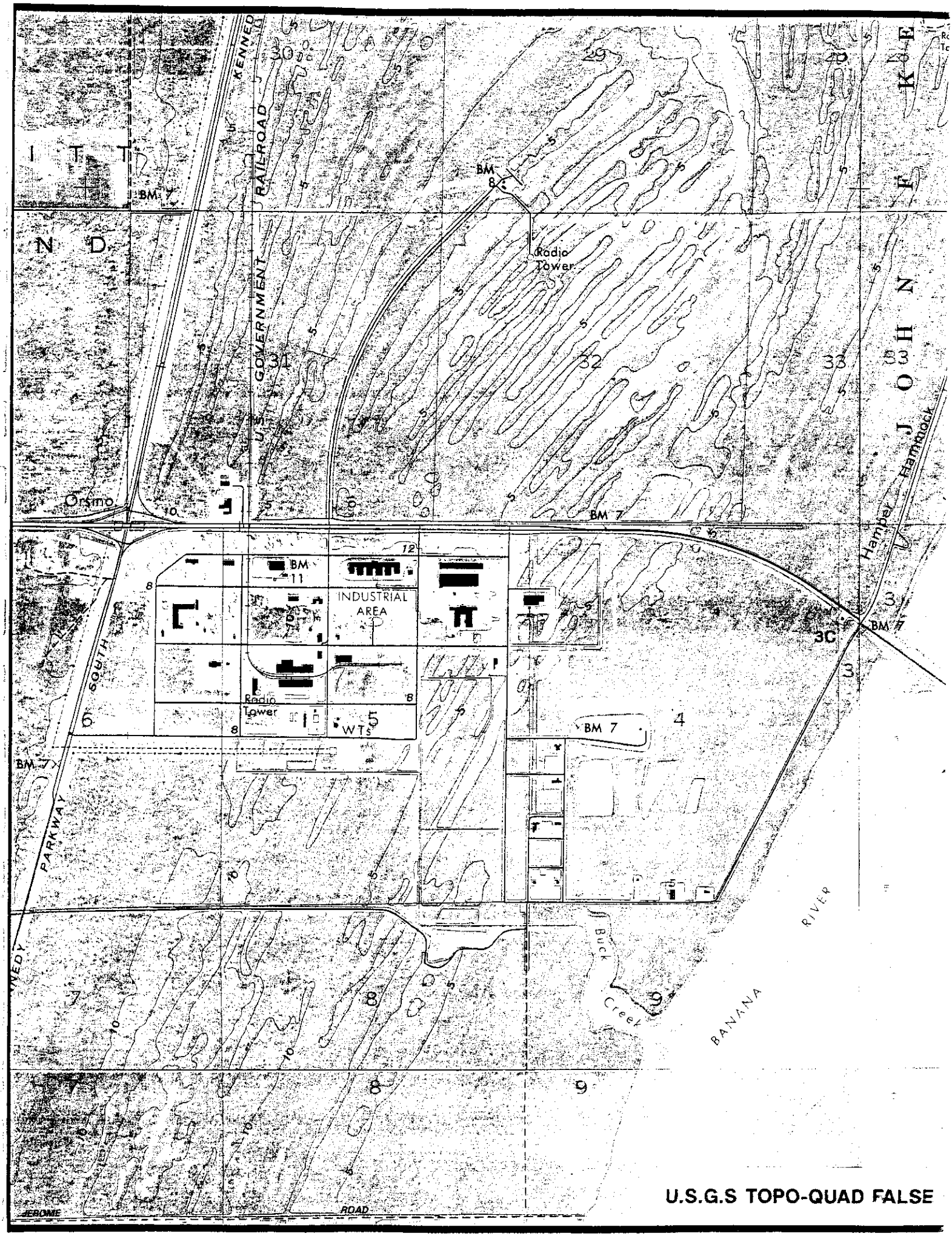
PLATE
A-2

90-379



U.S.G.S TOPO-QUAD FALSE

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SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

LOCATION MAP / STUDY AREA B

GEE & JENSON
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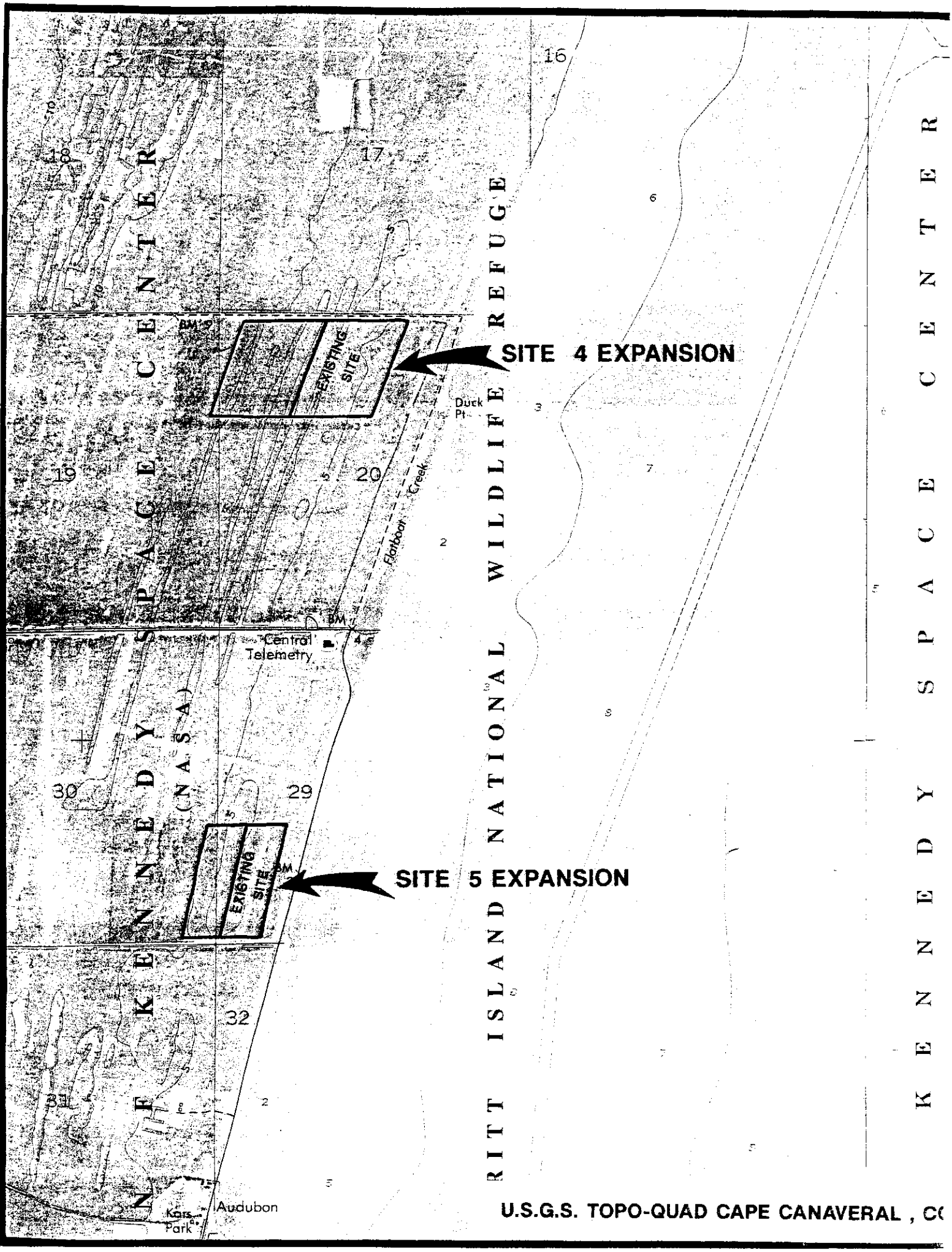
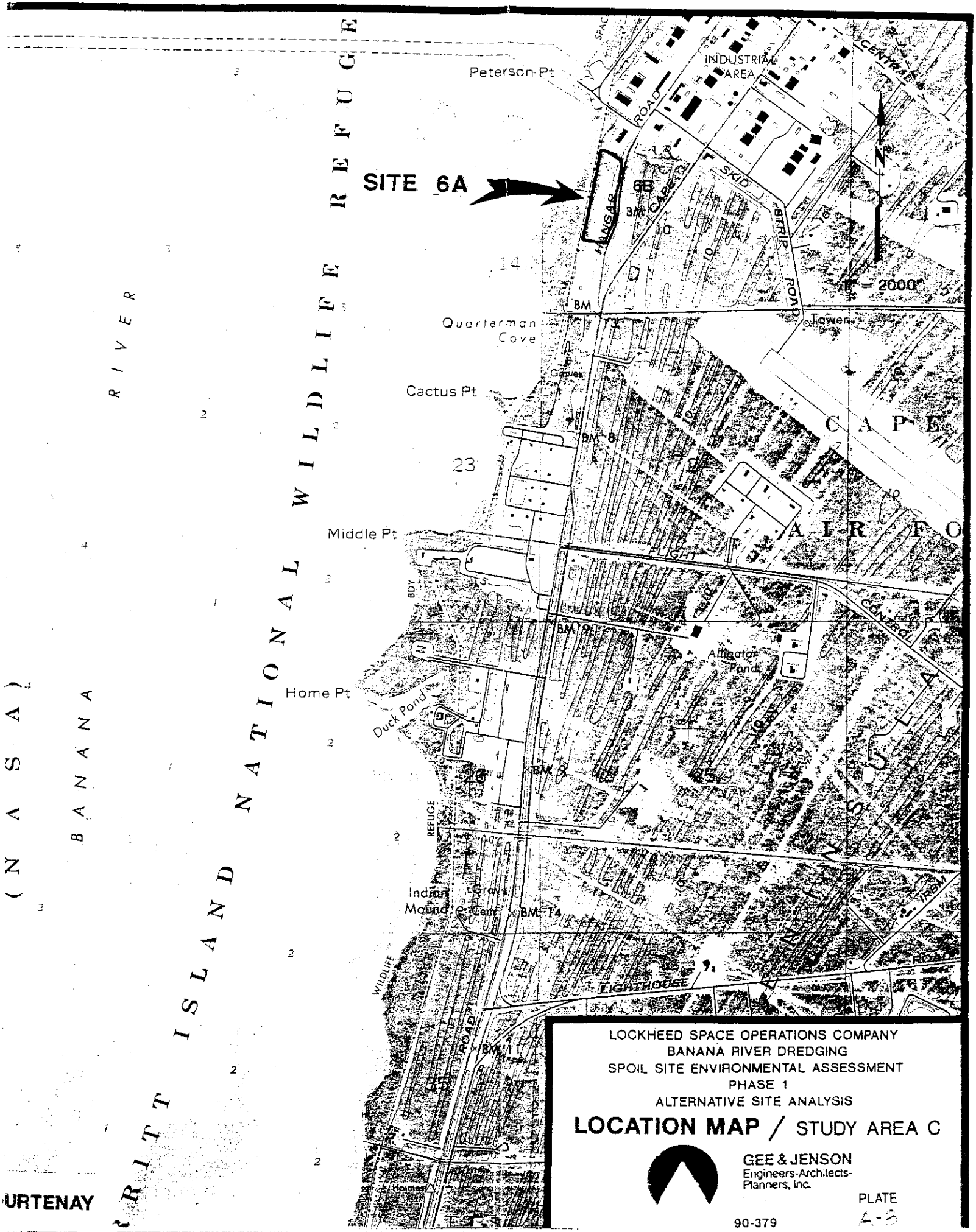
PLATE
A-2

90-379

APE , ORSINO , CAPE CANAVERAL , COURTENAY


SITE 4 EXPANSION
SITE 5 EXPANSION
EXISTING SITE
EXISTING SITE
KENNEDY SPACE CENTER (NASA)
KENNEDY SPACE CENTER
RITT ISLAND NATIONAL WILDLIFE REFUGE
Central Telemetry
Duck Pt
Flatboat Creek
Audubon
Kars Park
U.S.G.S. TOPO-QUAD CAPE CANAVERAL , C(



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BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

LOCATION MAP / STUDY AREA C

GEE & JENSON
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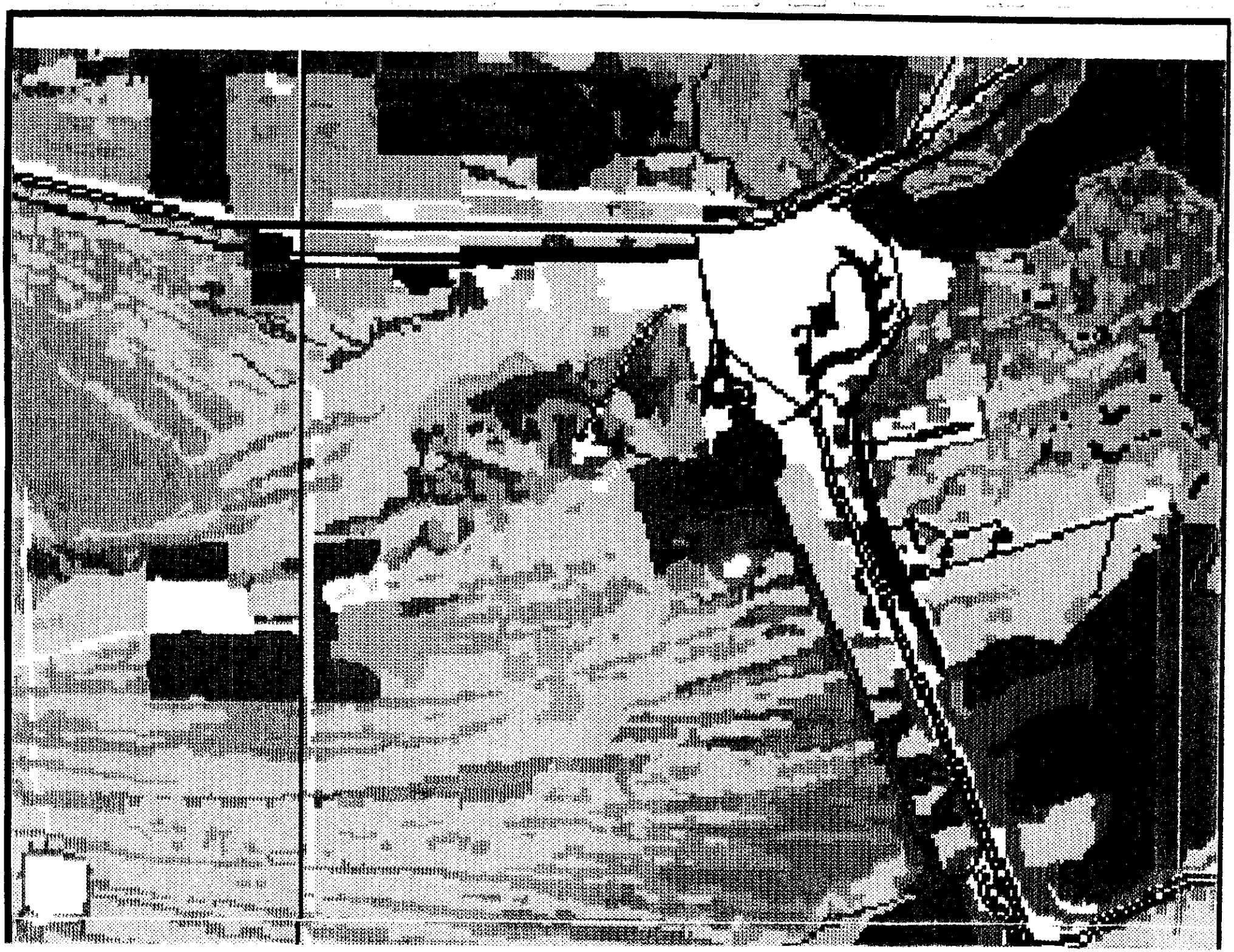
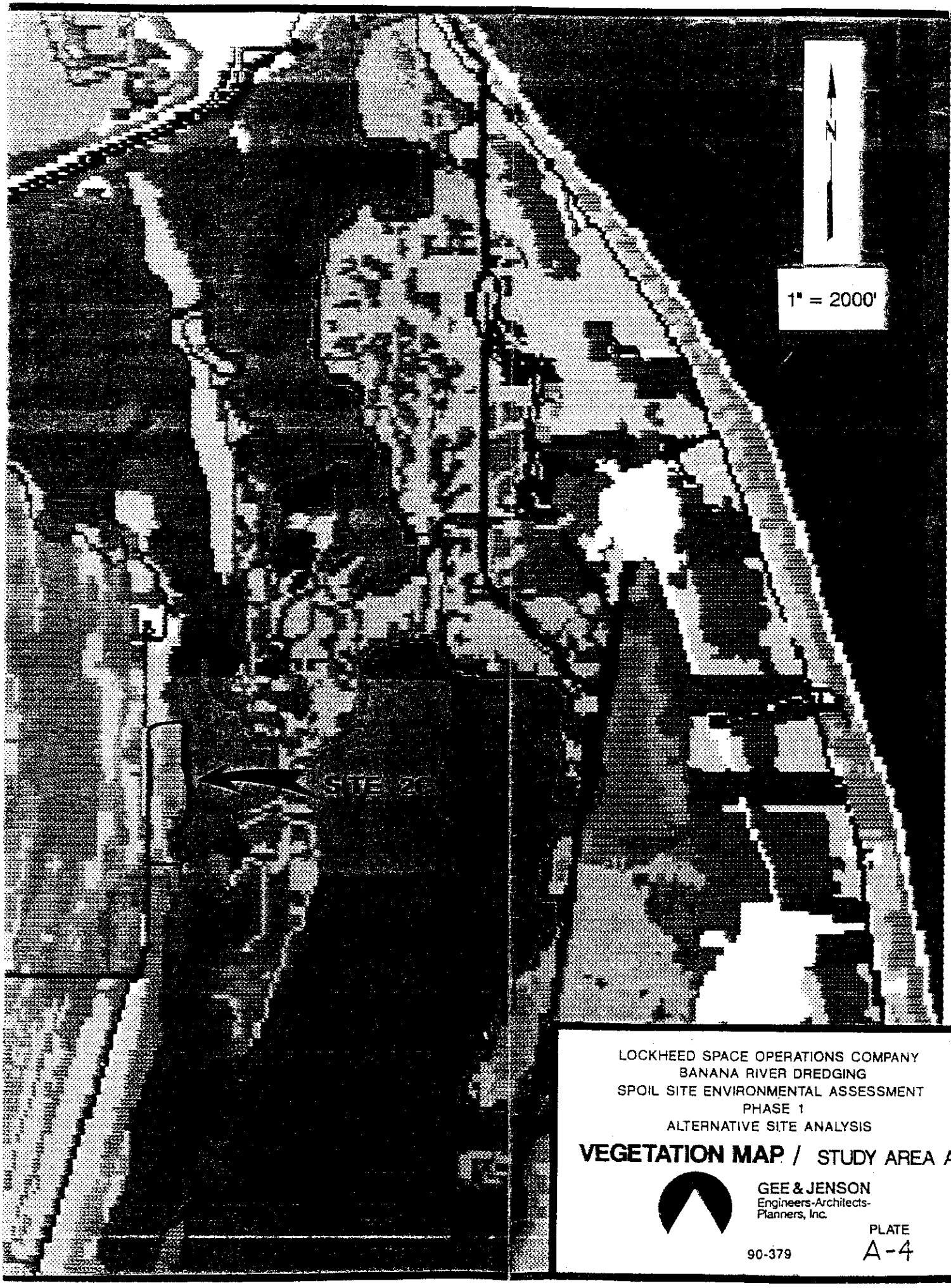
PLATE
A-2

90-379





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SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

VEGETATION MAP / STUDY AREA A

GEE & JENSON
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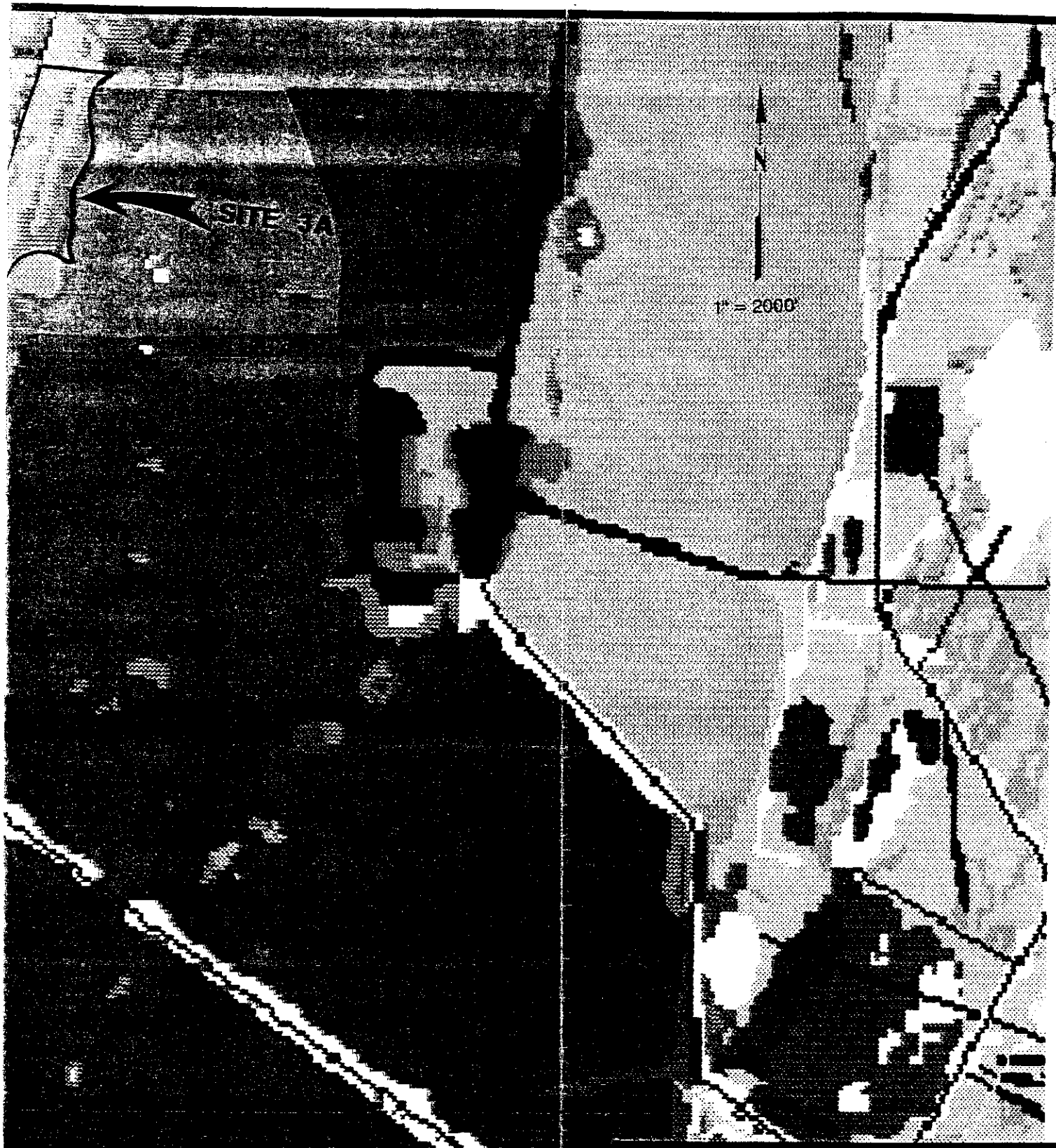
90-379

PLATE
A-4



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BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

VEGETATION MAP / STUDY AREA B

GEE & JENSON
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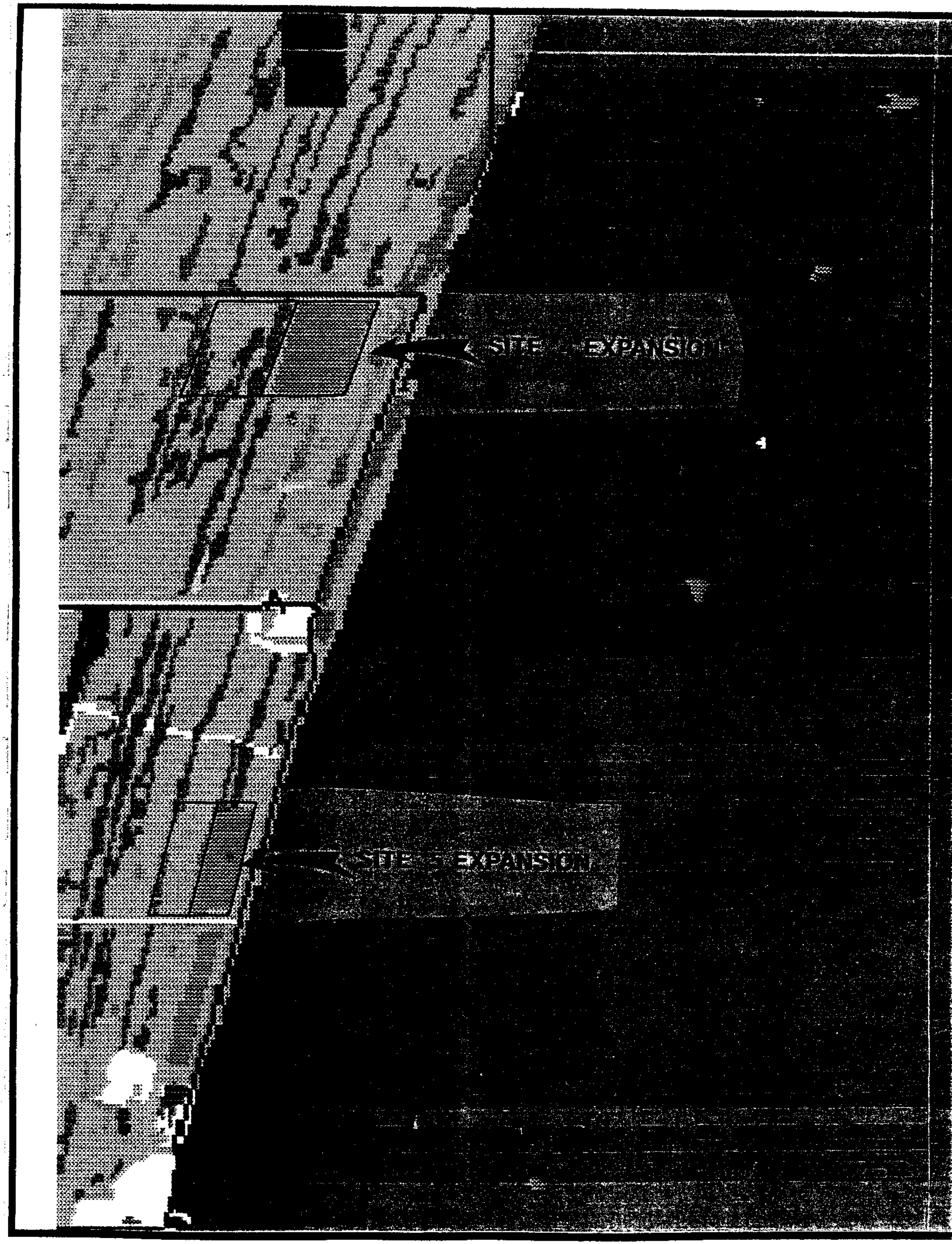
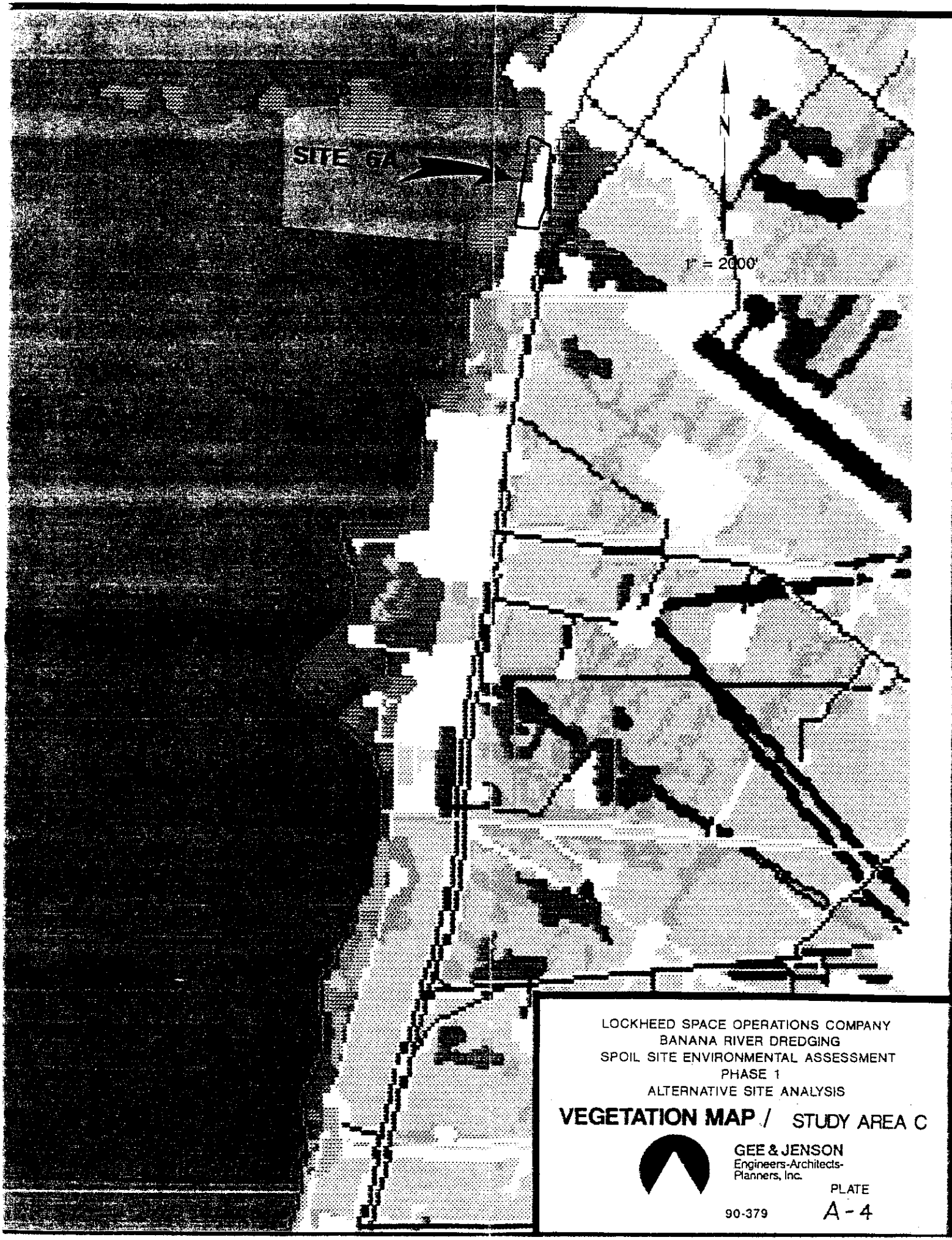
PLATE
A-4


SITE EXPANSION
SITE 5 EXPANSION



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BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

VEGETATION MAP / STUDY AREA C

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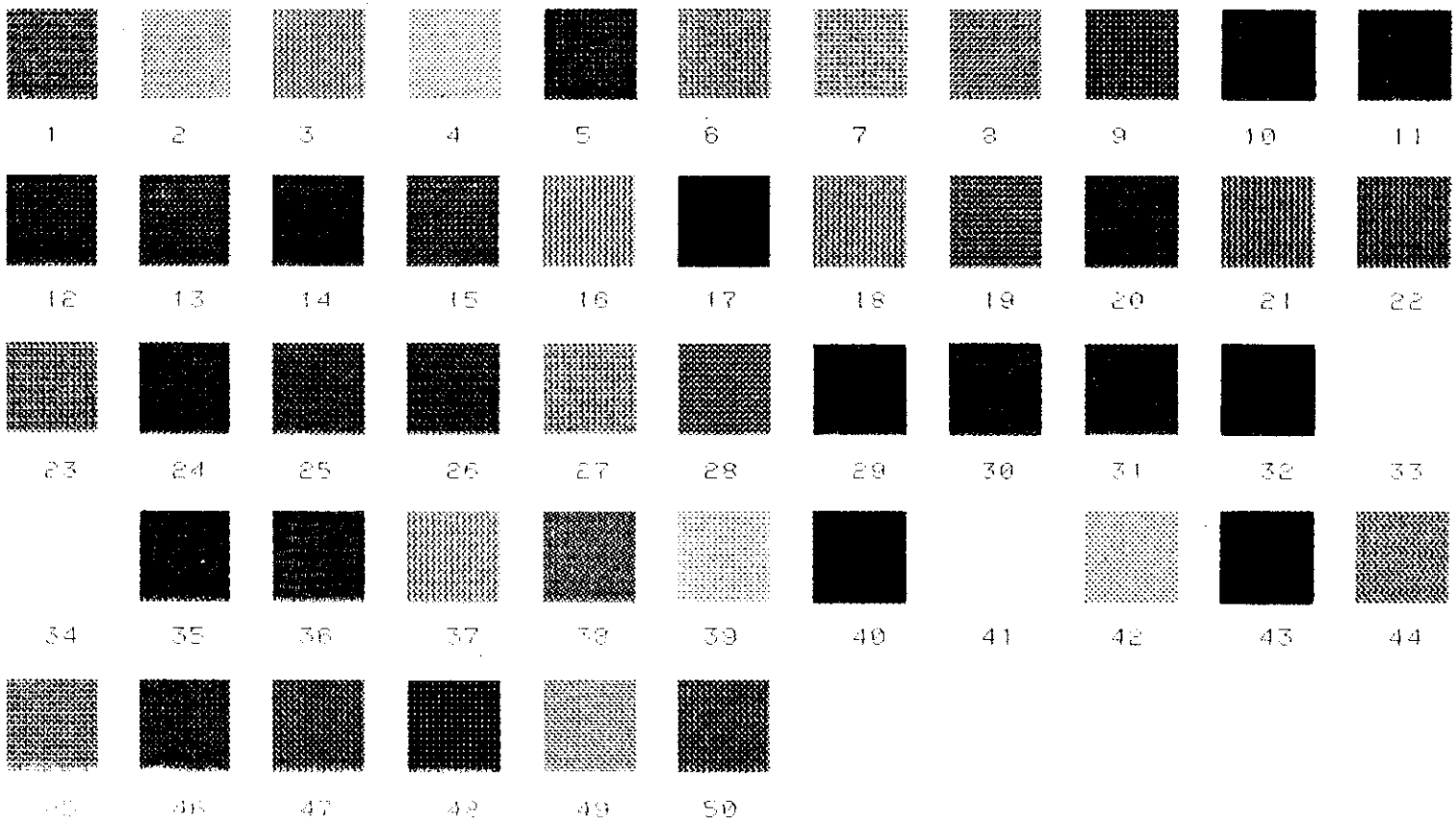
PLATE
A - 4



VALUE	CLASS NAME	NO. OF POINTS	%	NO. OF ACRES
1	COASTAL DUNES	1343.	0.36	167.874
2	COASTAL STRAND	1188.	0.32	148.499
3	SAND PINE	74.	0.02	9.250
4	MIXED OAK/SAW PALMETTO	54495.	14.55	6811.832
5	COASTAL LIVE OAK WOODS	2423.	0.65	302.873
6	SLASH PINE FLATWOODS	30743.	8.21	3842.851
7	LIVE OAK/CABBAGE PALM HAMMOCK	1029.	0.27	128.624
8	RED BAY/LAUREL OAK/LIVE OAK	4337.	1.16	542.122
9	CABBAGE PALM HAMMOCK	509.	0.14	63.625
10	SOUTHERN RED CEDAR/LIVE OAK HAM	99.	0.03	12.375
11	SALTMARSH CORDGRASS	282.	0.08	35.250
12	BLACK MANGROVE	3787.	1.01	473.372
13	SALTWORT/GLASSWORT	1468.	0.39	183.499
14	BLACK MANGROVE/SALTWORT/GLASSWO	11.	0.00	1.375
15	MIXED SALT-TOLERANT GRASSES MAR	1339.	0.36	167.374
16	WHITE MANGROVE/MIXED MANGROVE	1601.	0.43	200.124

18	MUD FLATS	49.	0.01	6.000
19	WILLOW SWAMP	4394.	1.17	548.247
20	HARDWOOD SWAMP	897.	0.24	112.124
21	MIXED GRASS/SEDGE	944.	0.25	117.999
22	CATTAIL MARSH	5357.	1.43	669.631
23	GRAMINOID MARSH	17510.	4.68	2188.736
24	CABBAGE PALM SAVANNA	4510.	1.20	563.746
25	WAX MYRTLE/BRAZILIAN PEPPER	7649.	2.04	956.119
26	AUSTRALIAN PINE	396.	0.11	49.500
27	SOUTHERN RED CEDAR THICKET	0.	0.00	0.000
28	SHRUB/HERBACEOUS SPOIL VEGETATI	1431.	0.38	178.874
29	CITRUS	1820.	0.49	227.499
30	MIXED OAK/SAW PALMETTO DISTURBE	6789.	1.81	848.620
31	DIKES	3960.	1.06	494.997
32	DEAD MANGROVE	275.	0.07	34.375
33	RUDERAL	20348.	5.43	2543.484
34	BEACH/BARE GROUND	863.	0.23	107.874
35	OCEANIC	12245.	3.27	1530.615
36	W2 OPEN LAGOONAL AND ASSOCIATED	132454.	35.37	16556.845
37	W3 IMPOUNDED WATERS	17326.	4.63	2165.736
38	W4 INLAND WATERS	278.	0.07	34.750
39	W5 LANDFILL DITCHES, BARROW PIT	1257.	0.34	157.124
40	ALL TRANSPORTATION	11244.	3.00	1405.491
41	ALL CULTURAL FEATURES	10197.	2.72	1274.617
42	ALL OTHER LAND	1.	0.00	0.125
43	SITE LINES	1291.	0.34	161.374
44	HAMMOCK (SEMI-TROPICAL)	249.	0.07	31.125
45	DREDGE SPOIL SITE	0.	0.00	0.000
46	OBSTACLE COURSE	0.	0.00	0.000
47	SCRUB OAK-SAW PALMETTO/HICKORY	601.	0.16	75.125
48	LANDFILL	14.	0.00	1.750
49	DISTURBED SITES (OCCAS. BARE SO	4079.	1.09	509.873
50	INLAND WATERS OUTSIDE BOUNDARY	0.	0.00	0.000

TOTALS:

374479. 46809.875

Counts, totals and percentages based on Multi-IRIS data values in the EMIKE input image

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

VEGETATION KEY

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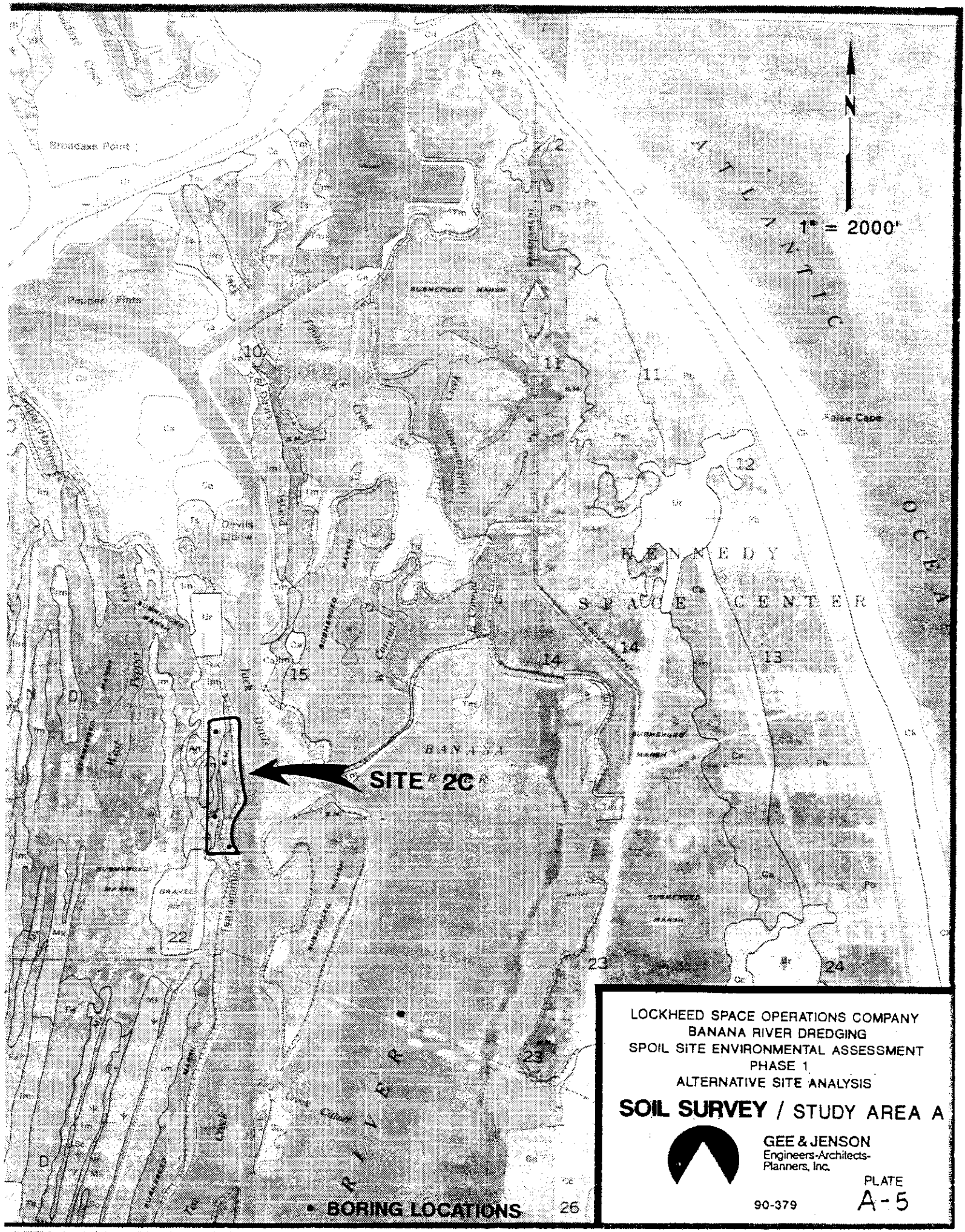
PLATE A-4a


KENNEDY SPACE CENTER
MERRITT ISLAND
MERRITT ISLAND
Cove
5
8
9
16
17
18
19
20
21



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SOIL SURVEY / STUDY AREA A

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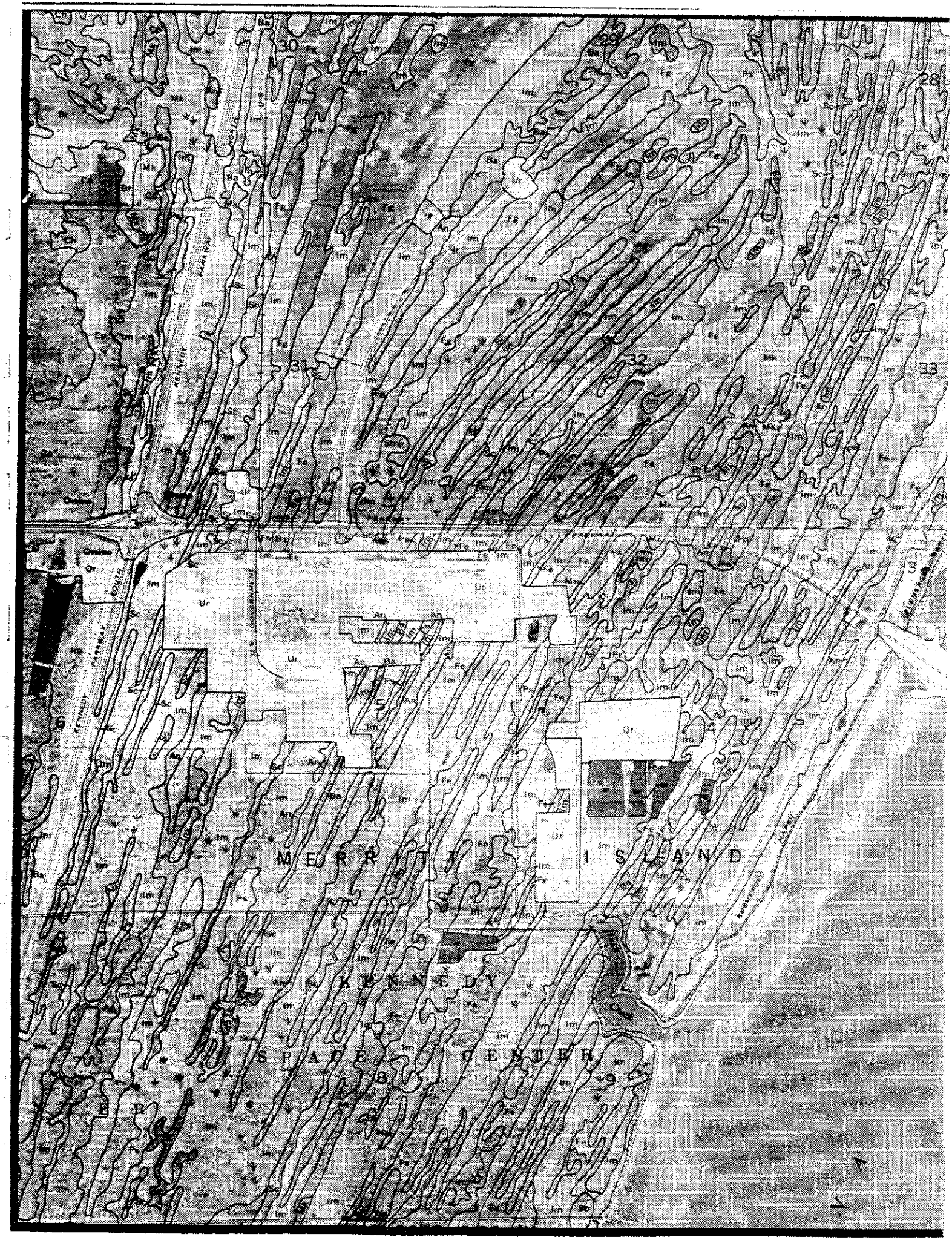
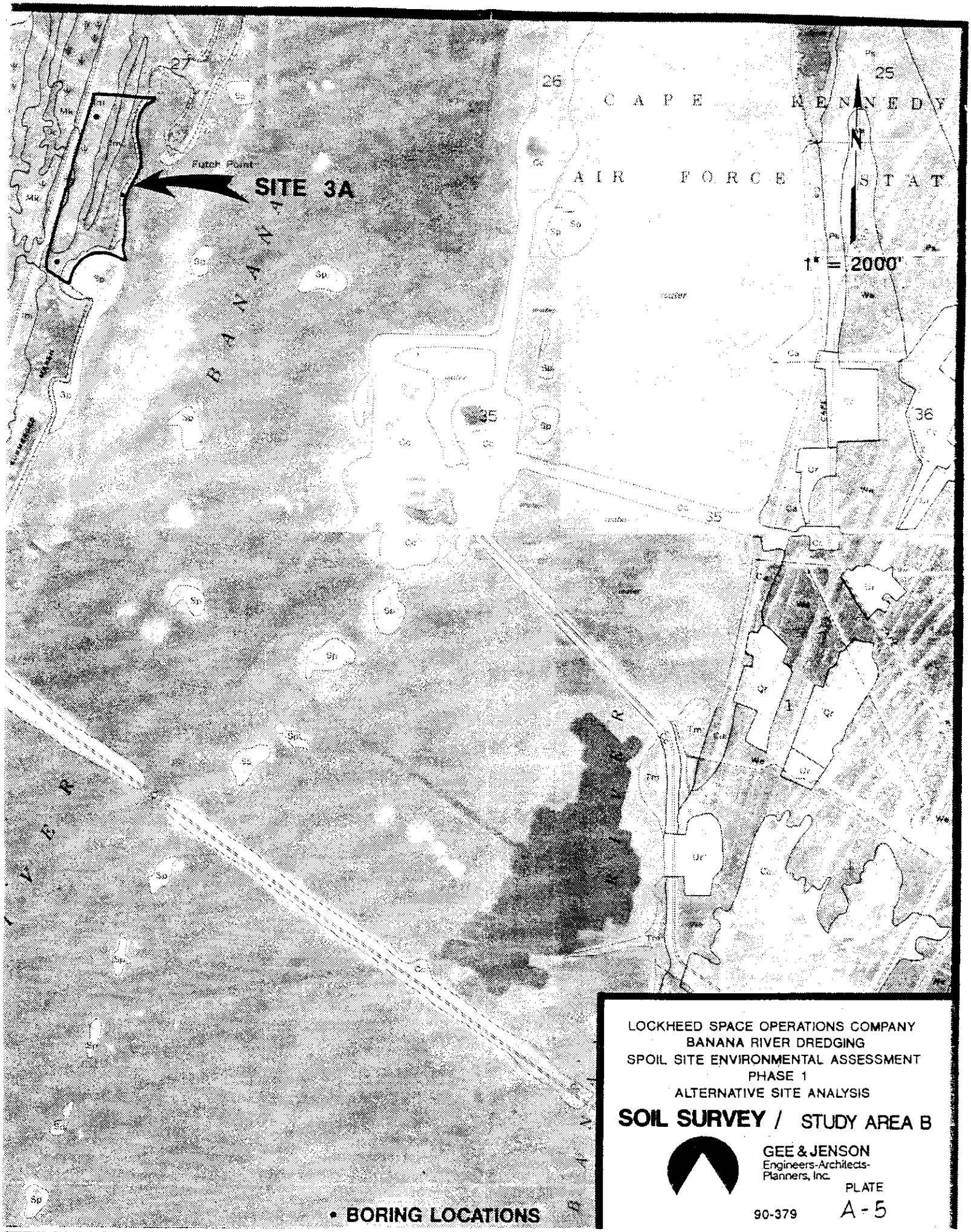
PLATE
A-5


MERRITT ISLAND
KENNEDY SPACE CENTER



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BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SOIL SURVEY / STUDY AREA B

GEE & JENSON
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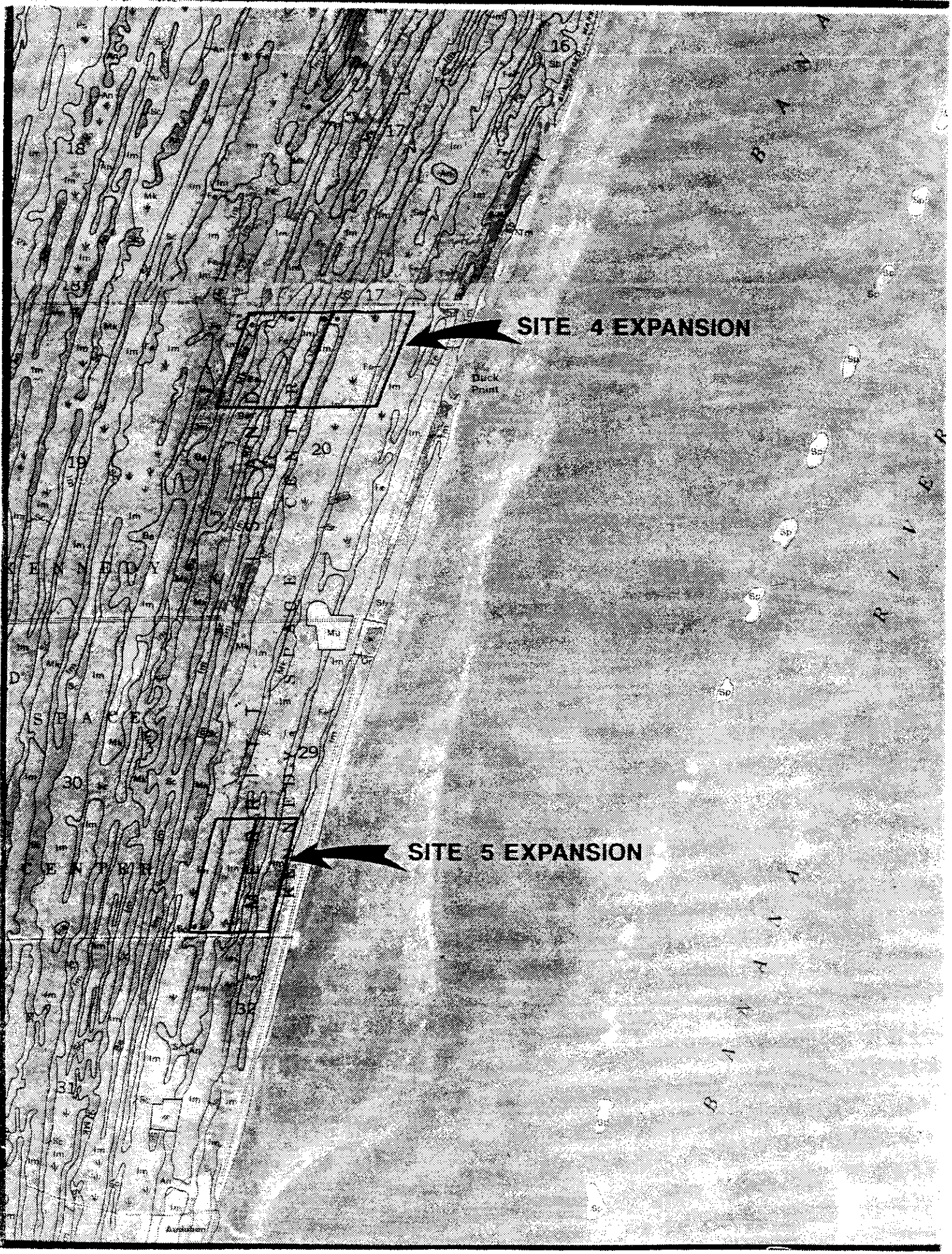
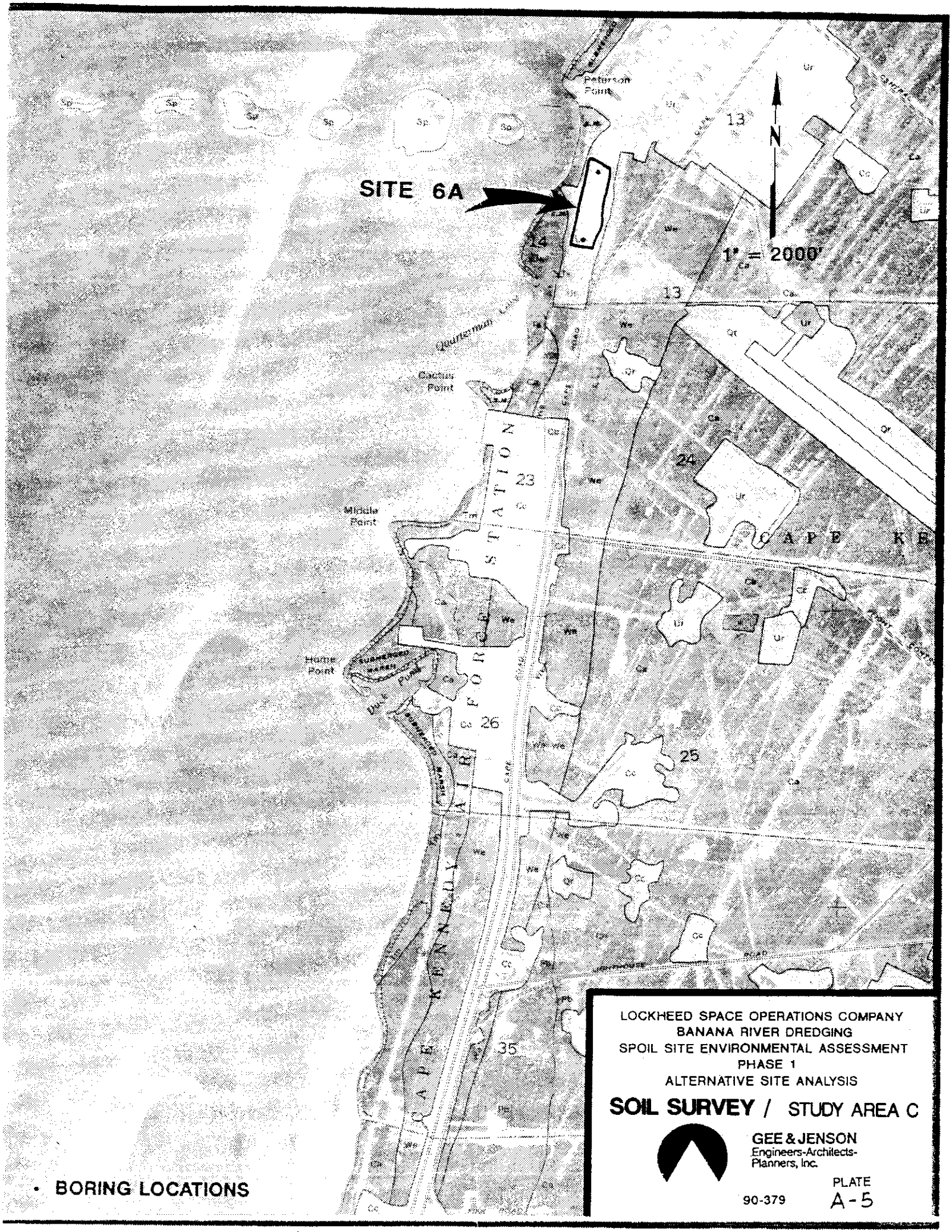
PLATE
A-5

• BORING LOCATIONS


SITE 4 EXPANSION
SITE 5 EXPANSION
Brick Point



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SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SOIL SURVEY / STUDY AREA C

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PLATE
A-5

• BORING LOCATIONS

Map symbol	Mapping unit	Range site
An	Anclote sand	Slough
As	Astatula fine sand, dark surface	Sandhill
At	Astatula-Urban land complex	-------
Ba	Basinger sand	Slough
Br	Bradenton fine sand, shallow variant	Hammock
Ca	Canaveral complex, gently undulating	Sand Scrub
Cc	Canaveral-Urban land complex	-------
Cd	Canova peat	Fresh Marsh (organic)
Ch	Chobee sandy loam	Fresh Marsh (mineral)
Ck	Coastal beaches	-------
Co	Cocoa sand	Sandhill
Cp	Copeland complex	Hammock
Eg	EauGallie sand	Acid Flatwoods
Eu	EauGallie sand, bedded	-------
Ew	EauGallie, Winder, and Felda soils, ponded	Sand Pond
Fa	Felda sand	Fresh Marsh (mineral)
Fd	Felda sand, bedded	-------
Fe	Felda and Winder soils	Slough
Fg	Felda and Winder soils, ponded	Salt Marsh (mineral)
Fn	Floridana sand	Fresh Marsh (mineral)
Fo	Floridana, Chobee, and Felda soils, flooded	Fresh Marsh (mineral)
Ga	Galveston-Urban land complex	-------
Ho	Holopaw sand	Fresh Marsh (mineral)
Im	Immokalee sand	Acid Flatwoods
Ma	Malabar sand	Sweet Flatwoods
Mb	Malabar, Holopaw, and Pineda soils	Sweet Flatwoods
Mc	Micco peat	Fresh Marsh (organic)
Me	Montverde peat	Fresh Marsh (organic)
Mk	Myakka sand	Acid Flatwoods
Mp	Myakka sand, ponded	Sand Pond
Mu	Myakka-Urban land complex	-------
Od	Oldsmar sand	Acid Flatwoods

Pb	Palm Beach sand	Sand Scrub
PfB	Paola fine sand, 0 to 5 percent slopes	Sand Scrub
PfD	Paola fine sand, 5 to 12 percent slopes	Sand Scrub
Ph	Paola-Urban land complex	-------
Pk	Parkwood fine sand, moderately fine subsoil variant	Hammock
Pn	Pineda sand	Sweet Flatwoods
Po	Pineda sand, bedded	-------
Pp	Pineda sand, dark surface variant	Hammock
Ps	Pomello sand	Sand Scrub
Pu	Pomello-Urban land complex	-------
Pw	Pompano sand	Slough
Qr	Quartzipsamments, smoothed	-------
Sa	Satellite sand	Acid Flatwoods
Sb	St. Johns sand	Acid Flatwoods
Sc	St. Johns soils, ponded	Slough
SfB	St. Lucie fine sand, 0 to 5 percent slopes	Sand Scrub
SfD	St. Lucie fine sand, 5 to 12 percent slopes	Sand Scrub
Sp	Spoil banks	-------
Sw	Swamp	Swamp
Ta	Tavares fine sand	Sandhill
Tc	Terra Ceia muck	Fresh Marsh (organic)
Tm	Tidal marsh	Salt Marsh (mineral)
Ts	Tidal swamp	-------
Tw	Tomoka muck	Fresh Marsh (organic)
Ur	Urban land	-------
Va	Valkaria sand	Slough
Wa	Wabasso sand	Acid Flatwoods
We	Welaka sand	Sand Scrub
Wn	Winder loamy sand	Fresh Marsh (mineral)

SOIL SURVEY OF BREVARD COUNTY , FLORIDA , 1974

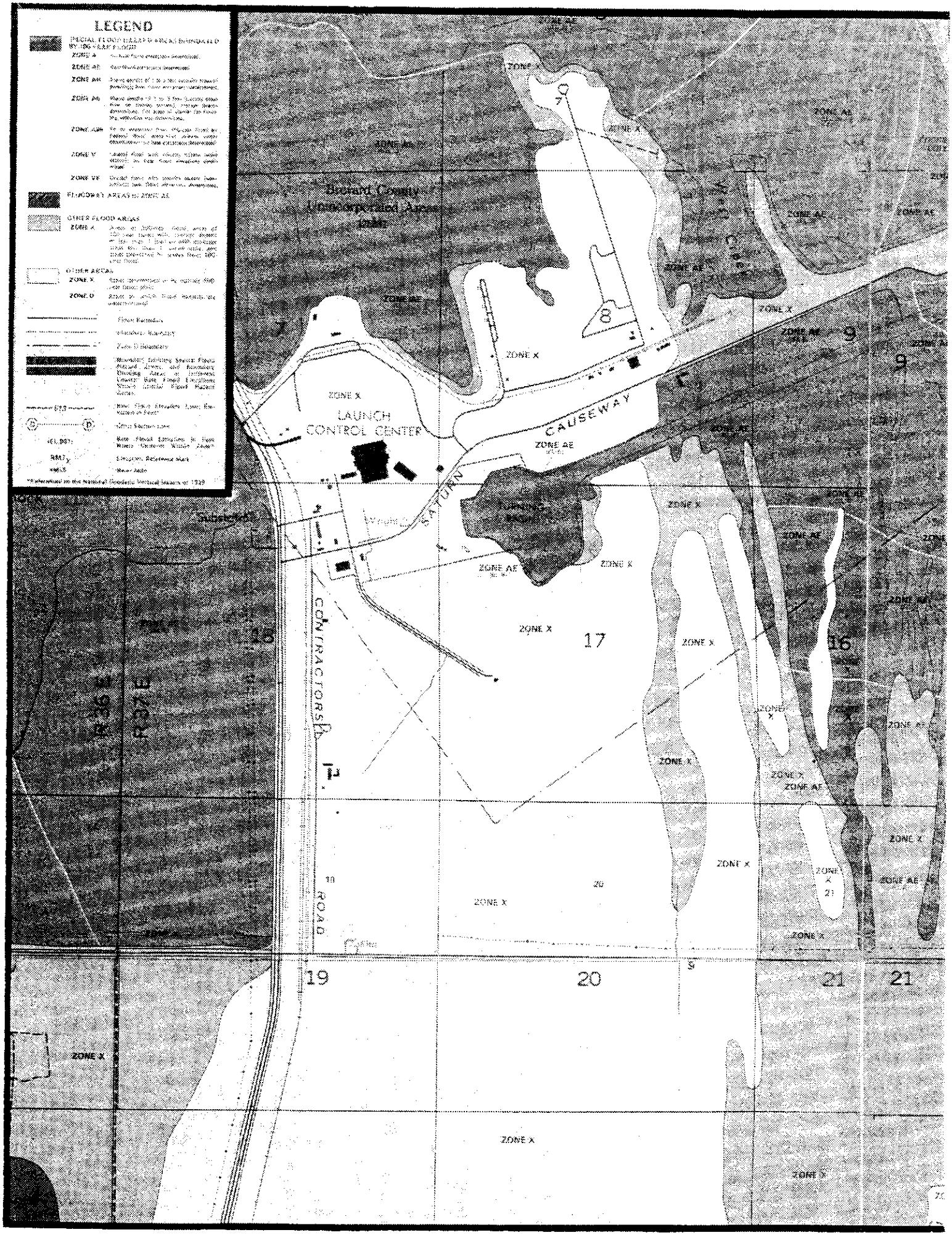
LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

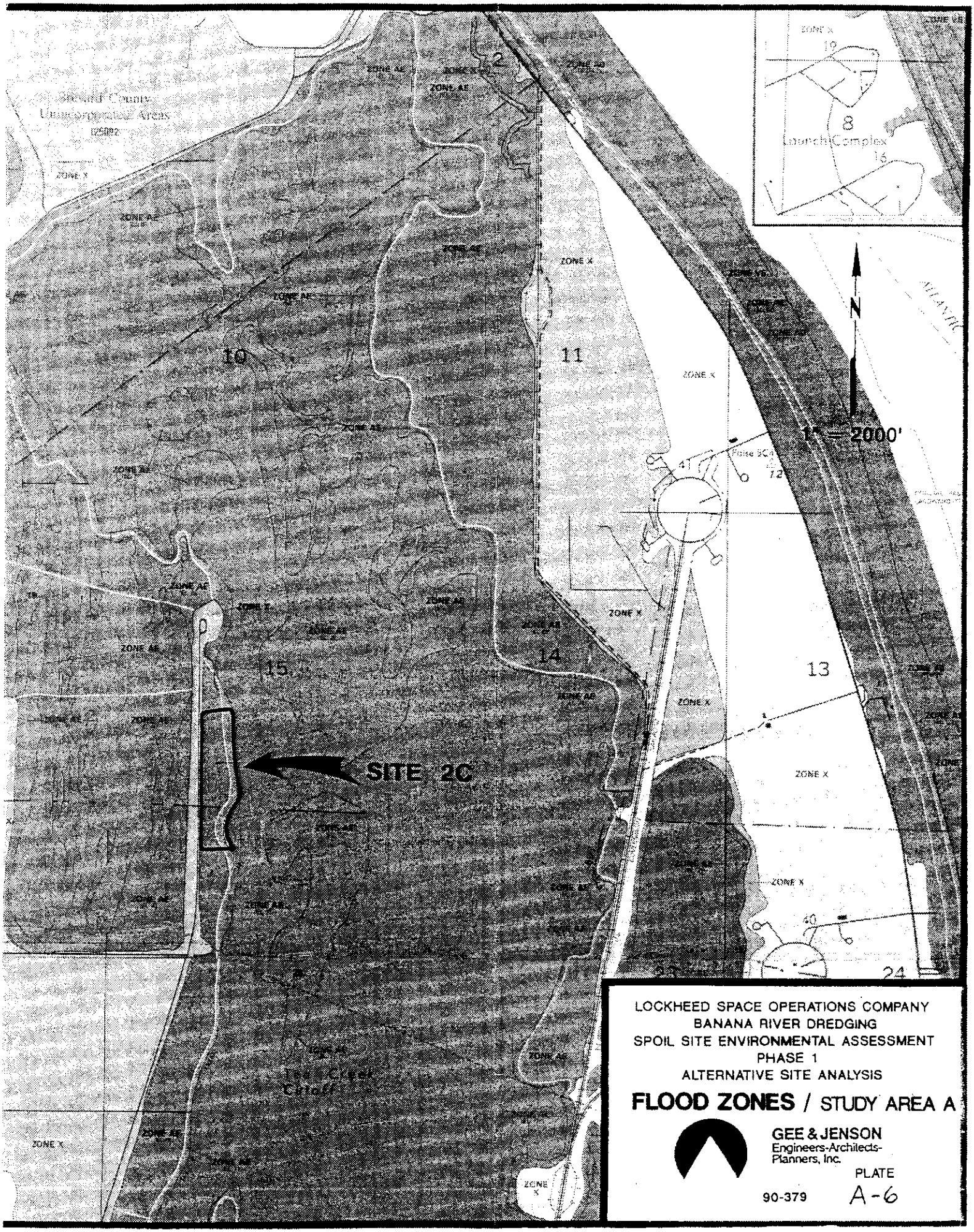
SOIL LEGEND

GEE & JENSON
Engineers-Architects-Planners, Inc.

90-379

PLATE
A-5a


LEGEND
SPECIAL FLOOD HAZARD AREAS (Inundated by 100-Year Flood)
ZONE A
ZONE AE
ZONE AH
ZONE AO
ZONE A99
ZONE V
ZONE VE
FLOODWAY AREAS in ZONE AE
OTHER FLOOD AREAS
ZONE X
OTHER AREAS
ZONE X
ZONE D
Brevard County
Unincorporated Area
LAUNCH CONTROL CENTER
CAUSEWAY
SATURN
CONTRACTORS
ROAD
Subscribed
ZONE X
ZONE AE
7
8
9
16
17
18
19
20
21



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

FLOOD ZONES / STUDY AREA A

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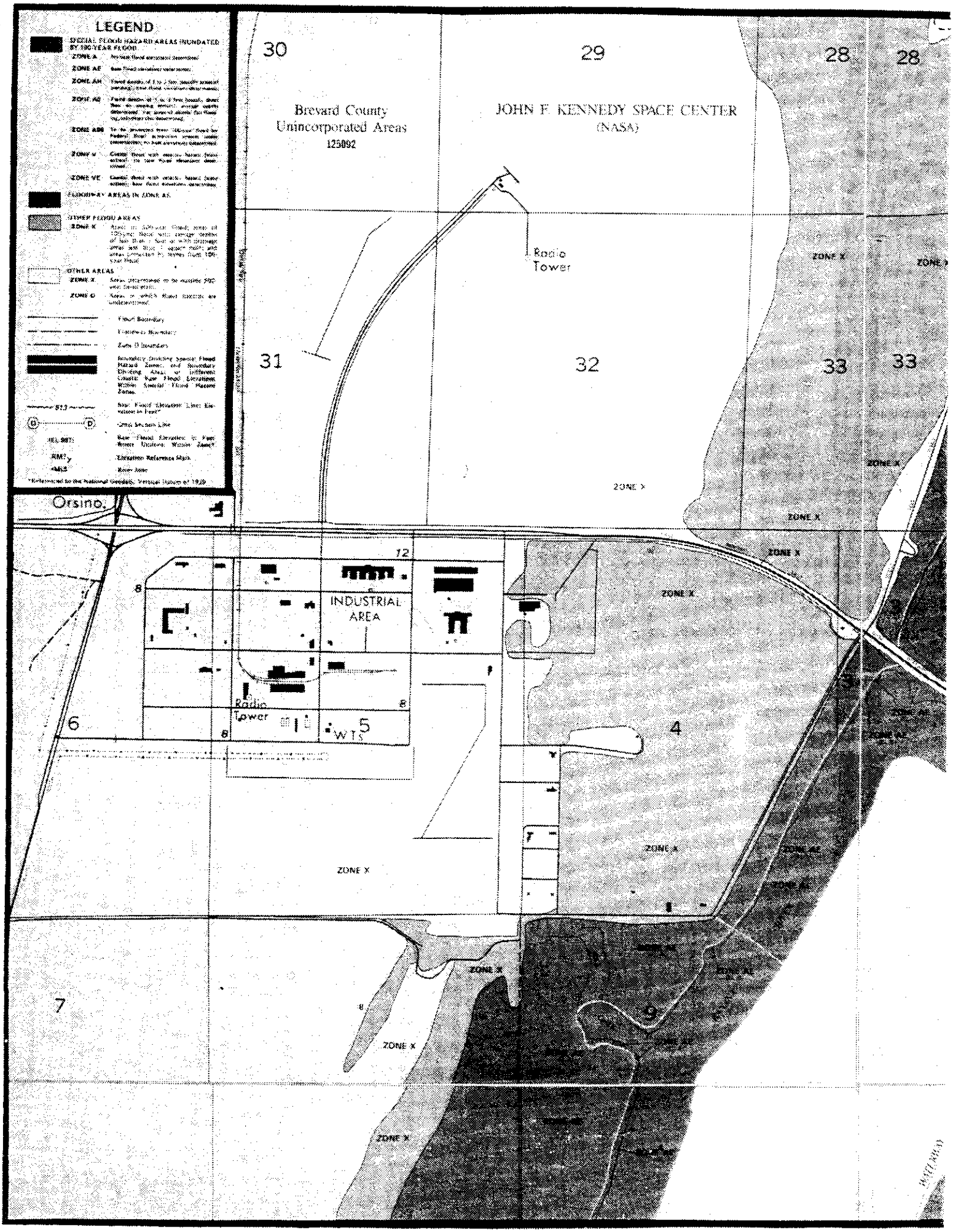
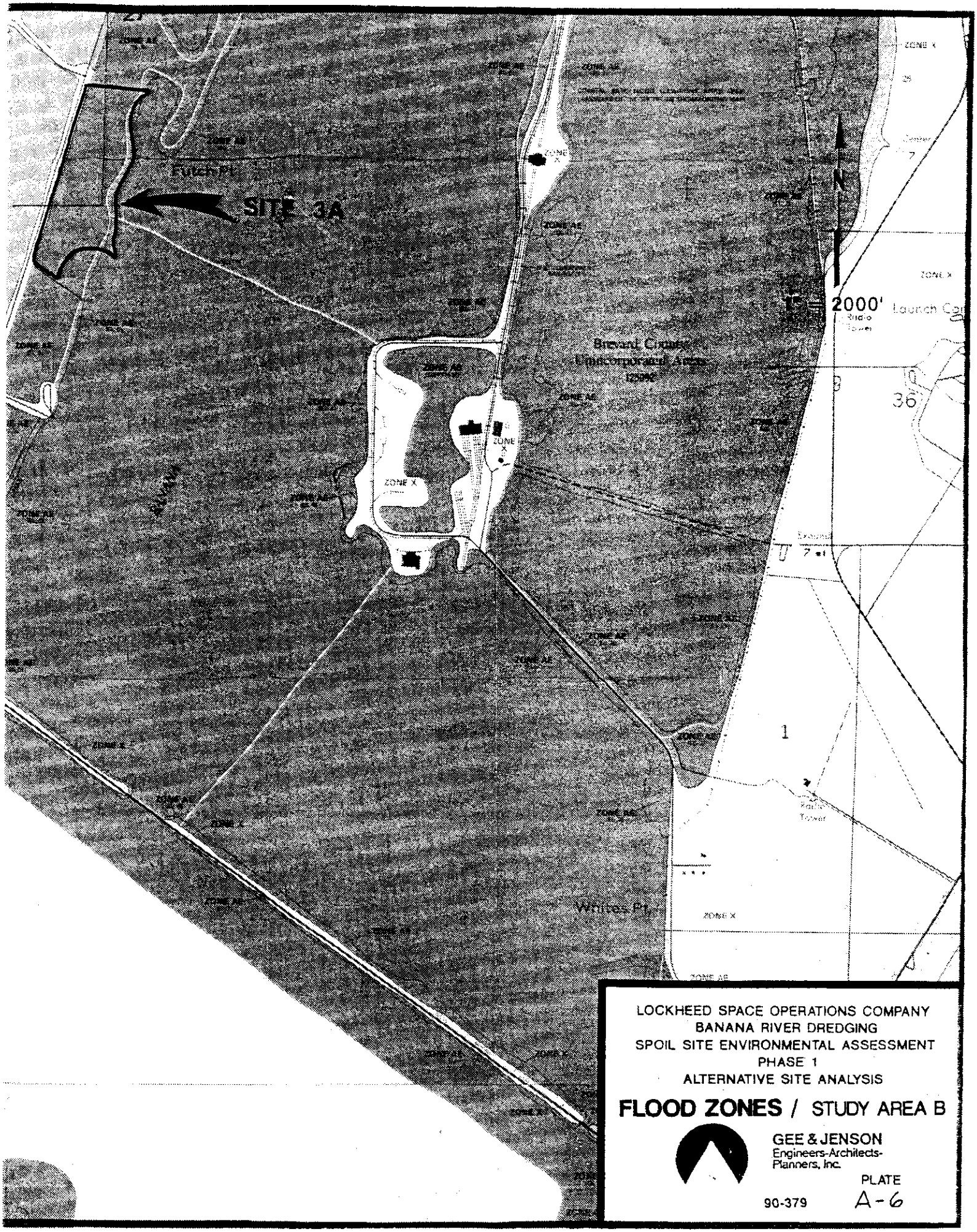
90-379

PLATE A-6


LEGEND
SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD
ZONE A
ZONE AE
ZONE AH
ZONE AO
ZONE A99
ZONE V
ZONE VE
FLOODWAY AREAS IN ZONE AE
OTHER FLOOD AREAS
ZONE X
OTHER AREAS
ZONE X
ZONE D
Limit Boundary
Floodway Boundary
Zone D Boundary
Boundary Dividing Special Flood Hazard Zones and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones
Base Flood Elevation Lines; Elevation in Feet*
Cross Section Line
Base Flood Elevation in Feet Where Uniform Within Zone*
(EL 987)
Elevation Reference Mark
River Mile
*Referenced to the National Geodetic Vertical Datum of 1929
30
29
28
28
Brevard County
Unincorporated Areas
125092
JOHN F. KENNEDY SPACE CENTER
(NASA)
Radio
Tower
31
32
33
33
ZONE X
Orsino
12
8
INDUSTRIAL
AREA
Radio
Tower
WTS
6
4
5
7
9
ZONE AE



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

FLOOD ZONES / STUDY AREA B

GEE & JENSON
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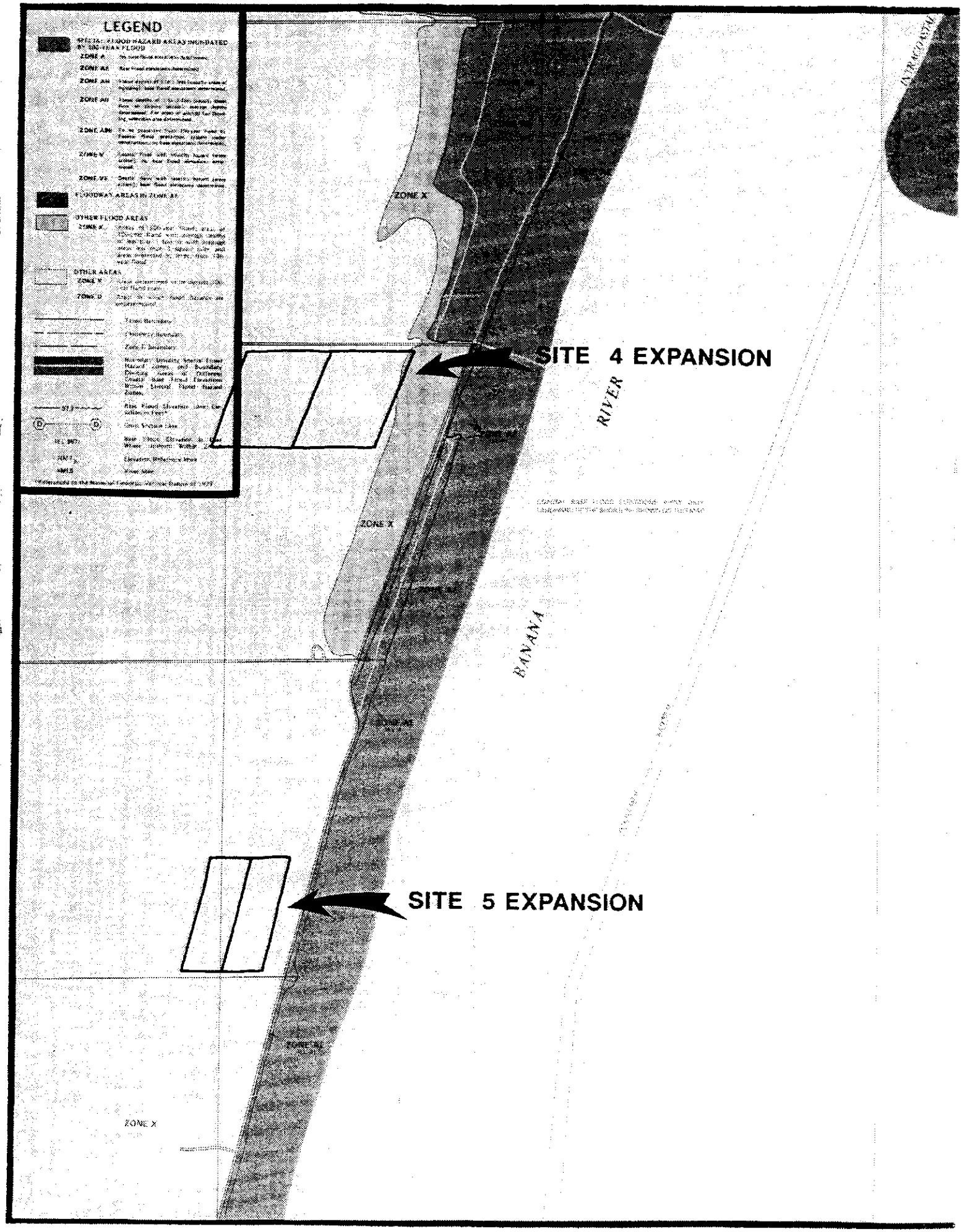
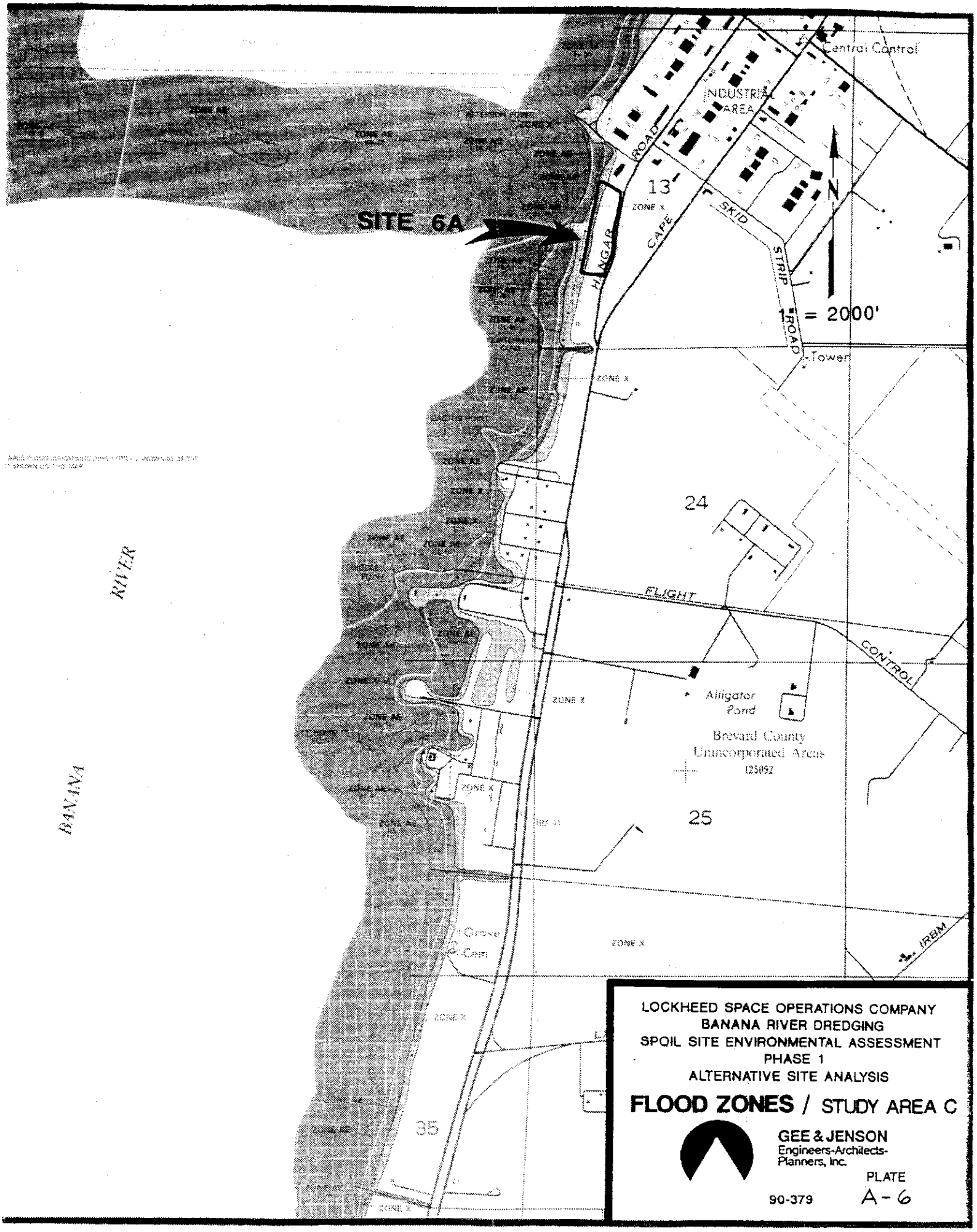
90-379

PLATE
A-6


LEGEND
ZONE X
SITE 4 EXPANSION
RIVER
BANANA
SITE 5 EXPANSION
ZONE X



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

FLOOD ZONES / STUDY AREA C

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90-379

PLATE
A-6

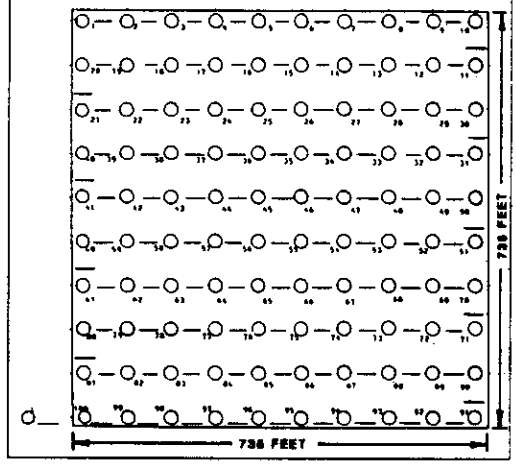
SHE Data Analysis Sheet.

PHOTO ID. _____

FEATURES _____

RUNS _____

SIMPLIFIED INDEX _____



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

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90-379

PLATE
A-7

B. Alternative Sites Analysis

Based on evaluation criteria, the resultant 12 sites identified as potential sites for spoil disposal areas compiled during the geographic analysis, are ranked in Table A-1. The alternative site ranking methodology was compiled in an effort to develop a quantitative system for making a comparative analysis of one site to another. Variables considered included results of the "simplified habitat evaluation"; vegetation type and quality; wetland impacts; soils suitability; previous disturbance; "listed" species; proximity to the river and study area location; and sizing, access roads and surrounding areas. Highest scores indicated the best combination of variables in selecting the final five (5) of 12 sites. The following is a summary of each of the non-selected sites and why they were disqualified from further consideration:

1A: Site 1A is a disturbed area east of the Turning Basin. It was chosen in the initial analysis due to the fact that a major portion of the site was bare ground as indicated on the aerials, as well as vegetation and soils base maps. It was omitted from further consideration due to "listed" species, particularly the observance of numerous gopher tortoise burrows in the area. It also may be used for further development of the launch complex in the future.
Score: 16

1B: Site 1B was initially considered due to its proximity to the river and study area location. Soils and vegetation maps also indicated predominantly non-hydric soils and uplands vegetation. Upon field surveillance, it was noted that numerous "listed" species were in the area, including sitings of scrub jays, gopher tortoise, etc. It was therefore eliminated from further consideration.
Score: 15

2A: Site 2A was initially considered due to its upland features and disturbed vegetation. It was also eliminated for "listed" species as well as roadway rights-of-way through the area which could not be impacted. **Score: 13**

2B: Site 2B was selected early in the process as the Brevard County soils survey indicated this area as a former "gravel pit". Field reconnaissance revealed the area contained extensive wetland vegetation. In light of the above and a high score on the "simplified habitat evaluation", it was eliminated from further consideration. **Score: 14**

3B: Site 3B was selected as an area of primarily uplands and scored low in habitat evaluation. It was eliminated, however, after further consideration due to sizing constraints. **Score: 16**

3C: Site 3C was picked due to its strategic location and predominance of uplands. It was eliminated due to having no previous disturbance in the area. **Score: 13**

6B: Site 6B is located to the west of Hangar Road on the Air Force side. It was selected as it appeared to have low habitat diversity as well as an indication of non-hydric soils and no wetlands. It was eliminated as it required a crossing of Hangar Road and was not as desirable as Site 6A in the immediate area. **Score: 18**

Table A-1 illustrates the scoring of the 12 sites and the ranking methodology behind the selection of sites 2C, 3A, 4, 5 and 6A.

TABLE A-1
ALTERNATIVE SITE RANKING SYSTEM
FOR THE
BANANA RIVER DREDGING SPOIL DISPOSAL AREAS

SCORE FOR EACH CRITERIA	SIMPLIFIED HABITAT EVAL. S.H.E. (DIVERSITY)	VEGETATION TYPE AND QUALITY	WETLAND IMPACTS	SOILS SUITABILITY	PREVIOUS DISTURBANCE	"LISTED" SPECIES	PROXIMITY TO RIVER & STUDY AREA LOCATION	SIZING, AND SURROUNDING AREA
3	LOW (0 - 100)	NONE - EXOTICS POOR QUALITY	ALL UPLANDS NO PERMITTING CONSIDERATIONS	SANDY SOILS	EXTENSIVE DISTURBANCE	NONE ON SITE	GOOD	GOOD
2	MEDIUM (100 - 200)	EXOTIC/NATIVE MIX--FAIR QUALITY	MINOR IMPACTS TO LOW QUALITY WETLANDS	MIXTURE	MODERATE DISTURBANCE	POSSIBILITY AS NOTED IN GENERAL STUDY AREA	FAIR	FAIR
1	HIGH (> 200)	QUALITY NATIVE VEGETATION IN HEALTHY STATE	IMPACTS TO WETLANDS--MAJOR PERMITTING CONSIDERATIONS	HYDRIC SOILS	NO DISTURBANCE IN NATIVE STATE	LISTED SPECIES NOTED ON SITE	POOR	POOR

TOTAL SCORING:
17 - 24 PTS. -- HIGH
13 - 16 PTS. -- MODERATE
8 - 12 PTS. -- LOW

SOURCE: GEE & JENSON, 1990

TABLE A-1 (CONT.)
ALTERNATIVE SITE RANKING SYSTEM
FOR THE
BANANA RIVER DREDGING SPOIL DISPOSAL AREAS

SITE DESIGNATION	SIMPLIFIED HABITAT EVALUATION S.H.E.	VEGETATION TYPE AND QUALITY	WETLAND IMPACTS	SOILS SUITABILITY	PREVIOUS DISTURBANCE	LISTED SPECIES	PROXIMITY TO RIVER & STUDY LOCATION	SIZING, AND SURROUNDING AREA	RANKING SIGNIFICANCE SCORE	
1A	3	3	2	2	3	1	1	1	16	
1B	3	2	2	2	1	1	3	1	15	
2A	1	2	2	2	2	1	2	1	13	
2B	1	2	1	3	2	2	1	2	14	
2C	2	2	1	2	2	2	3	3	17	*
3A	2	2	1	2	3	2	3	3	18	*
3B	3	2	2	2	2	2	2	1	16	
3C	2	1	2	2	1	2	1	2	13	
4	2	2	2	2	2	2	2	3	17	*
5	3	2	2	2	2	2	3	3	19	*
6A	3	3	3	3	3	3	3	1	22	*
6B	3	2	3	3	2	3	1	1	18	

SOURCE: GEE & JENSON, 1990

* Selected Sites (2C, 3A, 4, 5, 6A)

C. Selected Sites

Table A-2 is a summary of site data for the five selected spoil disposal areas. Table A-2 indicates dominant vegetation, approximate percent wetlands, soils types, archaeological considerations, distance from the river, flood zone designations, "listed" species noted on the site, estimated site acreage and estimated perimeter of each site in feet.

2C: Site 2C is an impacted mosquito control impoundment area approximately 29.1 acres located east of Static Test Road in the area of Jack Davis Cut. The site scored high in its proximity to the river, strategic study area location, sizing, access roads and surrounding areas. The site could be considered approximately 55% wetlands based on vegetation mapping and County soils survey designations. Wetland species were primarily cattails and graminoid marsh grasses as well as transitional vegetation including wax myrtle, willow, cabbage palm and broomsedge. The uplands contained primarily mixed scrub oak and saw palmetto, as well as cabbage palms, saltbush, grapevine, and sumac. Major soil types are Immokalee Sand, Anclote Sand, submerged marsh, and tidal swamp. Score: 17

3A: Site 3A is also an impacted mosquito control impoundment area, 73.6 acres. It is north of a former spoil disposal site and is located west of Futch Point (just southwest of the boot). This area was also chosen initially due to its proximity to the river and study area location as well as for its size, access roads and surrounding area. There was also some previous disturbance in the area. It is approximately 48% wetland based on vegetation mapping and County soils surveys. Common wetland vegetation is willow swamp and cattails, indicative of previous disturbance. The uplands are mixed oak/saw palmetto with saltbush on the perimeter. The old spoil site to the south is presently

filled with Brazilian Pepper. Dominant soil associations include Immokalee Sand, submerged marsh and Felda and Winder soils. **Score: 18**

4: Site 4 (expansion area) is located to the west of Duck Point. This site is a proposed expansion to an existing site. It is approximately 55.5 acres. Based on vegetation and soils mapping, it appears to be approximately 42% wetlands in the form of cabbage palm savanna. The balance of the site is slash pine flatwoods or uplands. Major soil types include Immokalee Sand, Felda and Winder, Bassinger Sand and Myakka Sand. It is located approximately 1,050 ft. from the Banana River. The site would be essentially an additional cell attached to the existing spoil disposal site. **Score: 17**

5: Site 5 (expansion area) is a proposed spoil disposal area adjacent to an existing spoil disposal site. It would be approximately 31.8 ac. located midway between Central Telemetry and Audubon. It is approximately 350 ft. west of the Banana River. It is made up of primarily slash pine flatwoods. Approximately 19% of area is possible wetlands in the form of cabbage palm savanna and willow swamp. Soils types are Immokalee Sand and Anclote Sand as well as St. John's soils, ponded. This site also would be an additional cell attached to an existing spoil disposal site. The site scored well in terms of size, access roads, surrounding area, proximity to the river and strategic study area location. **Score: 19**

6A: Site 6A is located just south of Peterson Point approximately 500 ft. east of the Banana River. It is west of Hangar Road and north of Quarterman Cove. The site is a disturbed area classified as urban lands with almost no wetlands (5%). It's approximately 14.5 ac. and was located to accommodate

dredge spoils from the AF basin and access channel. Because of previous use as a landfill, this site has not been released for alternative uses and no borings have been performed. While the availability of this site for spoil disposal is undetermined, it was considered as a potentially viable (alternate) site for purposes of this assessment. The site scored well in its proximity to the river, study area location, "listed" species, previous disturbance, soils suitability, wetland impacts, lack of vegetation and low habitat value. **Score: 22**

TABLE A-2
SUMMARY TABLE OF SELECTED SITES
FOR THE
BANANA RIVER DREDGING SPOIL DISPOSAL AREAS

SITE DESIGNATION	DOMINANT VEGETATION	PERCENT WETLANDS	SOILS TYPES	ARCHIOLOGICAL CONSIDERATIONS	DISTANCE FROM RIVER	FLOOD ZONE	LISTED SPECIES NOTED ON SITE	ESTIMATED* SITE ACREAGE	ESTIMATED* PERIMETER (FEET)
2C	MIXED OAK/ SAW PALMETTO GRAMINOID MARSH CATTAILS	55%	IMMOKALEE SAND ANCLOTE SAND SUBMERGED MARSH TIDAL SWAMP	NONE	< 100'	100 YR ZONE	NONE	29.1	5740
3A	MIXED OAK/ SAW PALMETTO WILLOW SWAMP CATTAILS	48%	IMMOKALLE SAND SUBMERGED MARSH FELDA & WINDER	NONE	< 100'	100 YR ZONE	NONE	73.6	8840
4	SLASH PINE FLATWOODS CABBAGE PALM SAVANNA	42%	IMMOKALEE SAND FELDA & WINDER BASINGER SAND MYAKKA SAND	NONE	1,050'	OUTSIDE 500 YR ZONE	NONE	55.5	6270
5	SLASH PINE FLATWOODS CABBAGE PALM SAVANNA WILLOW SWAMP	19%	IMMOKALEE SAND ANCLOTE SAND ST. JOHN'S SOILS, PONDED	NONE	350'	OUTSIDE 500 YR ZONE	NONE	31.8	5290
6A	NONE	5%	URBAN LANDS	NONE	500'	OUTSIDE 500 YR ZONE	NONE	14.5	3850

SOURCE: Gee & Jenson, 1990

*Digitized (+/- 5%) from approx. 1" = 350' NASA aerials

PHASE II

ENVIRONMENTAL ASSESSMENT

SELECTED SITES

ENVIRONMENTAL ASSESSMENT

BANANA RIVER MAINTENANCE DREDGING SPOIL DISPOISAL SITES

Lockheed Space Operations Company
Modification Management

Kennedy Space Center, Florida 32899
Telephone 407/867-6262

April, 1991

Banana River channel maintenance dredging is required for ship and barge travel on the KSC property. This is in direct support of the Solid Rocket Booster retrieval ships and external tank barges for the Shuttle Program, as well as advanced Solid Rocket Motors in the future. Dredge spoil disposal areas will be required in support of the hydraulic dredging. The results of the Assessment support a "finding of no significant impact" (FONSI).

National Aeronautics & Space Administration
John F. Kennedy Space Center

TABLE OF CONTENTS

LIST OF TABLES AND PLATES

II. PHASE II - ENVIRONMENTAL ASSESSMENT

A. Summary and Conclusions

Dredge spoil disposal areas are required in support of Banana River channel maintenance dredging. Solid rocket booster retrieval ships, and external tank barges travel the river in support of the Shuttle Program. Based on an analysis of design constraints, costs, and environmental sensitivities, five sites were selected to retain 1,200,000 cubic yards of hydraulic dredge material. Two of the sites are existing mosquito impoundment areas (2C and 3A) and two are expansions of existing dredge spoil disposal areas (4 and 5). Existing sites 4 and 5 will continue to be reused. A fifth (alternate) site on the Air Force side is a disturbed ruderal area.

The estimated cumulative aerial coverage of the five sites is 205 acres. This area will adequately store the projected quantity of dredged material. It is estimated that there will be a 4.8 day average retention time for the five sites. Effluent quality needs to meet discharge standards of "Outstanding Florida Waters" (OFW) or ambient river water quality. It is recommended that "bench scale" settleability work be undertaken so that minimum detention times for each basin can be established.

Berms have been designed to be 10 ft. high with depths of solids reaching about 4 ft. in each basin. The remaining depth will be for retention of water to achieve desired effluent quality with 2 ft. of freeboard. It has been estimated that approximately 1 ft. or less of excavation will be required on the average site for construction of berms. Soils borings indicate that "in-situ" material is acceptable as construction material for an estimated 19,500 ft. of new berm which will be required for these sites.

Cost estimates indicate $1,500,000 for construction of these facilities or $1.25/cubic yard of dredged material.

The results of the EA state that there will be some impacts to biotic resources, in particular wetlands (approximately 83 acres) and some native uplands (approximately 95 acres). Some of these areas have previously been disturbed/impacted (fair quality), while others may be considered good or of a higher quality and relatively undisturbed.

Appropriate mitigation, however, is feasible and cost-effective and will be addressed during the regulatory permitting process, therefore allowing us to suggest a "finding of no significant impact" (FONSI).

Permitting agencies include the Florida Department of Environmental Regulation (DER), the St. Johns River Water Management District (SJRWMD), the U.S. Army Corps of Engineers (COE), and the Florida Game & Freshwater Fish Commission (FGFWFC). The issues will be addressed in detail during the regulatory permitting process with each agency. The purpose of this EA is to summarize and identify these issues.

B. Purpose and Need

The spoil sites for the hydraulic dredging of the Banana River channel is in direct support of the Shuttle Program, including the Solid Rocket Booster (SRB) retrieval ships and External Tank (ET) barges. Hydraulic dredging of the Banana River channel is required to maintain navigable access for the SRB retrieval ships and ET barges. Spoil disposal sites are required to support hydraulic dredging operations.

The SRB retrieval ships travel from the Barge Canal to the Air Force Turning Basin to return the usable SRB's to Kennedy Space Center (KSC). The ET barges travel from the Barge Canal to the VAB Turning Basin delivering ET's to Kennedy Space Center for Shuttle Missions. In the future, the advance solid rocket motors (ASRM) will be sent to KSC via the Banana River channel to the VAB Turning Basin. As a result, the spoil sites will support river channel operations for ship and barge travel on the KSC property.

C. Project Description

Banana River channel maintenance dredging is required for ship and barge travel on the KSC property. This is in direct support of the Shuttle Program. Dredge spoil disposal areas will be required for storage of the dredged material as the river accumulates deposits of approximately .2 ft. per year. This requires maintenance dredging for the Banana River every 5 to 7 years. As a result of this dredging, it is estimated that spoil sites accommodating 1,200,000 cubic yards of dredged solids will be needed sometime in the future (1991/92). It will be necessary to site four spoil disposal facilities on the KSC side of the Banana River (west) and one spoil disposal facility on the Air Force side (east). The sites were selected based upon environmental and engineering constraints. An alternative site selection methodology ranking system was developed considering variables including habitat evaluation, vegetation type and quality, wetland impacts, soils suitability, previous disturbance, "listed" species, proximity to the river, strategic study area locations, sizing, access roads and surrounding areas. Based upon the results of this analysis, five sites were selected specifically sites 2C, 3A, 4, 5 and 6A. These sites are delineated on base map Plates A-3 through A-6. They have been sized to accommodate the cumulative estimated 1,200,000 cubic yards of material in conjunction with providing the necessary retention time to meet water quality standards of OFW.

D. Environments Affected

(Information extracted from the Environmental Resources Document, John F. Kennedy Space Center/NASA, November 1986, KSC-DF-3080).

1. General

Four of the spoil disposal facilities will be located on Merritt Island and one on Cape Canaveral, both of which are barrier islands. Merritt Island, or the KSC side, is bordered on the west by the Indian River, the east by the Banana River, and the north by Banana Creek. This area of Merritt Island is composed of relic beach ridges on the eastern side of the island which gives the land surface an undulating effect. The troughs are near sea level and the ridges rise to a maximum of approximately 10 ft. NGVD (Plate A-3). Cape Canaveral is typical coastal strand with a shoreline elevation at sea level and dune peaks at about 20 ft. NGVD (Plate A-3).

Surface deposits on Merritt Island are of pleistocene and recent ages consisting primarily of sand and sandy coquina. The differences in landscape, position, drainage and age have produced a wide variety of soils. Five general soil associations have been identified at KSC and are as follows:

Paola-Pomillo-Astatula Associations - excessively to moderately drained soils and sandy throughout the profile

Canaveral-Palm Beach-Welaka Associations - also moderately to excessively well drained and sandy throughout

Myakka-Eau Gallie-Immokalee Associations - poorly drained, sandy throughout and loamy below

Copeland-Wabasso Associations - very poorly to poorly drained, sandy throughout and loamy below

Saltwater Marsh-Saltwater and Swamp Associations - very poorly drained, saline to brackish soils of variable textures (Plates A-5 and A-5a)

2. Air

The ambient air quality at KSC is mostly influenced by vehicle traffic as well as NASA operations, land management practices and omission sources outside KSC. The ambient air quality is monitored by one permanent air monitoring system (PAM) station. The data from PAM's A which is located within the study area is included as Table B-1 and is located at the Environmental Health Facility site. Data is extracted from a 1985 Annual Report and monitors ozone, sulphur dioxide, nitrogen dioxide and carbon monoxide. There were a number of exceedances during this period that were correlated with power plants located to the west of KSC. The most consistently high criteria pollutant (although never exceeding established standards) was the ozone parameter. Air quality at KSC is considered generally good and is an attainment area for all regulated air pollutants. The spoil disposal areas will have no effect on air quality.

3. Water

a. Surface Water

The surface water surrounding the KSC study area includes portions of the Banana River. These waters are best described as shallow estuarine lagoons with natural water depths generally less than 5 ft. Oceanic influences are minimal. Special classification has been established for this water which posses demonstrated exceptional recreational significance. "Outstanding Florida Waters" (OFW) are afforded the highest protection of any surface waters in the State of Florida. Water quality standards are established by ambient water conditions. As such, surface waters adjacent to Merritt Island National Wildlife Refuge have been designated as OFW's. Water quality standards would be based on ambient water quality conditions. This level of protection prohibits any activity which would reduce water quality below the existing levels. Table B-2 illustrates Banana River water quality in summary for Segments 1 and 2. This area is contiguous to the study area. The mean turbidity expressed as JTU is 4.3.

TABLE B-1
KENNEDY SPACE CENTER AIR QUALITY DATA SUMMARY PAMS A

1985 ANNUAL REPORT

PARAMETER	FEDERAL[4] AND STATE STANDARD	January	February	March	April	May	June
OZONE (ppb)	Primary 120 (HR-AVG)1	64 (96.9%)	77 (98.9%)	87 (91.6%)	78 (44.5%)	93 (76.2%)	83 (17.9%)
SULFUR DIOXIDE (ppb)	Primary 140 (24-HR)2,4 Secondary 500 (3-HR)2	4 15 (97.0%)	3 4 (42.9%)	5 7 (82.4%)	15 20 (90.6%)	10 14 (68.1%)	11 12 (51.8%)
NITROGEN DIOXIDE (ppb)	Primary3 50	345 (96.2%)	125 (99.3%)	21 (91.7%)	31 (90.8%)	28/54 (73.1%)	13 (71.0%)
CARBON MONOXIDE	35 (HR-AVG)1 9 (8-HR)2	1.23 0.833 (97.3%)	1.19 1.12 (99.3%)	1.11 0.982 (91.8%)	1.11 0.895 (91.8%)	2.78 0.829 (92.6%)	2.32 0.625 (45.8%)

KEY:
1-Maximum hourly average concentration (not to be exceeded more than once per year).
2-Maximum time-period average concentration (not to be exceeded more than once per year).
3-Annual arithmetic mean.
4-Federal and State Standard Values are identical except for SO_2; State Primary (24-hour) is 100 PPB.
21 days are required to yield a valid month.
No exceedence level set for NO_2 to date. 50 PPB is considered significantly high.

SOURCE: Reference 21

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

TABLE B-1
(Continued)
KENNEDY SPACE CENTER AIR QUALITY DATA SUMMARY PAMS A

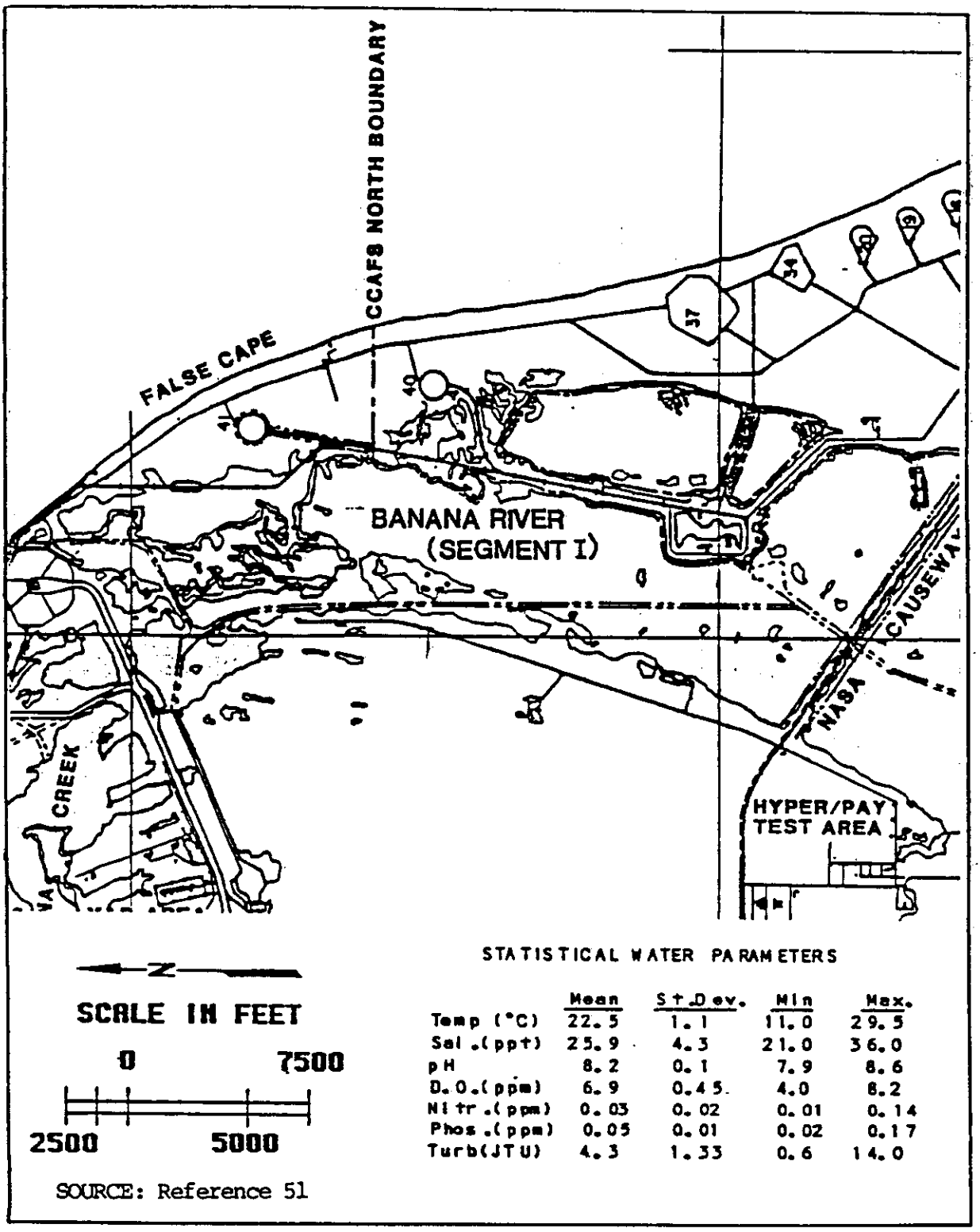
1985 ANNUAL REPORT

PARAMETER	FEDERAL[4] AND STATE STANDARD	July	August	September	October	November	December
OZONE (ppb)	Primary 120 (HR-AVG)[1]	102 (71.7%)	97 (95.2%)	79 (99.2%)	86 (95.9%)	82 (93.3%)	80 (94.0%)
SULFUR DIOXIDE (ppb)	Primary 140 (24-HR)2,4 Secondary 500 (3-HR)2	7 11 (50.0%)	1 3 (91.5%)	4 11 (98.3%)	2 4 (96.0%)	2 8 (87.5%)	18 27 (55.9%)
NITROGEN DIOXIDE (ppb)	Primary3 50	5 (27.0%)	23 (83.2%)	49 (78.9%)	71 (95.7%)	34 (78.1%)	25 (93.8%)
CARBON MONOXIDE	35 (HR-AVG)1 9 (8-HR)2	1.00 0.537 (86.7%)	1.25 0.611 (91.9%)	1.19 0.728 (98.9%)	0.95 0.588 (96.4%)	0.75 0.619 (93.2%)	1.13 0.772 (93.8%)

KEY:
1-Maximum hourly average concentration (not to be exceeded more than once per year).
2-Maximum time-period average concentration (not to be exceeded more than once per year).
3-Annual arithmetic mean.
4-Federal and State Standard Values are identical except for SO_2; State Primary (24-hour) is 100 PPB.
21 days are required to yield a valid month.
No exceedence level set for NO_2 to date. 50 PPB is considered significantly high.

SOURCE: Reference 21

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

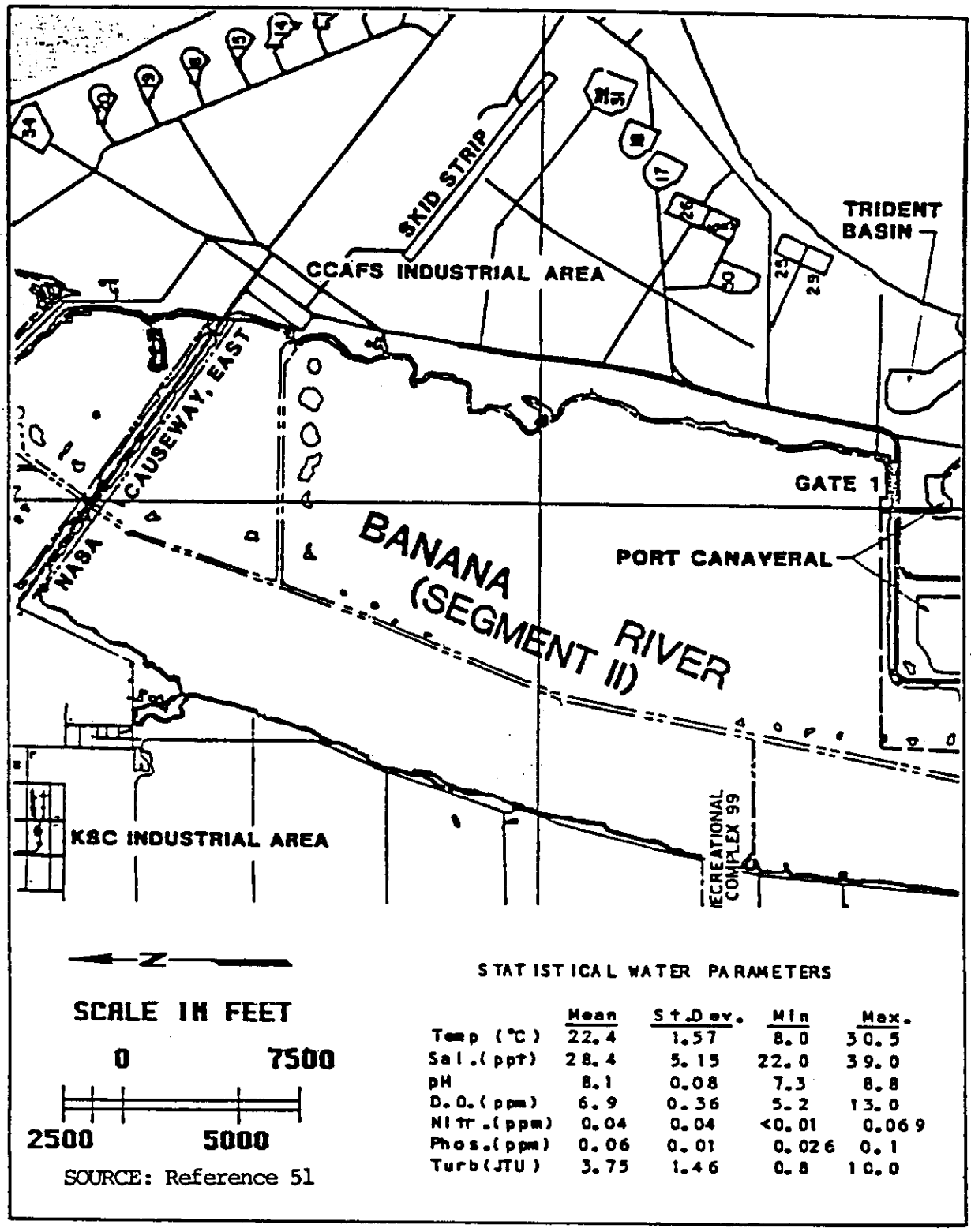


STATISTICAL WATER PARAMETERS

	Mean	St.Dev.	Min	Max.
Temp (°C)	22.5	1.1	11.0	29.5
Sal.(ppt)	25.9	4.3	21.0	36.0
pH	8.2	0.1	7.9	8.6
D.O.(ppm)	6.9	0.45	4.0	8.2
Nitr.(ppm)	0.03	0.02	0.01	0.14
Phos.(ppm)	0.05	0.01	0.02	0.17
Turb(JTU)	4.3	1.33	0.6	14.0

TABLE B-2 BANANA RIVER SEGMENT I
WATER QUALITY SUMMARY

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080



	Mean	St.Dev.	Min	Max.
Temp (°C)	22.4	1.57	8.0	30.5
Sal.(ppt)	28.4	5.15	22.0	39.0
pH	8.1	0.08	7.3	8.8
D.O.(ppm)	6.9	0.36	5.2	13.0
Nitr.(ppm)	0.04	0.04	<0.01	0.069
Phos.(ppm)	0.06	0.01	0.026	0.1
Turb(JTU)	3.75	1.46	0.8	10.0

TABLE B-2 BANANA RIVER SEGMENT II
WATER QUALITY SUMMARY

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

This will have an impact on the discharge criteria established for decant water effluent from the spoil disposal areas as ambient conditions will be required as a result of the OFW designation. Salinity in this area averages 27 parts per thousand while dissolved oxygen mean is 6.9 parts per million. The average depth of segment 1 is 2.3 ft. and the average depth of Segment 2 is 3.3 ft. (outside the channel). Surface water quality at KSC would generally be considered good. The Banana River segment within KSC is influenced by NASA as well as Air Force operations at Cape Canaveral.

b. Groundwater

KSC is on a relatively flat coastal area characterized by a near-surface level water table. It is surrounded by brackish to saline surface water. Four geohydrologic units underlay KSC. They are the surficial aquifer 35 to 45 ft. thick composed of sand and shell; a confining bed roughly 105 ft. thick composed of marl and clay; minor beds of limestone and sand referred to as a secondary semi-confined aquifer; and the Floridan aquifer composed of limestone. Table B-3 describes these geohydrologic units.

Recharge to surficial aquifer primarily comes from the direct infiltration of precipitation. Plate B-1 illustrates potential recharge areas for the surficial aquifer. It should be noted that all spoil disposal areas are located out of prime or good recharge areas. Expansion sites 4 and 5 may fall within the fair to poor recharge zone.

Table B-4 indicates water quality of the surficial aquifer. It is assumed that most of the spoil disposal areas will be located above what may be considered the "transitional saline-intruded fringe" areas. High chloride concentrations occur on the fringes of the aquifer due to intrusion from surrounding saline water-bodies. Therefore quality improves towards the north-south

TABLE B-3

GEOHYDROLOGIC UNITS

Unit	Thickness (ft)	Lithology	Hydraulic Properties
Surficial Aquifer	30-60	Fine-coarse sand, some silts, coquina, sandy shell, and inland marsh deposits	Generally low in sands and silts, however can be productive in coquina and sandy shell beds. Hydraulic conductivity ranges from 0.2 to 25 ft/day
Upper Confining Unit. Contains secondary aquifers	34-71	Interbedded gray-green silty clay and clayey sand; minor deposits of fine-medium sand and friable limestone	Low permeability to relatively impermeable beds act as a confining unit; wells tapping discontinuous sand or limestone beds yield low flows, these beds are under either semi-artesian or artesian conditions. Hydraulic conductivity ranges from 0.03 to 0.5 ft/day
Principal Confining Unit. Contains secondary aquifers	26-90	Occurrence of phosphate in sands, clays and dolomites, light green to greenish gray sandy marl, thin beds of phosphatic sandy limestone.	Low permeability to relatively impermeable beds, moderate yields come from the minor limestone and sand beds. Hydraulic conductivity of low permeability beds ranges from .001 to 0.5 ft/day
Floridan Aquifer	1510-1650	Chalky-granular, massive limestone, dolomite beds in lower deposits.	Very high permeability, yields large quantities of water. Transmissivity ranges from 1,000,000 to 3,000,000 gpd/ft

From: Environmental Resources Document
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November 1986
KSC-DF-3080

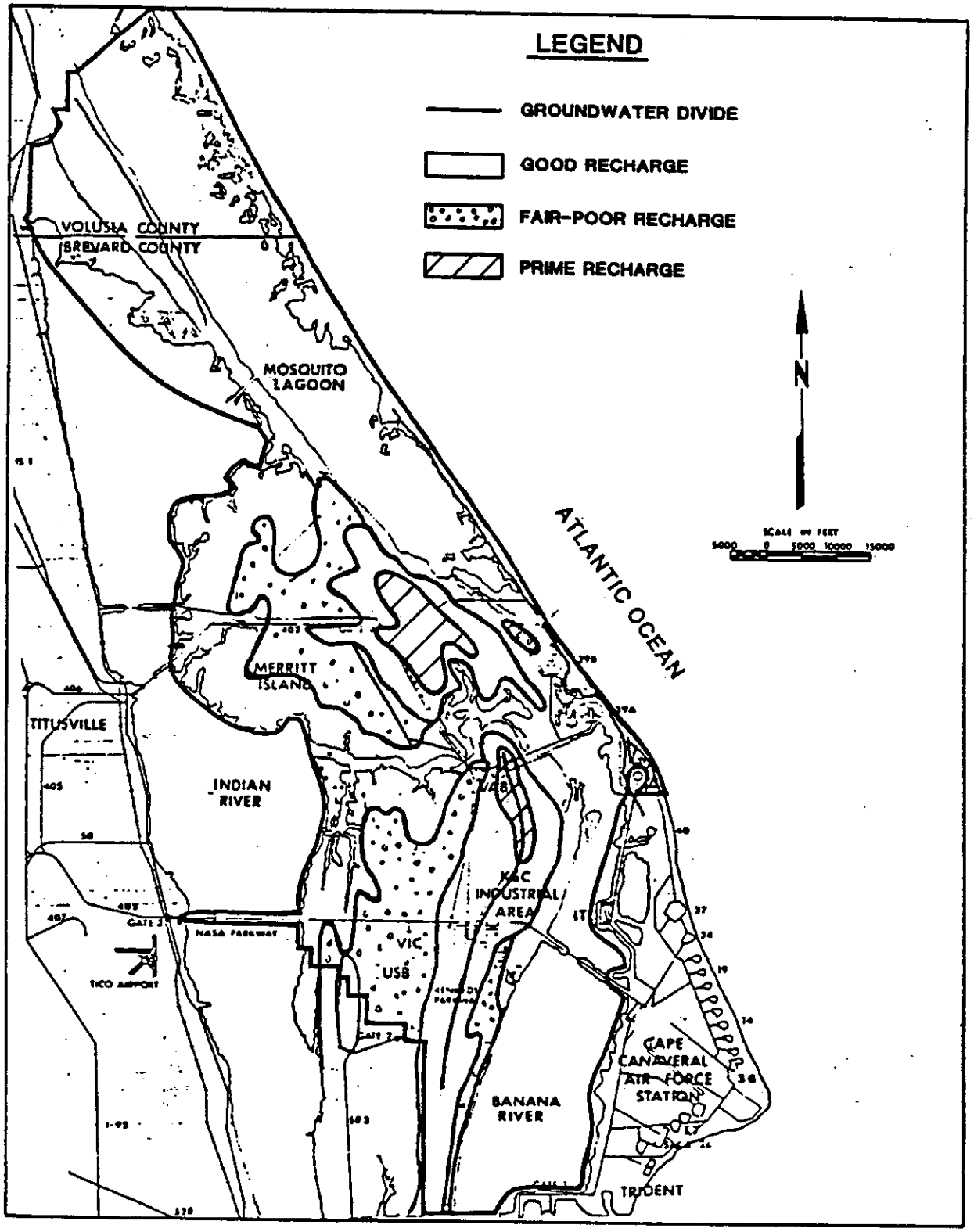

PLATE B-1 POTENTIAL RECHARGE FOR THE SURFICAL AQUIFER

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

TABLE B-4

WATER QUALITY OF THE SURFICIAL AQUIFER*
Based on Data Collected August, 1985

Parameter	UPLANDS Range (mg/l)	INTERMEDIATE ZONE Range (mg/l)	TRANSITIONAL-SALINE INTRUDED ("FRINGE AREAS") Range (mg/l)
Iron	<0.05 - 13.9	1.3 - 4.2	0.3 - 1.8
Calcium	<10 - 200	63 - 140	10.3 - 350
Magnesium	<10 - 61	<10 - 130	55 - 970
Sodium	<10 - 300	53 - 240	410 - 14,000
Alkalinity	16 - 620	300 - 470	5 - 370
Sulfate	<10 - 940	<10 - 36	11 - 2,600
Chloride	9 - 960	78 - 800	1,570 - 71,000
Total Dissolved Solids	130 - 2,350	460 - 2,400	3,940 - 95,500
Nitrate	<0.01	<0.01	<0.01
pH	7.5 - 8.2	7.4 - 8.1	7.2 - 8.4

* These are the results of preliminary analysis, results are subject to change.

Source: Ref. 24
From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

axis of the center. This would be the areas of prime recharge; a significant distance from the location of the spoil disposal areas. The surficial aquifer is currently exhibiting good water quality; however, is susceptible to contamination.

c. Mosquito Control Impoundments

The KSC surface water shorelines are dominated by mosquito control impoundments such as the two proposed impoundments designated as spoil disposal areas 2C and 3A (Plate A-3). Very often these impoundments are typically fringed by mangroves and salt marsh communities. However, this does not appear to be the case in the two mosquito impoundments selected as prospective spoil disposal areas. These appear to be dominated by graminoid grasses and cattails, willowheads and other species indicative of impacted areas. Mosquito control at KSC is jointly administered by the U.S. Fish & Wildlife Service (USFWS) and the Brevard County Mosquito Control District (BCMCD). There are approximately 75 mosquito control impoundments for which the USFWS performs dike maintenance operations and regulates water elevations within the impoundments. The BCMCD retains the responsibility of monitoring mosquito populations at KSC and the spraying of larvae sites, etc. Mosquito control impoundments were constructed to control the salt marsh mosquito, primarily Aedes sollicitans and A. taeniorhynchus. Flooding these impounded marshes proves to be an extremely effective mosquito control technique. The 75 cells within KSC comprise approximately 21,500 acres. These impoundments may provide some habitat value; however, the two impoundments selected in this study are comprised mostly of vegetation typical of previously disturbed areas as well as significant uplands as indicated by vegetation mapping (Plate A-4) and County soils surveys (Plate A-5).

4. Wetlands

Interior wetlands on Merritt Island are found primarily in the interdunal swales within scrub or slash pine flatwoods. Proposed spoil disposal sites 4 and 5 contain some areas of cabbage palm savanna which may be found in these interdunal swales (Plate A-4). Many of the wetlands along the periphery of Merritt Island (as previously stated) have been modified by impounding water for mosquito control. This is indicative of the wetlands contained within proposed spoil disposal areas 2C and 3A (Plate A-4). Table B-5 illustrates wetland types in the area as well as dominant examples of trees shrubs grasses, etc. that would occur in these wetland categories. In summary, the following indicates wetland impacts from the proposed spoil disposal areas:

Site	Dominant Vegetation	Acres	% Wetlands
2C	Graminoid marsh, cattails	16	55%
3A	Willow swamp, cattails	36	48%
4	Cabbage palm savanna	24	42%
5	Cabbage palm savanna, willow swamp	6	19%
6A	Cattails	± 1	5%
	Totals	83	40%

The impacted wetlands may be described as follows:

- o Willow swamp community - a swamp of small trees dominated by the carolina willow, Salix carolina and some wax myrtle.
- o Cattail marsh - dominated by southern cattail, Typha domingensis and the common cattail, Typha latifolia. This may occur in fresh or brackish areas. Cattails typically colonize in disturbed areas particularly in the mosquito impoundments where high water levels may exist.
- o Cabbage palm savanna - has an open or scattered canopy of cabbage palm and an understory of sand cordgrass and other possible graminoids. The cabbage palm savanna occurs in swales and transitional areas between brackish marsh and uplands.

TABLE B-5

CHARACTERISTIC SPECIES OF MAJOR PLANT COMMUNITIES OF JOHN F. KENNEDY SPACE CENTER

	WETLAND TYPES											
	NON-SALINE					BRACKISH OR SALINE						
	HARD-WOOD SWAMP	WILLOW SWAMP	CABBAGE PALM SAVANNAH	FRESH-WATER SWALE MARSH	CAT-TAIL MARSH	SAND CORDRASS-BLACK RUSH MARSH	MIXED SALT-TOLERANT GRASSES MARSH	SEA OXEYE	SALTWORT-GLASSWORT	SALTMARSH CORDGRASS MARSH	MANGROVE SWAMP
Trees											
Acer rubrum	X	X									
Persea spp.	X										
Q. laurifolia	X										
Sabal palmetto	X		X								
Salix caroliniana		X									
Ulmus americana	X										
Shrubs and Woody Vines											
Avicennia germinans											X
Baccharis halimifolia			X								
Batis maritima								X	X		X
Borrichia frutescens							X	X			
Conocarpus erecta											X
Languncularia racemosa											X
Lycium carolinianum								X			
Myrica cerifera		X	X			X					
Rhizophora mangle											X
Salicornia virginica									X	X	X
Grasses and Graminoids											
Andropogon spp.				X							
Cladium jamaicense				X							

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

TABLE B-5
CHARACTERISTIC SPECIES OF MAJOR PLANT COMMUNITIES OF JOHN F. KENNEDY SPACE CENTER
(Continued)

	WETLAND TYPES											
	NON-SALINE					BRACKISH OR SALINE						
	HARD-WOOD SWAMP	WILLOW SWAMP	CABBAGE PALM SAVANNAH	FRESH-WATER SWALE MARSH	CAT-TAIL MARSH	SAND CORDRASS-BLACK RUSH MARSH	MIXED SALT-TOLERANT GRASSES MARSH	SEA OXEYE	SALTWORT-GLASSWORT	SALTMARSH CORDGRASS MARSH	MANGROVE SWAMP
Distichlis spicata							X				
Erianthus giganteus			X								
Fimbristylis castanea			X								
Juncus roemerianus			X			X					
Panicum hemitomon				X							
Paspalum distichum							X				X
Spartina alterniflora									X	X	
S. bakeri			X	X		X					
Sporobolus virginicus							X				
Typha domingensis					X						
T. latifolia					X						
Forbs											
Acrostichum danaeifolium						X		X			
Bacopa spp.						X					
Blechnum serrulatum				X							
Lemna spp.		X			X						
Osmunda regalis	X										
Sagittaria lancifolia				X							
S. stagnorum		X									
Salicornia bigelowii									X		
Sesuvium portulacastrum							X		X		
Suaeda linearis											X
Urena lobata			X			X	X				
Urticularia spp.		X			X						
Woodwardia virginica	X			X							

SOURCE: Reference 96

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

- o Graminoid grasses - predominantly sand cordgrass and black rush with associated species including wax myrtle. This is generally the most inland type of brackish wetland vegetation.

5. Uplands

The following summarizes native upland impacts by the proposed spoil disposal areas:

Site	Dominant Vegetation	Acres	Percentage Native Uplands
2C	Mixed oaks/saw palmetto	8	27%
3A	Mixed oaks/saw palmetto	31	42%
4	Slash pine flatwoods	29	52%
5	Slash pine flatwoods	24	75%
6A	Wax myrtle	3	21%
	Totals	95	46%

Table B-6 summarizes the major upland plant communities for KSC including characteristic species of trees, shrubs, vines, grasses, etc.

The impacted communities may be described as:

- o Oak scrub - occurs on the best drained inland areas dominated by myrtle oak (Quercus myrtifolia), chapman oak (Quercus chapmanii), sand live oak (Quercus geminata), and saw palmetto (Serona repens). Other associates may include rusty lyonia, staggerbush and blueberry. Saw palmetto scrub occurs on somewhat less drained sites than oak scrub, but composition is generally similar in this area with saw palmetto being more dominant. They are usually classified and mapped as a single unit; however, can be described accordingly based on dominance.

TABLE B-6

CHARACTERISTIC SPECIES OF MAJOR PLANT COMMUNITIES OF JOHN F. KENNEDY SPACE CENTER

	UPLAND TYPES							
	COASTAL		INLAND					
	COASTAL DUNE	COASTAL STRAND	OAK SCRUB	SAW PALMETTO SCRUB	SLASH PINE FLATWOODS	CABBAGE PALM HAMMOCK	OAK-CABBAGE PALM HAMMOCK	XERIC HAMMOCKS
Trees								
Carya glabra								X
Juniperus silicicola							X	
Morus rubra							X	
Persea spp.							X	
Pinus elliottii					X			
Quercus chapmanii			X	X	X			
Q. laurifolia							X	
Q. myrtifolia			X	X	X			
Q. virginiana							X	X
Q. virginiana var. geminata		X	X	X	X			
Sabal palmetto						X	X	
Ulmus americana							X	
Shrubs and Woody Vines								
Chicococca alba		X						
Coccoloba uvifera	X	X						
Croton punctatus	X							
Ilex glabra					X			
I. vomitoria						X		
Iva imbricata	X							
Lyonia ferruginea			X		X			
L. fruticosa			X		X			

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

TABLE B-6
CHARACTERISTIC SPECIES OF MAJOR PLANT COMMUNTIIES OF JOHN F. KENNEDY SPACE CENTER
(Continued)

	UPLAND TYPES							
	COASTAL		INLAND					
	COASTAL DUNE	COASTAL STRAND	OAK SCRUB	SAW PALMETTO SCRUB	SLASH PINE FLATWOODS	CABBAGE PALM HAMMOCK	OAK-CABBAGE PALM HAMMOCK	XERIC HAMMOCKS
Lyonia lucida			X	X	X			
Myrcianthes fragrans		X					X	
Myrica cerifera		X						
Nectandra coriaceae							X	
Psychotria spp.							X	
Rapanea punctata		X					X	
Scaevola plumieri	X							
Serenoa repens		X	X	X	X	X		X
Smilax auriculata		X	X		X			
Vaccinium myrsinites			X		X			
Grasses and Graminoids								
Aristida spp.				X	X			
Panicum amarum	X							
Spartina patens	X							
Uniola paniculata	X							
Forbs								
Helianthus debilis	X							
Heterotheca subaxillaris	X							
Ipomoea pes-caprae	X							

SOURCE: Reference 96

From: Environmental Resources Document
John F. Kennedy Space Center/NASA
November 1986
KSC-DF-3080

- o Slash pine flatwoods - occur on moderately to poorly drained sites and has an open to dense canopy of slash pine, Pinus elliottii. Understory usually is dominated by myrtle, chapman and sand live oak, saw palmetto, lyonia and wire-grass, etc., on better drained sites. On wetter sites saw palmetto has a greater dominance and gallberry is also more important.

6. "Listed" Species

Merritt Island supports a large and diverse community of flora and fauna. The Merritt Island National Wildlife Refuge has been maintained in a mostly undeveloped state. The diversity of flora and fauna is compounded by the fact that Merritt Island is the northernmost area of the U.S. with both tropical and subtropical species. Tables B-7 and B-8 include an index of protected fauna and flora, respectively, for KSC. Also included is the designated status of the U.S. Fish & Wildlife Service; the Convention on International Trade and Endangered Species; the Florida Game & Freshwater Fish Commission; the Florida Committee on Rare and Endangered Plants and Animals, and the Florida Natural Areas Inventory.

It should be noted that the prospective spoil disposal sitings in the alternatives analysis phase of this work considered "listed" species very seriously and omitted possible sites in the northern part of the Refuge from further considerations. Most common considerations were gopher tortoises, scrub jays, and indigo snakes, as well as manatees, colonial nesting birds such as the roseate spoonbill, osprey and the southern bald eagle. These seven species are known to be in the area of the proposed spoil disposal sites; however, none were actually noted on any of the sites.

TABLE B-7

INDEX OF PROTECTED FAUNA AT KSC

SCIENTIFIC NAME	COMMON NAME	DESIGNATED STATUS[1] USFWS[2]	CITES[3]	FDFWFC[4]	FDREPA[5]	FNAI[6]
FISH						
Centropomus undecimalis	Common snook			SSC		
REPTILES AND AMPHIBIANS						
Alligator mississipiensis[7]	American alligator	T(S/A)	II	SSC	SSC	G5,S4
Caretta caretta caretta[7]	Atlantic loggerhead turtle	T	I	T	T	G3,S2
Chelonia mydas mydas[7]	Atlantic green turtle	E	I	E	E	G3,S2
Dermochelys coriacea	Leatherback turtle	E	I	E	R	G3,S2
Drymarchon corais couperi[7]	Eastern indigo snake	T		T	SSC	G4T3,S3
Eretmochelys imbricata imbricata	Atlantic hawksbill turtle	E	I	E	E	G3,S1
Gopherus polyphemus[7]	Gopher tortoise	C2		SSC	T	G3,S3
Lepidochelys kempi[7]	Atlantic ridley turtle	E	I	E	E	G1,S1
Nerodia fasciata taeniata[7]	Atlantic salt marsh water snake	T		T	E	G4T1Q,S1
Ophiosaurus compressus	Island glass lizard	C2				
Pituophis melanoleucus mugitus	Florida pine snake	C2		SSC		G5T3?,S?
Rana areolata	Gopher frog; Crawfish frog	C2		SSC		G4,S3
Sceloporus woodi	Florida scrub lizard	C2			R	G3,S3
BIRDS						
Aimophila aestivalis	Bachman's sparrow	C2				G3,S?
Ajaia ajaja	Roseate spoonbill			SSC	R	G5,S2S3
Ammodramus savannarum floridanus	Florida grasshopper sparrow	E		E	E	G4T1,S1
Ammodramus maritima nigrescens[7]	Dusky seaside sparrow	E		E	E	G4TX,SX
Aphelocoma coerulescens coerulescens[7]	Florida scrub jay	T		T	T	G5T3,S3
Aramus guarauna	Limpkin			SSC	SSC	G5,S3
Athene cunicularia	Burrowing owl			SSC	SSC	G5T3,S3
Charadrius melodus	Piping plover	T		T	SSC	G2,S2
Circus cyaneus	Marsh hawk; Northern harrier		II			
Cistothorus palustris griseus	Worthington's marsh wren			SSC		G5T3,S2
Cistothorus palustris marianae	Marian's marsh wren			SSC		G5T3,S3?
Dendroica dominica stoddardi	Stoddard's yellow-throated warbler	C2				G5T3Q,S2S3
Egretta caerulea	Little blue heron			SSC	SSC	G5,S4
Egretta rufescens	Reddish egret	C2		SSC	R	G4,S2
Egretta thula	Snowy egret			SSC	SSC	G5,S4

INDEX OF PROTECTED FAUNA AT KSC
(Continued)

SCIENTIFIC NAME	COMMON NAME	DESIGNATED STATUS[1] USFWS[2]	CITES[3]	FGFWFC[4]	FCREPA[5]	FNAI[6]
BIRDS (Cont'd)						
Egretta tricolor	Tricolored heron; Louisiana heron			SSC	SSC	G5,S4
Falco columbarius	Merlin, pigeon hawk		II		SUD	G4,SU
Falco peregrinus tundrius[7]	Arctic peregrine falcon	T	I	E	E	G3,S2
Falco sparverius paulus[7]	Southeastern American kestrel	C2	II	T	T	G5T3T4,S3?
Falco sparverius sparverius	Eastern American kestrel		II			
Grus canadensis pratensis	Florida sandhill crane		II	T	T	G5T2T3,S2S3
Haematopus palliatus[7]	American oystercatcher			SSC	T	G5,S3
Haliaeetus leucocephalus[7]	Bald eagle	E	I	T	T	G3,S2S3
Mycteria americana[7]	Wood stork	E		E	E	G5,S2
Pandion haliaetus[7]	Osprey		II		T	G5,S3S4
Pelecanus occidentalis	Brown pelican			SSC		G5S3
Picoides borealis	Red-cockaded woodpecker	E		T	E	G2,S2
Sterna antillarum[7]	Least tern			T	T	G4,S3
Sterna dougallii[7]	Roseate tern	T		T	T	G3,S1
MAMMALS						
Felis concolor coryi	Florida panther	E	I	E	E	G4T1,S1
Lutra canadensis	River otter		II			
Lynx rufus	Bobcat		II			
Mustela frenata peninsulae	Florida long-tailed weasel	C2			R	G5T3,S3?
Mustela vison lutensis	Florida mink	C2			R	G5T3,S2
Neofiber alleni	Round-tailed muskrat	C2			SSC	G3?,S3?
Peromyscus floridanus[7]	Florida mouse	C2		SSC	T	G3,S3
Peromyscus polionotus niveiventris	Southeastern beach mouse	T		T		G5T1,S1
Trichechus manatus latirostris	West Indian manatee	E	I	E	T	G2?,S2?
Ursus americanus floridanus	Florida black bear	C2		T	T	G5T3,S3
	TOTALS	E - 11 T - 8 C1 - 0 C2 -14 T(S/A)-1 34	I - 9 II - 9 18	E - 10 T - 13 SSC-17 40	E - 10 T - 14 R - 6 SSC - 9 SUD - 1 39	47

GRAND TOTAL = 53 (1 Fish, 1 Amphibian, 12 Reptiles, 29 Birds, 10 Mammals)

INDEX OF PROTECTED FAUNA AT KSC
(Continued)

[1] E = Endangered;
T = Threatened;
T(S/A) = Threatened due to Similarity of Appearance;
PE = Proposed Endangered;
PT = Proposed Threatened;
C1 = A Candidate for federal listing, with enough substantial information on biological vulnerability and threats to support proposals for listing. See note below;
C2 = A Candidate for listing, with some evidence of vulnerability, but for which not enough data exist to support listing. See note below;
SSC = Species of Special Concern;
CE = Commercially Exploited;
I = Appendix I Species;
I = Appendix II Species;
SUD = Status Undetermined;
R = Rare.

* Note: Although C1 and C2 species are not protected under the Endangered Species Act, in the Federal Register notice (Volume 55, Number 35, pages 6184-6229) designating them as "candidates," the U.S. Fish and Wildlife Service "....encourages their consideration in environmental planning.....".

[2] United States Fish and Wildlife Service (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12).

[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora.

[4] Florida Game and Freshwater Fish Commission (list published in Section 39-27.03-05, Florida Administrative Code).

[5] Florida Committee on Rare and Endangered Plants and Animals.

[6] The Florida Natural Areas Inventory (FNAI) assigns 2 ranks for each element. The global element ranks is based on an element's worldwide status; the state element rank is based on the status of the element in Florida. Element ranks are based on many factors the most important ones being estimated number of elements occurrences (EOs), estimated abundance (number of individuals for species; area for natural communities), range, estimated adequately protected EOs, relative threat of destruction, and ecological fragility

Global Element Rank (priority):

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some biological or man-made factor.
G3 = Either very rare and local throughout its range (21 - 100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction because of other factors.
G4 = Apparently secure globally (may be rare in parts of range).
G5 = Demonstrably secure globally.
GH = Of historical occurrence throughout range, may be rediscovered (e.g., ivory-billed woodpecker).
GX = Believed to be extinct throughout range.
G#? = Tentative rank (e.g., G2?)
G#G# = Range or rank; insufficient data to assign specific global rank (e.g., G2,G3).
G#T# = Ranks of taxonomic subgroup such as subspecies or variety; numbers have same definition as above (e.g. G3,T1).
G#T#Q# = Same as above, but validity as subspecies or variety is questioned.
G#Q = Rank of questionable species - ranked as species but questionable whether it is species or subspecies; numbers have same definition as above (e.g., G2Q)
GU = Due to lack of information, no rank or range can be assigned (e.g. GUT2).
G? = Not yet ranked (temporary).

State Element Rank (priority)

Definition parallels global element rank: substitute "S" for "G" in above global ranks, and "in state" for "globally" in above global rank definitions.
Additional state element ranks:

SA = Accidential in Florida, i.e., not part of the established biota.
SE = An exotic species stablished in state; may be native elsewhere in North America.

[7] Listed in Final Environmental Impact Statement (EIS) for KSC (NASA 1979).

TABLE B-8

INDEX OF PROTECTED FLORA AT KSC

SCIENTIFIC NAME	COMMON NAME	DESIGNATED STATUS[1] USFWS[2]	CITES[3]	FDA[4]	FCREPA[5]	FNAI[6]	DOA[7]
Acrostichum danaeifolium[3,9]	Giant leather fern			T			
Amyris balsamifera	Balsam torchwood					G3G4,S1	
Asclepias curtissii[3, 10]	Curtiss milkweed; sandhill milkweed			E		G3,S3	E 50
Asplenium platyneuron	Ebony spleenwort			T			
Avicennia germinans[3, 5, 10]	Black mangrove				SSC		
Azolla caroliniana	Mosquito fern				T		
Calamovilfa curtissii[3, 9]	Curtiss reedgrass; Curtiss sand grass	C2		E		G1G2,S1S2	E 100
Calopogon barbatus	Bearded grass pink		II	T			
Calopogon multiflorus	Many-flowered grass pink	T	II				
Calopogon tuberosus[9]	Grass pink (unnamed)		II	T			
Campyloneurum phyllitidis	Strap fern (unnamed)			T			
Cereus eriophorus var. *fragrans*[8]	Fragrant wool-bearing cereus; fragrant prickly apple	E	II	E		G2G3,T1,S1	E100
Cereus gracilis	Prickly-apple	C2	II	E	T	G2G3,S2S3	E 80
Cereus undatus	Night-blooming cereus; Queen of the night		II	T			
Chrysophyllum oliviforme[3, 10]	Satinleaf			E			E 80
Cocos nucifera	Coconut palm			T			
Conradina grandiflora	Large-flowered rosemary	C2		E		G2,S3	E 50
Dryopteris ludoviciana	Florida shield fern			T			
Epidendrum conopseum	Greenfly orchid		II	T			
Ernodea littoralis	Beach creeper			T			T 10
Eulophia alta	Wild coco; ground coco		II	T			
Eulophia ecristata (=*Pteroglossaspis ecristata*)	False coco		II	T		G3G4,S2	T 80
Habenaria odontopetala	Rein Orchid (unnamed)		II	T			
Habenaria repens	Water spider orchid; creeping orchid		II	T			
Hexalectris spicata	Crested coralroot		II	E			E 25
Hymenocallis latifolia[3, 9]	Broad-leaved spider lily					G3,S2S3	
Ilex amblgua	Carolina holly; sand holly			T			
Lechea cernua[3]	Nodding pinweed; drooping pinweed	C2		E		G3,S3	E 50
Lilium catesbaei	Catesby lily			T		G4,S3	T 25
Lycopodium alopecuroides	Foxtail club moss			T			

INDEX OF PROTECTED FLORA AT KSC
(Continued)

SCIENTIFIC NAME	COMMON NAME	DESIGNATED STATUS[1] USFWS[2]	CITES[3]	FDA[4]	FCREPA[5]	FNAI[6]	DCA[7]
Lycopodium appressum	Southern club moss			T			
Lycopodium carolinianum	Slender club moss			T			
Malaxis spicata	Florida malaxis; Florida adder's mouth		II	T			
Nephrolepis biserrata	Boston fern (unnamed)			T			
Ophioglossum palmatum[6, 10]	Hand adder's tongue fern (unnamed)			E	E		
Ophioglossum petiolatum[9]	Adder's tongue fern (unnamed)			T			
Opuntia compressa	Twistpine prickly pear cactus		II	T			
Opuntia stricta (= *Opuntia humifusa*)	Prickly pear cactus (unnamed)		II	T			
Osmunda regalis var. spectabilis[9]	Royal Fern			CE			
Pavonia spinifex	Pavonia					G4G5,S2S3	
Peperomia humilis	Pepper (unnamed)			E		G5,G2,	E 80
Peperomia obtusifolia[10]	Florida peperomia			E		G5,S2	E 80
Pereskia aculeata	Lemon vine; blade apple cactus		II	T			
Persea borbonia var. humilis[6, 9]	Dwarf redbay; redbay persea					G4,S3	
Phlebodium aureum[9]	Golden polybody			T			
Pogonia ophioglossoides	Rose pogonia		II	T			
Polygala rugelii	Big yellow milkwort			T			
Polypodium plumula	Polypody fern (unnamed)			T			
Ponthieva racemosa	Shadow witch		II	T			
Psilotum nudum[9]	Whisk fern, form fern			T			
Remirea maritima	Beach star			E		G3,S1	E 100
Rhizophora mangle[6, 9, 10]	Red mangrove				SSC		
Rhynchosia cinerea[8]	Brown-haired snoutbean					G3,S3	
Scaevola plumieri[9]	Inkberry			T			
Selaginella arenicola	Sand spikemoss			T			
Sophora tomentosa	Necklace pod					G4,S3	
Spiranthes laciniata	Lace-lip ladies'-tresses; lace-lip spiral orchid		II	T			
Suriana maritima	Bay cedar			E			
Tephrosia angustissima	Narrow-leaved hoary pea; coastal hoary pea	C1		E		G1Q,S1	E 100
Thelypteris hispidula	Aspidium fern (unnamed)			T			
Thelypteris interrupta	Aspidium fern (unnamed)			T			
Thelypteris kunthii	Aspidium fern (unnamed)			T			

INDEX OF PROTECTED FLORA
(Continued)

SCIENTIFIC NAME	COMMON NAME	DESIGNATED STATUS USFWS[2]	CITES[3]	FDA[4]	FCREPA[5]	FNAI[6]	DCA[7]
Thelypteris palustris	Marsh fern			T			
Tillandsia connivens	Wild pine; air plant (unnamed)			T			
Tillandsia utriculata	Giant wild pine; giant air plant			CE			
Tournefortia gnaphalodes[10]	Sea lavender			T		G4,S2	E 50
Verbena maritima[8,9] (=*Glandularia maritima*)	Coastal vervain	C2		E		G2,S2	E 80
Verbena tampensis[8,9] (=*Glandularia tampensis*)	Tampa vervain	C1		E		G1,S1	E 100
Vittaria lineata[3]	Shoestring fern			T			
Woodwardia areolata	Netted chain fern			T			
Zamia umbrosa[8,10] (=*Zamia pumila*)	East coast coontie		II	CE	T		

TOTALS	E - 1						100 - 5
	T - 1		E- 15	E - 1			80 - 6
	C1- 2	I - 0	T- 42	T - 3			50 - 4
	C2- 5	II- 20	CE - 3	SSC- 2			25 - 2
	9	20	60	6	21		17

GRAND TOTAL = 71

[1] E = Endangered;
T = Threatened;
T(S/A) = Threatened Due to Similarity of Appearance;
PE = Proposed Endangered;
PT = Proposed Threatened;
C1 = A candidate for federal listing, with enough substantial information on biological vulnerability and threats to support proposals for listing. See note below;
C2 = A candidate for listing, with some evidence of vulnerability, but for which not enough data exist to support listing. See note below;
SSC = Species of Special Concern;
CE = Commercially Exploited;
I = Appendix I species;
II = Appendix II Species.

* Note: Although C1 and C2 species are not protected under the Endangered Species Act, in the Federal Register notice (Volume 55, Number 35, pages 6184-6229) designating them as "candidates," the U.S. Fish and Wildlife Service "...encourages their consideration in environmental planning...".

[2] United States Fish and Wildlife Service (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12).

[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora.

[4] Florida Department of Agriculture and Consumer Services (list published in Preservation of Native Flora Florida Act, Section 581.185-187, Florida Statutes).

[5] Florida Committee on Rare and Endangered Plants and Animals.

[6] The Florida Natural Areas Inventory (FNAI) assigns 2 ranks for each element. The global element rank is based on an element's worldwide status; the state element rank is based on the status of the element in Florida. Element ranks are based on many factors the most important ones being estimated number of elements occurrences (EOs), estimated abundance (number of individuals for species; area for natural communities), range, estimated adequately protected EOs, relative threat of destruction, and ecological fragility.

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GX = Believed to be extinct throughout range.
G*? = Tentative rank (e.g., G2?).
G*G* = Range of rank; insufficient data to assign specific global rank (e.g., G2,G3).
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G*Q = Rank of questionable species - ranked as species but questionable whether it is species or supspecies; numbers have same definition as above (e.g., G2Q).
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State Element Rank (priority)

Definition parallels global element rank - substitute "S" for "G" in above global ranks, and "in state" for "globally" in above global rank definitions.
Additional state element ranks:

SA = Accidential in Florida, i.e., not part of the established biota
SE = An exotic species stablished in state, may be native elsewhere in North America.

[7] Florida Department of Community Affairs Wildlife Advisory Group (August 1, 1990).
100 = 100% onsite preservation recommended
80 = 80% onsite preservation recommended
50 = 50% onsite preservation recommended
25 = 25% onsite preservation recommended
10 = 10% onsite preservation recommended

[8] Sites or populations identified by Poppleton (1981)

[9] Sites or populations known from Bionetics field work (1982-1989)

[10] Listed in Final Environmental Impact Statement (EIS) for KSC (NASA 1979)

E. Effects on the Environment

1. Environments

Table B-9 is a summary of effects on the environment. It considers both construction impacts and operational impacts pertaining to the spoil areas (not dredging operations) from a potential and anticipated perspective. In summary, there appears to be "little" impact anticipated to surface water during construction and operation and a "moderate" impact anticipated to biotic resources and wetlands during construction activities. "Listed" species also anticipates "little" impact. The following is a summary of each category.

a. Air Quality

Construction - no air quality impact is expected from the general construction activities at the proposed site.

Operation - no air quality impact is expected from general operational activities of the proposed site.

b. Surface Water

Construction - there is potential for moderate impact; however, little impact is anticipated on surface water. As the surrounding waters are OFW's. No discharge will be allowed which will raise water quality conditions above ambient levels. Construction of sites 4, 5 and 6A are not expected to adversely affect surface water quality. Sites 2C and 3A are mosquito impoundment areas in proximity to the Banana River. While some improvement of the perimeter ditches is likely, erosion and siltation control measures will be deployed to prevent the discharge of dike construction material to adjacent surface waters.

Operation - there is potential for moderate impact during operations; however, little impact is anticipated. The spoil sites will be designed based on "bench-scale" settleability testing to ensure that ambient Banana River water quality is obtained in the decant water effluent prior to discharge, as necessary. Preliminary engineering indicates an average retention time of 4.8 days prior to discharge for solids settlement.

TABLE B-9

SUMMARY OF EFFECTS ON THE ENVIRONMENT

Environments	Construction Impacts		Operations Impacts	
	Potential	Anticipated	Potential	Anticipated
Air Quality	0	0	0	0
Surface Water	2	1	2	1
Groundwater	1	0	1	0
Waste-Related	0	0	0	0
Noise	0	0	0	0
Toxic Substances	0	0	0	0
Biotic Resources	2	2	0	0
Radioactivity	0	0	0	0
Archaeology	0	0	0	0
"Listed" species	2	1	0	0
Wetlands	2	2	0	0
Socioeconomic	0	0	0	0

0 = no impact

1 = little impact

2 = moderate impact

3 = significant impact

c. Groundwater

Construction - the potential for impact to groundwater is limited with no anticipated impact during construction. All spoil disposal sites have been located out of prime and good aquifer recharge areas. Surficial aquifer water quality indicates "transitional saline-intruded fringe" areas in the area of the proposed spoil sites construction. No impact is anticipated during this period.

Operation - there is little potential for impact during operation and no impact anticipated during operations of the dredge disposal facilities. As previously stated, all spoil disposal sites are located out of prime and good recharge areas. Water quality of the surficial aquifer in the spoil disposal areas indicates "transitional saline-intruded fringe" quality. Introduction of hydraulic dredge material to site 6A could infiltrate the former landfill and may encourage the release of leachate to surrounding areas. However, this site is not released for use at this time.

d. Waste-related

Construction - no waste-related impact is expected from the general construction activities at the proposed sites.

Operation - no waste-related impact is expected from general operational activities of the proposed sites.

e. Noise

Construction - no noise impact is expected from the general construction activities at the proposed sites.

Operation - no noise impact is expected from the general operation of the proposed sites.

f. Toxic Substances

Construction - no impact from toxic substances is expected from the general construction activities at the proposed sites.

Operation - no impact from toxic substances is expected from the general operation of the proposed sites.

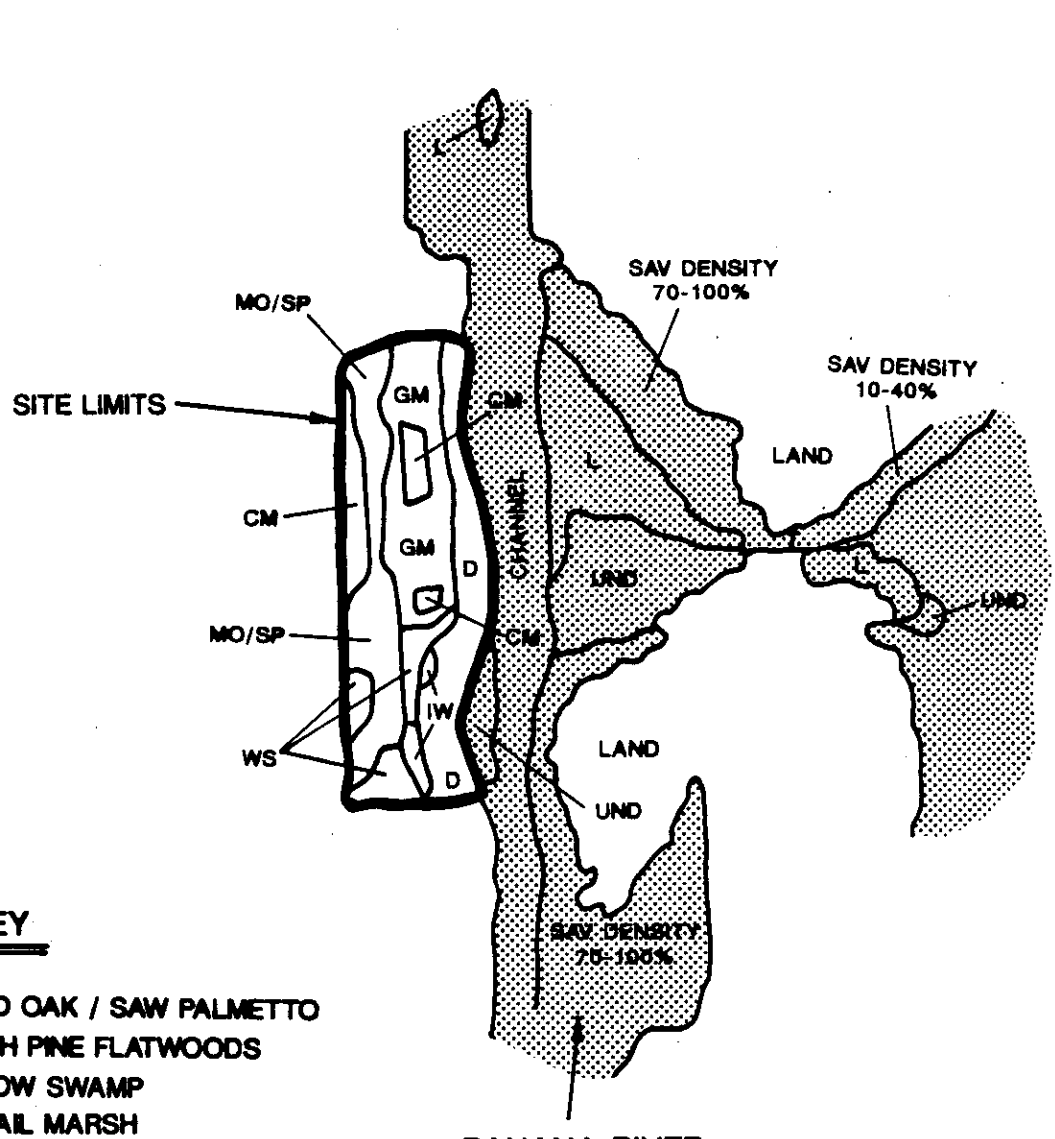
g. Biotic Resources

Construction - potential for moderate impact to biotic resources is possible and anticipated. Approximately 178 acres of the 205 total acres (86%) is comprised of wetlands and native uplands will be moderately impacted. The balance of the sites are existing dikes, ruderal areas, etc. All sites have some form of previous disturbance within or in contiguous areas and have already been impacted to a certain degree. Sites 2C and 3A are mosquito control impoundment areas and Sites 5 and 6 are located adjacent to existing spoil disposal sites. Site 6A (15 acres) is ruderal area with no impact to biotic resources expected from construction activities. It is expected that of the total 178 acres, approximately 83 (40%) acres of fair to good quality wetlands will be impacted and approximately 95 (46%) acres of fair to good quality uplands will be impacted.

Plates B-2 through B-6 are vegetation/sea grass maps for each site. The associations represented within site borders will be impacted by construction. The following indicate cumulative acreage impacts for each wetland or native upland association and how it relates to the entire KSC/CC complex:

Vegetative Association	Cumulative Areas Impacted	Total Areas In KSC/CC Complex	% Impacted
NATIVE UPLAND			
Mixed oak/saw palmetto	39	6,812	0.6
Slash pine flatwoods	53	3,843	1.4
Wax myrtle/(Brazilian Pepper)	3	956	0.3
WETLAND			
Cattail marsh	11	670	1.6
Willow swamp	29	549	5.3
Graminoid marsh	11	2,189	0.5
Cabbage palm savanna	31	564	5.5
Inland waters	1	35	2.9
Totals	178 ac.	15,618 ac.	1.1%

Operation - no potential or anticipated impacts from operational activities to biotic resources are expected. Any impacts will have occurred during the construction phase.



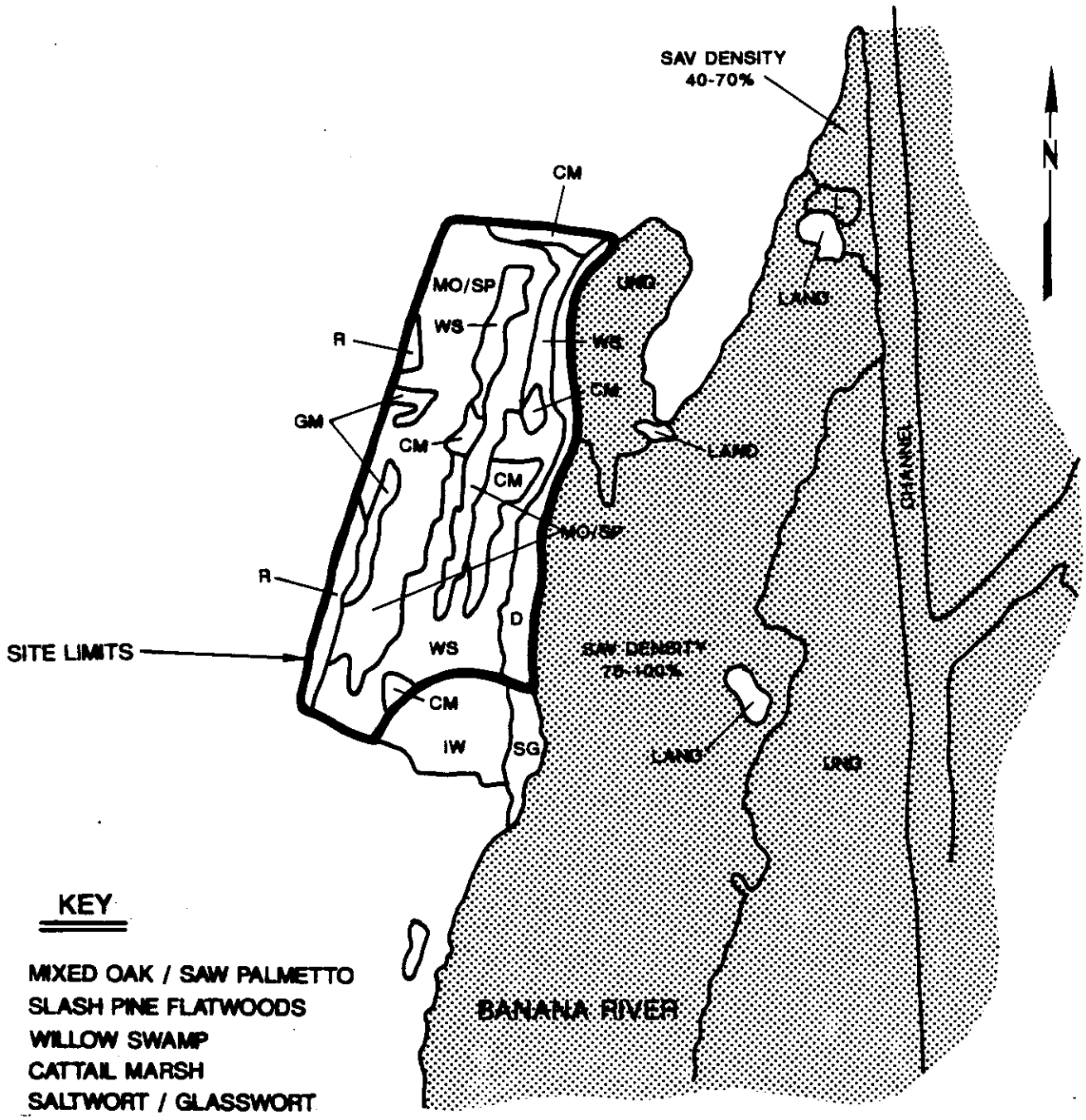
KEY

MO/SP	MIXED OAK / SAW PALMETTO
SPF	SLASH PINE FLATWOODS
WS	WILLOW SWAMP
CM	CATTAIL MARSH
SG	SALTWORT / GLASSWORT
BM	BLACK MANGROVE
GM	GRAMINOID MARSH
CPS	CABBAGE PALM SAVANNA
WM/BP	WAX MYRTLE / BRAZILIAN PEPPER
R	RUDERAL
SV	SPOIL VEGETATION
D	DIKES
W	IMPOUNDED WATERS
SAV	SUBMERGED AQUATIC VEGETATION
UND	(SAV) DENSITY - UNDISCERNABLE
-	LAGOON (SAV DENSITY - 0 - 10%)
T	TRANSPORTATION
ILW	INLAND WATERS

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
SITE 2C - VEGETATION / SEAGRASS MAP

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD	JTW	90379	PLATE B - 2
DATE 4/12/91	SCALE 1" = 1000'	APPROVED JSG	FILE NO.	SHEET 1 OF 5



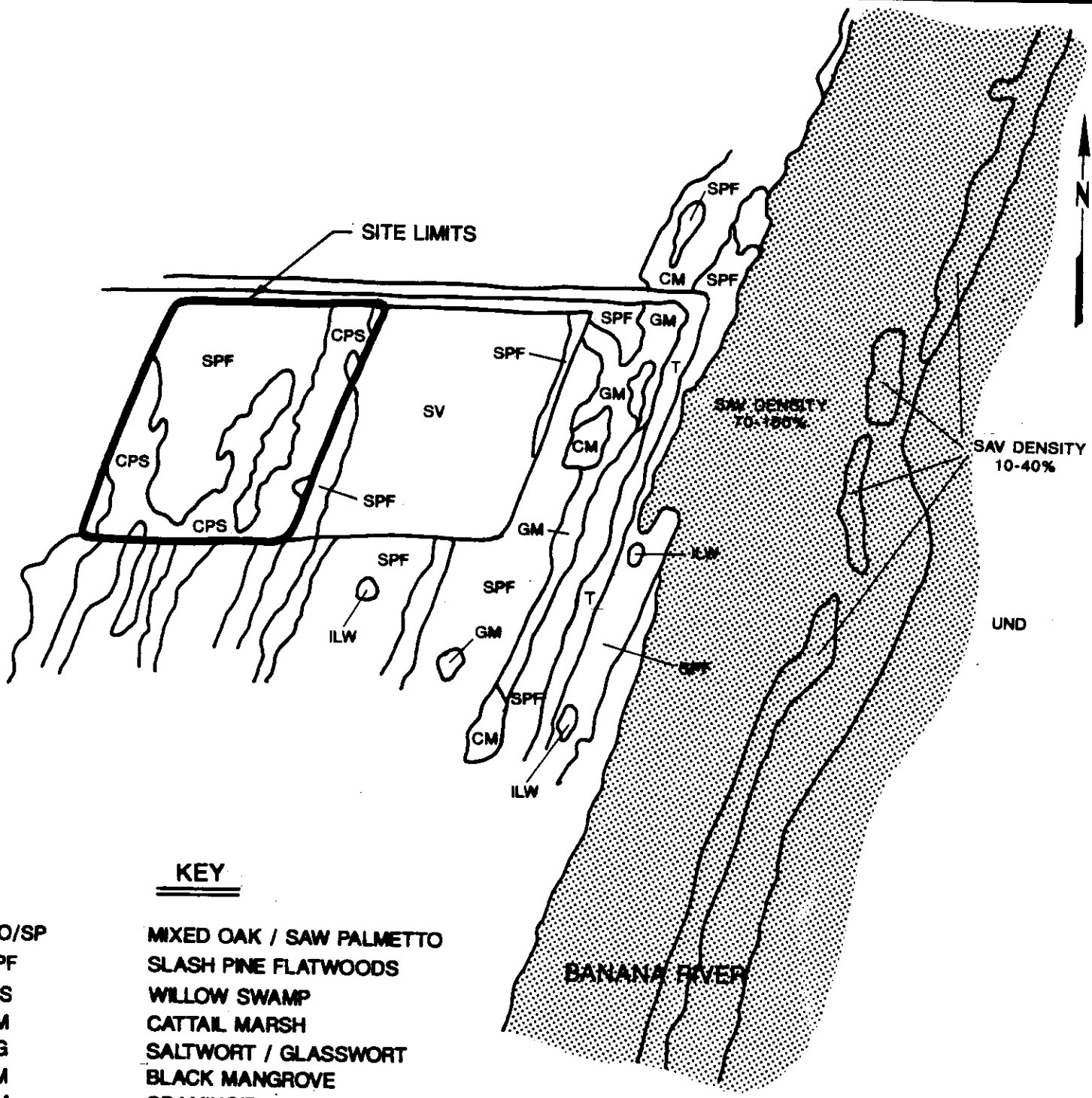
KEY

MO/SP	MIXED OAK / SAW PALMETTO
SPF	SLASH PINE FLATWOODS
WS	WILLOW SWAMP
CM	CATTAIL MARSH
SG	SALTWORT / GLASSWORT
BM	BLACK MANGROVE
GM	GRAMINOID MARSH
CPS	CABBAGE PALM SAVANNA
WM/BP	WAX MYRTLE / BRAZILIAN PEPPER
R	RUDERAL
SV	SPOIL VEGETATION
D	DIKES
IW	IMPOUNDED WATERS
SAV	SUBMERGED AQUATIC VEGETATION
UND	(SAV) DENSITY - UNDISCERNABLE
L	LAGOON (SAV DENSITY - 0 - 10%)
T	TRANSPORTATION
ILW	INLAND WATERS

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
SITE 3A - VEGETATION / SEAGRASS MAP

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD	JTW	90379	PLATE B - 3
DATE 4/12/91	SCALE 1" = 1000'	APPROVED JTW	FILE NO.	SHEET 2 OF 5



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R	RUDERAL
SV	SPOIL VEGETATION
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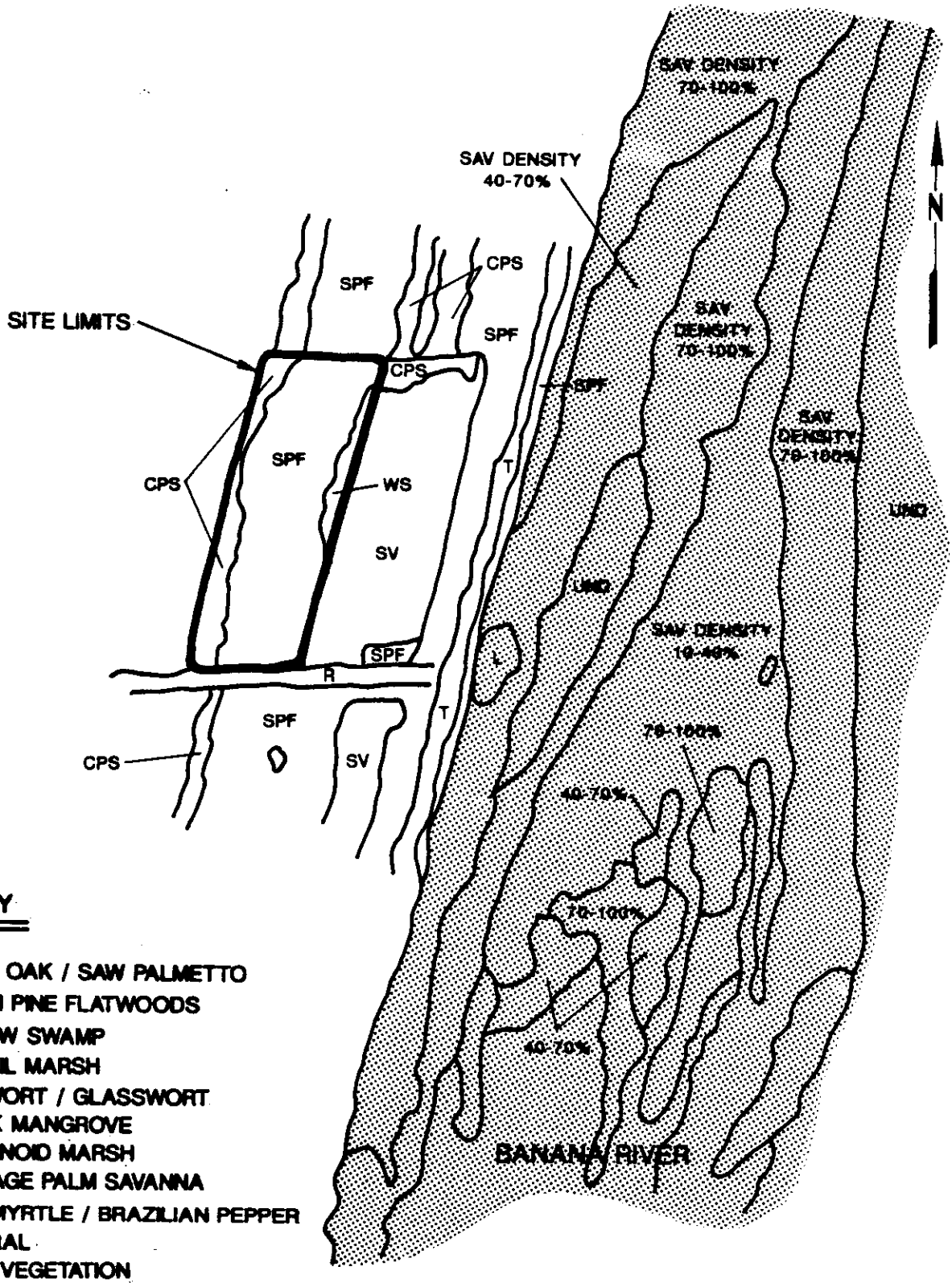
UND	(SAV) DENSITY - UNDISCERNABLE
L	LAGOON (SAV DENSITY - 0 - 10%)
T	TRANSPORTATION
LW	INLAND WATERS

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
SITE 4 - VEGETATION / SEAGRASS MAP

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PTK	RAD	JTW	90379	PLATE B - 4
DATE 4/12/91	SCALE 1" = 1000'	APPROVED JTW	FILE NO.	SHEET 3 OF 5



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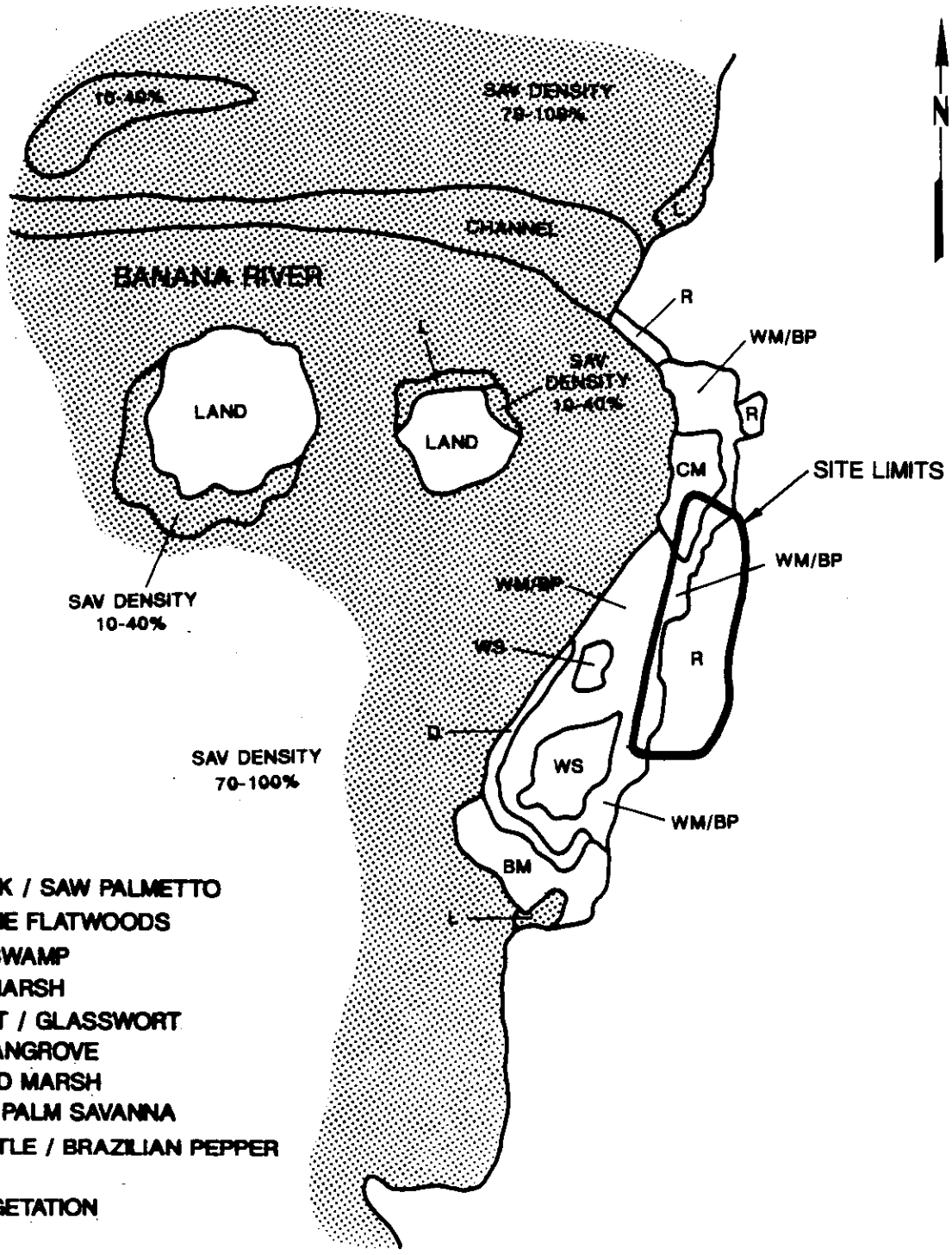
ILW	INLAND WATERS

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
SITE 5 - VEGETATION / SEAGRASS MAP

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD	JTW	90379	PLATE B - 5
DATE 4/12/91	SCALE 1"=1000'	APPROVED JTW	FILE NO.	SHEET 4 OF 5



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GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
SITE 6A -VEGETATION / SEAGRASS MAP

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD	JTW	90379	PLATE B - 6
DATE 4/12/91	SCALE 1"=1000'	APPROVED	FILE NO.	SHEET 5 OF 5

h. Radioactivity

Construction - no impact, potential or anticipated, is expected from the construction activities at the proposed sites.

Operation - no impact, potential or anticipated, is expected from the general operational activities at the proposed sites.

i. Archaeology

Construction - as noted by the enclosed correspondence (with regard to archaeological sites which may occur in the study area), the only known archaeological site in the study area appears to be Pepper Hammock (see Attachment). All proposed spoil disposal sites are located a significant distance from Pepper Hammock. Therefore, there is no potential or anticipated impact from construction activities to the archaeological resources in the study area.

Operation - no potential or anticipated impacts from the general operations of the proposed sites will impact the archaeological resources of the area.

j. "Listed" Species

Construction - there is moderate potential for impact to "listed" species with little impact anticipated during construction activities. As previously stated, potential spoil disposal sites in the northern fringe areas of Merritt Island National Wildlife Refuge were eliminated from further consideration due to actual sitings of "listed" species. No "listed" species were observed on any of the proposed sites; however, they are reported to be in the general area of the refuge. The anticipated impacts may include loss of habitat and territorial problems with displaced species. Most likely candidates for disturbance to existing population patterns may include gopher tortoise, scrub jay, indigo snakes, bald eagles, ospreys, colonial nesting birds and manatees in receiving waters. Plate B-7 indicates the location of an eagle's nest in the study area; however, out of the range of all proposed spoil sites.

AVOID VERBAL ORDERS

DATE: August 28, 1990

TO: LSO-142/D. Black

FROM: DF-EMS/M. Busacca

SUBJECT: Information for Spoil Site Study Contract

In regard to the Archaeologic sites which may occur in the subject study are, the only known site, north of Schwartz Road is in Pepper Hammock (see attached map). Based on a recent study, the hammock type habitat is the only type in the study area likely to contain archaeological sites. Therefore, these habitats should be considered not viable for spoil disposal. It is unlikely that there are any other sites in the study area below Schwartz Road as there are no hammocks in the area.

If you have any questions, please call me.

Mario Busacca ex. 7-4049

315980

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATION COMPANY
BANANA RIVER DREDGING SPOIL SITE
ENVIRONMENTAL ASSESSMENT
EAGLES' NEST LOCATIONS

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
FJK	RAD	JTW	90379	PLATE B - 7
DATE 4/12/91	SCALE 1:50,000	APPROVED JSC	FILE NO.	SHEET 1 OF 1

Operation - no potential or anticipated impact is expected on "listed" species from operational activities. Any impacts would be during the construction phase. Manatee awareness, including education to operators, logging of sitings and shutdowns, if necessary, will be considered. However, this is more an issue for channel maintenance dredging than spoil sites operations.

k. Wetlands

Construction - there will be moderate potential impact and moderate anticipated impact during construction activities to wetlands. Total cumulative wetlands at the proposed sites, as previously mentioned, is approximately 83 acres. Significant portions of these wetlands are marginal quality, including cattails and willowheads. Other areas include graminoid grasses, as well as cabbage palm savanna. Refer to (g.) Biotic Resources for more detail.

Operation - there will be no potential for impact or anticipated impact as a result of operations at the site. Any impacts would be during the construction phase.

l. Socioeconomic

Construction - no socioeconomic potential or anticipated impact is expected during construction activities at the proposed sites.

Operation - no potential or anticipated impact to socioeconomic activities is expected during operations at the proposed sites.

2. Actions to Eliminate Effects

As discussed in the previous section, "moderate" construction impacts are anticipated for wetlands and biotic resources with "little" impact anticipated for "listed" species and surface water. Operational impacts are negligible except for "little" impact anticipated on surface water.

The following is a breakdown by environmental category with proposed action to eliminate effects:

- Surface water - during construction, particularly of Sites 2C and 3A (former mosquito control impoundment areas), any culverts, control structures, etc., identified will be closed off so that any internal surface waters impacted by construction activities be detained. During operations control structures will be regulated so that decant effluent water will meet OFW's ambient discharge standards with appropriate retention times maintained. This will be done based on actual settleability "bench-scale" testing of actual dredge spoil material as well as up-to-date measurements on ambient water quality conditions particularly turbidity expressed as NTU's in the Banana River.

- Biotic Resources - there is moderate impact anticipated during construction activities. There are presently no legislated regulatory programs for uplands; however, there are requirements for wetlands and "listed" species. These will be discussed as follows:
  - "Listed" species - there is little impact anticipated from construction activities on "listed" species. None have been observed on any of the sites; however, certain fauna may be displaced. If nesting or burrowing activities are observed during surveys on the sites, efforts can be made for relocation in accordance with regulatory requirements.

  - Wetlands - there is moderate impact expected from construction activities of the proposed spoil disposal sites. A cumulative total of approximately 83 acres of fair to good quality isolated wetlands are expected to be impacted by this project. These wetlands can be mitigated if required during the permitting process. Wetlands of equal or greater value at appropriate

ratios required by the regulatory agencies could be negotiated during the permitting process.

3. Alternatives to Action Proposed

There are alternatives to the proposed action, namely: (1) no action, (2) utilization of spoil islands, and (3) ocean disposal. The following is a discussion of each.

(1) No Action - this is not an option. The Banana River channel receives approximately .2 ft. of accumulated deposition per year. It requires maintenance dredging in support of the Shuttle Program approximately every 5 to 7 years. Spoil disposal facilities are required in support of maintenance dredging.

(2) Spoil Islands - because of proximity to surface waters and the presence of sensitive wildlife and biotic resources, the development or expansion of spoil islands was not considered a viable option.

(3) Ocean Disposal - not considered due to the cost-prohibitive nature of barging dredge spoil material out to sea. This alternative would result in significant financial hardship as well as additional environmental impacts to the ocean environments.

4. Lack of EIS Required

There are identified moderate impacts anticipated on biotic resources and wetlands as well as little impacts anticipated on "listed" species and surface water. There are actions to eliminate and mitigate these effects. The overall EA shows a "finding of no significant impact". The project should proceed to more detailed engineering and preapplication permitting discussions with the regulatory community.

PHASE III

PRELIMINARY ENGINEERING

SELECTED SITES

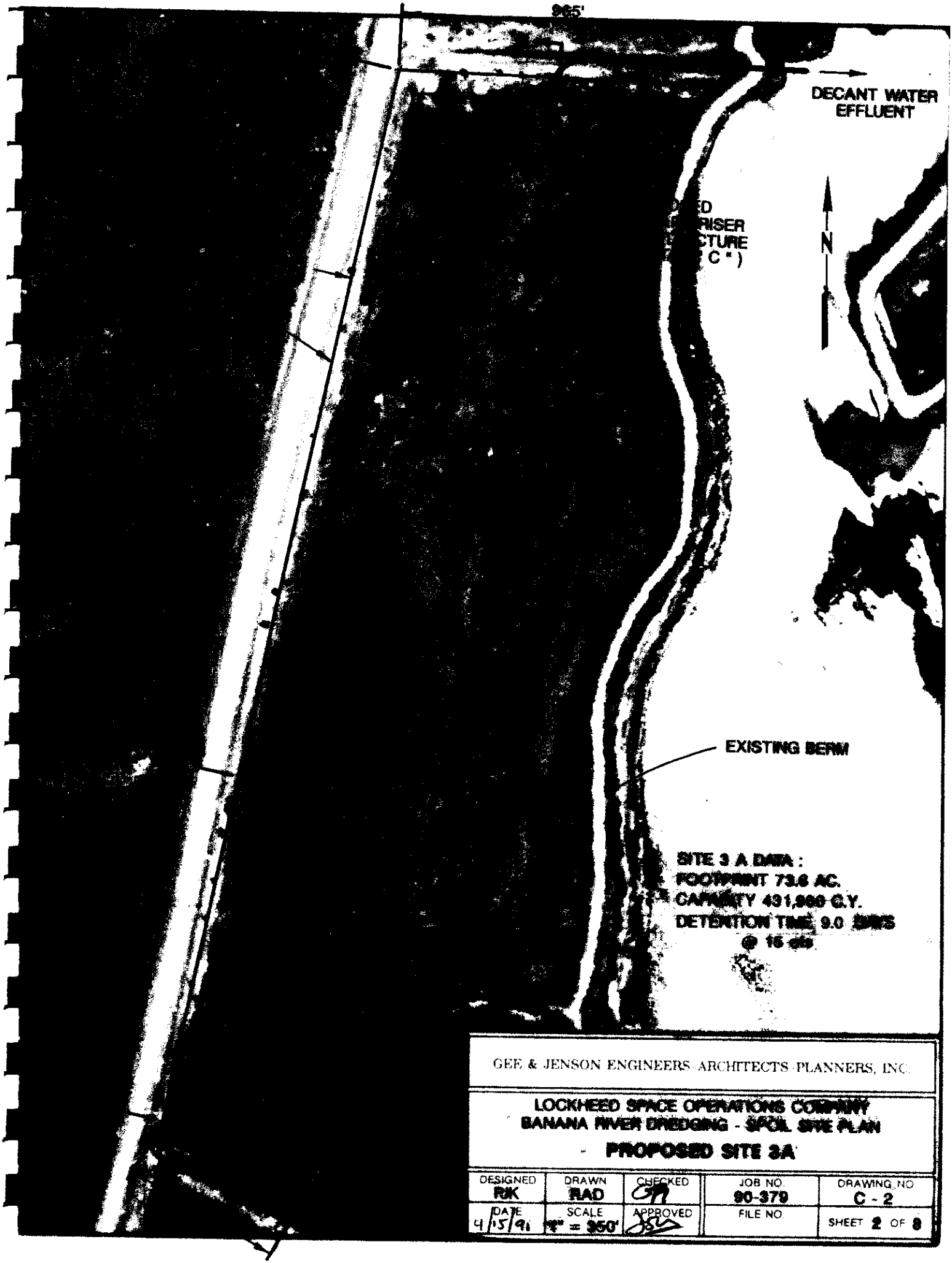
III-A - PLAN VIEW SKETCHES OF SPOIL DISPOSAL SITES

GEE & JENSON ENGINEERS ARCHITECTS-PLANNERS, INC

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE PLAN

PROPOSED SITE 2C

DESIGNED	DRAWN	CHECKED	JOB NO	DRAWING NO
RJK	RAD	CM	90-379	C - 1
DATE 4/12/91	SCALE 1" = 350'	APPROVED	FILE NO	SHEET 1 OF 8



GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE PLAN

PROPOSED SITE 3A

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
RJK	RAD		90-379	C - 2
DATE 4/15/91	SCALE 1" = 350'	APPROVED	FILE NO.	SHEET 2 OF 8

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE PLAN

PROPOSED SITE 4 - EXPANSION

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
RJK	RAD	GF	90-379	C - 3
DATE	SCALE	APPROVED	FILE NO.	SHEET 3 OF 8
4/15/91	1" = 350'	JSA		

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE PLAN

PROPOSED SITE 5 - EXPANSION

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD	CM	90-379	C - 4
DATE 4/12/91	SCALE 1" = 300'	APPROVED	FILE NO.	SHEET 4 OF 8

GILL & JENSEN ENGINEERS ARCHITECTS PLANNERS INC

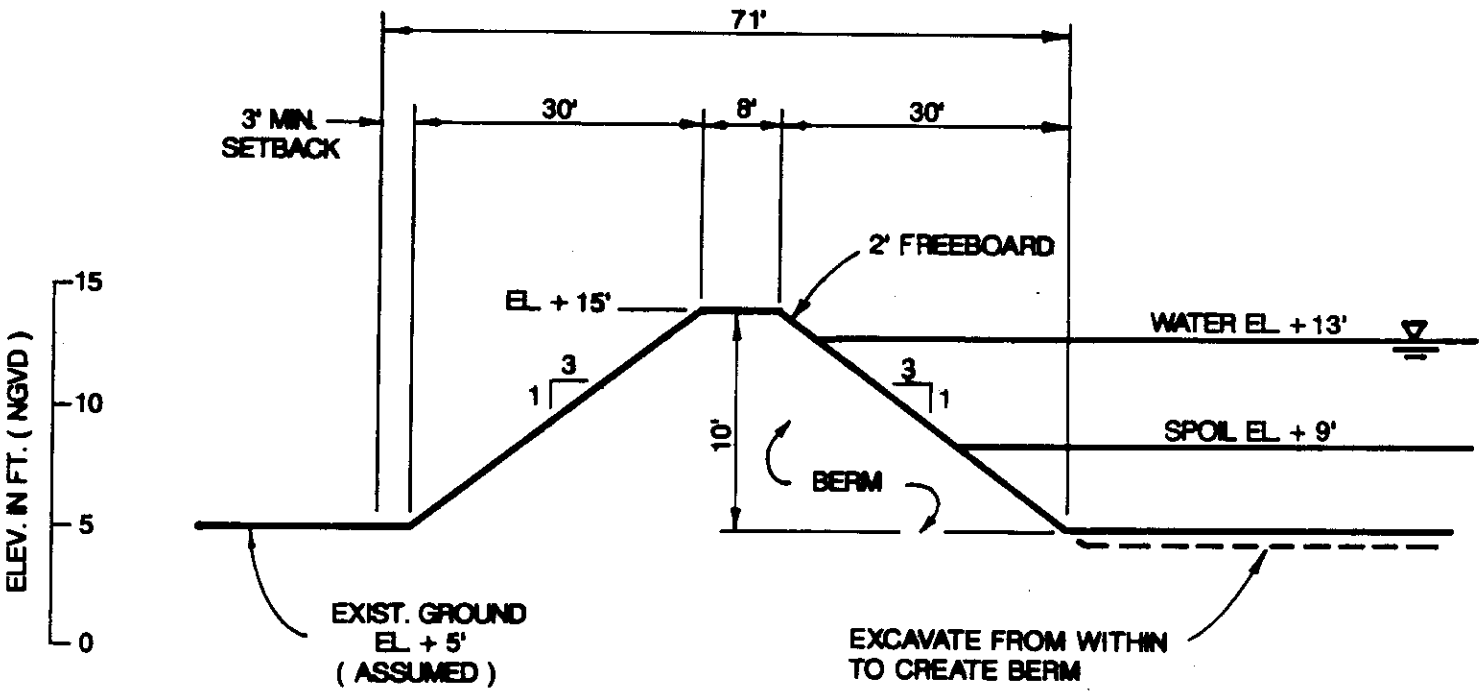
LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE PLAN

PROPOSED SITE 6A

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
PJK	RAD		90-379	C - 5
DATE	SCALE	APPROVED	FILE NO.	SHEET 5 OF 8
	1" = 350'			

III-B - TYPICAL CROSS SECTIONS AND DETAILS

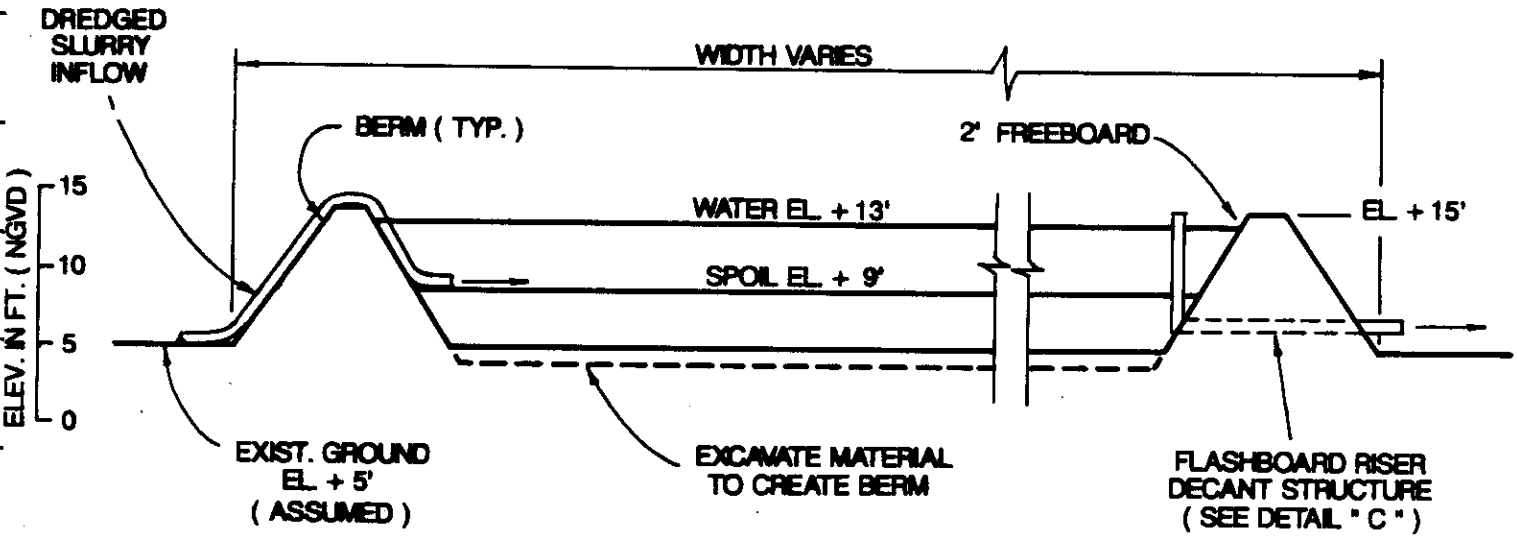
315980



TYPICAL SECTION A - A

HORIZ SCALE
0 20
FEET

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.				
LOCKHEED SPACE OPERATIONS COMPANY BANANA RIVER DREDGING - SPOIL SITE DETAILS **TYPICAL SECTION A - A**				
DESIGNED RJK	DRAWN RAD	CHECKED GJJ	JOB NO. 90-379	DRAWING NO. C - 6
DATE 4/12/91	SCALE SHOWN	APPROVED JJ	FILE NO.	SHEET 6 OF 8



TYPICAL SECTION B - B

HORIZ. SCALE

0 60

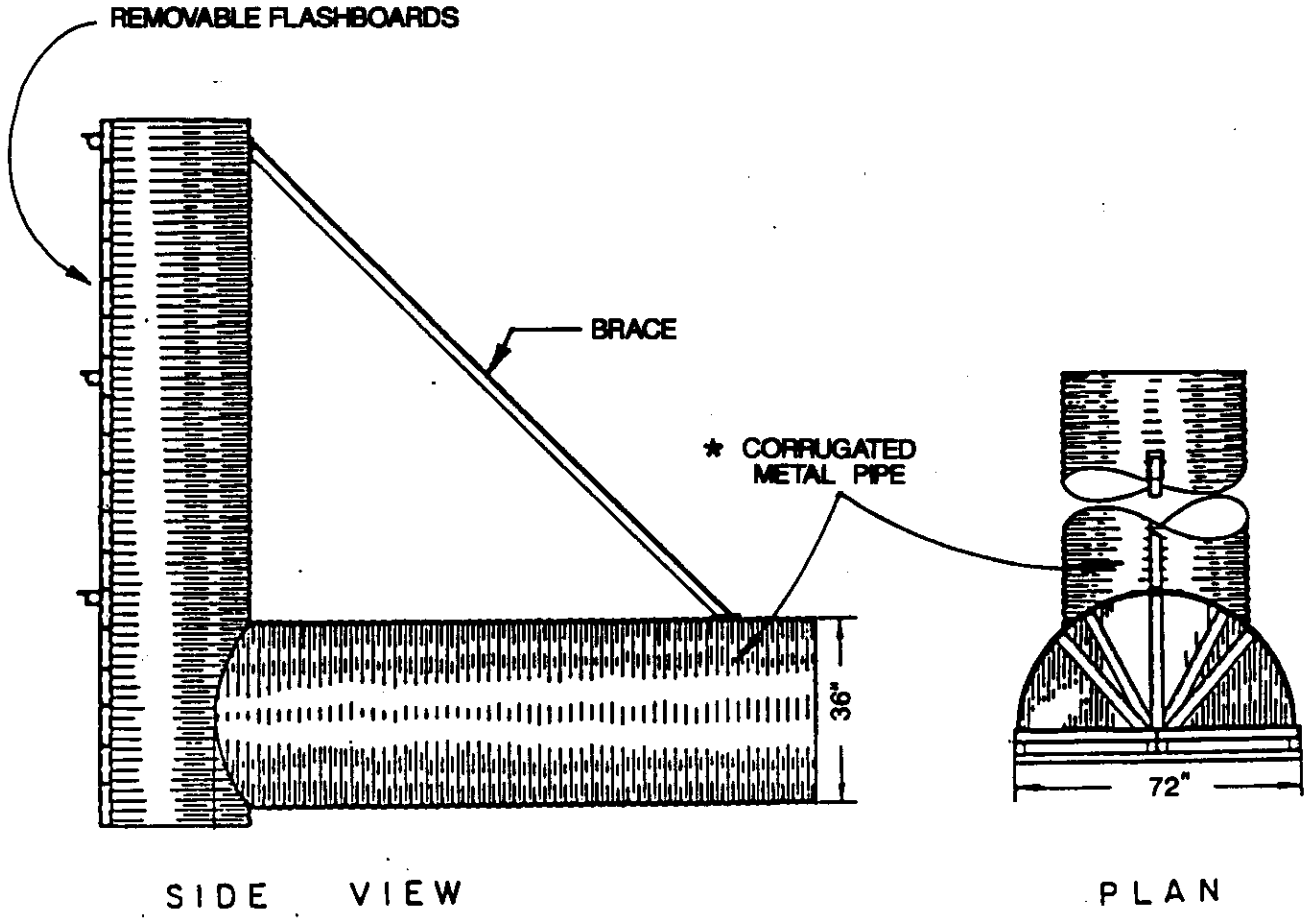
FEET

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE DETAILS

TYPICAL SECTION B - B

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
RJK	RAD	DJ	90-379	C - 7
DATE 4/12/91	SCALE SHOWN	APPROVED	FILE NO.	SHEET 7 OF 8



FLASHBOARD RISER DECANT STRUCTURE

DETAIL " C "

N.T.S.

* COLD TAR EPOXY COATED IF REQUIRED

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING - SPOIL SITE DETAILS
DETAIL " C "

DESIGNED	DRAWN	CHECKED	JOB NO.	DRAWING NO.
RJK	RAD	GP	90-379	C - 8
DATE 4/12/91	SCALE SHOWN	APPROVED	FILE NO.	SHEET 8 OF 8

III-C - SUPPORTING PRELIMINARY ENGINEERING COMPUTATIONS

TABLE C-1

COMPUTATION OF SPOIL SITE CAPACITIES AND DETENTION TIMES.

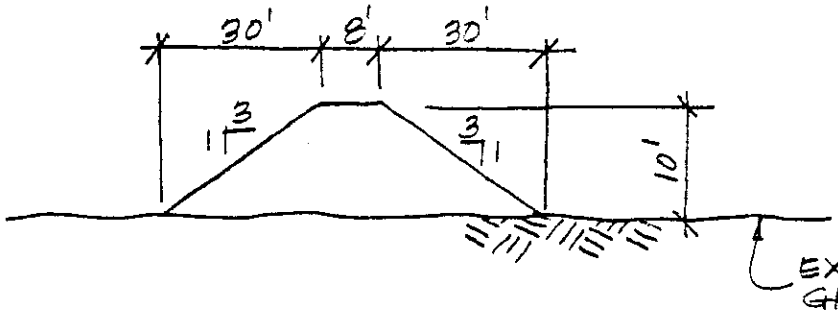
5 SITES

SITE AREAS (DIGITIZED FROM 1" = 350' AERIALS)

SITE	AREA * (AC.)	AVG LENGTH * (FT.)	AVG. WIDTH * (FT.)
2C	29.1	2,450	517
3A	73.6	3,030	1,041
4	55.5	1,770	1,366
5	31.8	1,925	720
6A	14.5	1,505	420
TOTAL	204.5		

* INCLUDES FOOTPRINT OF SPOIL CONTAINMENT BERM

BERMS (EXISTING AND PROPOSED)

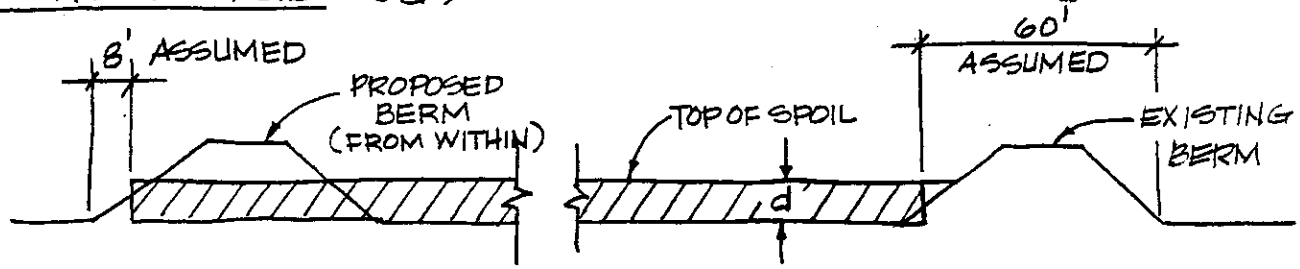


BERM MATERIAL PUSHED UP FROM WITHIN SPOIL SITE.

REQUIRED SITE CAPACITIES

SITE	PROPORTION (BY AREA)	X	TOTAL VOLUME	=	REQ'D SITE CAPACITY
2C	29.1/204.5		1,200,000 C.Y.		170,758 C.Y.
3A	73.6/204.5				431,899 C.Y.
4	55.5/204.5				325,672 C.Y.
5	31.8/204.5				186,601 C.Y.
6A	14.5/204.5				85,086 C.Y.
					1,200,000 C.Y.

DEPTH OF SPOIL (d)



USED FOR CAPACITY COMPUTATION

SITE	FOOTPRINT DIMENSIONS L (FT)	FOOTPRINT DIMENSIONS W (FT)	CAPACITY COMP. DIMENSIONS L (FT)	CAPACITY COMP. DIMENSIONS W (FT)	CAPACITY COMP. AREA (FT^2)
2C	2,450	517	2,434	449	1,092,866 ✓
3A	3,080	1,041	3,064	973	2,981,272 ✓
4	1,770	1,366	1,754	1,298	2,276,692 ✓
5	1,925	720	1,909	652	1,244,668 ✓
6A	1,505	420	1,489	404	601,556 ✓

	VOLUME (CY)	× 27 = (FT^3)	÷ AREA (FT^2)	= DEPTH OF SPOIL (FT)
2C	170,758	4,610,466 ✓	1,092,866	4.2 ✓
3A	431,883	11,660,841 ✓	2,981,272	3.9 ✓
4	325,672	8,793,144 ✓	2,276,692	3.9 ✓
5	186,601	5,038,227 ✓	1,244,668	4.0 ✓
6A	85,086	2,297,322 ✓	601,556	3.8 ✓

MIN. WATER DEPTH (AT CAPACITY)

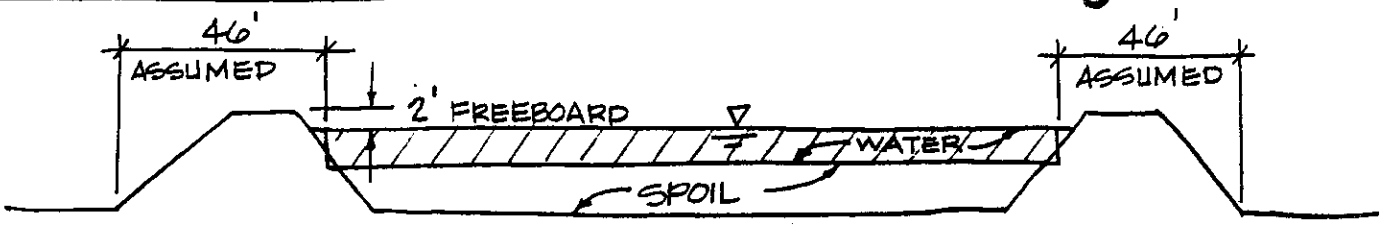
SITE	BERM HEIGHT	− FREEBOARD	− SPOIL DEPTH	= WATER DEPTH
2C	10 FT.	2 FT.	4.2	3.8 ✓
3A	↓	↓	3.9	4.1 ✓
4			3.9	4.1 ✓
5			4.0	4.0 ✓
6A			3.8	4.2 ✓

GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLA.

SUBJECT KSC DREDGE SPOIL SITES

SHEET NO. 3 OF 4
JOB NO. 90379
BY GFI DATE 10-18-90
CHK JAS DATE 11-7-90
APV JS DATE 11/7/90

DETENTION TIMES



▨ USED FOR DETENTION TIME COMP.

46 + 46 = 92'

SITE	FOOTPRINT DIMENSIONS L (FT)	FOOTPRINT DIMENSIONS W (FT)	DETENTION COMP. DIMENSIONS L (FT)	DETENTION COMP. DIMENSIONS W (FT)	DETENTION COMP. AREA (FT²)
2C	2,450	517	2,358	425	1,002,150 -
3A	3,080	1,041	2,988	949	2,835,612 -
4	1,770	1,366	1,678	1,274	2,137,772 -
5	1,925	720	1,833	628	1,151,124 -
6A	1,505	420	1,413	328	463,464 -

	AREA (FT²)	× DEPTH (FT)	÷ INFLOW RATE (FT³/S)	= DETENTION TIME (SEC)	÷86,400 = (DAYS)
2C	1,002,150	3.8	15	253,878	2.94 -
3A	2,835,612	4.1	↓	775,067	8.97 -
4	2,137,772	4.1		584,324	6.76 -
5	1,151,124	4.0		306,966	3.55 -
6A	463,464	4.2	↓	129,770	1.50 -

GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLA.

SUBJECT KSC
DREDGE SPOIL SITES

SHEET NO. 4 OF 4
JOB NO. 90379
BY GG DATE 10-18-90
CHK JKA DATE 11-7-90
APV [signature] DATE 11/[illegible]

SUMMARY

SITE	FOOTPRINT AREA (AC)	BERM HEIGHT (FT)	SPOIL DEPTH (FT)	SPOIL CAPACITY (CY)	DETENTION TIME @ 15 cfs (DAYS)
2C	29.1	10	4	170,800	2.9
3A	73.6	10	5	431,900	9.0
4	55.5	10	5	325,700	6.8
5	31.8	10	5	186,600	3.6
6A	14.5	10	5	85,000	1.5
	204.5			1,200,000	

GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.
WEST PALM BEACH, FLA.

SUBJECT KSC
DREDGE SPOIL SITES

SHEET NO. 1 OF 1
JOB NO. 90379
BY GFT DATE 10-18-90
CHK AKL DATE 11-7-90
APV JSG DATE 11/7/90

SPOIL SITES CONSTRUCTION COST ESTIMATES

COSTS

CLEAR & GRUB — $250 (MOB/DEMOB) PER SITE + $900 / ACRE

DIKES — $250 (MOB/DEMOB) PER SITE + $4 / C.Y.

RISERS — $800 EACH

SITE	AREA (AC)	LENGTH NEW DIKES (FT)	VOL. NEW DIKES (C.Y.)	CLEAR & GRUB ($)	DIKES ($)	RISERS ($)	TOTAL ($)
2C	29.1	3,175	44,685	26,440	178,990	800	206,230
3A	73.6	4,620	65,022	66,490	260,338	800	327,628
4	55.5	4,500	63,333	50,200	253,582	800	304,582
5	31.8	3,365	47,359	28,870	189,686	800	219,356
6A	14.5	3,850	54,185	13,300	216,995	800	231,090

$1,288,886

CONTINGENCY X 1.15 = $1,482,219

SAY $1.5 MILLION

III-D - PRELIMINARY ENGINEERING REPORT

D. Preliminary Engineering Report

Data Summary

Preliminary calculations show that the proposed specified aerial coverage (204.5 acres) for the spoil disposal facilities is adequate. The retention ponds could be used to store the estimated 1.2 million cubic yards of dredged material with an average retention time of 4.8 days for the decant water effluent. Depth of solids will be 4 feet in each basin. The remaining capacity will be for retention of water with 2 ft. of freeboard. About 1 ft. or less of excavation will be required on the average site for construction of berms.

Settling information for previous dredging projects at this site were not available for determination of optimum retention time in the dredge spoil basins. Partial information on settling times for similar sites was available. These reports indicate possible excessive settling times for the dredged material. Based on lack of information, we recommend that the dredge spoil material be subjected to a laboratory "bench-scale" settleability test so that the minimum detention time for the basins can be refined. The basins can then be decanted as water quality discharge criteria allows.

As the (OFW) designation for this area requires stringent criteria to be met, namely ambient conditions in the river for turbidity, a "mixing zone variance" may need to be applied for from FDER.

The OFW discharge standard will be ambient river turbidity. This test should be run during the "bench-scale" settleability work to determine over time when this condition is met. Existing data indicates average river turbidity to be 4 JTU's. Baseline river samples should be run for turbidity expressed as NTU's to confirm this number.

Borings Results

Results of the soil borings indicate that soils at each site will be suitable material for dike construction.

Cost Estimates

It is estimated that 19,510 ft. of new berm construction will be required. Costs to be considered are clearing/grubbing, dikes and risers. Total cost is estimated at $1,500,000 or $1.25 per cu.yd. of dredge material.

Recommendations

Summary of recommendations include:

1. Settleability "bench testing" for establishing minimum retention times required based on turbidity as NTU's. Baseline ambient river testing for turbidity.

2. Consideration of applying for "mixing zone" variance to the Dept. of Environmental Regulation in Tallahassee considering the OFW discharge standard of ambient river levels for turbidity.

3. Permits will need to be acquired from the DER/COE and the SJRWMD. The former for dredge/fill and water quality; the latter for water management.

4. On-site survey or control photographs for more accurate dimensions and engineering.

REFERENCES

REFERENCES

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3. Engineering Development Directorate. 1986. Environmental Resources Document. NASA, Kennedy Space Center, Florida.

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5. National Flood Insurance Program, 1989. Flood Insurance Rate Map, Brevard County, Florida. Federal Emergency Management Agency.

6. Soil Conservation Service, 1974. Soil Survey of Brevard County, Florida. U.S. Dept. of Agriculture.

7. United States Dept. of the Interior Geological Survey, 1976. False Cape, Orsino, Cape Canaveral, Courtenay. Brevard County, Florida.

Agencies and individuals consulted:

Tom Smith - Lockheed Space Operations Company
Denise Black - Lockheed Space Operations Company
Mario Busacca - NASA/KSC
Andreas Goetzfried - EG&G, Florida Inc.

Document prepared by:

Gee & Jenson Engineers-Architects-Planners, Inc.
Peter J. Krinsky, C.E.P.
John S. Yeend, P.E.

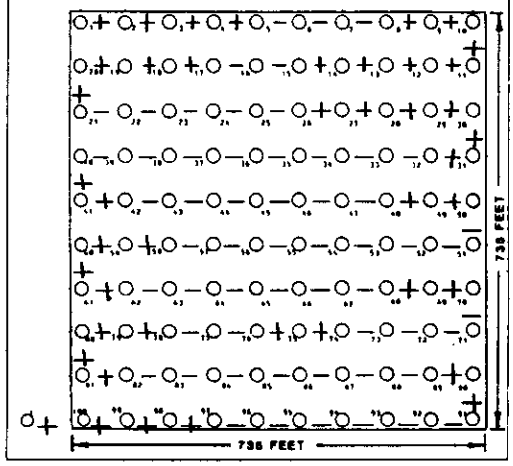
APPENDICES

APPENDIX A

SIMPLIFIED HABITAT EVALUATION (S.H.E.) ANALYSIS SHEETS

SHE Data Analysis Sheet.

PHOTO ID.	1A
# FEATURES	3
# RUNS	22
SIMPLIFIED INDEX	66



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
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90-379

SHE Data Analysis Sheet.

PHOTO ID.	18
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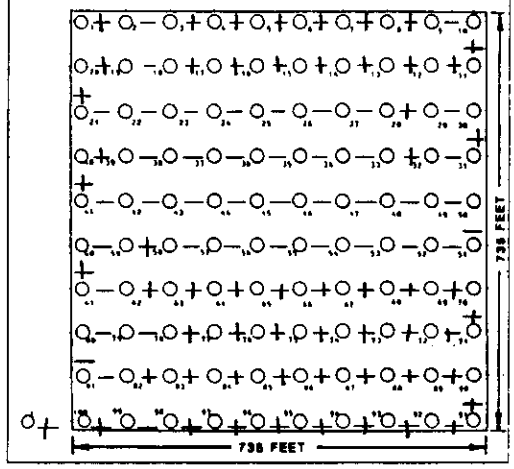

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
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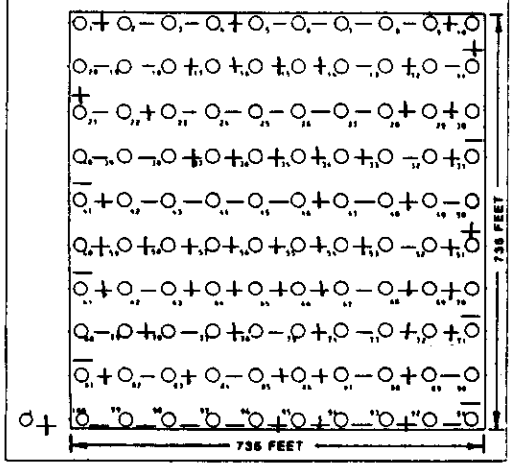
90-379

SHE Data Analysis Sheet.

PHOTO ID.	2A
# FEATURES	4
# RUNS	56
SIMPLIFIED INDEX	224



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

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90-379

SHE Data Analysis Sheet.

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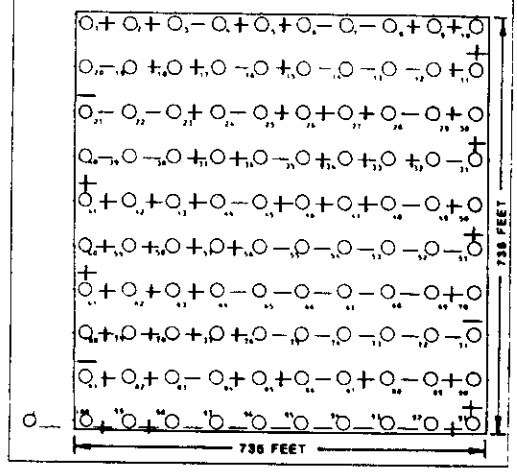

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	2C
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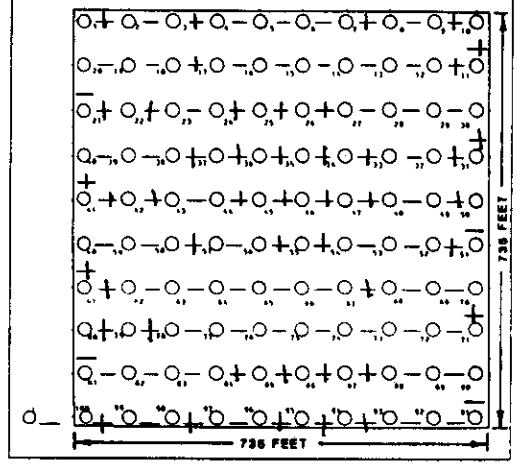
SIMPLIFIED INDEX	184



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

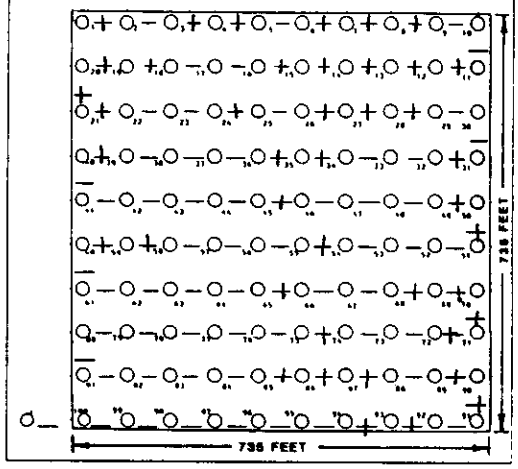
SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	3A
# FEATURES	3
# RUNS	40
SIMPLIFIED INDEX	120



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

SHE Data Analysis Sheet.

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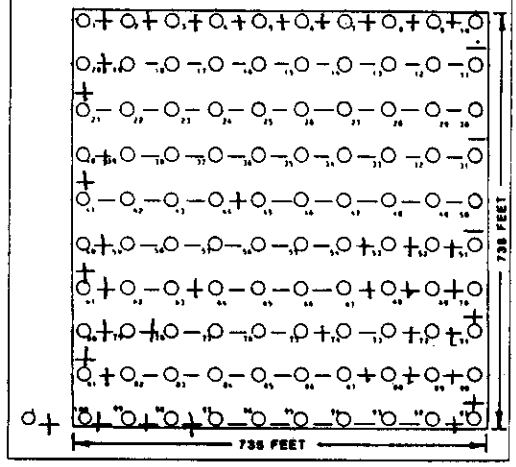

LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID	3C
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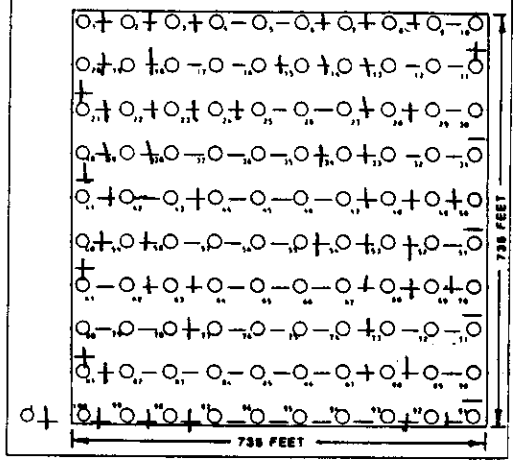
# RUNS	38
SIMPLIFIED INDEX	114



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

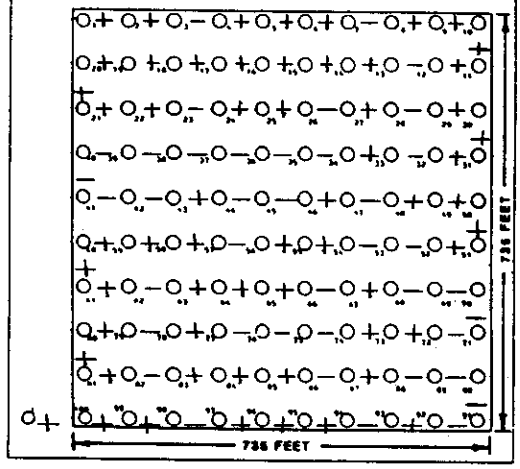
SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	4
# FEATURES	3
# RUNS	45
SIMPLIFIED INDEX	135



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

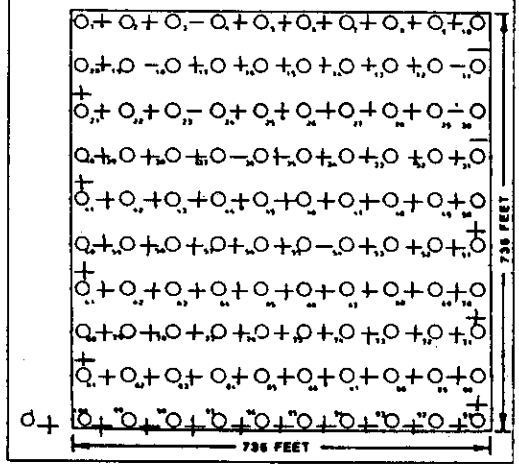
SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	5
# FEATURES	3
# RUNS	15
SIMPLIFIED INDEX	45



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

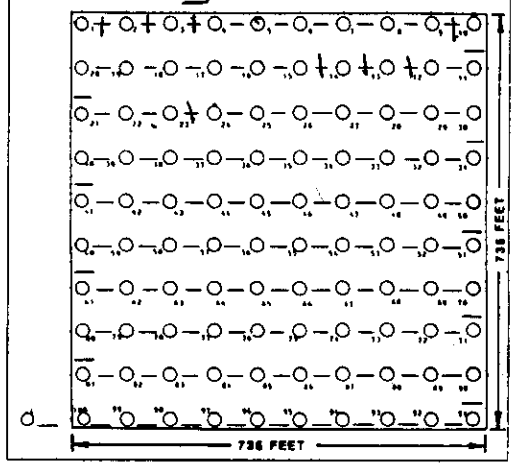
SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	6A
# FEATURES	2
# RUNS	8
SIMPLIFIED INDEX	16



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

SHE Data Analysis Sheet.

PHOTO ID.	6B
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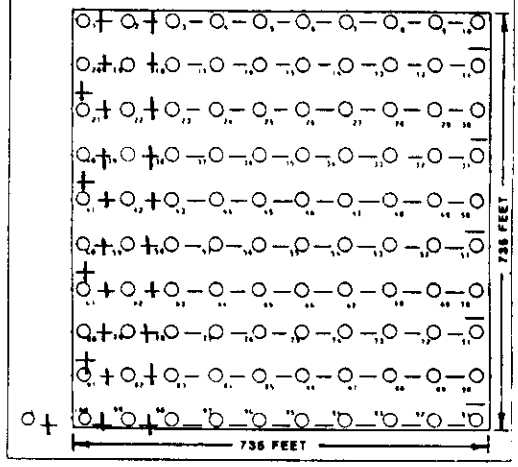
# RUNS	10
SIMPLIFIED INDEX	20



LOCKHEED SPACE OPERATIONS COMPANY
BANANA RIVER DREDGING
SPOIL SITE ENVIRONMENTAL ASSESSMENT
PHASE 1
ALTERNATIVE SITE ANALYSIS

SIMPLIFIED HABITAT EVALUATION

GEE & JENSON
Engineers-Architects-
Planners, Inc.

90-379

APPENDIX B

BORING LOGS

Soil Borings for Banana River
Dredging/Spoil Sites Environmental Assessment
Lockheed Space Operations Company
Kennedy Space Center, Florida

Ardaman & Associates, Inc.

OFFICES

Orlando, 8008 S. Orange Avenue, Orlando, Florida 32859-3003, Phone (407) 855-3860
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Cocoa, 1300 N. Cocoa Blvd., Cocoa, Florida 32924, Phone (407) 632-2503
Fort Myers, 2508 Rockfill Road, Fort Myers, Florida 33916, Phone (813) 337-1288
Miami, 2608 W. 84th Street, Hialeah, Florida 33016, Phone (305) 825-2683
Port St. Lucie, 1017 S.E. Holbrook Ct., Port St. Lucie, Florida 34985, Phone (407) 337-1200
Sarasota, 2500 Bee Ridge Road, Sarasota, Florida 34277, Phone (813) 922-3526
Tallahassee, 3175 West Tharpe Street, Tallahassee, Florida 32303, Phone (904) 576-6131
Tampa, 105 N. Faulkenburg Road, Suite D, Brandon, Florida 34299-1506, Phone (813) 654-2336
West Palm Beach, 2511 Westgate Avenue, Suite 10, West Palm Beach, Florida 33409, Phone (407) 687-8200

MEMBERS:
American Concrete Institute
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American Consulting Engineers Council
Association of Soil and Foundation Engineers
Florida Institute of Consulting Engineers
American Council of Independent Laboratories

Ardaman & Associates, Inc.

Consultants in Soils, Foundations and Materials Testing

October 19, 1990
File Number 90-146

Gee & Jenson
One Harvard Circle
West Palm Beach, Florida 33409-1923

Attention: Mr. Peter Krinsky

Subject: Soil Borings for Banana River Dredging/Spoil Sites Environmental Assessment, Lockheed Space Operations Company, Kennedy Space Center, Florida

Gentlemen:

As requested, we have completed 10 soil borings for the above subject project. The borings were located in the field according to approximate locations which were pointed out to our drill crew by Mr. Tom Smith of Lockheed. The locations were not surveyed or located by tape measurement. The approximate locations of the borings are shown superimposed on the enclosed sketches for Sites 2C, 3A, 4, and 5.

The test borings were drilled between October 10 and October 15, 1990 using a CME 45 rotary drilling rig mounted on an all terrain vehicle. The borings were advanced to a depth of 10.5 feet using the methodology outlined in ASTM D-1586. A summary of this field procedure is included in Appendix A. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed containers for further classification and laboratory testing.

The test borings are presented in the form of test boring logs in Appendix B. The visual classification of the soils according to the Unified Classification System (ASTM D-487) are indicated on the boring logs. The groundwater level at each of the boring locations was measured upon completion of drilling and is indicated on the logs.

The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied. The boring logs do not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations may not become evident until during construction.

We are pleased to be assistance to you on this phase of your project. Please contact us when we may be of further service to you or should you have any questions.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

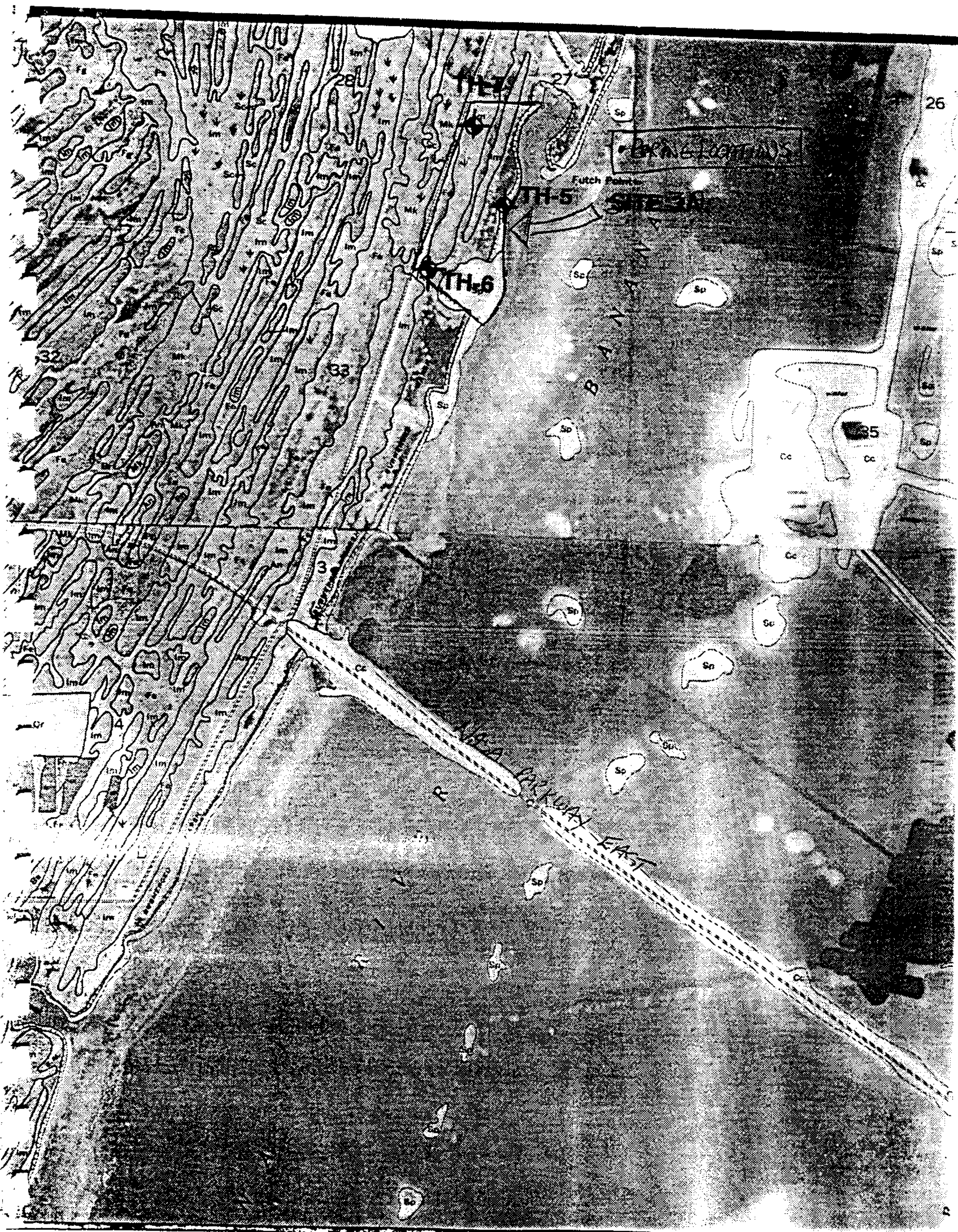
Ashraf H. Riad
Project Engineer

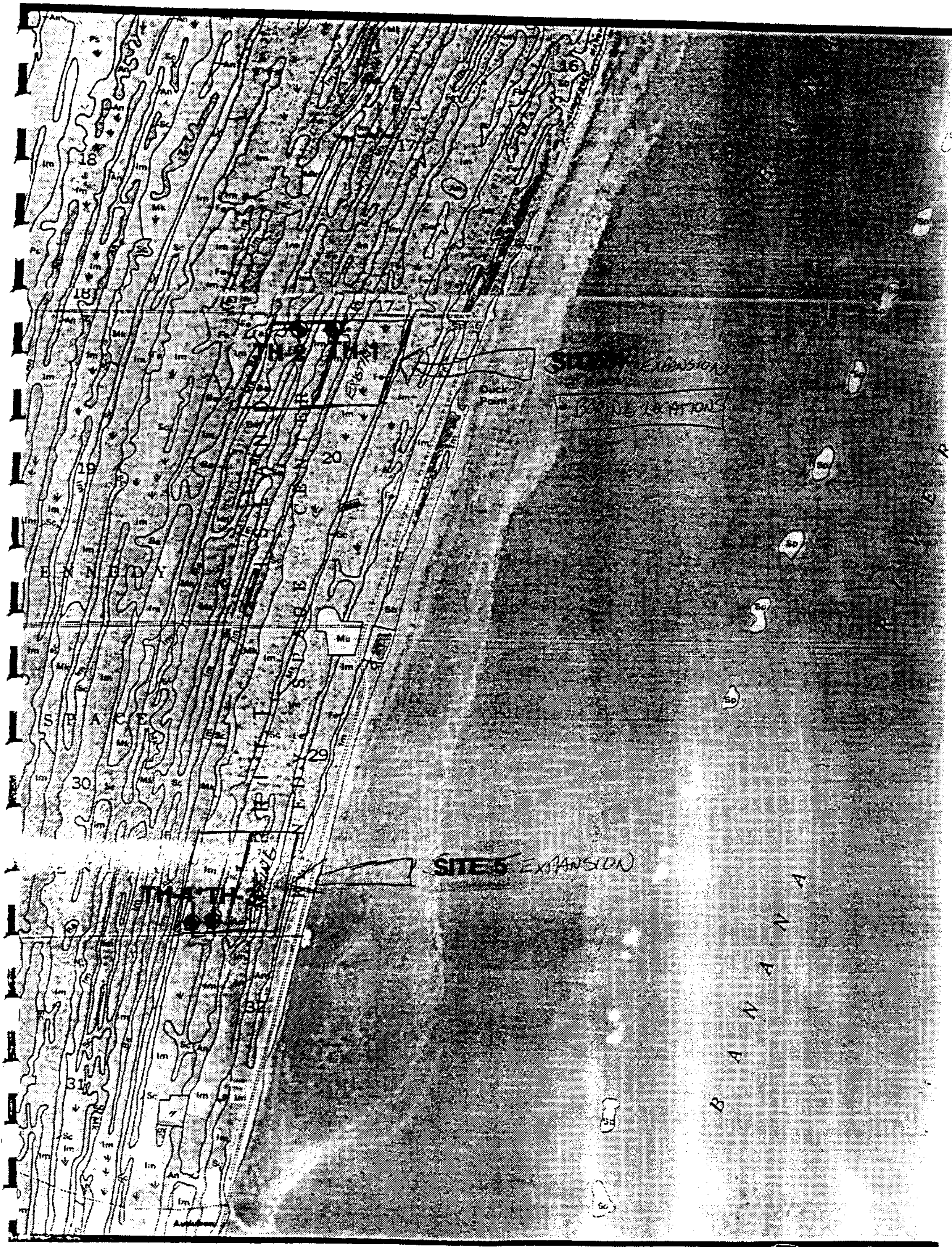
James W. Babcock, P.E.
Senior Project Engineer
Florida Registration No. 28492

JWB:jb/cc

Encl.


Cochran Cove
Broadaxe Point
Pepper Flats
Devils Elbow
Devils Cut
BANANA RIVER
TH-10
TH-9
TH-8
SITE 2
Borrow Location
16
15
22
23
26


TH-5
SITE 3A
TH-6
Futch Point
26
27
28
32
33
35
NASA PARKWAY EAST


TH-2 TH-1
EXPANSION
• BORING LOCATION
Duck Point
SITE 5 EXPANSION
TH-4 TH-3
S P A C E
B A N A N A

Appendix A

STANDARD PENETRATION TEST PROCEDURE

STANDARD PENETRATION TEST

The standard penetration test is a widely accepted method of *in situ* testing of foundation soils (ASTM D-1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or to prevent the loss of circulating fluid.

Representative split-spoon samples from soils at every 5 feet of drilled depth and from every different stratum are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for at least six months prior to being discarded. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.

Appendix B

TEST BORINGS

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-1
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites — FILE NO. 90-146
CLIENT Gee and Jenson / Lockhead Space Operations Company — ELEVATION
BORING LOCATION Site #4 ; 100 feet West of Northwest Corner of existing Dike — BORING TYPE Rotary / SPT
COUNTY Brevard — STATE Florida — CASING TYPE Drilling Mud
DATE STARTED 10/10/1990 — COMPLETED 10/10/1990 — DRILLER/RIG M. Haskett / CME 45
WATER TABLE: 1st depth 5.5' — DATE 10/10/1990 — TIME
WATER TABLE: 2nd depth -- — DATE -- — TIME --
REMARKS

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-1	2	1						Dark Brown Slightly Silty Fine Sand w/ Roots (SP-SM)		
	1-1-2	3	2						Brown Slightly Silty Fine Sand (SP-SM)		
-5 5	5-5-9	14	3								
			3A								
	6-9-11	20	4						Reddish-Brown Silty Fine Sand (SM)		
	8-9-9	18	5								
	6-8-7	15	6						Reddish-Brown Slightly Silty Fine Sand (SP-SM)		
-10 10	5-4-6	10	7								
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-2
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #4 ;≈600 feet West of Northwest Corner of existing Dike
COUNTY Brevard STATE Florida
DATE STARTED 10/10/1990 COMPLETED 10/10/1990
WATER TABLE: 1st depth 5.5' DATE 10/10/1990
WATER TABLE: 2nd depth -- DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-2	3	1						Dark Brown Fine Sand w/ Roots (SP)		
	2-2-4	6	2						Dark Reddish-Brown Slightly Silty Fine Sand w/ Roots (SP-SM)		
	3-2-3	5	3						Yellow Clayey Fine Sand (SC)		
-5 5	8-10-10	20	4						Brown Slightly Silty Fine Sand (SP-SM)		
			4A								
	6-7-10	17	5						Light Gray Fine Sand (SP)		
	7-7-10	17	6								
-10 10	8-7-8	15	7								
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-3
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #5 :±200 feet West of Southwest Corner of existing Dike
COUNTY Brevard STATE Florida
DATE STARTED 10/11/1990 COMPLETED 10/11/1990
WATER TABLE: 1st depth 1.5' DATE 10/11/1990
WATER TABLE: 2nd depth -- DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-2	3	1						Dark Brown Fine Sand w/ Roots (SP)		
	3-5-6	11	2						Brown Slightly Silty Fine Sand (SP-SM)		
	3-2-2	4	3								
-5 5	6-9-14	23	4								
	7-11-11	22	5						Reddish-Brown Slightly Silty Fine Sand (SP-SM)		
	9-7-7	14	6								
-10 10	4-5-4	9	7								
-15 15									Boring terminated at 10.5 feet		
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-4
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #5 ; ≈400 feet West of Southwest Corner of existing Dike
COUNTY Brevard STATE Florida
DATE STARTED 10/11/1990 COMPLETED 10/11/1990
WATER TABLE: 1st depth 2.0' DATE 10/11/1990
WATER TABLE: 2nd depth -- DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-2	3	1						Brown Fine Sand w/ Roots (SP)		
	3-3-4	7	2						Gray Fine Sand w/ Roots (SP-SM)		
-5 5	7-7-9	16	3								
	10-10-13	23	4								
	2-5-8	13	5						Very Dark Reddish-Brown Organic Stained Silty Fine Sand (SM)		
	5-10-8	18	6								
-10 10	2-1-2	3	7						Brown Slightly Silty Fine Sand (SP-SM)		
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-5
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites — FILE NO. 90-146
CLIENT Gee and Jenson / Lockhead Space Operations Company — ELEVATION
BORING LOCATION Site #3A ; Dike Wall — BORING TYPE Rotary / SPT
COUNTY Brevard — STATE Florida — CASING TYPE Drilling Mud
DATE STARTED 10/15/1990 — COMPLETED 10/15/1990 — DRILLER/RIG M. Haskett / CME 45
WATER TABLE: 1st depth Not Encountered — DATE 10/15/1990 — TIME
WATER TABLE: 2nd depth -- — DATE -- — TIME --
REMARKS

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks
5	1-2-2	4	1						Brown Slightly Silty Fine Sand (SP-SM)
	2-1-2	3	2						
	3-2-2	4	3						
	2-3-4	7	4						
	4-5-4	9	5						
	4-6-7	13	6						
			6A						
10	5-8-8	16	7						Dark Brown Slightly Silty Fine Sand w/ Hardpan & Roots (SP-SM)
15									Boring terminated at 10.5 feet
20									
25									
30									
35									
40									

Depth (ft) — Graphic Log

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-6
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites — FILE NO. 90-146
CLIENT Gee and Jenson / Lockhead Space Operations Company — ELEVATION
BORING LOCATION Site #3A ; Southwest Edge of proposed Pond — BORING TYPE Rotary / SPT
COUNTY Brevard — STATE Florida — CASING TYPE Drilling Mud
DATE STARTED 10/15/1990 — COMPLETED 10/15/1990 — DRILLER/RIG M. Haskett / CME 45
WATER TABLE: 1st depth 2.5' — DATE 10/15/1990 — TIME
WATER TABLE: 2nd depth -- — DATE -- — TIME --
REMARKS

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-3	4	1								
	3-1-2	3	2						Dark Brown Silty Sand w/ Roots (SM)		
-5 5	3-3-2	5	3								
	3-5-8	13	4								
	5-9-8	17	5						Brown Slightly Silty Fine Sand (SP-SM)		
	6-6-6	12	6								
-10 10	6-8-8	16	7								
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-7
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites — FILE NO. 90-146
CLIENT Gee and Jenson / Lockhead Space Operations Company — ELEVATION
BORING LOCATION Site #3A ---> Northwest Corner of proposed Pond — BORING TYPE Rotary / SPT
COUNTY Brevard — STATE Florida — CASING TYPE Drilling Mud
DATE STARTED 10/15/1990 — COMPLETED 10/15/1990 — DRILLER/RIG M. Haskett / CME 45
WATER TABLE: 1st depth 2.5' — DATE 10/15/1990 — TIME
WATER TABLE: 2nd depth -- — DATE -- — TIME --
REMARKS

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-3	4	1						Brown Fine Sand w/ Roots (SP)		
	4-5-5	10	2						Lt. Gray Fine Sand (SP)	▽	
-5 5	5-7-7	14	3 3A						Reddish-Brown Organic, Stained Silty Fine Sand (SM)		
	8-10-12	22	4								
	10-12-17	29	5						Brown Slightly Silty Fine Sand (SP-SM)		
-10 10	18-15-19	34	6								
	5-7-7	14	7								
-15 15									Boring terminated at 10.5 feet		
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-8
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #2C ---> Southeast Corner of proposed Pond --> Dike Wall
COUNTY Brevard
STATE Florida
DATE STARTED 10/15/1990
COMPLETED 10/15/1990
WATER TABLE: 1st depth 9.0'
DATE 10/15/1990
WATER TABLE: 2nd depth --
DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	2-3-3	6	1						Brown Slightly Silty Fine Sand w/ Roots (SP-SM)		
	2-2-4	6	2								
-5 5	3-3-3	6	3								
	3-2-2	4	4								
	1-2-1	3	5								
			5A								
	1-1-1	2	6						Gray Clayey Fine Sand (SC)		
-10 10	1-1-1	2	7						Reddish-Brown Organic, Stained Slightly Silty Fine Sand (SP-SM)		
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-9
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #2C ---> Northwest Corner of proposed Pond
COUNTY Brevard
STATE Florida
DATE STARTED 10/15/1990
COMPLETED 10/15/1990
WATER TABLE: 1st depth 6.0'
DATE 10/15/1990
WATER TABLE: 2nd depth --
DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-1	2	1						Brown Slightly Silty Fine Sand w/ Roots (SP-SM)		
	1-2-3	5	2						Gray Fine Sand (SP)		
	3-3-4	7	3 3A						Reddish-Brown Slightly Silty Fine Sand w/ Roots (SP-SM)		
-5 5	7-7-8	15	4								
	4-5-7	12	5						Brown Slightly Silty Fine Sand (SP-SM)	▽	
	6-8-10	18	6								
-10 10	9-10-10	20	7								
									Boring terminated at 10.5 feet		
-15 15											
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO: TH-10
TOTAL DEPTH: 10.5ft.
SHEET 1 OF 1

PROJECT Banana River Dredging / Spoil Sites
CLIENT Gee and Jenson / Lockhead Space Operations Company
BORING LOCATION Site #2C ---> Southwest Corner of proposed Pond
COUNTY Brevard
STATE Florida
DATE STARTED 10/15/1990
COMPLETED 10/15/1990
WATER TABLE: 1st depth 7.5'
DATE 10/15/1990
WATER TABLE: 2nd depth --
DATE --
REMARKS

FILE NO. 90-146
ELEVATION
BORING TYPE Rotary / SPT
CASING TYPE Drilling Mud
DRILLER/RIG M. Haskett / CME 45
TIME
TIME --

Depth (ft)	Standard Pen. Test ASTM D-1586 Blows/6 in	N Value	Sample Number	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Dry Den (pcf)	Soils Description and Remarks	Depth (ft)	Graphic Log
	1-1-1	2	1						Gray Slightly Silty Fine Sand w/ Roots (SP-SM)		
	2-1-1	2	2						Dark Brown Clayey Fine Sand (SC)		
-5 5	1-2-5	7	3								
	6-6-6	12	4								
	5-10-12	22	5						Brown Slightly Silty Fine Sand (SP-SM)		
	9-14-14	28	6							▽	
-10 10	2-3-5	8	7								
-15 15									Boring terminated at 10.5 feet		
-20 20											
-25 25											
-30 30											
-35 35											
-40 40											

AVO

October 11, 1990

To: D. Rye, LSOC 40-50, LSO-360

From: T. L. Smith, LSOC 33-35, 7-6262

Subject: Test Borings on Air Force Spoil Site
Gee & Jenson; P.O. #147348
F/N 101190

The Cape Canaveral Air Force Station (CCAFS) spoil site selected by Gee & Jenson (site #6A) under the Environmental Assessment contract is still a viable site for future dredging requirements of the Air Force Turn Basin. However, at this time, per M. Busacca (NASA DF-EMS), the Air Force will not allow any test borings being performed in this area. Gee & Jenson shall consider this site for the assessment, but shall delete the two (2) test bores required under contract.

Thomas L. Smith, Eng.
Modification Management

cc.
M. Busacca, DF-EMS
P. Krinsky, Gee & Jenson
M. Palmer, LSO-084