ANNEX 8　騒音調査結果 (NBRO)

REPORT ON THE AMBIENT NOISE SURVEY
FEASIBILITY STUDY ON COMBINED CYCLE POWER DEVELOPMENT PROJECT AT KERAWALAPITIYA SRI LANKA

REPORT No . NBRO/ENV/26101/98/201
JOB NO. AQP/98/01

REPORT TO :
MR. ZENIRO TSUTSUI
PROJECT PLANNING & ENGINEERING DEPT.
TOKYO ELECTRIC POWER SERVICES CO LTD
3-3, HIGASHI-UENO 3-CHOME, TAITO-KU
TOKYO 110, JAPAN

THIS REPORT CONTAINS FIVE PAGES

ENVIRONMENTAL DIVISION
NATIONAL BUILDING RESEARCH ORGANISATION
99/1, JAWATTA ROAD
COLOMBO 05
SRI LANKA

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வீடமைப்பு, நகர அபிவிருத்தி அமைச்சு
MINISTRY OF HOUSING AND URBAN DEVELOPMENT
ජාතික ගොඩනැගිලි පර්යේෂණ සංවිධානය
தேசிய கட்டட ஆராய்ச்சி நிலையம்
NATIONAL BUILDING RESEARCH ORGANISATION
99/1, ජාවත්ත පාර, කොළඹ - 5, ශ්‍රී ලංකාව, 99/1, ஜாவத்தை வீதி, கொழும்பு - 5, இலங்கை. 99/1, JAWATTA ROAD, COLOMBO - 5, SRI LANKA

අපේ අංකය / எமது இல. / OUR REF. ....
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June 23, 1998

NBRO/ENV/26101/98/201
AQP/98/ 01

CLIENT : Mr. Zeniro Tsutsui
Project Planning & Engineering Dept.
Tokyo Electric Power Services Co Ltd.
3-3, Higashi-Ueno 3-chome, Taito-ku
Tokyo 110, Japan.

REPORT ON MONITORING OF NOISE LEVELS FOR THE PROPOSED POWER PLANT AT KERAWALAPITIYA

1. SCOPE

The Client, Tokyo Electric Power Services Company Ltd., Japan requested the Environmental Division of NBRO to carry out a noise level survey in order to note current noise levels at the proposed 150 MW combine cycle power plant site at Kerawalapitiya.

2. NOISE LEVEL MEASUREMENTS :

As per the client's requirements, 4 points were selected around the boundary of the proposed site and the noise survey was carried out on 7th – 08th January 1998 to cover a week day and 07th –08th June 1998 to cover a week-end at Kerawalapitiya. Each sampling point, 10 minutes continuos noise level measurement was carried out at every hour for 24 hrs as per the client's request.

Description of Locations (map is attached, herewith)

Location A : Middle of the Southern boundary of the site

Location B : Middle of the Western boundary of the site

Location C : Middle of the Northern boundary of the site

Location D : Middle of the Eastern boundary of the site

2.1. MEASURING INSTRUMENTS :

- Sound level meter : Cirrus CR:703 A
- Calibrator : Cirrus CR:513 A

The sound level meter conforms to the requirements of Type 1 of both IEC 651 and IEC 804.

RESULTS

Table --: Noise Levels around the Site

* Refer map for the identification of Locations

- Leq - The equivalent noise level generated during the sampling period.

Time : From 9.00 a.m on 7th January to 10.00 a.m on 8th January 1998.

Location (A)

Start time (hrs.)	Leq dB(A)	Major contribut or to Leq
09.00	41.4	
10.00	38.4	
11.00	40.1	
12.00	44.2	
13.00	42.0	
14.00	44.1	
15.00	38.8	
16.00	41.6	
17.00	41.2	
18.00	43.3	
19.00	40.1	
20.00	38.8	
21.00	37.0	
22.00	39.5	
23.00	36.0	
24.00	40.2	
01.00	36.0	
02.00	33.7	
03.00	34.5	
04.00	33.6	
05.00	36.6	
06.00	40.6	
07.00	38.8	
08.00	40.6	
09.00	42.0	

Location (B)

Start time (hrs.)	Leq dB(A)	Major contributor to Leq
09.15	51.7	Birds
10.15	41.0	
11.15	42.6	
12.15	43.0	
13.15	44.1	
14.15	40.0	
15.15	36.1	
16.15	42.4	
17.15	41.5	
18.15	40.2	
19.15	39.5	
20.15	38.0	
21.15	38.5	
22.15	40.0	
23.15	37.5	
24.15	37.7	
01.15	35.2	
02.15	36.3	
03.15	34.6	
04.15	34.9	
05.15	36.2	
06.15	38.6	
07.15	42.3	
08.15	47.6	
09.15	43.0	

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Location C

Start time (hrs.)	Leq dB(A)	Major contributor to Leq
09.30	41.5	
10.30	38.8	
11.30	41.0	
12.30	44.1	
13.30	41.0	
14.30	39.5	
15.30	46.1	Airplane
16.30	44.8	
17.30	40.0	
18.30	42.6	
19.30	38.8	
20.30	39.5	
21.30	36.6	
22.30	37.0	
23.30	38.2	
24.30	40.3	
01.30	34.6	
02.30	36.4	
03.30	37.3	
04.30	41.5	
05.30	40.5	
06.30	42.2	
07.30	41.8	
08.30	42.0	
09.30	39.8	

Location D

Start time (hrs.)	Leq dB(A)	Major contributor to Leq
09.45	39.4	
10.45	42.0	
11.45	41.0	
12.45	40.0	
13.45	42.0	
14.45	44.1	
15.45	47.4	Airplane
16.45	42.7	
17.45	41.5	
18.45	36.6	
19.45	39.4	
20.45	37.0	
21.45	36.0	
22.45	39.5	
23.45	36.6	
24.45	34.1	
01.45	36.0	
02.45	35.2	
03.45	36.7	
04.45	40.0	
05.45	67.1	Airplane
06.45	40.5	
07.45	42.2	
08.45	41.0	
09.45	40.5	

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Time : From 9.00 a.m on 6th June to 10.00 a.m on 7th June 1998.

Location (A)

Start time (hrs.)	Leq dB(A)	Major contributor to Leq
09.00	40.0	
10.00	39.7	
11.00	44.1	
12.00	40.3	
13.00	41.7	
14.00	44.9	
15.00	46.3	Birds
16.00	47.6	Birds
17.00	44.0	
18.00	44.2	
19.00	41.5	
20.00	46.8	Factory
21.00	51.6	Factory
22.00	52.7	Factory
23.00	51.3	Factory
24.00	46.2	Factory
01.00	40.2	
02.00	41.2	
03.00	55.8	Dogs
04.00	38.7	
05.00	70.6	Airplane
06.00	46.4	
07.00	46.3	
08.00	44.2	
09.00	42.5	

Location (B)

Start time (hrs.)	Leq dB(A)	Major contributer to Leq
09.15	48.1	
10.15	46.2	Birds
11.15	42.5	
12.15	43.0	
13.15	45.3	
14.15	44.8	
15.15	46.0	
16.15	42.4	
17.15	44.4	
18.15	45.8	
19.15	45.7	Factory
20.15	50.5	Factory
21.15	48.9	Factory
22.15	51.6	Factory
23.15	41.3	Factory
24.15	52.5	Factory
01.15	38.4	
02.15	35.7	
03.15	56.0	Dogs
04.15	39.8	
05.15	57.2	Dogs
06.15	56.3	Dogs
07.15	48.5	
08.15	44.3	
09.15	45.1	

NBRO/ENV/26101/98/201
AQP/98/01

Location C

Start time (hrs.)	Leq dB(A)	Major contributer to Leq
09.30	41.5	
10.30	42.3	
11.30	38.6	
12.30	37.9	
13.30	47.5	
14.30	45.7	
15.30	53.9	People
16.30	41.6	
17.30	45.8	
18.30	42.0	
19.30	39.5	
20.30	46.0	
21.30	37.0	
22.30	45.6	
23.30	39.5	
00.30	43.6	
01.30	47.2	Dogs
02.30	45.7	
03.30	59.4	Airplane
04.30	40.5	
05.30	67.1	Airplane
06.30	41.8	
07.30	42.0	
08.30	41.5	
09.30	44.0	

Location D

Start time (hrs.)	Leq dB(A)	Major contributer to Leq
09.45	39.7	
10.45	39.8	
11.45	44.6	
12.45	51.7	Airplane
13.45	43.7	
14.45	44.1	
15.45	47.0	
16.45	43.9	
17.45	42.9	
18.45	39.9	
19.45	48.9	
20.45	46.1	
21.45	39.5	
22.45	49.6	Dogs
23.45	38.7	
00.45	36.6	
01.45	51.8	Dogs
02.45	46.8	
03.45	41.0	
04.45	46.7	Dogs
05.45	56.9	Airplane
06.45	41.4	
07.45	42.0	
08.45	42.5	
09.45	44.2	

Coordinator/Air Quality

Scientist/Air Quality

Head/Environmental Division
National Building Research Organisation

HEAD/ENVIRONMENTAL DIVISION
National Building Research Organisation
99/1, Jawatta Road
COLOMBO-5.

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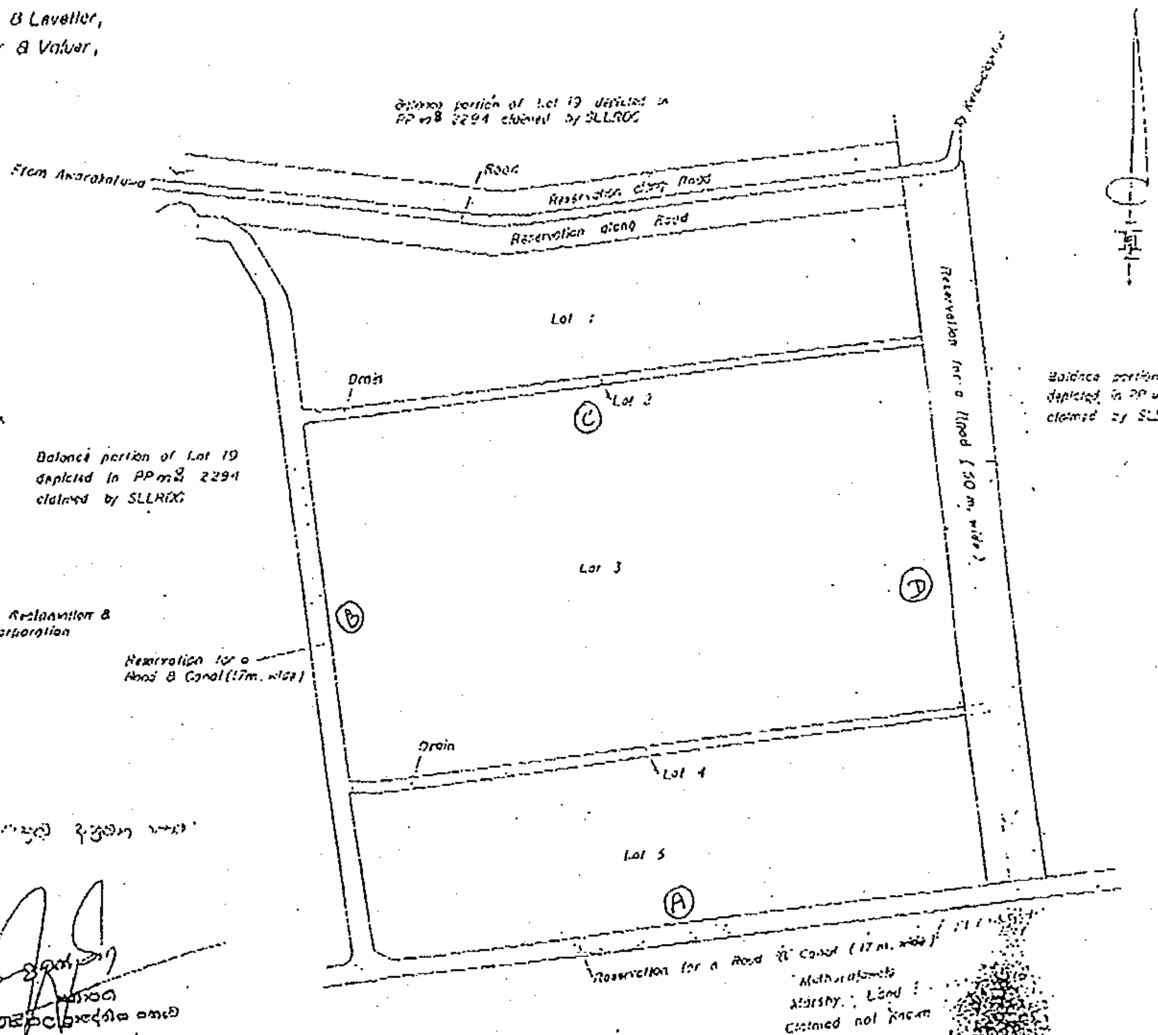
PLAN No. 92/SLLRDC



Note
SLLRDC - Sri Lanka Land Reclamation & Development Corporation

96-09-06

Scale 1 : 4000

PLAN

of five (05) allotments of land marked lot 1 - 5 (being a portion of Lot 2 depicted in my Plan No. 75/SLLRDC and originally being a portion of Lot 19 depicted in Plan No. PPගම 2294 authenticated by Surveyor General) of the land called Mutturajawela situated at Malagoda Village in Ragam Pattu of Aluth Kuru Korale

GAMPAHA DISTRICT

WESTERN PROVINCE

ANNEX 9 動植物資料

TABLE A9.1 PROFILES OF VEGETATION ALONG THE DUTCH CANAL, DRAINAGE CHANNELS AND IRRIGATION CHANNELS AT MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Acrosticum aurium l.	Karan Koku		
Annona glavra l.	Wel atha		
Bruguiera sexangula (lour) poir.			
Calapagonium sp.			
Calophyllum l.	Domba		
Carex indica l.			
Cerbra manchas l.	Kaduru, Gon Kaduru		
Commelina diffusa burm f.	Gira Pola		
Cyperus spiralis (Rottab.) Roem & Shult			
Dolichandrone spathesia (L.F.) K. Shum			
Eleocharis geniculata (L.) Roem & Shult			
Eupatorium odoratum l.			
Fimbristysis consanguinea kunth .			
Hanguana malayana 'Jack) merr.			
Ischaemum rugosum salisb	Kudu Kedu		
Jussieae repens l.			
Lygodium microphyllum (cavi.) R.BR	Pumba		
Mikania scandens l. willd			
Osbeckia aspera (L.) Blume	Bowitiya		
Pandanus odoratissimus LF.	Watakeiya		
Nymphaea stellata willd (Blue)	Kumudu, Manel Nilupul (Blue)		
Nymphaea stellata willd (White)	Kumudu, Manel Nilupul (White)		
Pandanus odoratissimus lf.			
Panicum repens l.	Atora		
Paspalum vaginatum sw.	Lunu Atora		
Phragmites karka (Retz.) Trin exsteud	Nala gas Wal-Uk		
Salvinia molesta d.s. mitchell	Salvinia		
Schoenoplectus grossus (L.F.) Palla			
Syzygium caryophylltatum (L) alston	Heen dan Dan		
Typha angustifolia l.	Hombupon		

* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown
** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.2 PHYTOPLANKTON SPECIES RECORDED FROM THE MUTHURAJAWELA

SCIENTIFIC NAME	STATUS*	REMARKS**
BLUE GREEN ALGAE		
Anabaena sp.		
Chroococcus sp.		
Lyngbya sp.		
Merismopedia sp.		
Microcystis sp.		
Oscillatoria sp.		
Rivularia sp.		
BLUE ALGAE		
Chlorella sp.		
Chladophora sp.		
Closterium sp.		
Cosmerium sp.		
Mougeotia sp.		
Pediastrum sp.		
Scenedesmus sp.		
Spiroggra sp.		
Volvox sp.		
DIATOMS		
Amphora sp.		
Achnanthes sp.		
Biddulphia sp.		
Campylosira sp.		
Coscinodiscus sp.		
Cyclotella sp.		
Cymbella sp.		
Diatoma sp.		
Diploneis sp.		
Gramatophora sp.		
Licmophora sp.		
Melosida sp.		
Navicula sp.		
Nitzchia sp.		
Pinnularia sp.		
Pleurosigma sp.		
Prorocentrum sp.		
Surirella sp.		
Tabellaria sp.		
DINOFLAGELLATES		
Ceratium sp.		
Gymodinium sp.		
Peridinium sp.		

* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown
** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source ; "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.3 AQUATIC MACROPHYTES RECORDED FROM THE MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Salvenia molesta	Ferns		
Eichhornia crassipes	Water hyacinth		
Lemna sp.	Duckweed		
Phragmites karla	Reeds		
Typha angustifolia	Cattails		
Hydrilla verticillata	Hydrilla		
Aponogeton crispes	Kekatiya		
Nymphaea stellata	Manel		
* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown ** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance			

Source ; "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.4 MARSH VEGETATION RECORDED FROM THE MUTHURAJAWELA

SCIENTIFIC NAME	STATUS*	REMARKS**
Acrosticum aurium		
Annona glabra		
Carex indica		
Cyclosorus sp.		
Cyperus spiralis		
Eleocharis geniculata		
Fimbristylis sp.		
Fimbristylis sanguinea		
Flagellaria indica		
Fuirena umbellata		
Hydrocera triflora		
Isachne globosa		
Ischaemum rugosum		
Lepironia articulata		
Lygodium micophyllum		
Panicum repens		
Paspalum vaginatus		
Phragmites karka		
Polygonum barbatum		
Schoenoplectus grossus		
Typha angustifolia		
* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown ** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance		

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.5 (1) SHRUB, HERB AND CLIMBING SPECIES RECORDED TO BE PRESENT ALONG THE TRANSMISSION LINE

SCIENTIFIC NAME	REMARKS*
Acrosticum aurium	
Alternanthera sessilis	
Annona glabra	
Antidesma ghaesembilla	
Ardisia willisii	END
Asparagus falcata	
Asteracantha longifolia	
Bacopa monnieri	
Ccalamus sp.	
Centella asiatica	
Carex indica	
Cassia alata	
Cassia tora	
Ceratopteris sp.	
Cinamomum verum	
Coffea arabica	
Coix sp.	
Commelina diffusa	
Crinum sp.	
Cuscuta chinensis	
Cyperus pilosus	
Cyperus spiralis	
Derris uliginosa	
Dolichandrone spathesia	
Eclipta prostrata	
Eleocharis geniculata	
Eleocharis dulcis	
Eleocharis lankana	END
Ericaulon thwaitsii	
Ericaulon sp.	
Eupatorium odoratum	
Fimbristylis consanguinea	
Fimbristylis Zeylanica	END
Flagellaria indica	
Fuirena sp.	
Hanguana malayana	
Hygrophila spinosa	
Hyptis capitata	
Impatiens sp.	
Ipomoea aquatica	
Ipomoea triloba	
Isachne globosa	
Ischaemum rugosum	
Ixora coccinea	
Loranthus sp.	
Ludwigia decurrens	
Ludwigia peruviana	
Laginandra thwaitsii	
Lantana camera	
Lepironia articulata	
Limnophila repens	
Lygodium microphyllum	
* END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance	

Source ; Survey record by a local consultant

TABLE A9.5 (2) SHRUB, HERB AND CLIMBING SPECIES RECORDED TO BE PRESENT ALONG THE TRANSMISSION LINE

SCIENTIFIC NAME	REMARKS*
Lucas Zeylanica	
Marsilea quadrifolia	
Memecylon umbellatum	
Microcos paniculata	
Mikania scandens	
Mollugo oppositifolia	
Osbeckia aspara	
Pagiantha dichotoma	
Pandanus odoratissimus	
Panicum repens	
Paspalum vaginatum	
Pavetta indica	
Phragmites karka	
Phyllanthus debilis	
Polygonum barbatum	
Pothos scandens	
Premna sp.	
Punica granatum	
Scaviola sp.	
Schoenoplectus grossus	
Scoparia dulcis	
Selaginella sp.	
Sphaeranthus indicus	
Syzgium caryophyllatum	
Typha angustifolia	
Utricularia sp.	
Walidda antidysenterica	END
Xyris indica	
Zizyphus oenoplia	
* END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance	

Source ; Survey record by a local consultant

TABLE A9.6 STATUS OF MAMMALS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Suncus murinus murinus	musk shrew	VC	
S. murinus caerulescens	musk shrew	C	
Peropus g. giganteus	fruit bat	VC	
Rousettus seminudus	fruit bat	VC	END
Rhinolopus r. rouxi	bat	C	
Hipposiderous l. lankadiva	bat	C	
H. galeritus brachyotus	bat	SU	
H. bicolor ater	bat	SU	
Megaderma lyra lyra	bat	C	
Pipistrellus m. mimus	bat	C	
Scotophilus heathi heathi	bat	SU	
Kerivoula picta picta	painted bat	R	THR
Taphozous saccolaimus erassus		C	
Loris tardigradus tardigradus	slender loris	R	THR/PRO
Macaca sinica sinica	toque macaque	VC	END
Lepus nigricollis singhala	black-naped hare	C	
Funambulus palmarum favonicus	Indian palm squirrel	VC	
Hystrix indica	Indian crested porcupine	C	
Bandicota indica indica	larger bandicoot rat	VC	
Mus musculus castaneus	house mouse	C	
M. cervicolor fulvidiventris	fawn coloured mouse	VC	
Rattus rattus rattus	common rat	VC	
R. rattus alexandrinus	browan rat	SU	
R. rattus kandianus	brown rat	C	
R. norvegicus	brown rat	SU	
Lutra lutra nair	Ceylon otter	C	THR
Canis aureus lanka	Asiatic jackal	R	
Viverricula indica mayori	larger Indian civet	R	
Paradoxurus hermaphroditicus	palm civet	C	
Herpestes fuscus rubidior	brown mongoose	C	
H. smithi zeylanicus	ruddy mongoose	C	
Felis (Zibethailurus) viverrina	fishing cat	R	THR/PRO
F. (Prionailurus) rubiginosa	rusty spotted cat	VR	THR/PRO
Tragulus meminna	mouse-deer	R	THR

* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown
** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance.

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.7 (1) STATUS OF RESIDENT BIRDS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Podiceps ruficollis capensis	Little Grebe		B
Phalacrocorax fuscicollis	Indian Shag		B
P. niger	Little Cormorant		B
Ardea cinerae rectirostris	Grey Heron		
A. purpurea manilensis	Purple Heron		B
Butorides striatus javanicus	Little Green Heron		B
Ardeola grayii grayii	Pond Heron		B
Bubulous ibis coromandus	Cattle Egret		
Egretta alba modesta	Large Egret		B
E. intermedia intermedia	Median Egret		B
E. garzetta garzetta	Little Egret		B
E. gularis schistacea	Reef Heron		THR
Nycticorax nycticorax nycticorax	Night Heron		B
Ixobrychus cinnamomeus	Chestnut Bittern		
I. sinensis	Yellow Bittern		B
Dupetor flavicollis flavicollis	Black Bittern		
Ibis leucocephalus	Painted Stork		
Anastomus oscitans	Open-bill Stork		
Threshkiornis melanocephala	White Ibis		
Dendrocygna javanica	Whistling Teal		
Haliastur indus indus	Brahaminy Kite		
Accipiter badius badius	Shikra		
Ichthyophaga ichthyaetus plumbeiceps	Grey-headed Fishing Eagle		THR
Coturnix chinensis chinensis	Blue-breasted Quail		
Rallus striatus albiventer	Blue-breasted Banded Quail		THR
Amaurornis fuscus zeylonicus	Ruddy Crake		
A. phoenicurus phoenicurus	White-breasted Waterhen		B
Gallicrex cinera cinera	Kora		
Gallinula chloropus indica	Indian Moorhen		B
Porphyrio porphyrio poliocephalus	Purple Coot		B
Hydrophasianus chirurgus	Pheasant-tailed Jacana		
Vanellus indicus lankae	Red-wattled Lapwing		B
Rostratula bengalensis bengalensis	Painted Snipe		
Himantopus himantopus ceylonensis	Black-winged Stilt		
Sterna albifrons	Lesset Tern		
S. bergii velox	Swift Tern		
Streptopelia ceylonensis	Spotted Dove		
Psittacula krameri manillensis	Rose-ringed Parakeet		
Clamator jacobinus jacobinus	Pied Crested Cuckoo		
Eudynamys scolopacea scolopacea	Koel		
Centropus sinensis parroti	Common Coucal		
Otus bakkamoena bakkamoena	Collared Scops Owl		
Bubo zeylonensis zeylonensis	Brown Fish Owl		
Ninox scutulata hirsuta	Brown Hawk Owl		
Apus melba pakeri	White-bellied Swift		
Cypsiurup parvus batasiensis	Palm Swift		
Ceryle rudis leucomelanura	Pied Kingfisher		
Alcedo atthis taprobana	Common Kingfisher		
Pelargopsis capensis capensis	Stork-billed Kingfisher		
Halcyon smyrensis fusca	White-breasted Kingfisher		

* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown
** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.7 (2) STATUS OF RESIDENT BIRDS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
H. pileata	Black-capped Kingfisher		THR
Coracias bengalensis indica	Indian Roller		
Megalaima zeylanica zeylanica	Brown-headed Barbet		
M. rubricapilla rubricapilla	Small Barbet		
Dinopium benghalense psarodes	Red-becked Woodpecker		
Hirundo daurica hyperythra	Sri Lanka Swallow		
Oriolus xanthornus ceylonensis	Black-headed Driole		
Dicrurus caerulescens leucopygialis	White-vented Drongo		
Artamus fuscus	Ashy Swallow Shrike		
Acridotheres tristis melanosternus	Common Mynah		
Corvus spendens protegatus	House Crow		
C. macrorhynchos culminatus	Black Crow		
Coracina melanoptera sykesi	Black-headed Cuckoo Shrike		
Pericrocotus c. cinnamomeus	Little Minivet		
Aegithina tiphia multicolor	Common Iora		
Pycnonotus cafer haemorrhousus	Red-vented Bulbul		
P. luteolus insulae	White-browed Bulbul		
Turdoides affinis taprobanus	Common Babbler		
Terpsiphone paradisi ceylonensis	Ceylon Paradise Flycatcher		
Cisticola juncidis omalura	Fantail Warbler		
Prinia subflava insularis	Plain Prinia		
P. sylvatica valida	Large Prinia		
Orthotomus sutorius sutorius	Tailor Bird		
Acrocephalus stentoreus	Great Red Warbler		
Copsychus saularis ceylonensis	Magpie Robin		
Saxicoloides fulicata leucoptera	Black Robin		
Parus major maharattarum	Grey Tit		
Anthus novaseelandidae malayensis	Indian Pipit		
Dicaeum erythrohynchos ceylonense	Tickell's Flowerpecker		
Nectarinia zeylonica zeylonica	Purple-rumped Sunbird		
N. lotenia lotenia	Loten's Sunbird		
Passer domesticus indicus	House Sparrow		
Lonchura striata striata	White-backed Munia		
L. punctulata punctulata	Spotted Munia		
L. malacca malacca	Black-headed Munia		

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Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.8 MIGRATORY BIRDS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Phalacrocorax carbo sinensis	Ingian Cormorant		THR
Ardea goliath	Goliath Heron		SU
Gorsachius m. melanolophus	Mallay Bittern		
Anas acuta	Pintail		
A. querquedula	Gargany		
Circus macrourus	Pale Harrier		
C. aeruginosus aeruginosus	Marsh Harrier		
Heiraaetus pennantus	Booted Eagle		
Rallus eurizonoides amauroptera	Banded Crake		
Pluvialis aquatarola	Grey Plover		
P. Dominica fulva	Eastern Golden Plover		
Charadrius mongolus atrifrons	Lesser Sandplover		
C. leschenaultil	Llarge Sandplover		
Numenius phaeopus phaeopus	Whimbrel		
Tringa totanus eurithinus	Redshank		
T. nebularia	Greenshank		
T. glareola	Wood Sandpiper		
T. stagnatilis	Marsh Sandpiper		
T. hypoleucos hypoleucos	Common sandpiper		
Capella stenura	Pintail Snipe		
Calidris feruginea	Curiew Sandpiper		
Larus fuscus	Lesser Black-backed Gull		
L. brunnicephalus	Brown-headed Gull		
Chlidonias hybrida indica	Indian Whiskered Tern		
Gelochilidon nilotica nilotica	Gull-billed Tern		
Hydroprogne caspia caspia	Caspian Tern		
Sterna hirundo tibetana	Common Tern		THR
S. bengalensis	Lesser Crested Tern		
S. repressa	White-cheeked Tern		SU
S. sandvicensis	Sandwich Tern		
Merops Philippinus Philippinus	Bleu-tailed Bee-eater		
Pitta brachyura brachyura	Indian Pitta		
Hirundo rustica gutturalis	Eastern Swallow		
Lanius cristatus cristatus	Brown Shrike		
Mascicapa latirostris	Brown Flycatcher		
Terpsiphone paradisi paradisi	Paradise Flycatcher		
Acrocephalus dumetorun	Blyth's Reed Warbler		
Anthus novaeseelandidae richardi	Richard's Pipit		
Motacilla flava	Grey-headed Yellow Wagtail		
M. caspica caspica	Grey Wagtail		

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Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.9 REPTILES RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Cnemaspis k. kandianus	diurnal gecko	R	
Hemadactylus brooki parvimaculatus	jungle gecko	C	
H. frenatus	jungle gecko	C	
Gehyra mutilata	fruit bat	C	
Calotes calotes	green garden lizard	VC	THR
C.versicolor	garden lizard	VC	
Mabuya carinata lankae	skink	VC	
M. macularia	spitted skink	C	END/THR
Sphenomorphus fallax	brown skink	R	END/THR
Riopa punctata	skink	C	
Varanus bengalensis	monitor	C	
V. salvator salvator	monitor	C	PRO
Crocodylus porosus	estuarine crocodile	C	THR/PRO
Melanochelys trijuga thermalis	hard-shelled terrapin	C	THR
Lissemys punctata ceylonensis	soft-shelled terrapin	C	THR
Typhlina bramina		C	THR
Cylindrophis maculatus	Sri Lankan pipe snake	R	END/THR
Python molurus	rock python	R	THR
Acrochordus granulatus		C	
Lycodon striatus	wolf snake	C	
L. aulicus	wolf snake	C	
Oligodon arnensis	kukri snake	R	
Ptyas mucosus		VC	
Boiga ceylonensis	cat snake	C	
Dendrelahis tristis	bronze back	C	
Ahaetulla nasuta		C	
Aspidura guentheri	Guether's roughside	VR	END/THR
Xenochrophis piscator	common pond snake	C	END/THR
Amphiesma stolata		C	
Xenochrophis piscator	pond snake	C	
Atretium schistosum		C	
Cerverus rhynchops	dog-faced water snake	VC	THR
Gerada prevostiana		VR	THR
Naja naja naja	cobra	C	
Bungarus caeruleus	krait	R	
Vipera russelli	Russel's viper	R	
Hypnale hypnale	Merrem's hump-nosed viper	C	THR

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Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.10 AMPHIBIANS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Bufo melanostictus	toad	VC	
B. stomaticus	toad	R	
B. atukoralei	Atukorali's dwarf toad	C	END/THR
Rana hexadactyla	frog	VC	
R. c. cyanophlyctis	frog	VC	
R. tigrina crassa	frog	C	
R. l. limocharis	frog	VC	
R. (Tomoptera) breviceps	frog	C	
R. (Hylarana) temporalis	frog	C	
Rhacophorus (polypedates) cruciger	greater hourglass tree frog	C	END/THR
R. (P.) leucomystax maculatus	tree frog	VC	
Philautus sp. (P. hayli ?)	tree frog	VC	
Kaloula pulchra taprobanica		C	
Uperodon systoma		C	
Microhyla rubra		C	

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Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.11 FISH SPECIES RECORDED FROM THE MUTHURAJAWELA SWAMP

SCIENTIFIC NAME	STATUS*	REMARKS**
Ambassis dayi		
Anabas testudineus		
Aplocheilus dayi		
A. parvus		
Caranx sexfasciatus		
Channa orientalis		
C. striatus		
Eleotris fusca		
Elops echinata		
Etroplus suratensis		
Etroplus maculatus		
Gerres abbreviatus		
Heteropneustes fossilis		
Hyporhamphus gaimardi		
Lates calcarifer		
Leiognathus equulus		
Lutjanus argentimaculatus		
Liza macrolepis		
L. tade		
Megalops cyprinoides		
Oligolepis acutipennis		
Ophiocephalus striatus		
Panchax melastigma		
Panchax pancha		
Puntius vittatus		
P. filamentosus		
Rasbora diniconius		
R. caverii		
Scatophagus argus		
Sarotherodon mossambicus		
Trichgaster pectoralis		

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** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)
"Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.12 BUTTERFLIES OF MUTHURAJAWELA

FAMILY NAME	TOTAL SPP	ENDEMIC SUBSPP	THREATENED SPP
DANEIDAE	8	4	-
SATYRIDAE	4	1	-
AMATHUSIIDAE	-	-	-
NYMPHALIDAE	17	1	-
LYCAENIDAE	14	-	-
PIERIDAE	9	-	-
PAPILIOIDAE	9	3	1
HESPERIIDAE	6	-	-
TOTAL	67	9	1

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.13 DRAGONFLIES OF MUTHURAJAWELA

FAMILY NAME	TOTAL SPP	SPP	ENDEMIC SUBSPP
EUPHAEIDAE	-	-	-
CHLOROCYPHIDAE	2	2	-
CALOPTERYGIDAE	-	-	-
LESTIDAE	-	-	-
PLATYSTICTIDAE	2	2	-
PROTONEURIDAE	3	3	-
PLATYCNEMIDAE	1	-	-
COENAGRIONIDAE	12	1	-
GOMPHIDAE	1	-	-
AESHNIDAE	-	-	-
CORDULIIDAE	-	-	-
LIBELLULIDAE	13	-	-
TOTAL	34	8	-

Source ; "Environmental Profile of Muthurajawela and Negombo Lagoon" (1991)

TABLE A9.14 ZOOPLANKTON SPECIES RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	STATUS*	REMARKS**
COPEPODS :		
Canthocamptus sp.		
Onchocamptus sp.		
CLADOCERANS :		
Leptodora sp.		
Ceriodaphnia sp.		
Daphnia sp.		
ROTIFERS :		
Keratella sp.		
Brachionus sp.		

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Source ; "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.15 FAUNAL SPECIES RECORDED FROM THE PELAGIC MARINE ENVIRONMENT OF THE PROJECT AREA

SCIENTIFIC NAME	STATUS*	REMARKS**
COELENTERATES :		
Physalia sp.		
Medusae		
ARTHROPODS :		
Penaeus monodon		
Penaeus indicus		
Metapenaeus dobsoni		
Portunus pelagicus		
Calanus sp.		
Tigriopus sp.		
Acartia sp.		
Metacaprella sp.		
Sphaeronema sp.		
MOLLUSCS :		
Loligo sp.		
Sepia sp.		
FISH :		
Sardinela melanura		
S. albella		
Chirocentrus nudus		
Amblygaster sirm		
Anchoviella commersoni		
Lates calcarifer		
Tylosurus strongulurus		
Epinephelus tauvina		
Lutianus argentimaculatus		
Leiognathus splendens		
Otolithus ruber		
Mugil cephalus		
Liza ceramensis		
L. oligolepis		
Siganus vermiculatus		
Caranx sp.		
Chorinemus tala		

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** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source : "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABEL A9.16 PHYTOPLANKTON SPECIES RECORDED IN THE MARINE ENVIRONMENT OF THE PROJECT AREA

SCIENTIFIC NAME	STATUS*	REMARKS**
DIATOMS		
Melosira		
Biddulphia		
Nitzchia		
Gyrosigma		
Pleurosigma		
Chaetoceros		
Navicula		
Coscinodiscus		
DINOFLAGELLATES		
Ceratium		
Peridinium		
* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown ** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance		

Source : "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.17 THE SPECIES OF MOLLUSCS THAT INHABIT THE OFF SHORE BENTHIC ENVIRONMENT

SCIENTIFIC NAME	STATUS*	REMARKS**
Afrocarduim latum		
Anadra maculosa		
A. pilula		
A. satowi		
A. troscheli		
Arca boucardi		
Architechtonica laevigata		
Barbatia bicolorata		
Cardita variegata		
Chama dunkeri		
Decatopecten striatus		
Erronea errones		
Fulvia asiatica		
Hydatina physis		
Murex ternispina		
Neohaustator columnaris		
Olivia ispidula		
Pitar striata		
Peribolus depressus		
Trochus callicoccus		
T. radiatus		
Turritella duplicata		
Varticardium lacunosum		
Virroconus ebraeus		
* E = Endangered, VR = Very Rare, R = Rare, C = Common, VC = Very Common, SU = Status Unknown ** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance		

Source : "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

TABLE A9.18 ORGANISMS RECORDED FROM THE NEAR SHORE REEF

ENGLISH NAME	STATUS*	REMARKS**
MARINE MACROPHYTES		
Ulva		
Laminaria		
Sargassum		
Chaetomorpha		
Velonia		
Halimeda		
Valoniopsis		
CRUSTACEANS		
Balanus sp.		
Amphipod		
Isopod		
ANNELIDS		
Nereid worm		
MOLLUSCS		
Mytilus edulis		
Clypidina notata		
Trochus radiatus		
Cellana radiata		
Drupa granulata		
D. serrialis		
ECHINODERMS		
Echinus sp.		
Star fishies		
Sea cucumbers		
Brittle stars		
FISH		
Banded moray eel		
Goby		

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** END = Endemic species, THR = Threatened species, PRO = Protected under Wildlife Ordinance

Source : "Proposed LPG Import Terminal - Sri Lanka at Kerawalapitiya EIA Report" (1996)

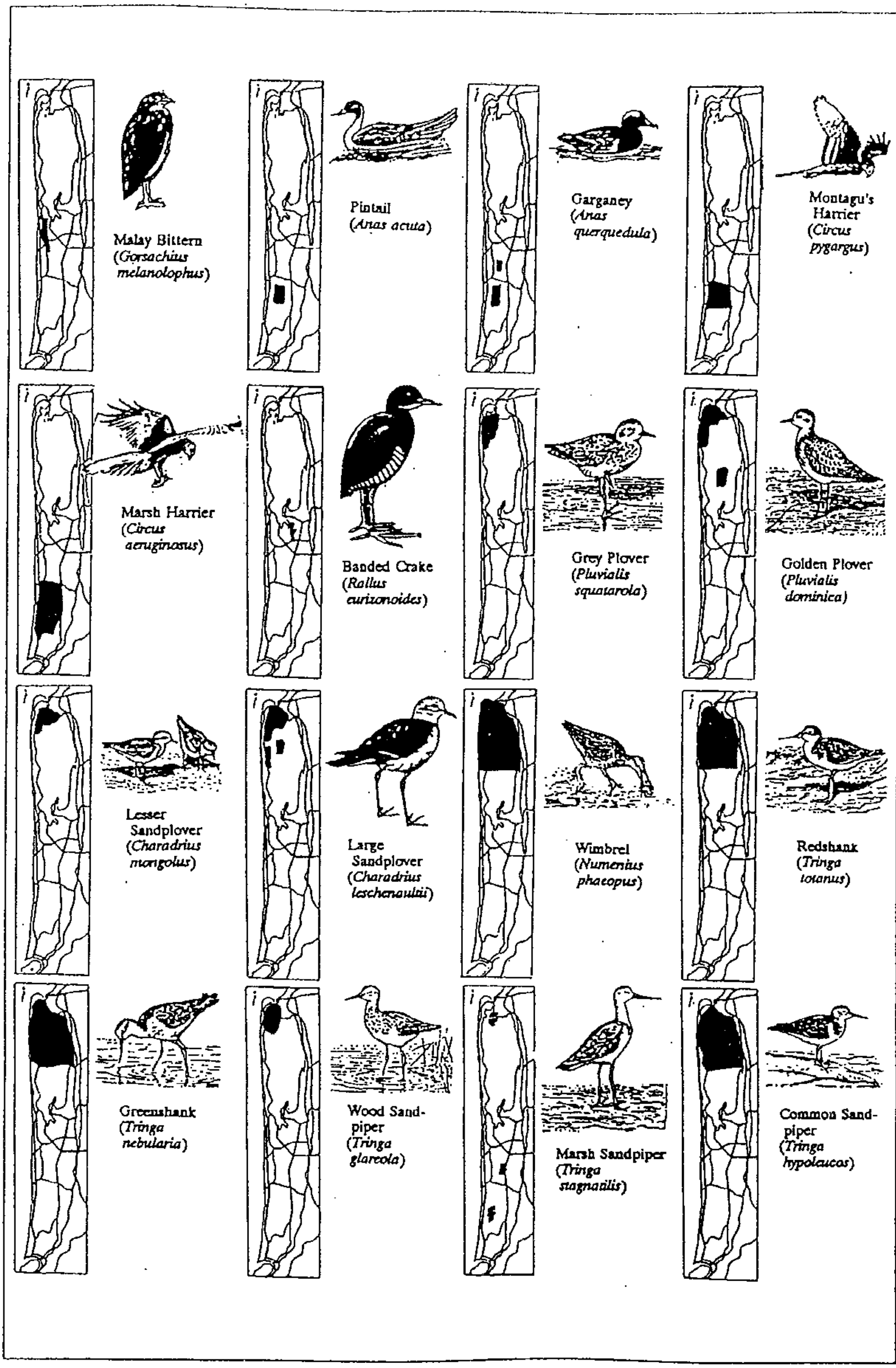


Figure A9.1 (1) Distribution of Migrant Birds in the Muthurajawela Marsh - Negombo Lagoon Wetland (De Silva 1990)

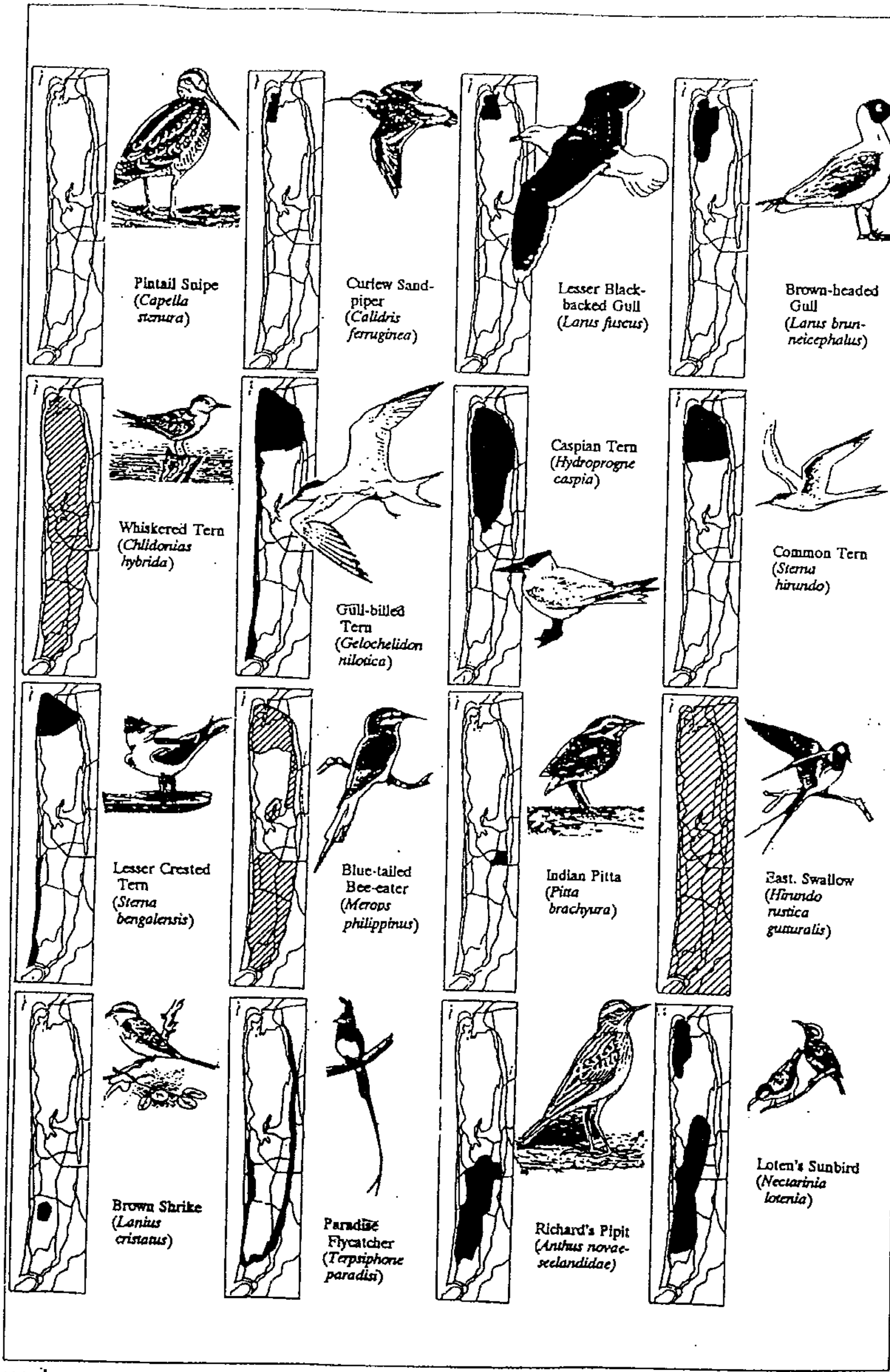


Figure A9.1 (2) Distribution of Migrant Birds in the Muthurajawela Marsh - Negombo Lagoon Wetland (De Silva 1990)

ANNEX 10 大気拡散予測

ANNEX 11 騒音予測

NOISE LEVEL ESTIMATION WORK FOR COMBINED CYCLE POWER PLANT PROJECT AT KERAWALAPITIYA

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

NOISE LEVEL ESTIMATION WORK FORCOMBINED CYCLE POWER PLANT PROJECT AT KERAWALAPITIYA

1. Construction Phase

1.1 Noise from Traffic

During the construction, proportion on the current traffic rate by vehicles related to the project is estimated less than 0.5 % as shown below in Table 1.1. Therefore, the construction vehicles will not give significant impact on the ambient noise level.

Table 1.1 Increase Ratio by Construction Vehicles During Construction Phase

	Current Traffic			Construction Vehicles			Increase Ratio (%)		
	Large	Other	Total	Large	Other	Total	Large	Other	Total
to Colombo	1,539	19,463	21,002	70	20	90	4.5	0.1	0.43
to Pattlam	1,448	18,993	20,441	70	20	90	4.8	0.1	0.44
Both	2,987	38,456	41,443	140	40	180	4.7	0.1	0.43

1.2 Noise from Construction activities

1.2.1 Methodology

The estimation work was implemented using the theoretical propagation equation as shown below.

$$L_A = L_{A0} - 20\, log_{10}(r/r_0)$$

Notice L_A : Noise Level at the estimation point(dB(A))

L_{A0} : Noise Level at the point r_0 m from noise source(dB(A))

r : Distance (m) from noise source to the estimation point, $r_0 < r$

The composition of sound was calculated by the equation as shown below.

$$L_A = 10\, log_{10}(10^{\frac{L_{A1}}{10}} + 10^{\frac{L_{A2}}{10}} + \cdots\cdots + 10^{\frac{L_{Ai}}{10}})$$

Notice L_A : Noise Level composed at the estimation point (dB(A))

L_{Ai} : Noise Level at the sound received point by sound source i (dB(A))

1.2.2 Input Data

Input data to be used for estimation is shown in Table 1.2. These are major noise sources concerned at the maximum construction activity period.

Table 1.2 Kind of Noise Source and Sound Pressure Level

No.	Name	No of Vehicles	Sound Pressure Level (dB(A))							
			63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
①	Earth Auger Machine	2	78	87	93	99	96	89	84	74
②	Back Hoe	2	85	94	89	89	84	80	76	67
③	Dump Track	3	88	99	93	90	91	87	80	17
④	Concrete Truck	2	98	107	101	97	97	96	91	17
⑤	Pile Driver	2	82	88	97	98	104	99	94	90
⑥	Crawler Crane	2	89	86	87	90	84	77	72	69
⑦	Generator	3	98	97	96	87	82	76	72	69
⑧	Vibro Hammer	2	95	100	96	96	95	93	89	17
⑨	Air Compressor	2	92	101	97	92	88	91	92	79

1.2.3 Results

The results of estimation from the construction activity are shown in Table 1.3 and Figure 1.1 below.

The estimated noise levels at the boundary of the proposed power plant site satisfy the limit of the noise level at day time which is 70 dB(A).

Table 1.3 Estimated Noise Level at the Boundary of the Site

Estimation Point (Survey Point)	Estimated Level (dB(A))	Survey Results (Top : Day, Bottom : Night)	Composed Level (dB(A))
① (B)	64	44	64
		40	64
② (C)	62	43	62
		42	62
③ (D)	58	43	58
		42	58
④ (A)	59	43	59
		40	59

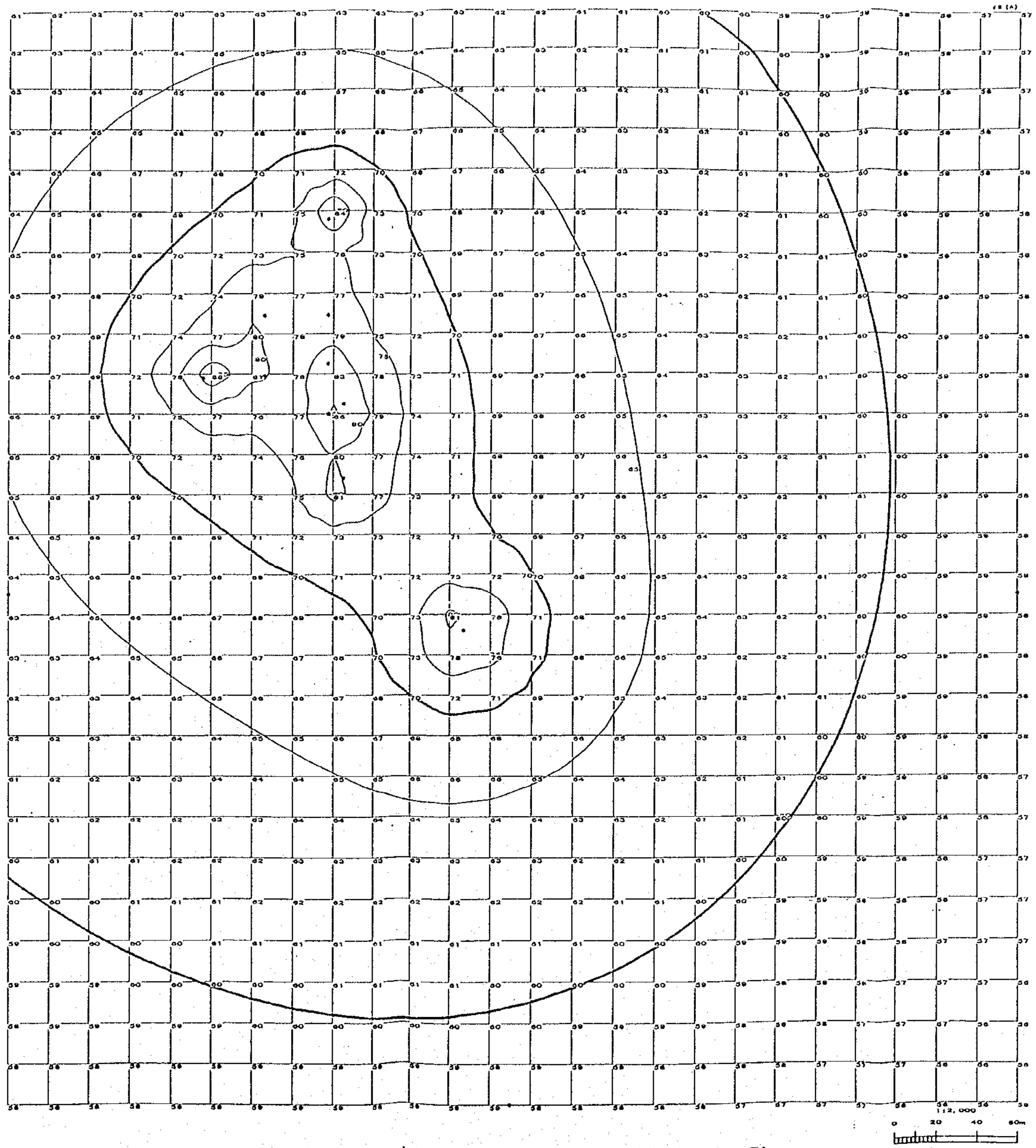


Figure 1.1 Contour of Noise Level Estimation During Construction Phase

2. Operational Phase

2.1 Noise from Traffic

During the operational phase (Regular Inspection Period), proportion on the current traffic rate by vehicles related to the project is estimated less than 0.2 % as shown below in Table 2.1. Therefore, the vehicles related to the power plant will not give significant impact on the ambient noise level.

Table 2.1 Increase Ratio by Vehicles at Regular Inspection Period

	Current Traffic			Vehicles at Regular Inspection Period			Increase Ratio(%)		
	Large	Other	Total	Large	Other	Total	Large	Other	Total
to Colombo	1,539	19,463	21,002	3	32	35	0.2	0.2	0.17
to Pattlam	1,448	18,993	20,441	3	32	35	0.2	0.2	0.17
Both	2,987	38,456	41,443	6	64	70	0.2	0.2	0.17

2.2 Noise from Power Plant Facilities

2.2.1 Methodology

The estimation work was implemented using the theoretical propagation equation as shown below.

$$L_A = L_{A0} - 20\,log_{10}(r/r_0)$$

Notice L_A : Noise Level at the estimation point (dB(A))

L_{A0} : Noise Level at the point r_0 m from noise source (dB(A))

r : Distance (m) from noise source to the estimation point, $r_0 < r$

The composition of sound was calculated by the equation as shown below.

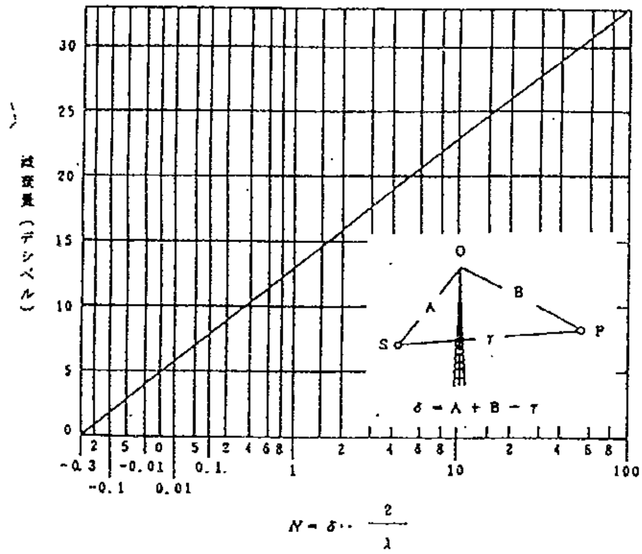
$$L_A = 10\,log_{10}(10^{\frac{L_{A1}}{10}} + 10^{\frac{L_{A2}}{10}} + \cdots + 10^{\frac{L_{Ai}}{10}})$$

Noise L_A : Noise Level composed at the estimation point(dB(A))

L_{Ai} : Noise Level at the sound received point by sound source i (dB(A))

Moreover, Fuel tanks, Fuel Oil Treatment Facility, P.R. Building and Service Building were considered as barriers, and noise reduction was taken into account.
The noise reduction was obtained by the figure below in Figure 2.1 with calculating Fresnel Number on every frequencies from the difference (δ) between the direct route of the source - the estimation point and the barrier diffraction route.

Figure 2.1 Noise Reduction



2.2.2 Input Data

Major sources of noise from the power plant during the operational phase are gas turbines, main transformers, heat recovery steam generators, etc. Input data to be used for estimation is shown in Table 2.2.

Table 2.2 Kind of Noise Source and Sound Pressure Level

No.	Name	Sound Pressure Level (dB(A))							
		63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
①	GT. Air Intake	87	88	84	86	88	93	91	89
②	GT. Air Intake	87	88	84	86	88	93	91	89
③	GT. Exhaust	96	93	79	81	84	77	84	85
④	GT. Exhaust	96	93	79	81	84	77	84	85
⑤	Main Transformer 1	48	80	88	84	86	78	71	69
⑥	Main Transformer 2	48	80	88	84	86	78	71	69
⑦	Main Transformer 3	48	80	88	84	86	78	71	69
⑧	HRSG1-1	93	95	90	71	57	53	49	43
⑨	HRSG2-1	93	95	90	71	57	53	49	43
⑩	GT. Building	76	81	78	86	85	72	66	56
⑪	ST. Building	76	81	78	86	85	72	66	56

2.2.3 Results

The results of estimation from the power plant during operational phase are shown in Table 2.3 and Figure 2.2.

The estimated noise levels at the boundary of the proposed power plant site satisfy the limit of the noise level which is 70 dB(A) at day time and 60 dB(A) at night time.

Table 2.3 Estimated Noise Level at the Boundary of the Site

Estimation Point (Survey Point)	Estimated Level (dB(A))	Survey result (Top : Day, Bottom : Night)	Composed Level (dB(A))
① (B)	49	44	50
		40	50
② (C)	50	43	51
		42	51
③ (D)	45	43	47
		42	47
④ (A)	43	43	46
		40	45

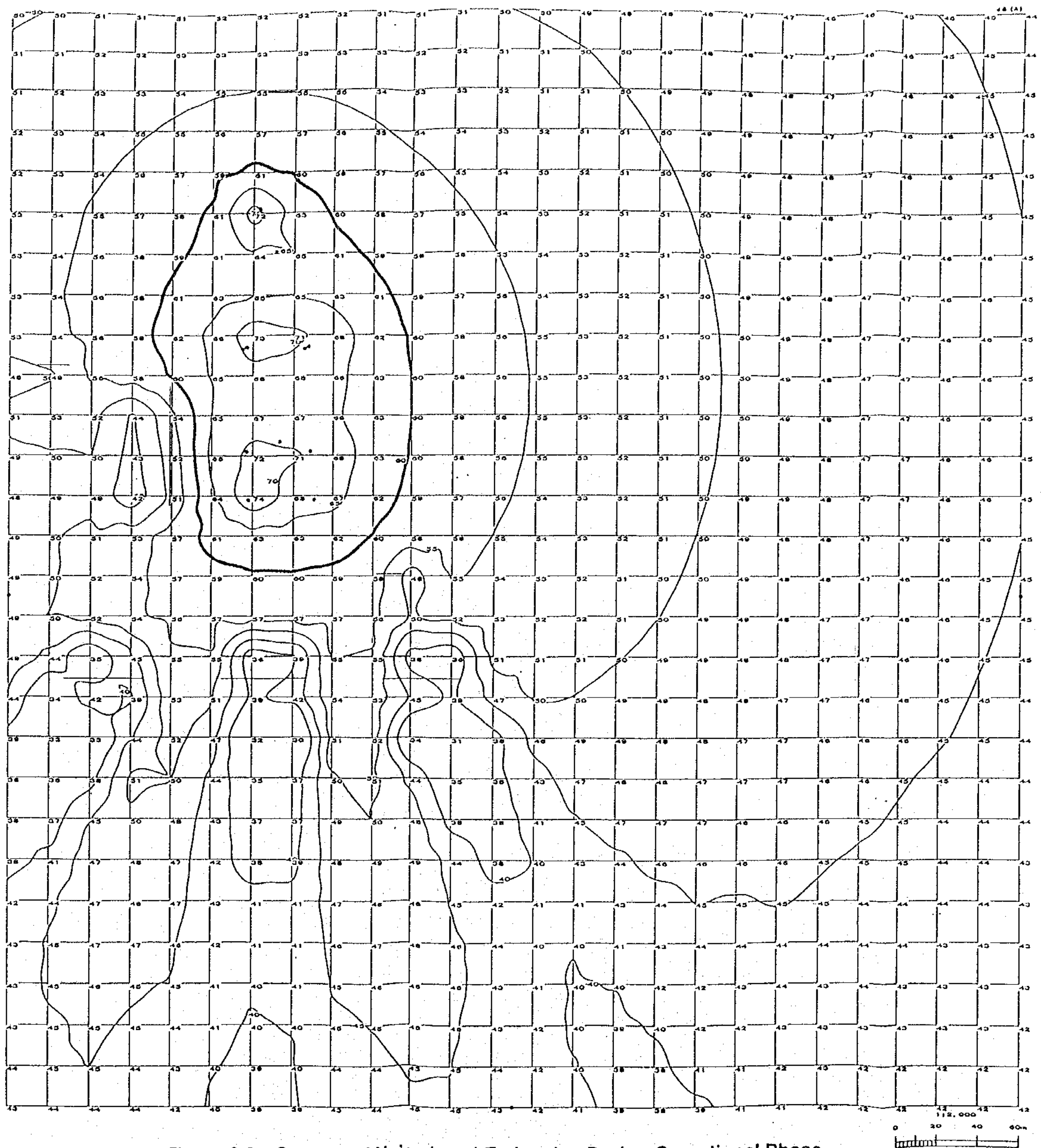


Figure 2.2 Contour of Noise Level Estimation During Operational Phase

ANNEX 12 温排水拡散予測(LHI)

COOLING WATER DISPERSION STUDY
FOR
THE COMBINED CYCLE POWER PLANT PROJECT
AT KERAWALAPITIYA

August 1998

JAPAN INTERNATIONAL AGENCY
STUDY TEAM OF THE FEASIBILITY STUDY ON KERAWALAPITIYA
COMBINED CYCLE POWER PLANT DEVELOPMENT

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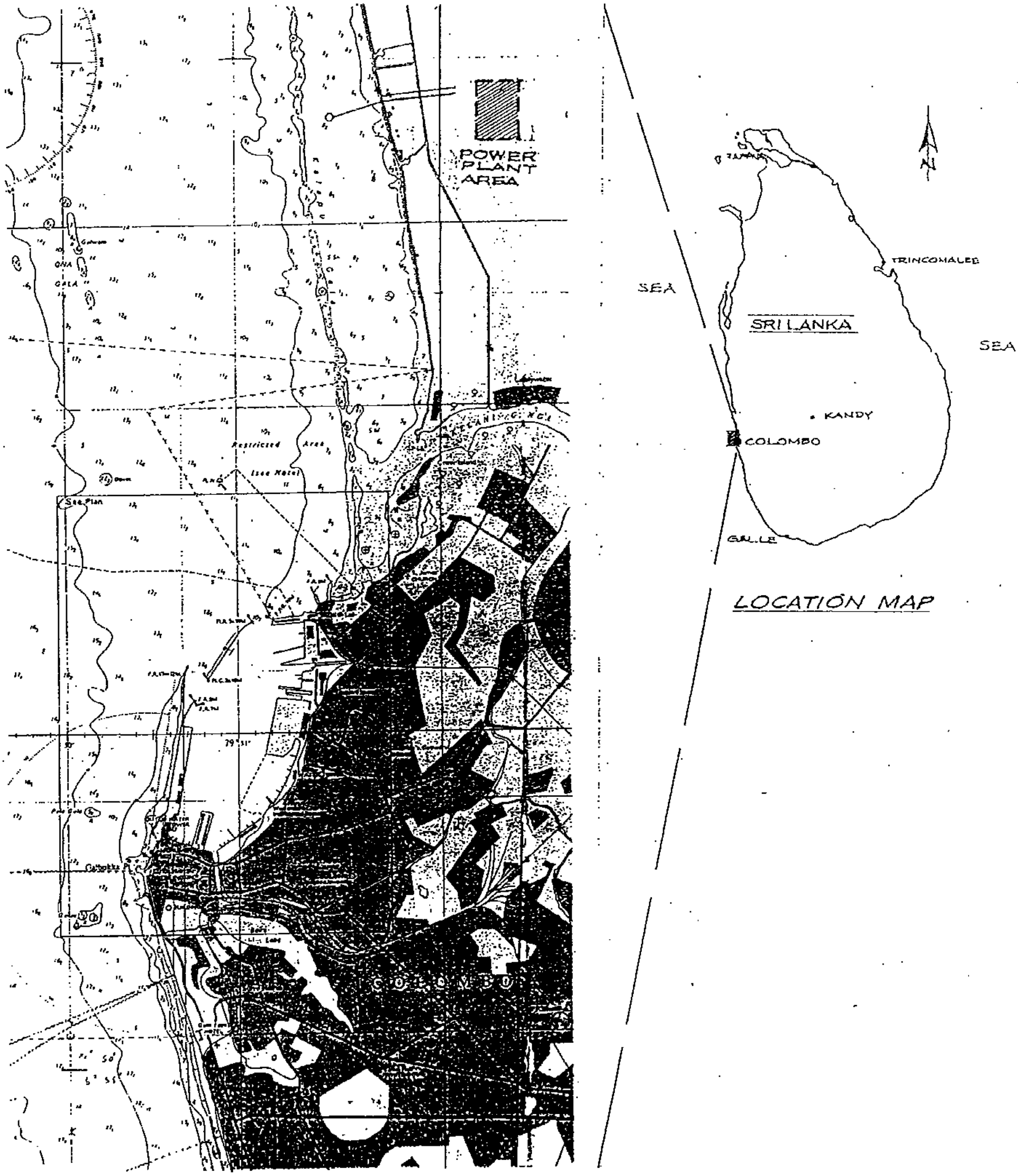
1. INTRODUCTION

1.1 Project Background

It is proposed that a Combined-Cycle Thermal Power Plant be set up at Kerawalapitiya. The feasibility of the proposed plant is being studied by the Tokyo Electric Power Services Co. Ltd. (TEPSCO) of Japan. The study is funded by the Japan International Co-operation Agency (JICA). The location of the proposed power plant on the West Coast is shown in Figure 1.1 . The planned power output is 150 MW.

1. 2 Scope of this Report

The study is carried out using the model CORMIX3, which is recommended by the US EPA for the type of discharge proposed. It should be mentioned here that the model results presented are for the near-field only and are based on a highly simplified representation of the ambient velocity and geometry.



SCALE. 1: 60.000.

Figure 1.1 Proposed Site for the Thermal Power Plant

2. OBJECTIVES AND STUDY PARAMETERS

2.1 Objectives

The objective of the study is to obtain the near-field temperature distribution for the cases listed in section 2.4. The results are to be presented as contour plots of surface excess temperature, with the lowest value being 1 degrees above the ambient.

2.2 Project Layout

The proposed layout of the project is shown in Figure 2.1. The power plant is located about 1 km from the shore. The cooling water intake is located 400 m from the shore at a location where the depth is around 7 m. The intake head is located 4.5 m below the water surface. The warmed cooling water is discharged through a rectangular culvert located on the shoreline.

2.3 Discharge Parameters

The discharge parameters were specified in terms of the discharge flow rate, temperature and dimensions of the discharge channel. These parameters are listed in the table below, together with the discharge velocity, which is a critical parameter when considering the dilution.

Discharge Flow Rate (m3/s)	Temperature (deg C above ambient)	Discharge Channel Dimensions	Discharge Velocity (m/s)
3.6	10	5.9 m x 1.2 m	0.5

Table 2.1 Expected Flows of Cooling Water

2.4 Cases to be Studied

The case was for the simulation of the following four ambient conditions.

a) South-west Monsoon - with historical maximum Kelani Ganga discharge
b) South-west Monsoon - typical conditions
c) Inter-monsoon Period - typical conditions
d) North-east Monsoon - typical conditions

The water temperature and salinity measurements, scheduled for the north-east and south-west monsoon, and water velocity measurements, scheduled for the north-east monsoon only, were to be used to define the ambient conditions.

These four cases were specified to account for the seasonal variability of the ambient conditions. The most important data requirements of CORMIX3, described in detail in Chapter 3, for the ambient conditions are the representative velocity and the density profile. The velocity will differ from season to season based on the wind regime, while the density structure, i.e., whether the ambient fluid is stratified or unstratified will depend primarily on whether the discharge from the Kelani Ganga is high or low and to a lesser extent the wave and wind climate.
Therefore it was decided to use the field data and the results of other studies to estimate parameters for the following flow conditions.

a) South-west Monsoon - high river discharge
b) South-west Monsoon - low river discharge
c) Inter-monsoonal period
d) North-east monsoon

Flow condition were shown in Table 2.1.

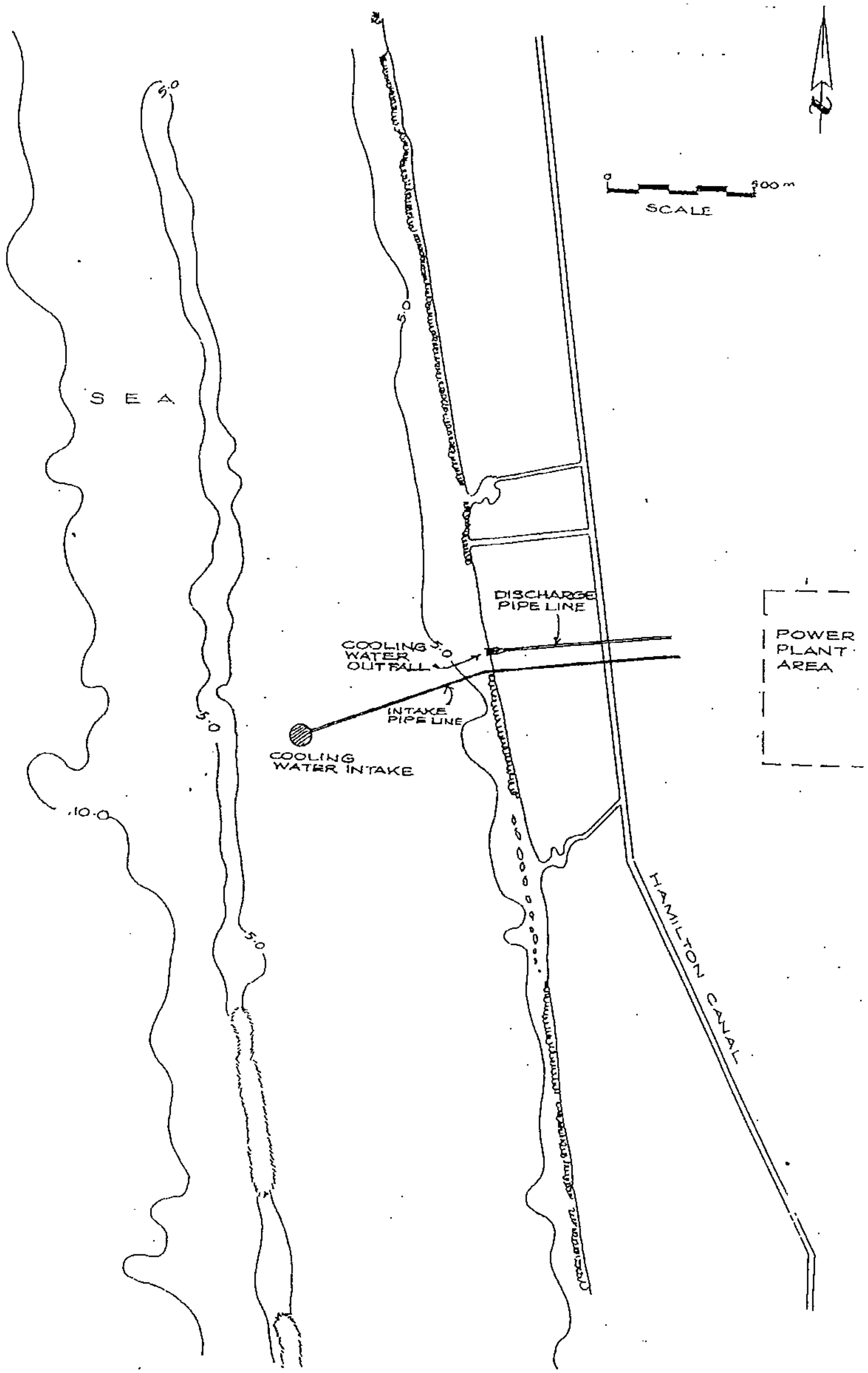


Figure 2.1 Proposed Layout of Cooling Water Intake and Discharge

3. Modelling Procedure

3.1 Description of CORMIX3

The Cornell Mixing Zone Expert System (CORMIX) is a general purpose software system for the analysis of aqueous discharges of various types of wastewater into diverse water bodies. The system was developed by researchers from Cornell University, with funding mainly from the U.S Environmental Protection Agency (EPA). Continuous improvement of the system is performed under an on-going EPA contract. The most recent release, Version 3.2, dated December 1996, is used in this study.

The model is recommended by the EPA and distributed by the EPA Centre for Environmental Exposure Modelling. A subset of this system, known as CORMIX3, has been developed for buoyant surface discharges. In general, Jones et al. (1996) estimate that CORMIX3 is applicable to about 90% of the buoyant horizontal discharges found in practice.However, it must be clearly understood that CORMIX 3 is primarily a near-field model. The very simplicity of the model requires input data that may be an over simplification of the actual situation.

3.2 Data Requirements for CORMIX3

The input data required by CORMIX3 can be divided into two sets - ambient data and discharge data. The data requirements for each set, with the values to be used for this study, are given below.

Ambient Data

1) Geometry - there are several entries needed here

   a) Laterally Bounded or Unbounded Water Body - as the receiving body is the ocean it seems that an unbounded water body should be specified. However, the presence of the sandstone reef has to considered. The selection is discussed in the next chapter.

   b) Depth - only a single value of the depth can be specified for the entire water body. The selection of an appropriate representative value will be discussed in the next chapter.

2) Flow - the following information is needed

a) Steady or Tidally Reversing - CORMIX3 assumes a steady state. Therefore all the simulations will be done for steady flow. The effect of tidally reversing flows on the near-field dilution will be considered separately.

b) Cross-flow Velocity - only a single value can be specified. This is assumed to apply uniformly everywhere. The selection of an appropriate value is described in the next chapter.

3) Fluid

a) Stratified or Unstratified - The density structure of the water body has to be specified as uniform (unstratified) or stratified (two possible profile shapes). This specification is developed in the next chapter, based on the field data.

b) Density - the density depends on the salinity and the temperature. The density will be based on the field measurements.

4) Other Parameters

a) Friction Factor - a single value of the friction factor must be specified. A value of 0.025 (Darcy friction factor) was used.

b) Wind Speed - a single value must be specified. No wind was specified.

c) Heat Loss Coefficient - a single value must be specified. A value of zero, i.e. no heat loss, was given.

Discharge Data

1) Location - All the cases specify a right bank discharge to aid the comparison of the results.
2) Type of Discharge - In the present study the shoreline discharge is a Flush Discharge.
3) Angle of Discharge - A value of 90 degrees is used
4) Discharge Channel Geometry - Rectangular Channel - the width and depth is given.
5) Water Body Geometry near Discharge - as most horizontal discharges are from close to the bank the geometry near the discharge may be quite different from the representative value for the entire water body. Therefore the following specifications are allowed
   a) Depth near Discharge
   b) Bottom Slope near Discharge
6) Effluent Parameters
   a) Effluent Density - The effluent density was specified based on the properties of the bottom layer (where the intake is located) and taking into account the specified rise in temperature.

b) Discharge - the discharge was specified by the volume flow rate.

4. Selection of Representative Parameters for CORMIX3

The input data needed by CORMIX3 was described in detail in the preceding chapter. The values for all these parameters that will be used in the present study will be listed and justified in this chapter. The appropriate values are usually quite obvious. The parameters that are the same for all cases, or are fixed by specification, are listed first. The most critical parameters are the ambient depth, velocity and density structure. These have to be derived for the various flow conditions by considering available field data and experience from other projects. This is done in section 4.2 .

4.1 Parameters

These include the geometry of the receiving body, the geometry and other parameters of the discharge and other physical parameters. All the parameters except the representative velocity and density structure will be considered here.

Geometry of the Receiving Body

Three profiles, normal to the shoreline, are shown in Figure 4.1 . The profiles are taken from the region just to the north of the proposed discharge location. This region is considered because the ambient flow is expected to be mostly to the north. The profiles show that the depth drops off quite sharply to about 5 m and then gradually increases to about 8 m . The offshore reef is located about 900 m from the shore and rises up to a depth of 4 m to 5 m .

The first decision is whether the water body should be specified as bounded or unbounded. If the discharge is well mixed over the depth, the presence of the offshore reef may act as a boundary to the flow. However, all the simulations show that the discharge is limited to a surface layer that is only about 1 m to 2 m thick when it reaches the reef. Therefore the water body can be considered to be unbounded.

The depth of the water body is specified by a representative depth, an intermediate depth and a depth near the discharge. Based on Figure 4.1 and previous experience, these values are taken to be 8 m, 6 m and 1.5 m, respectively. Finally, the model also uses a value for the bottom slope near the discharge. The bottom slope can be defined differently by using different distances. The values of the profiles shown range from 0.7 degrees to 1.7 degrees. An average value of 1.2 degrees is selected.

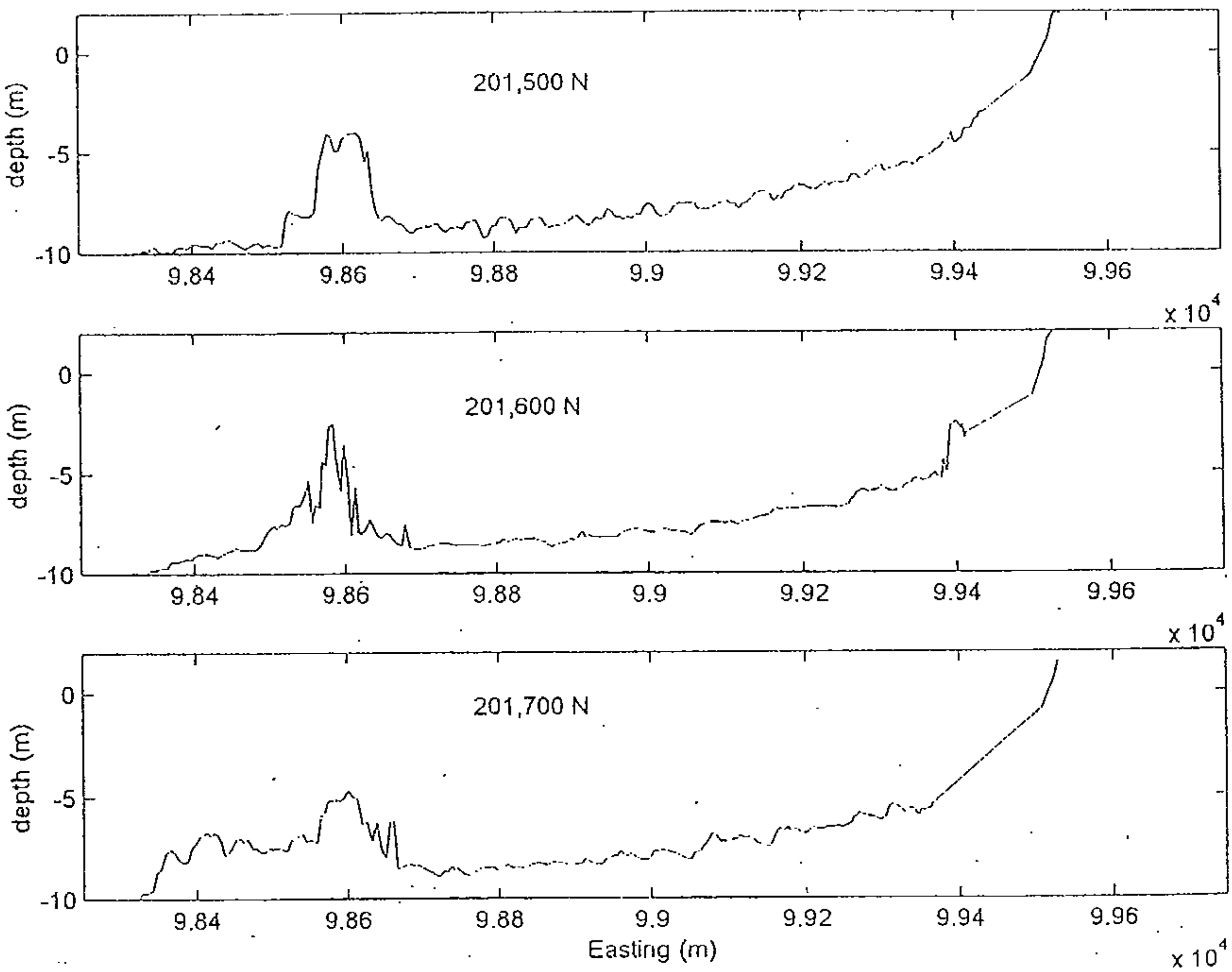


Figure 4.1 Shore Profiles at 201,500 N, 201,600 N and 201,700 N

Geometry of the Discharge

The discharge is flush with the shore and oriented at a 90 degree angle to the shore. The discharge is rectangular with dimensions given by Table 2.1 (which is shown again as Table 4.1 here for convenience). The table also shows the discharge flow rates, velocities and the increase in temperature.

Discharge Flow Rate (m3/s)	Temperature (deg C above ambient)	Discharge Channel Dimensions	Discharge Velocity (m/s)
3.6	10	5.9 m x 1.2 m	0.5

Table 4.1 Expected Flows of Cooling Water

Other Parameters

These include the friction factor, the wind speed and the heat loss coefficient. The same values are used for all the simulation. A Darcy-Weisbach friction factor of 0.025 is used. The wind speed and heat loss coefficients are set to zero, thereby making the results for the temperature distribution conservative.

4.2 Representative Velocity and Density Structure

These values will be based on field measurements as much as possible. These measurements were made at the location shown in Figure 4.2.

Representative Velocity

The velocity was measured for about 17 days from 28/02/1998, i.e., during the north-east monsoon. The time series of the shore-parallel and shore-normal velocities and the water level are shown in Figure 4.3. The velocity is presented in this manner as it is the shore parallel velocity that affects the spread of the plume.

The figure shows that the velocity variation matches the water level change closely, indicating that the velocity is dominated by tidal effects. The first half of the record shows velocity variations with about 0.5 days periods and magnitudes of 5 cm/s while the second half shows variations with periods of about 1 day and magnitudes of 10 cm/s or more.

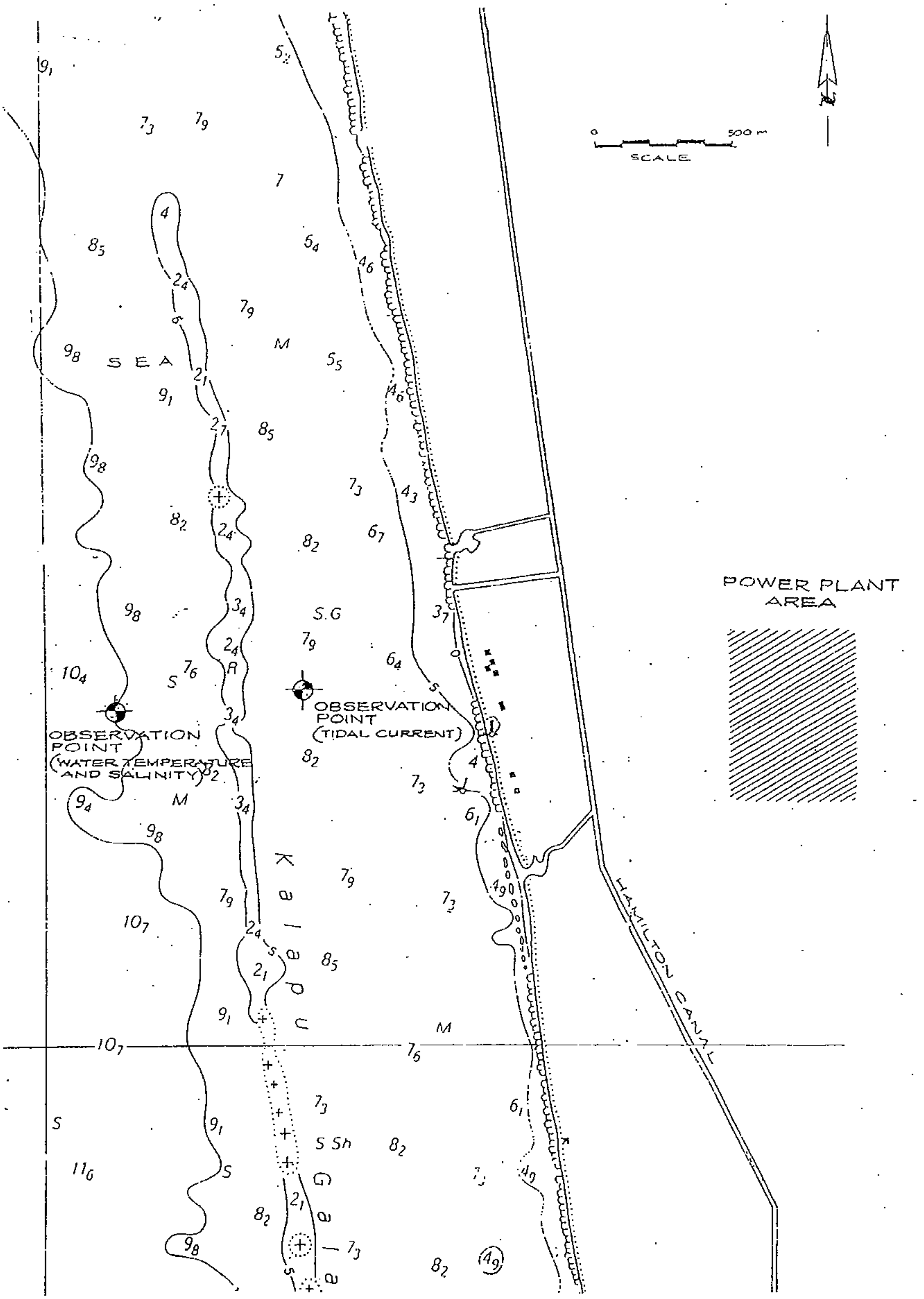


Figure 4.2 Location of Velocity and Temperature/Salinity Measurements

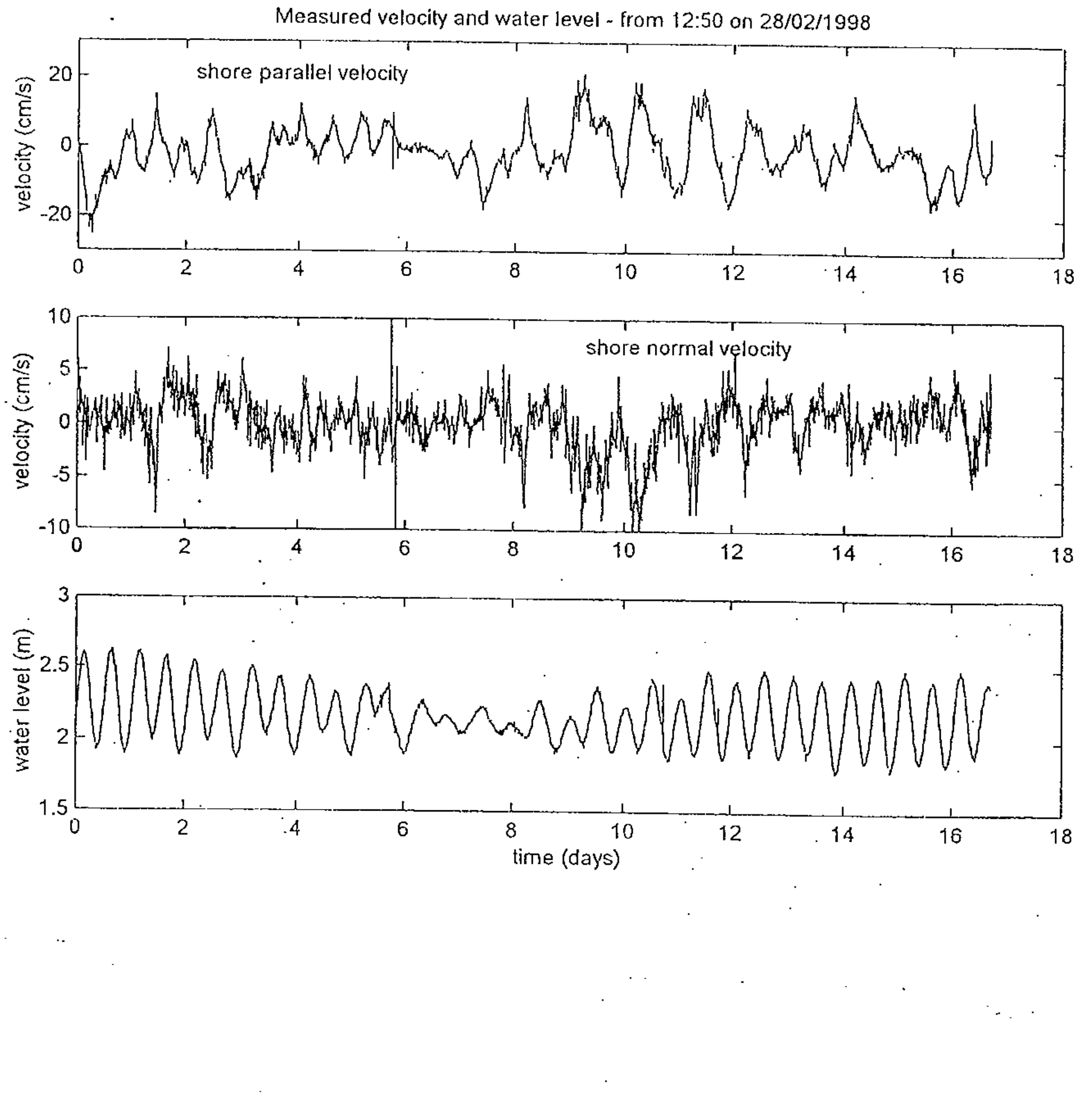


Figure 4.3 Time Series of Measured Velocity and Water Level

The overall average shore parallel velocity is about 1.5 cm/s . As CORMIX3 requires an average velocity, this value will be taken as representing the north-east monsoon. However, the domination by tidal effects suggests that a steady state model may not be applicable in this case. The effect of a tidally varying flow on the spread of the plume is shown in section 5 .

As the velocity measurement was not repeated, there is no field data from which the representative velocity for the other three conditions listed in Chapter 2 can be estimated. However, other available data indicate that the average velocities would be higher at other seasons. Based on this information the representative velocity during the Inter-monsoonal periods is taken to be 5 cm/s, while values of 5 cm/s and 10 cm/s are considered representative of the South-west Monsoon period.

Representative Density

The temperature and salinity at the location in Figure 4.2 were measured three times using three sensors at the top, middle and bottom of the water column. The results of the temperature and salinity measurements are converted into time series of density. These are presented in Figures 4.4, 45 and 4.6, for the three deployments carried out. The three figures are presented using the same density range to aid comparison.

In the first deployment, Figure 4.4, the middle sensor did not function, while the bottom sensor yielded only one day of data. The figure shows that the density is nearly the same, i.e., the sea is not stratified. In the second deployment, Figure 4.5, the top sensor only worked for one day and the bottom sensor was affected by bottom sediment during the deployment. Nevertheless, the figure shows clearly that three values are nearly the same, showing that the sea is not stratified.

The conclusion that can be made from the data in the first two figures is that the sea is not stratified during the north-east monsoon and the inter-monsoonal period. Therefore a constant density is specified. As the model results depend on the difference in density between the ambient water and the discharge rather than the actual values, the exact value selected is not critical. The specified temperature increase in the discharge will maintain the required density difference. Based on the data from the first two deployments, the ambient sea water is taken to have a salinity of 32.5 units and a temperature of 30 degrees C, so that the ambient density is 1019.86 kg/m^3 .

In contrast, the data from the third deployment, Figure 4.6, shows that there is distinct stratification. The density of the top layer falls below 1015 kg/m^3 on occasion, while the density at the middle is also significantly affected. The occurrence of stratification is clearly correlated with intermittent high discharge from the Kelani Ganga that took place during the measurement period. Therefore, a two layer ambient density structure must be specified for the south-west monsoon.

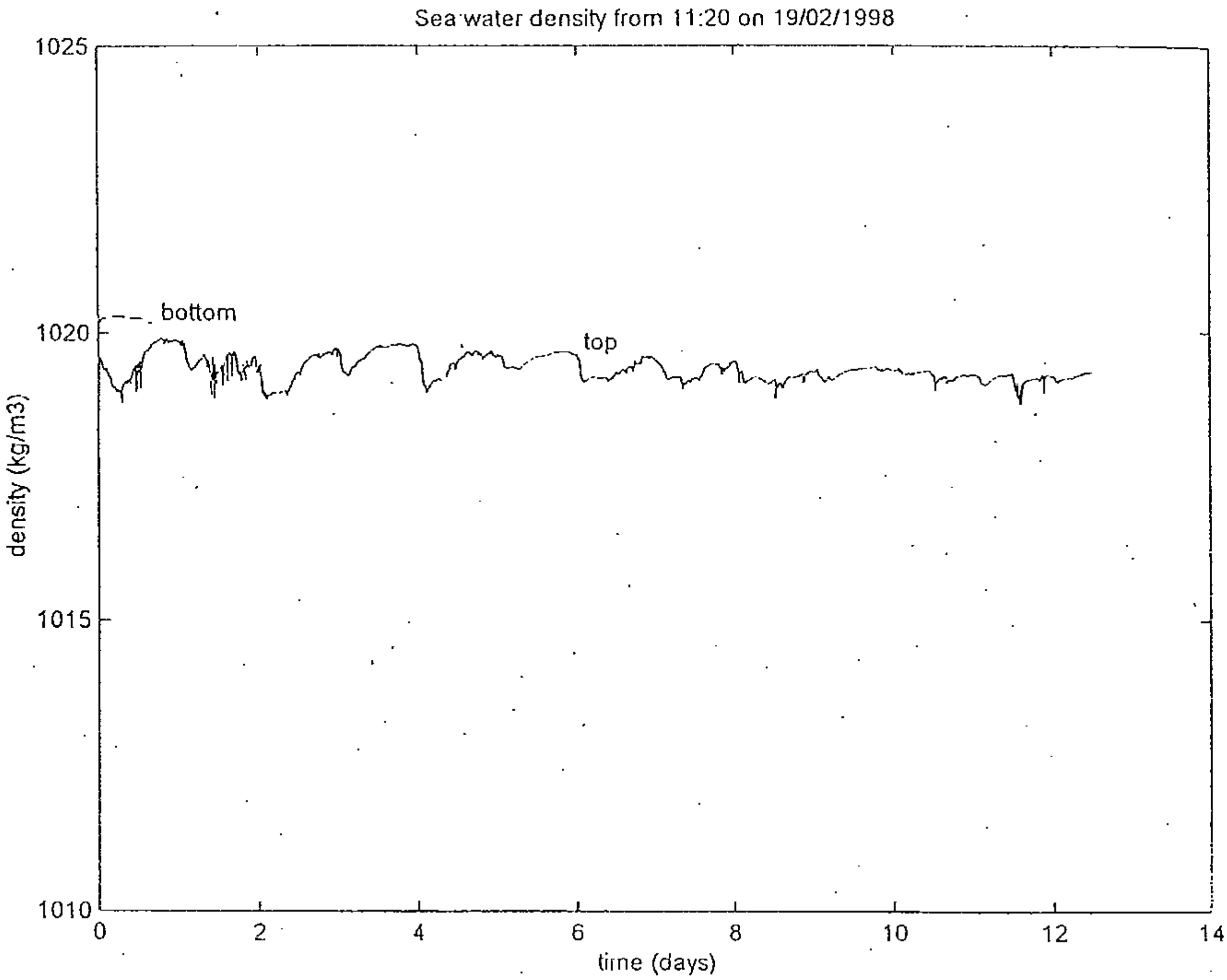


Figure 4.4 Measured Density Variation - First Deployment

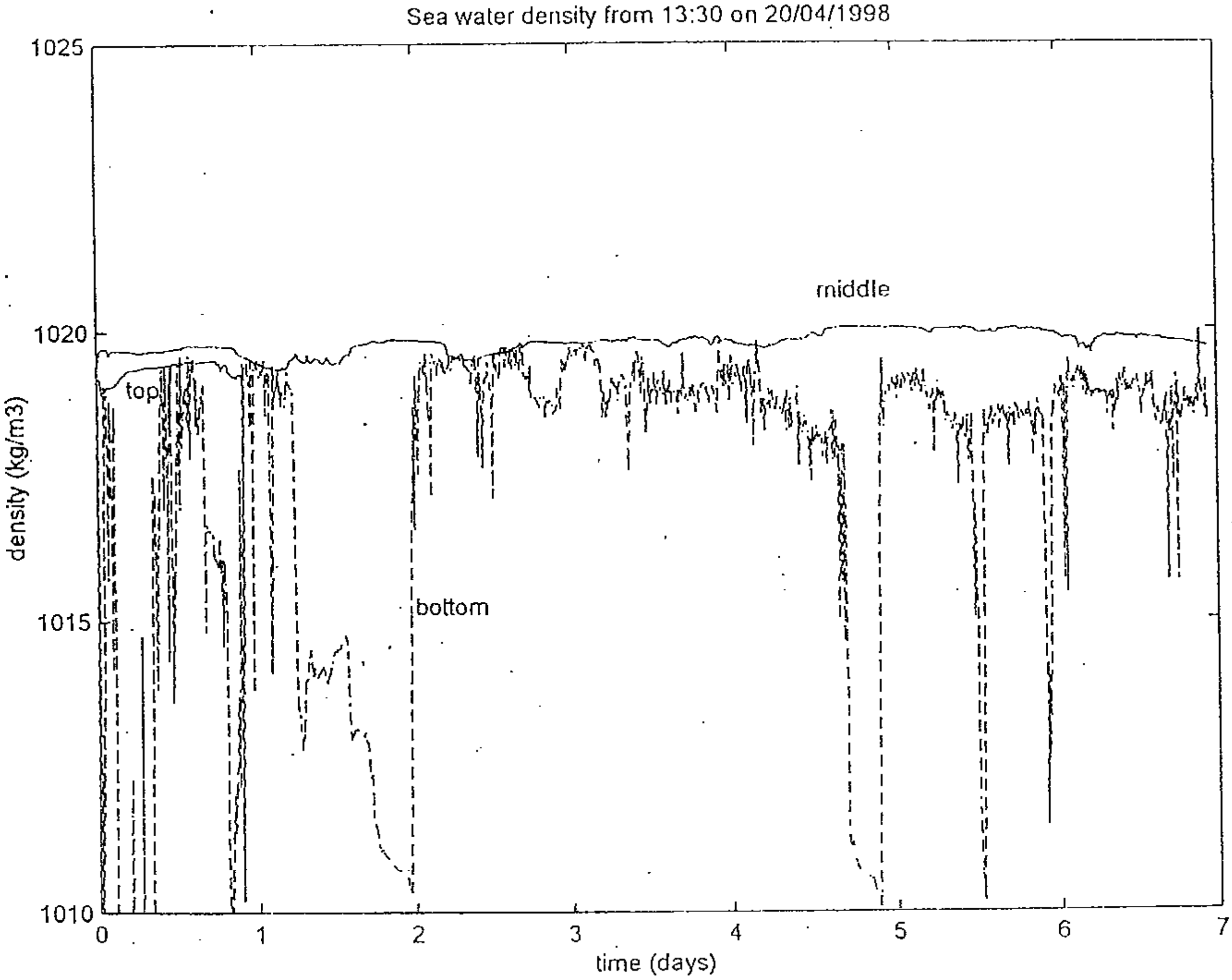


Figure 4.5 Measured Density Variation - Second Deployment

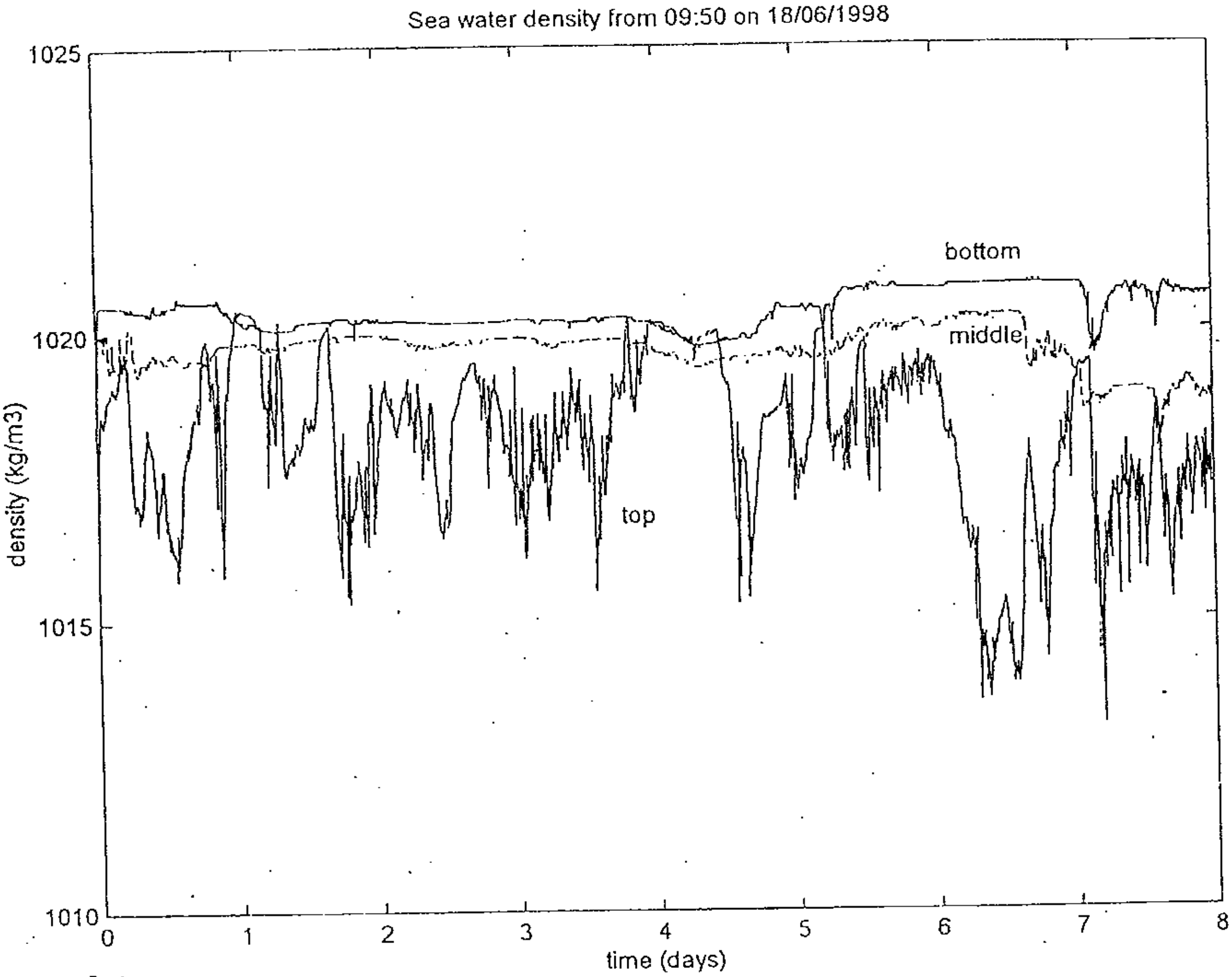


Figure 4.6 Measured Density Variation - Third Deployment

4.3 Summary of Simulations to be Performed

The requirement for this study was to carry out simulations that represented the variation of the ambient velocity and density over the year. The extent of this variation was obtained from the field data. The density structure can be obtained with a high degree of confidence as three deployments over three seasons, including a period of heavy river flow were done. However, the estimate of velocity outside the north-east monsoon remain somewhat speculative as no measurements were made. Based on the analysis of this data and other information, six cases are selected, one each for the north-east and inter-monsoonal periods and four for the south-west monsoon. The representative velocity and density are summarised in Table 4.2 .

Flow Case	Monsoon	Velocity (cm/s)	Stratification	Ambient Density (kg/m^3)	Top Layer Thickness (m)	Discharge Density (kg/m^3)
NE	North-east	1.5	no	1019.86	-	1016.12
IM	Inter-monsoon	5	no	1019.86	-	1016.12
SW1	South-west	10	no	1019.86	-	1016.12
SW2	South-west	5	medium	bottom - 1019.86 top - 1017.84	2	1016.12
SW3	South-west	5	high	bottom - 1019.86 top - 1016.32	3	1016.12
SW4	South-west	10	medium	bottom - 1019.86 top - 1017.84	2	1016.12

Table 4.2 Representative Ambient Velocities and Density Structures

The first three cases have a uniform density and three different velocities. As discussed above, the same ambient density is as the specified temperature increase will make sure that the density difference in correct. The next three cases are stratified, with a two layer density being specified. Here too the bottom layer density is set to the same value used in the first three cases to facilitate the comparison of the results. The fourth and sixth cases are based on the field data while the fifth case is an estimate for very high river flows. As the intake is situated in the bottom layer, the discharge density will be the same for all cases (assuming a temperature increase of 10 degrees).

These flow cases will be used to simulate the discharge conditions of Cases A.

5. RESULTS OF THE SIMULATIONS

The results of the simulations outlined in the preceding chapter will be presented in this chapter. The results will be presented as contour plots of excess surface temperature, with a contour interval of 1 degrees. When the flow is stratified, the surface may be somewhat warmer than the bottom. However, the analysis of field data shows that the principal cause of stratification is a reduction of surface salinity caused by the river discharge. Therefore, a uniform density is assumed for the purpose of presenting the results.

The contour plots are presented within the required boundaries, i.e., 1500 m off shore and 2500 m downstream. Some irregularities in the contours are due to the sudden transition between various modules of CORMIX3. Another important feature of the discharge plume, in addition to its spread, is the depth of the plume. According to the past investigation results for the dispersion of warm water、 it can be only reached to the depth below 1 m and not over 2m in depth in case of 5m 3/sec as out put volume size、 though horizontally it will dispersed wider area。 Therefore、 the expectation is that the plume will be on the surface and not mix down to the level of the intake.

The excess temperature contours for the six flow cases for discharge Case A are presented in Figures 5.1 to 5.6 . The three unstratified cases are in Figures 5.1, 5.2 and 5.3, where the velocities are 1.5, 5 and 10 cm/s, respectively. In Figure 5.1, with the lowest velocity, the flow is initially a weakly deflected jet, a region which extends about 400m offshore.

In Figures 5.2 and 5.3 the cross-flow is increased. The result is a shortening of the jet region and quicker attachment to the shore. In Figure 5.3, the discharge does not extend more than 1000 m from the shore.

When the ambient sea water is stratified, the flow patterns are quite different. In Figures 5.4 and 5.5, which have the same cross-flow as Figure 5.2, the jet region is longer in extent. This is because the surface layer is lighter than in the unstratified case, so that the dissipation of momentum is slower. The stronger jet results in the 1 degree contour being a little further from the shore than before. In flow case SW2, high stratification, in Figure 5.5, the model results are limited to about 200 m offshore. This is because the discharge density is only slightly lighter than the surface layer (see Table 4.2). After a little mixing the density of the discharge and surface become the same, the discharge is no longer buoyant and CORMIX3 is not applicable.

The results of Figure 5.6 should be compared with those of Figure 5.3 . The plume spread is much smaller than before and, as a result, the dilution is much slower.

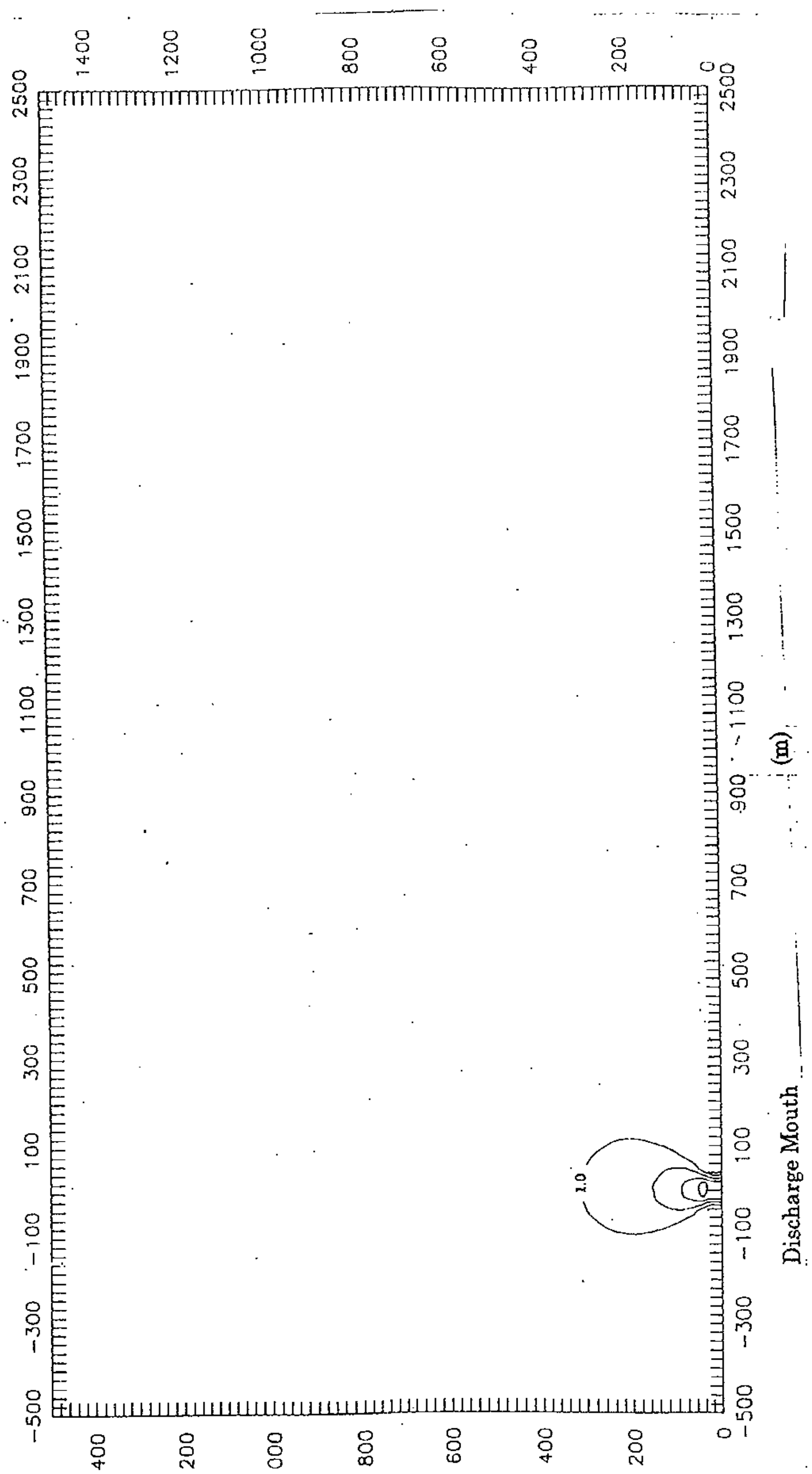


Figure 5.1 Temperature Contours for Case A - Flow Case NE

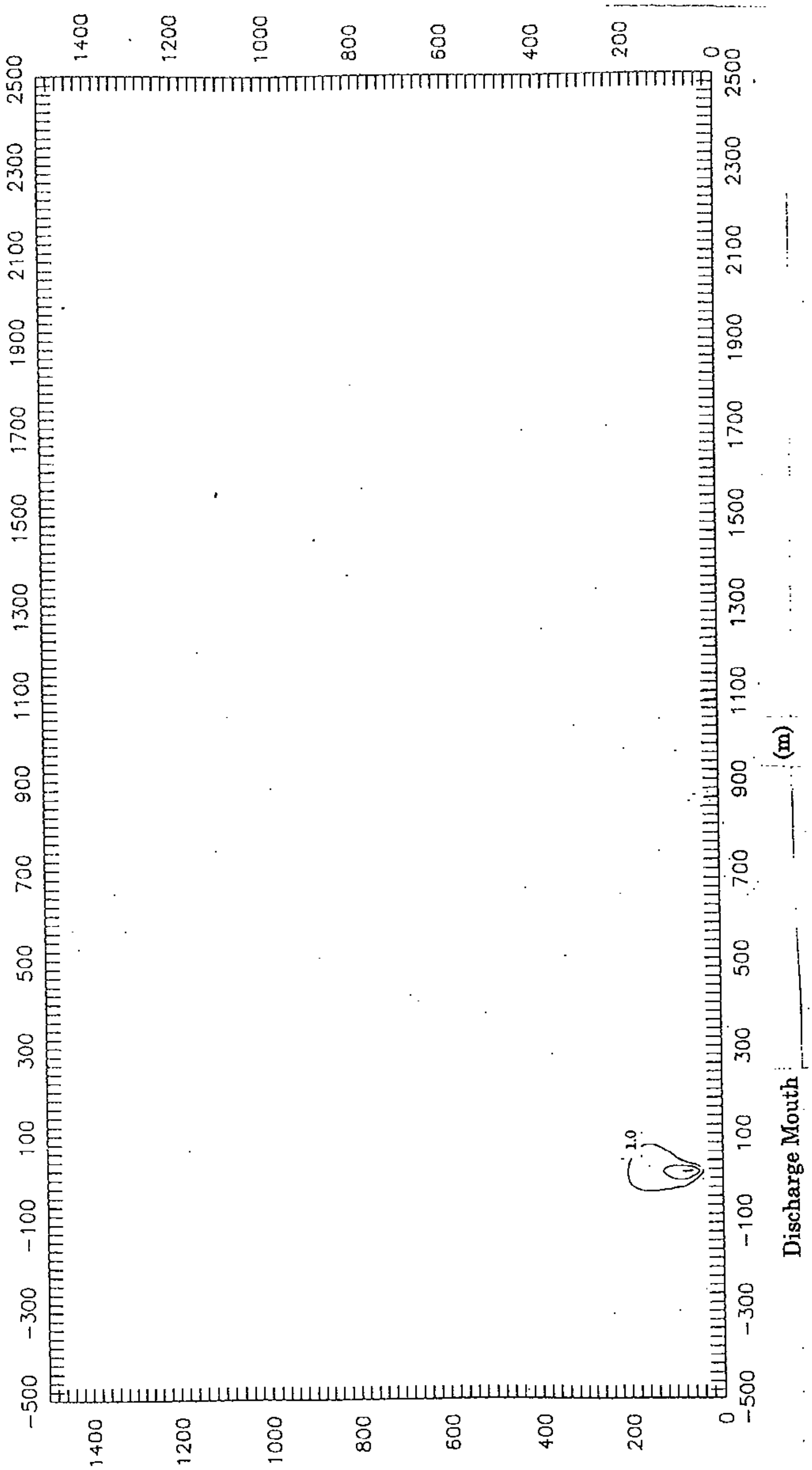


Figure 5.2 Temperature Contours for Case A - Flow Case IM

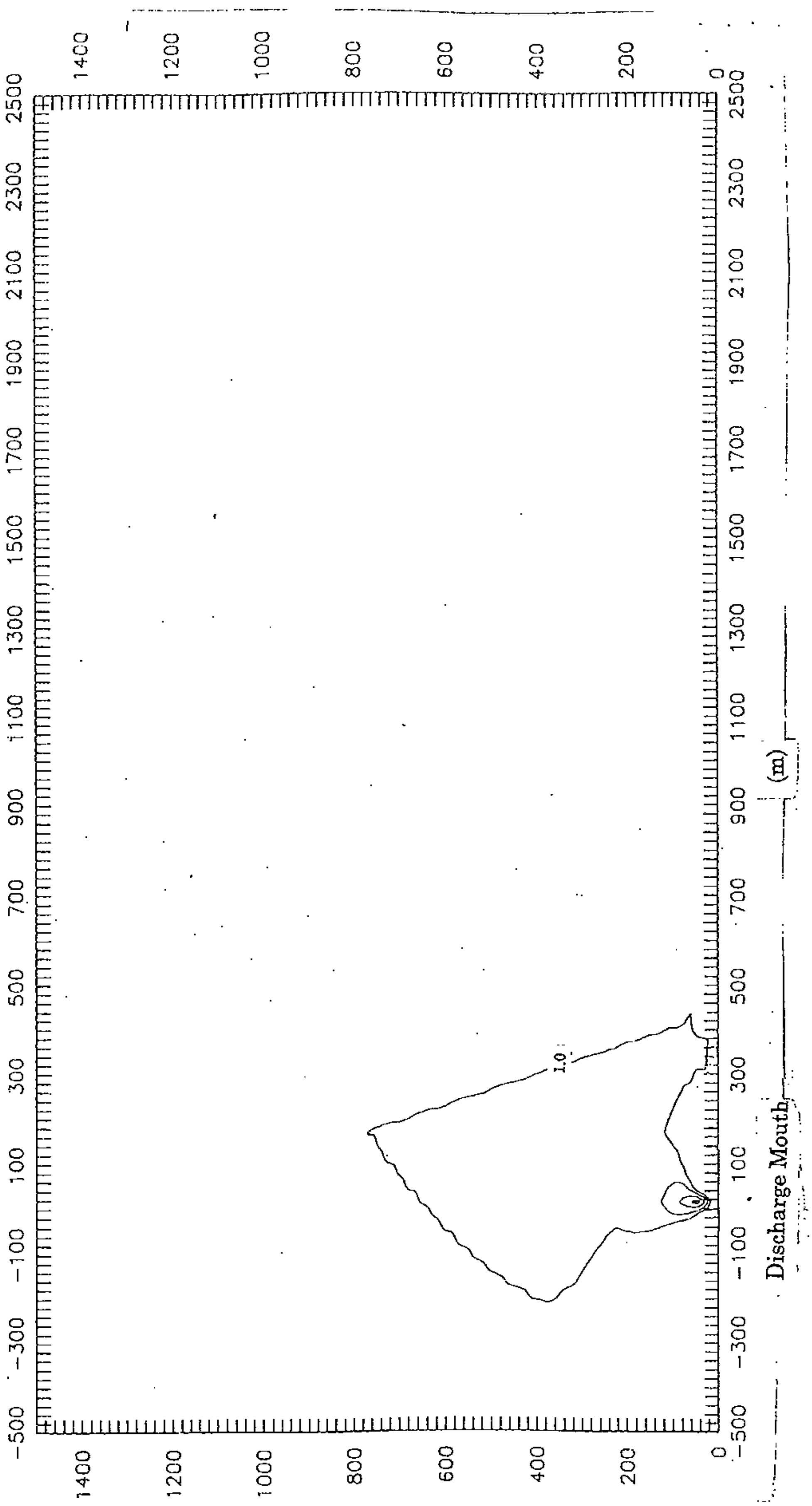


Figure 5.3 Temperature Contours for Case A - Flow Case SW1

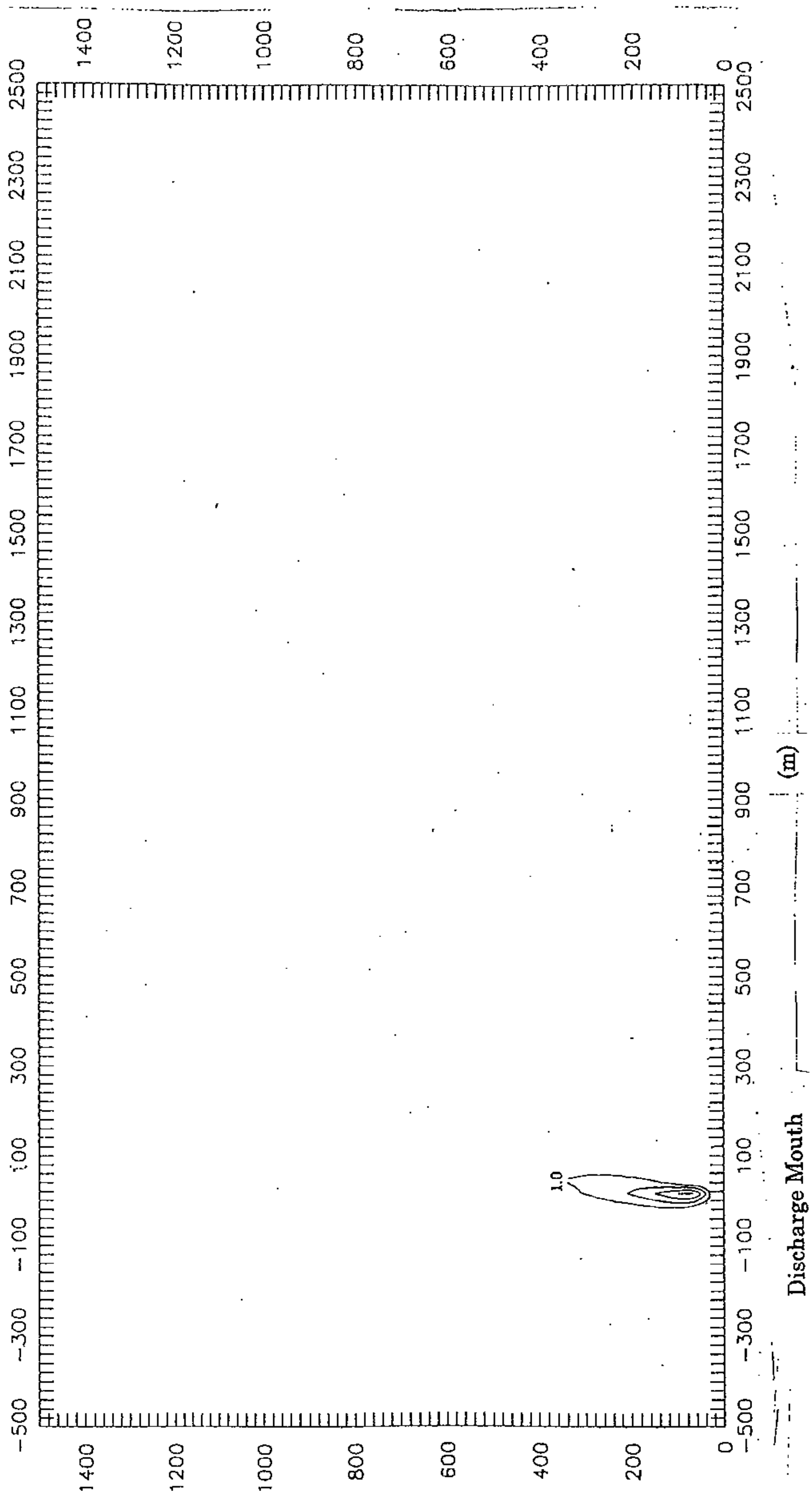


Figure 5.4 Temperature Contours for Case A - Flow Case SW2

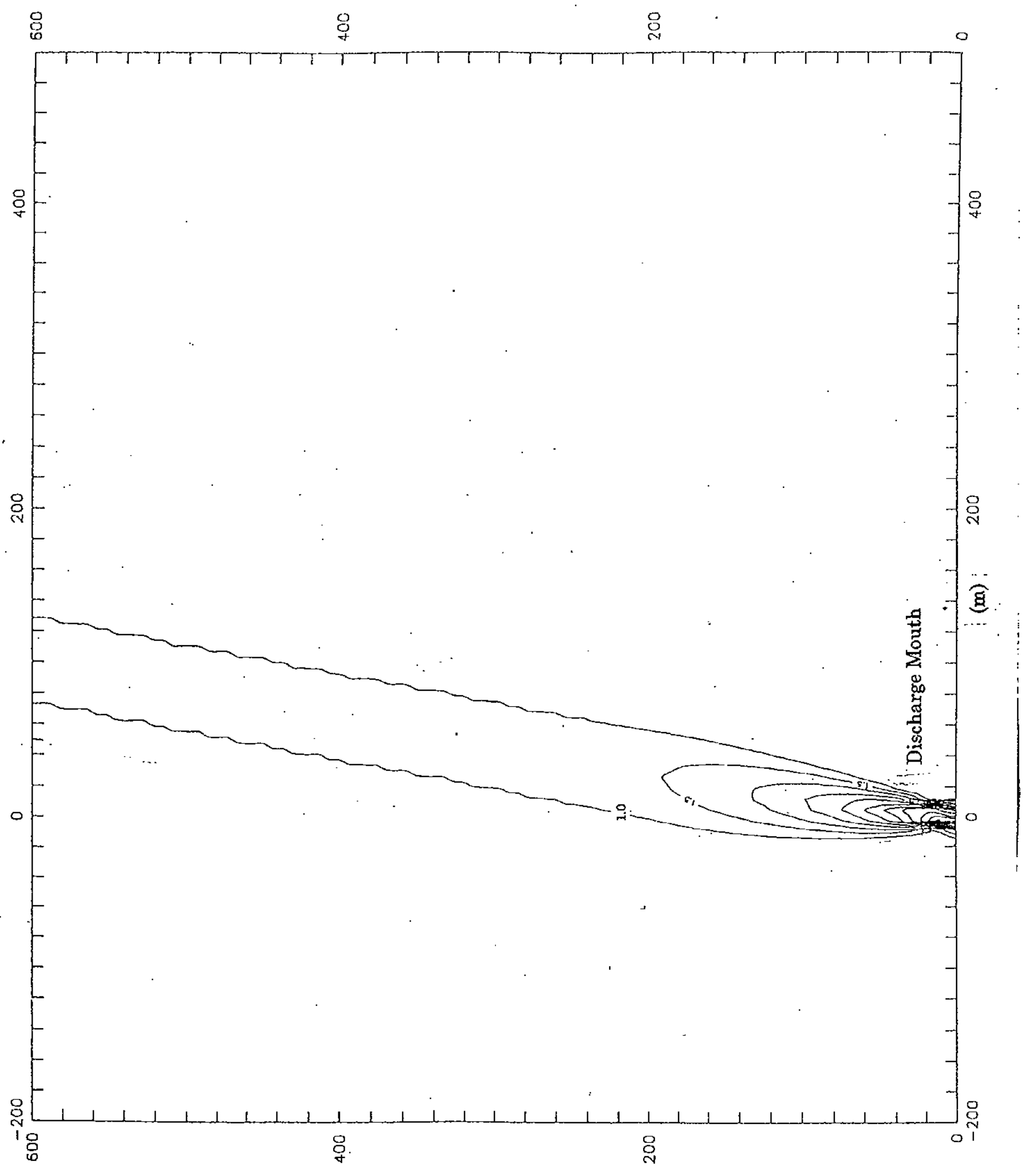


Figure 5.5 Temperature Contours for Case A - Flow Case SW3

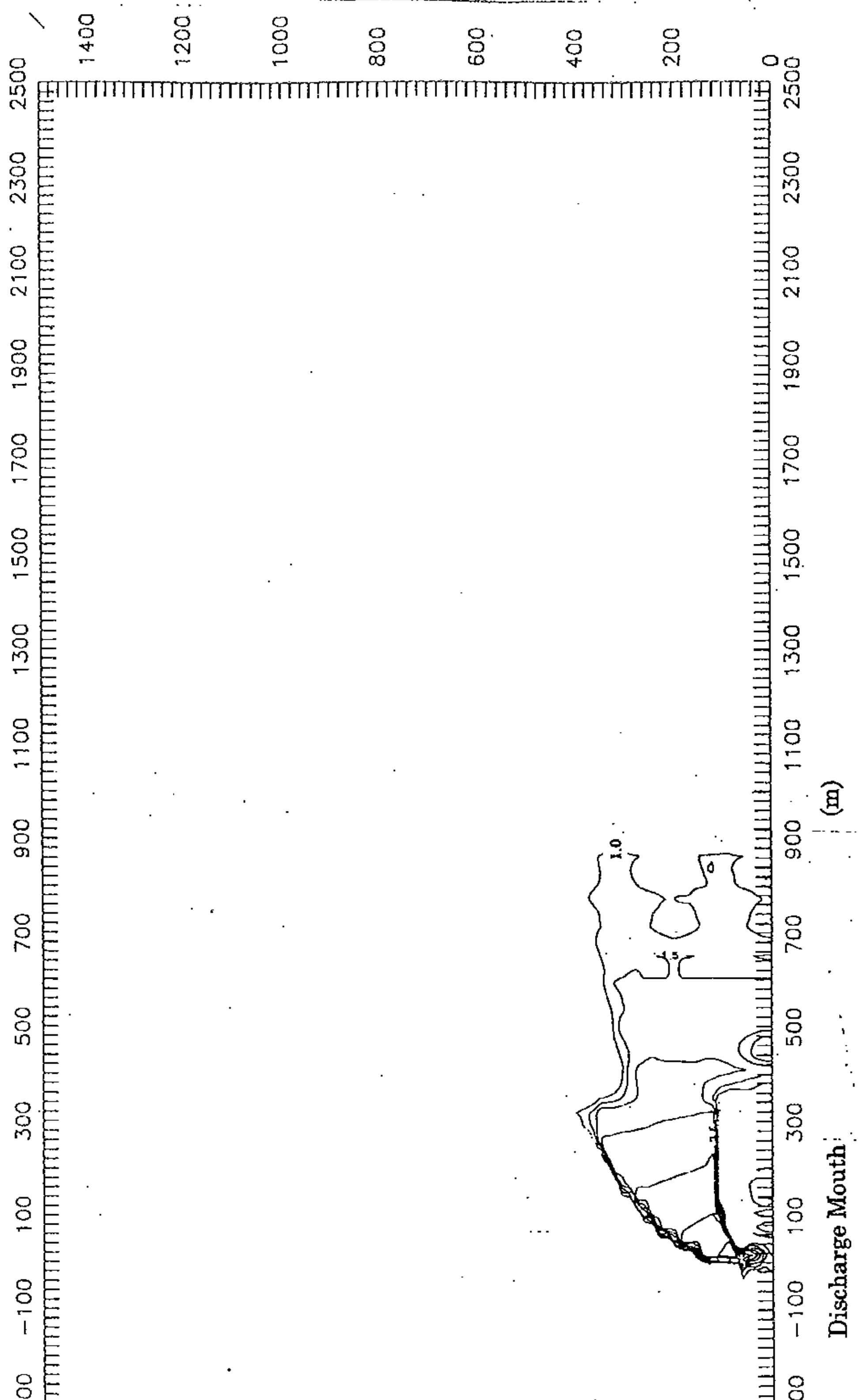


Figure 5.6 Temperature Contours for Case A - Flow Case SW4

As the steady state CORMIX3 model assumes that all the water entrained into the plume is at the ambient temperature the re-entrainment will cause the actual dilution to be less than that predicted by the model. The most recent version of CORMIX3 includes an enhancement that can be used to estimate the effects of tidal flow using a quasi-steady approach. Three examples will be given where the steady state results will be compared to the quasi-steady results.

Consider a case where the cross-flow is purely tidal, with a sinusoidal tidal variation of 24 hour period and a maximum amplitude of 10 cm/s. This type of variation is observed in the velocity data presented in Figure 4.3 . The maximum will occur six hours before and after slack tide, i.e. the time when the velocity is zero. A cross-flow velocity of 5 cm/s will occur 2 hours before and after slack tide. The plume temperatures at these instances, when the cross-flow is 5 cm/s, can be compared to the result for a steady cross-flow of 5 cm/s given in Figure 5.7 .

The temperature contours for the case of 2 hours after slack tide are shown in Figure 5.8 . The contours are only given in the region 200 m offshore as the quasi-steady model is not applicable beyond this point. The plume is quite different from that shown in Figure 5.7, with the temperature at 200 m being about double the value for the steady flow case. This increase is the result of the unsteadiness of the flow and the re-entrainment of warm water discussed above. The results for 2 hours before slack tide are shown in Figure 5.9 . The temperatures are not very different from the steady flow case, though they are slightly higher and the plume is broader. The region of validity of the solution now extends about 300 m offshore.

The differences between Figures 5.8 and 5.9 can be explained by considering the effect of the tidal cycle. Let us assume that the velocity is initially to the south, so that the plume forms to the south. The velocity reverses at slack tide, so that the pool of warm water formed south of the discharge is carried past the discharge to the north. At two hours after slack, the water that is carried past is what was discharged four hours before. As shown in Figure 5.8, the re-entrainment of this warm water causes significant differences from the steady case.

Eight hours later, i.e. two hours before the next slack period, the water that flows past the discharge is what was discharged twenty hours previously, i.e. eight hours before slack tide. This water has flowed north for ten hours and then moved back south for ten hours until it is once again at the discharge. During these twenty hours, the water has had time to mix with the ambient water and become fairly diluted. Therefore, as shown in Figure 5.9, the re-entrainment of this water does not result in significant differences from the steady state result.

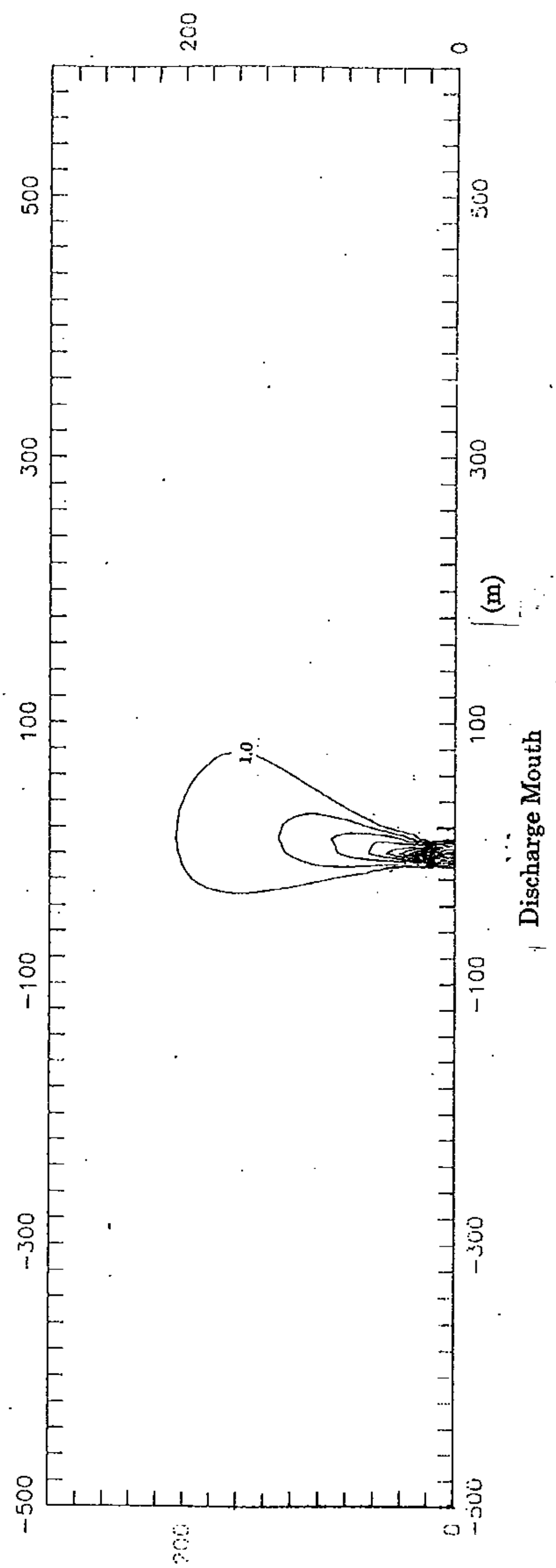


Figure 5.7 Temperature Contours for Case A - Flow Case IM (base case for tidal effect)

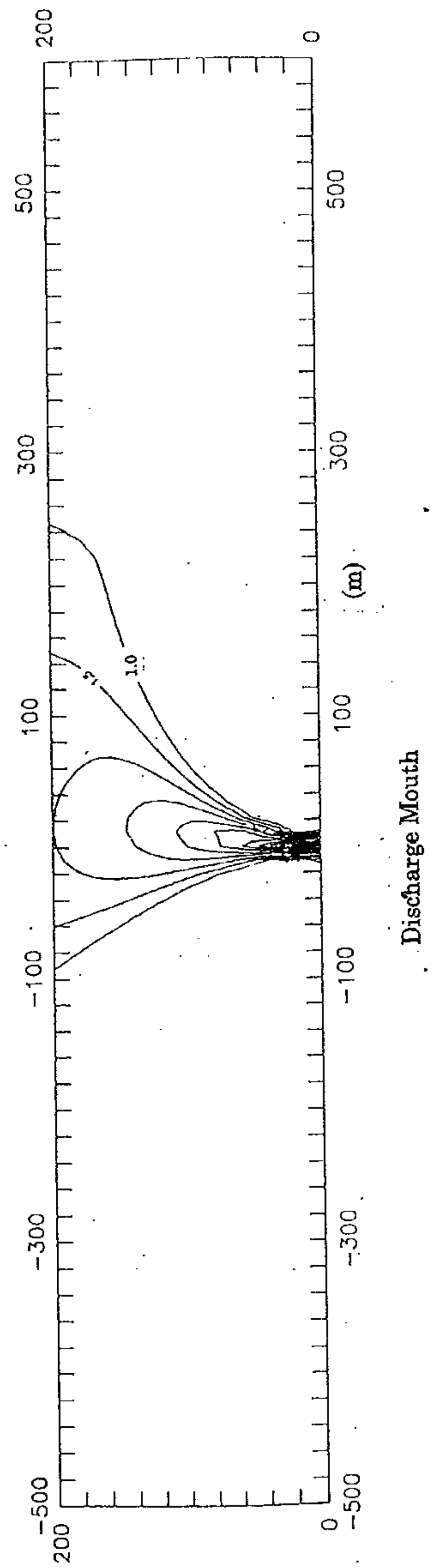


Figure 5.8 Temperature Contours for Case A - Tidal Flow 2 hours after slack

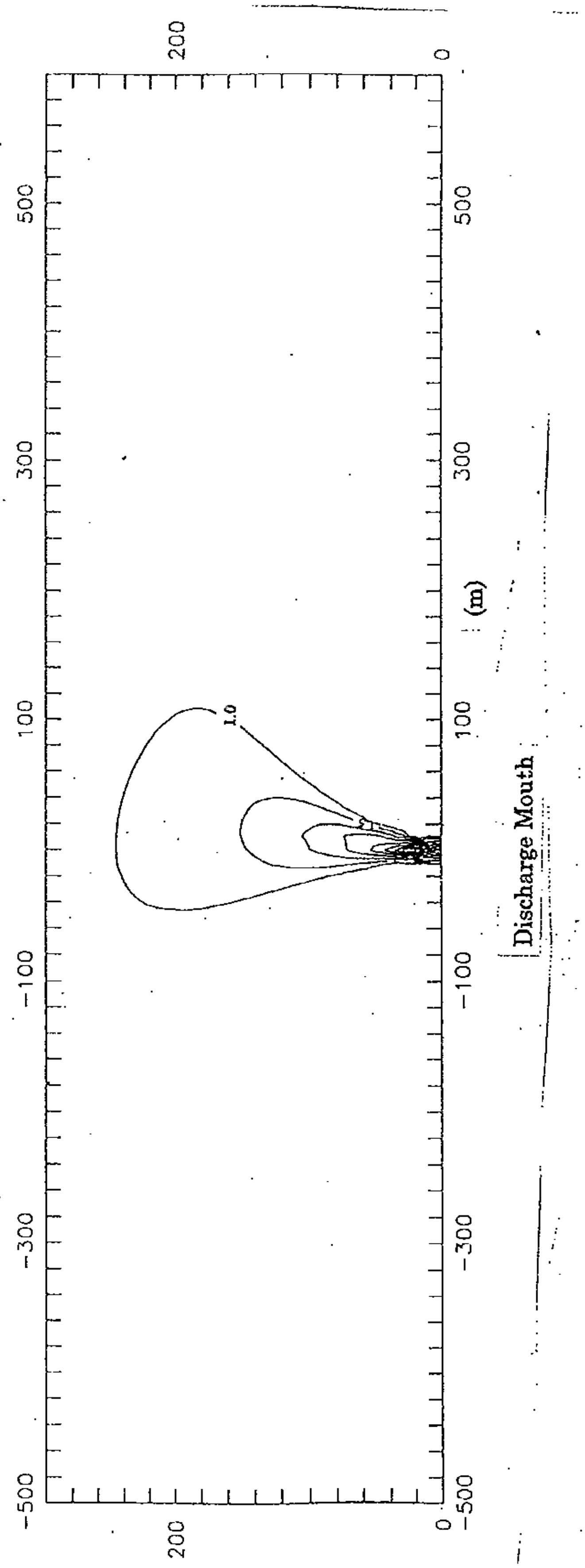


Figure 5.9 Temperature Contours for Case A - Tidal Flow 2 hours before slack

6. SUMMARY AND CONCLUSIONS

The objective of this study was to determine the dispersion of the cooling water discharge of the proposed combined-cycle power plant at Kerawalapitiya. The cooling water is to be discharged through a rectangular channel located at the shore-line, at velocities of 0.5 m/s.

The case study specifications required that four ambient conditions be simulated, based on the seasonal variation of the cross-flow and also the seasonal flow in the nearby Kelani Ganga, which may result in the stratification of the sea near the discharge. The important model parameters are the representation of the geometry, the ambient density structure and the ambient flow velocity. The model assumes that these parameters are the same throughout the model domain. The bathymetry was found to be quite uniform along the shore, i.e., in the direction of the cross-flow. The shore profile dropped off sharply to a depth of around 6 m to 8 m, so that the use of a representative rectangular cross-section by the model was justified. However, there was a sandstone reef about 900 m offshore, where the depth reduced abruptly to about 5 m before falling off to 10 m and more. This reef meant that the model results beyond 900 m from the shore are valid only if the plume is above the reef, i.e., the plume depth is less than 5 m, when it reaches the reef.

The temperature and salinity were measured at three depths. The measurement period included a period of high flow in the Kelani Ganga. Strong stratification was observed during this period. Based on this data three representative density profiles were developed, one unstratified (uniform) and two stratified (medium and high). Considering the data coverage it could be concluded that sufficient information was available to derive these profiles. On the other hand the velocity was only measured for two weeks during the north-east monsoon. Therefore velocities during other seasons were assumed based on experience with other projects in the same area.

The results of these simulations were presented as contour plots of surface temperature and the flow direction was assumed to be northward. Southward flows would merely produce a mirror image of the results. The results of Case A show that the discharge is diluted very rapidly, with an excess temperature of 1 degree being achieved within 500 m of the outfall.

COOLING WATER DISPERSION STUDY
FOR
THE COMBINED CYCLE POWER PLANT PROJECT
AT KERAWALAPITIYA

(３００MW, ７５０MW)

August 1998

JAPAN INTERNATIONAL AGENCY
STUDY TEAM OF THE FEASIBILITY STUDY ON KERAWALAPITIYA
COMBINED CYCLE POWER PLANT DEVELOPMENT

1. INTRODUCTION

1.1 Project Background

It is proposed that a Combined-Cycle Thermal Power Plant be set up at Kerawalapitiya. The feasibility of the proposed plant is being studied by the Tokyo Electric Power Services Co. Ltd. (TEPSCO) of Japan. The study is funded by the Japan International Co-operation Agency (JICA). The power outputs of this study are 300 MW and 750 MW.

1.2 Scope of this Report

The study is carried out using the model CORMIX3, which is recommended by the US EPA for the type of discharge proposed.

2. OBJECTIVES AND STUDY PARAMETERS

2.1 Objectives

The results are to be presented as contour plots of surface excess temperature, with the lowest value being 1 degrees above the ambient. The area of interest is 1 km from the shore and 2 km in the direction of the ambient flow.

2.2 Project Layout

The proposed layout of the project is shown in Figure 2.1 . The power plant is located about 1 km from the shore. The cooling water intake is located about 500 m from the shore at a location where the depth is around 8 m . The intake head is located 4.5 m below the water surface. The warmed cooling water is discharged through a rectangular culvert located on the shoreline.

2.3 Discharge Parameters

The discharge parameters were specified in terms of the discharge flow rate, temperature and dimensions of the discharge channel. Two different cases were specified for each stage of the project. These two cases are listed in the table below, together with the discharge velocity, which is a critical parameter when considering the dilution.

Case	Stage	Discharge Flow Rate (m3/s)	Temperature (deg C above ambient)	Discharge Channel Dimensions	Discharge Velocity (m/s)
B	300MW	7.2	10	5.9 m x 1.2 m	1
C	750MW	18	10	15 m x 1.2 m	1

Table 2.1 Expected Flows of Cooling Water

3. Cases to be Studied

Six flow cases from NE to SW4 were selected for Case B and two flow cases of IM and SW1 were selected for Case C. Representative velocity and density are shown in Table 3.1.

Flow Case	Monsoon	Velocity (cm/s)	Stratification	Ambient Density (kg/m^3)	Top Layer Thickness (m)	Discharge Density (kg/m^3)
NE	North-east	1.5	no	1019.86	-	1016.12
IM	Inter-monsoon	5	no	1019.86	-	1016.12
SW1	South-west	10	no	1019.86	-	1016.12
SW2	South-west	5	medium	bottom - 1019.86 top - 1017.84	2	1016.12
SW3	South-west	5	high	bottom - 1019.86 top - 1016.32	3	1016.12
SW4	South-west	10	medium	bottom - 1019.86 top - 1017.84	2	1016.12

Table 3.1 Representative Ambient Velocities and Density Structures

4. RESULTS OF THE SIMULATIONS

4.1 Discharge Case B

The discharge parameters are given in Table 2.1. The flows are twice those of Case A, which the same discharge channel is used. This means that the discharge velocity is 1m/sec,which is twice the value in Case A. The temperature contours for Case B , with flow conditions, IM, representind the inter monsoon period, are shown in Figure 4.1. The ambient fluid is unstratified and the cross-flow is 5cm/sec. The discharge jet extends 500m from the shore. When the cross flow is increased to 10cm/sec, flow case SW1 in Figure 4.2,the jet region only extends about 400m from the shore.

4.2 Discharge Case C

The temperature contours for Case C are presented in Figures 4.3 to 4.8 . The three unstratified cases - NE, IM and SW1 in Table 3.1 - are in Figures 4.3 to 4.5 .

Figure 4.3 shows that the discharge in Case C spreads over a much larger area than for Case A. This is because the discharge is 5 times as great as given in Table 2.1 . Furthermore, the velocity of discharge is also increased, 1 m/s as against 0.5 m/s before, so that the discharge jet is much stronger. Figure 4.3, for the case of the weakest cross-flow of 1.5 cm/s, shows that the initial weakly deflected jet penetrates more than 1200 m into the sea before becoming a strongly deflected plume.

The same extensive jet is observed in Figures 4.4, which are for a cross-flow of 5 cm/s . When the cross-flow increases to 10 cm/s - case SW1 in Figures 4.5 - the jet region is limited to 800 m and shore attachment occurs about 1200 m downstream.

Another feature that must be remembered is the reef approximately 900 m offshore. Therefore, the assumption of a constant depth of 8 m may not be very realistic if the plume depth is greater than the depth over the reef, which is about 5 m from the surface.

The results for the stratified flow cases - SW2, SW3 and SW4 - are given in Figures 4.6 to 4.8 . Figure 4.6 should be compared to Figure 4.4, which is the equivalent unstratified cases. The figures show that the effect of the stratified flow is an increase in initial dilution, with the 1 degree excess temperature extending less than 1000 m from the shore in Figure 4.6, compared to about 1200 m in

Figure 4.4 . The contour moves further in towards the shore in Figure 4.7, where the stratification is higher. The same increase in dilution can be seen when Figures 4.7 is compared to Figure 4.5. In Figure 4.8 the results are limited to within 600 m of the shore. This is because the discharge density is only slightly lower than that of the surface layer, so that after this distance the plume is no longer buoyant.

This difference is opposite to the results for Case A, where the distance to the 1 degree contour increased with stratification. The explanation is that the discharge velocity is greater in Case C, so that the jet region is longer. There is intense mixing, and deepening of the discharge plume, in the jet region. This mixing will be easier when the flow is stratified, as the ambient fluid will be lighter. The greater mixing will lead to quicker dilution. In Case A the jet region is much smaller, so that this mechanism is overshadowed by the slower loss of momentum.

- Increase of thermal effluent leads to a thicker mixing layer in the coastal area. Many of the previous cases suggest that the mixing layer is confined down to a depth of 2 to 3m when the flow of effluent is around $20m^3$/sec. The water intake of the present project will be located below a depth of 4m, and the increase of water temperature will be less than 2 degrees at the water surface above the intake when there comes thermal effluent. Even if several percent of the surface water is taken by the intake facility,there will not be a noticeable increase of temperature in intake water.

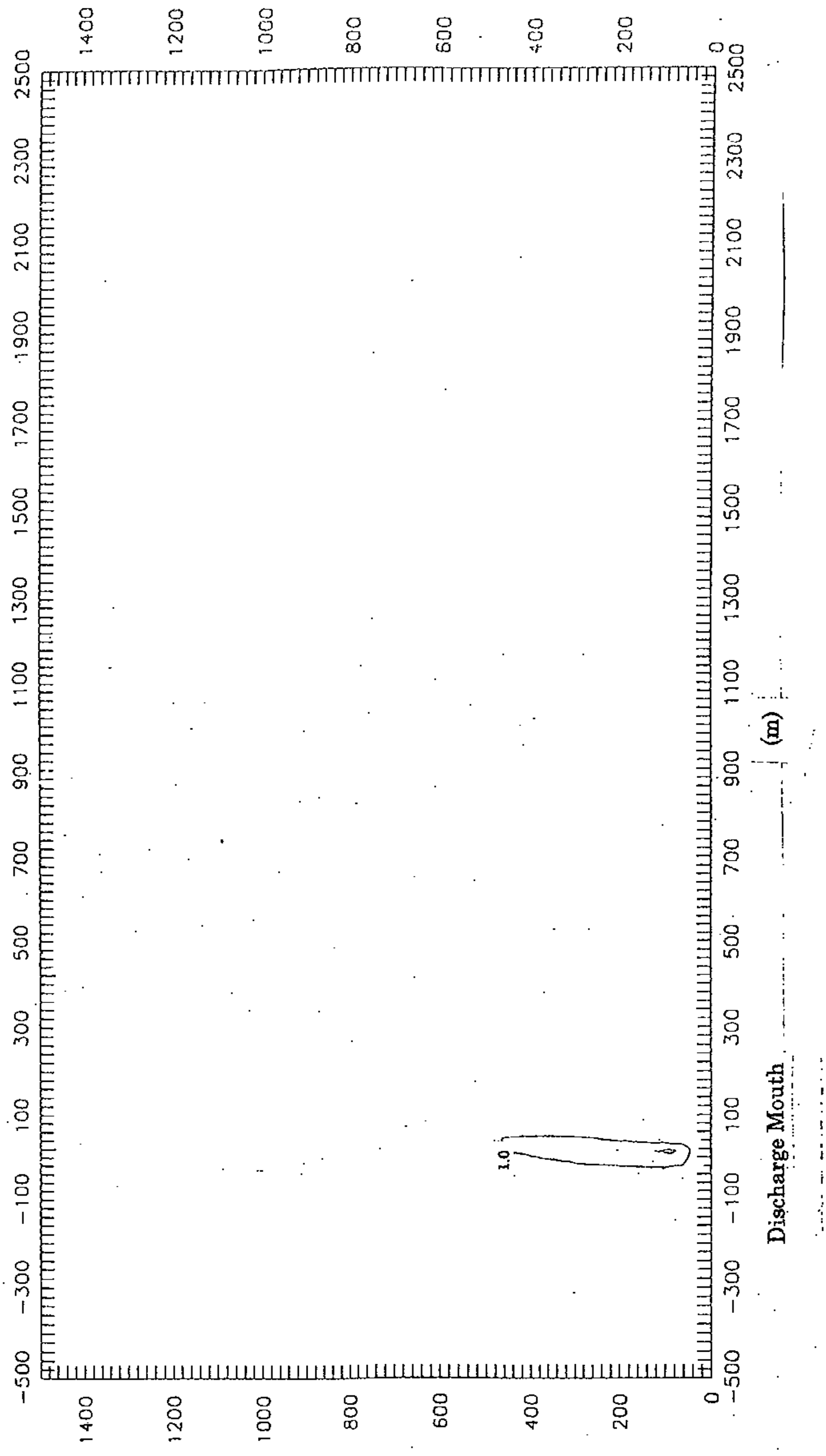


Figure 4.1 Temperature Contours for Case B - Flow Case IM

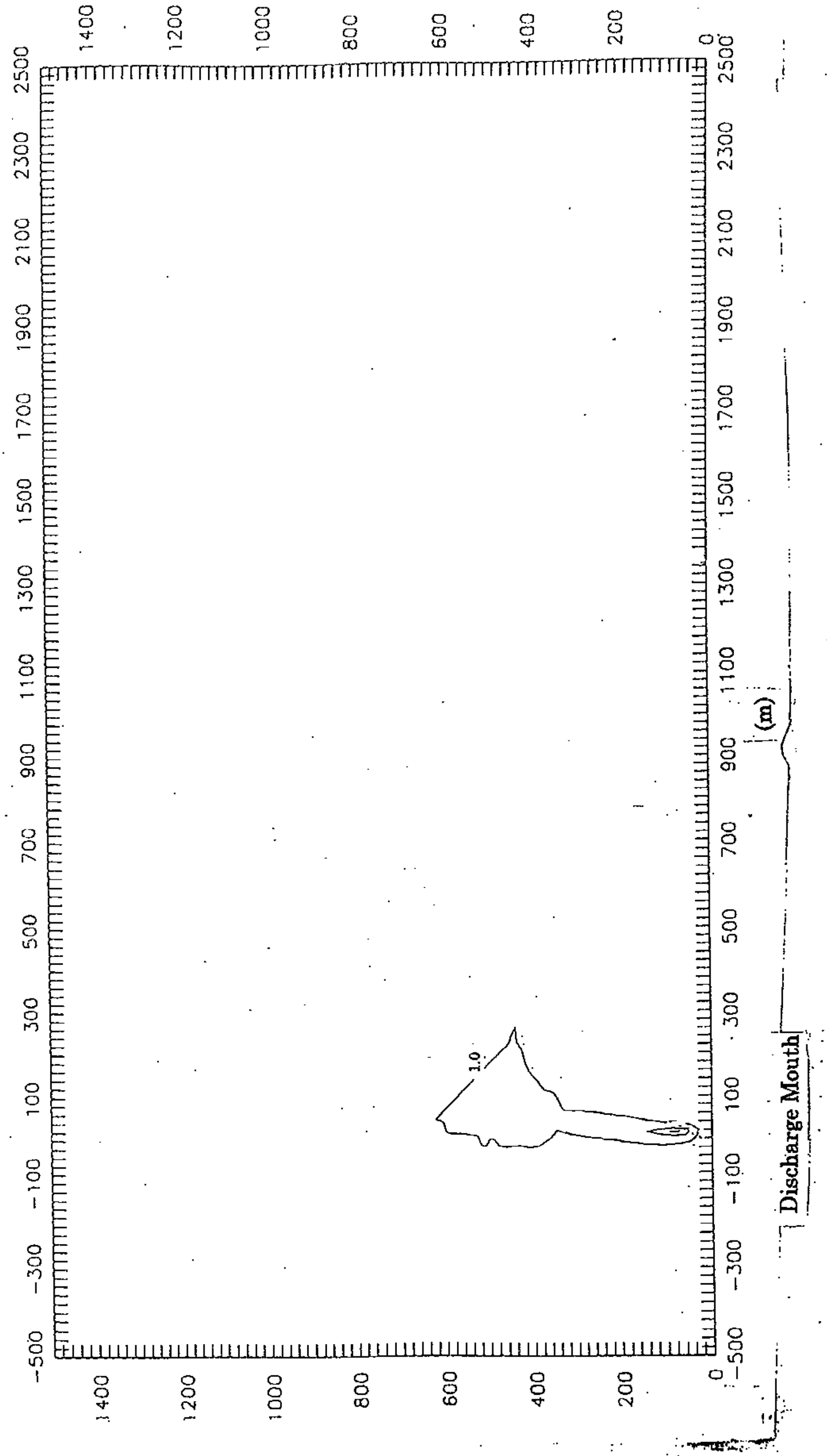


Figure 4.2 Temperature Contours for Case B - Flow Case SW1

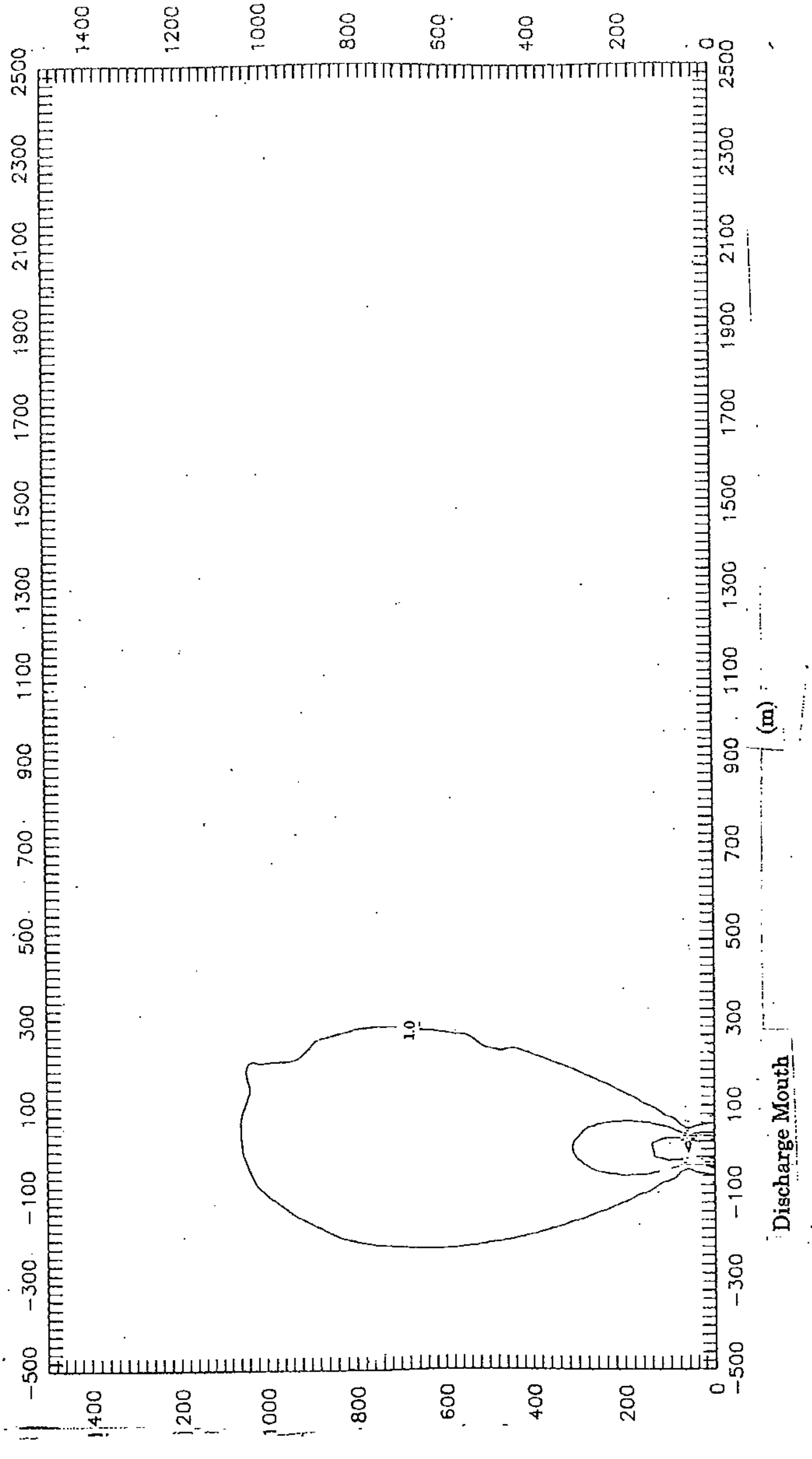


Figure 4.3 Temperature Contours for Case C - Flow Case NE

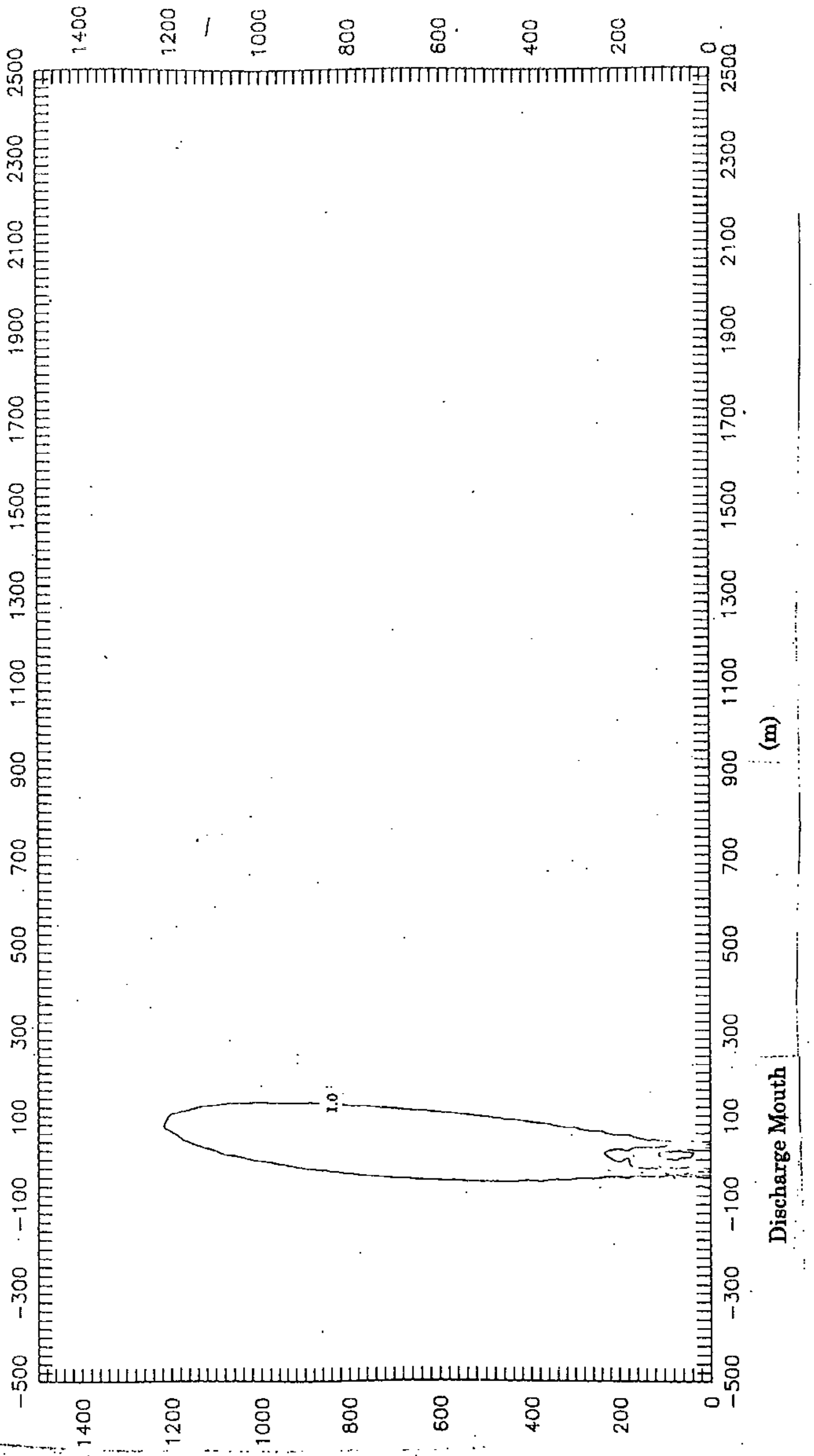


Figure 4.4 Temperature Contours for Case C - Flow Case IM

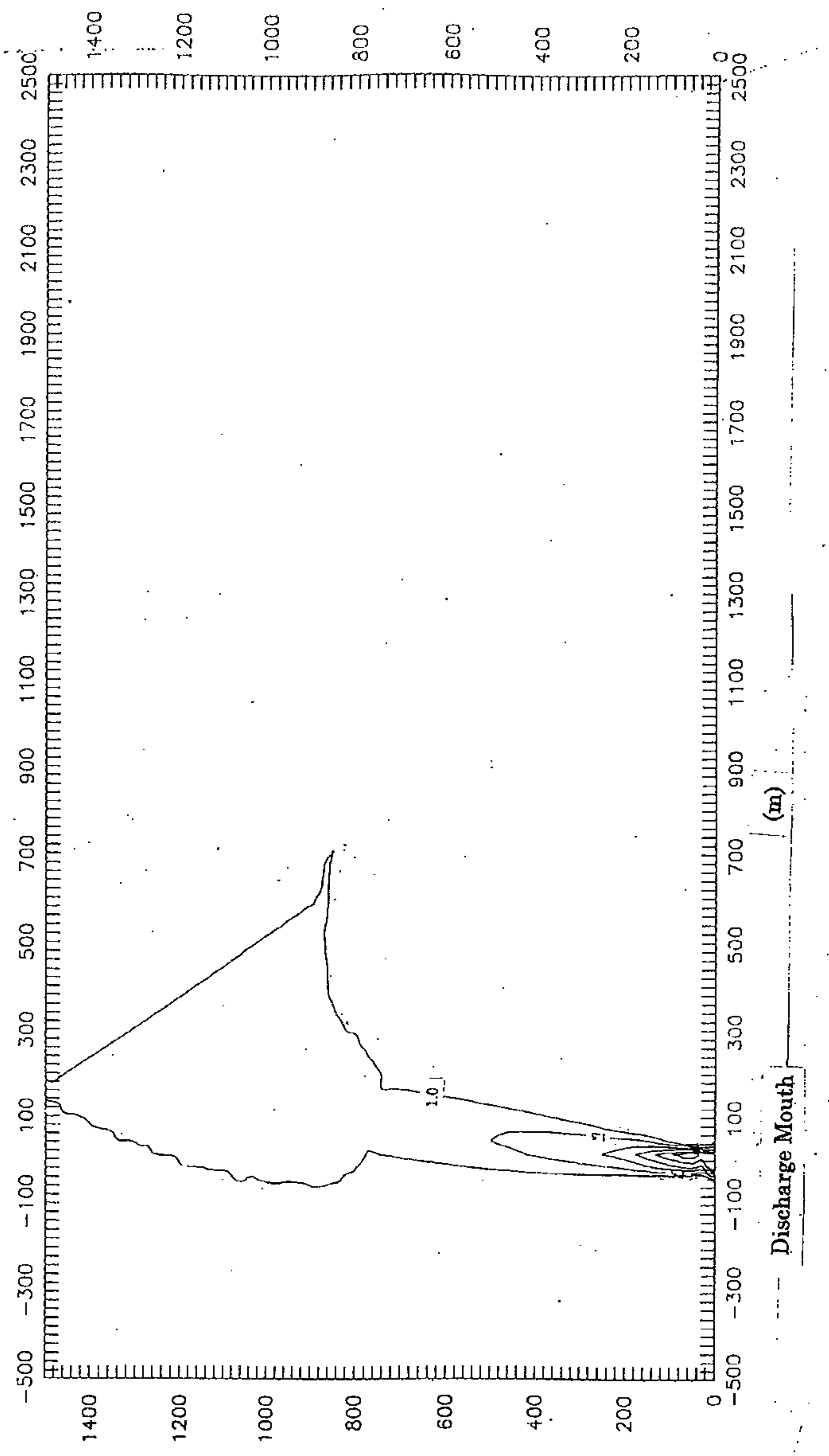


Figure 4.5 Temperature Contours for Case C - Flow Case SW1

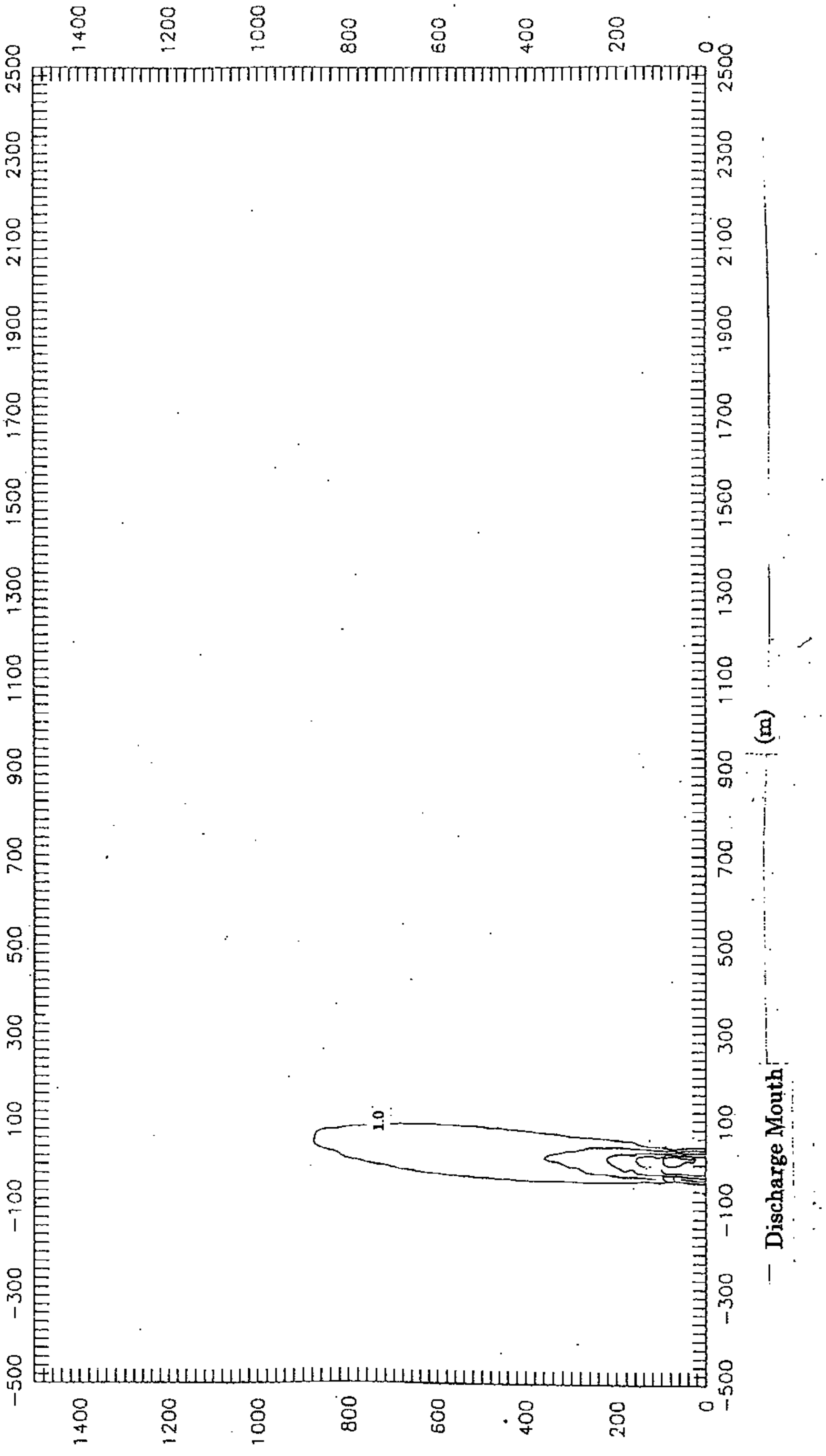


Figure 4.6 Temperature Contours for Case C - Flow Case SW2

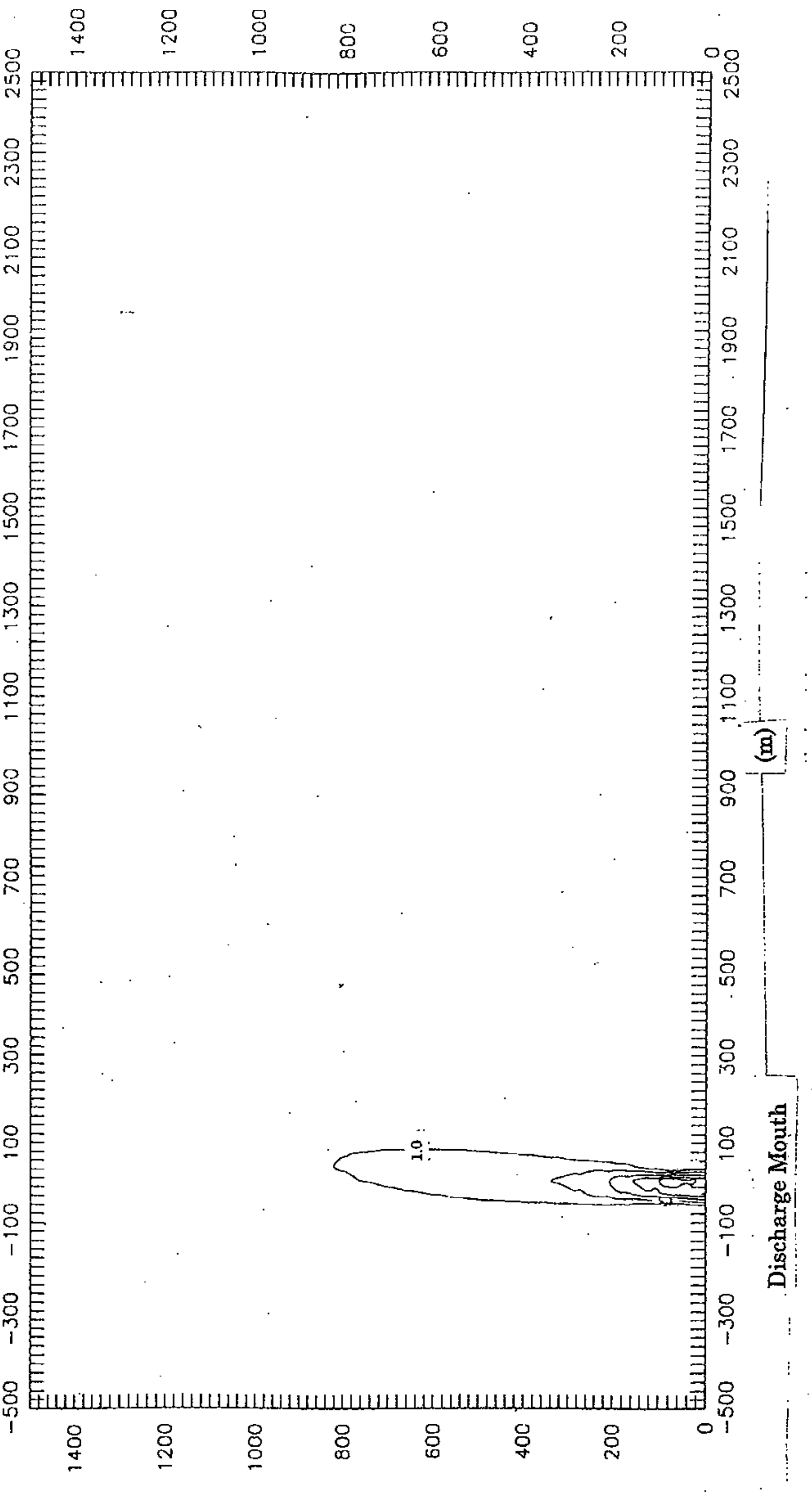


Figure 4.7 Temperature Contours for Case C - Flow Case SW3

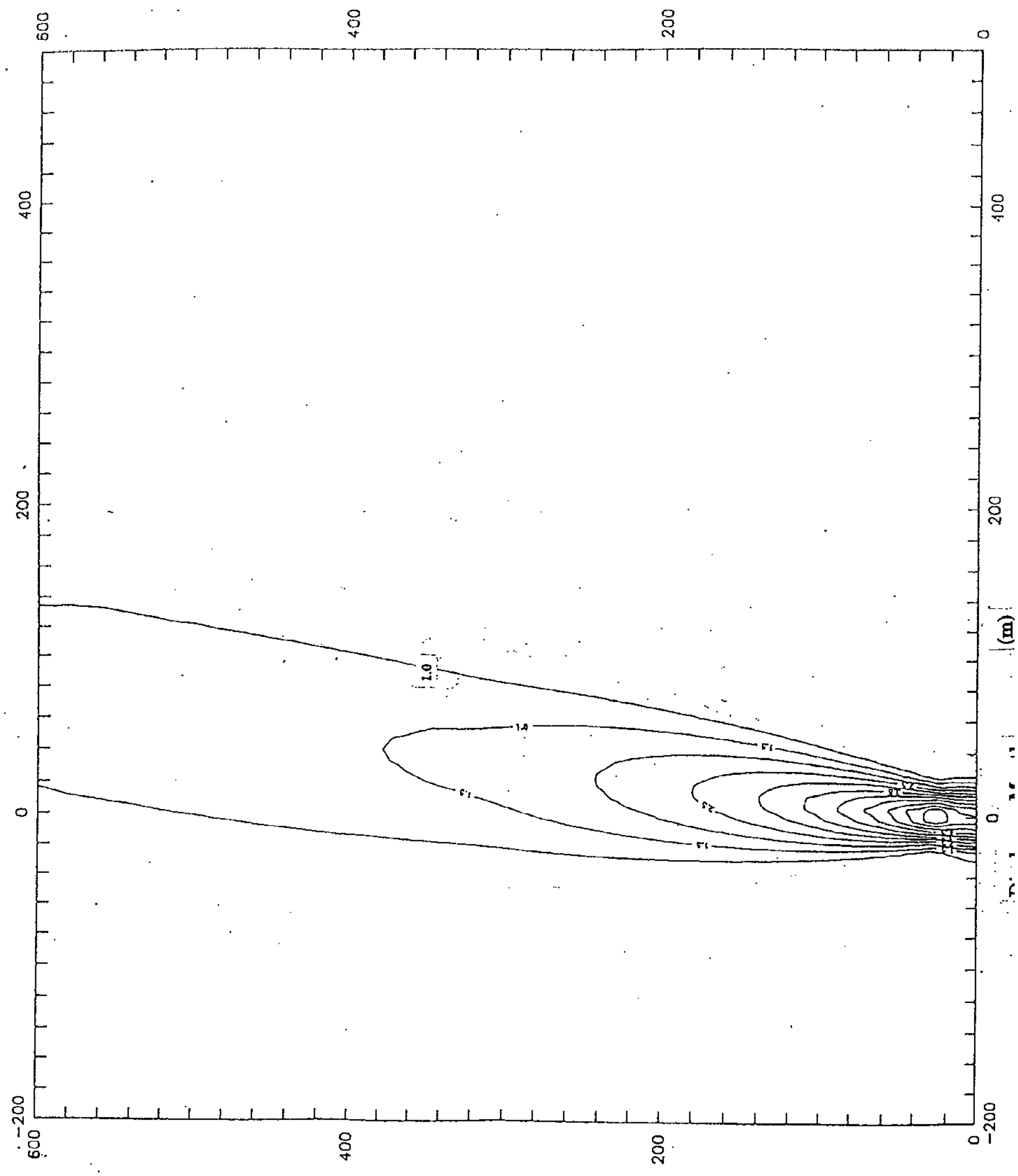


Figure 4.8 Temperature Contours for Case C - Flow Case SW4

5.. SUMMARY AND CONCLUSIONS

The objective of this study was to determine the dispersion of the cooling water discharge of the proposed 300MW and 750MW combined-cycle power plant at Kerawalapitiya. The cooling water is to be discharged through a rectangular channel located at the shore-line, at velocities of 1 m/s.

The original study specifications required that four ambient conditions be simulated, based on the seasonal variation of the cross-flow and also the seasonal flow in the nearby Kelani Ganga, which may result in the stratification of the sea near the discharge. Field measurements were carried out to help determine some of the model parameters. The measurements included bathymetry, velocity, temperature and salinity.

The important model parameters are the representation of the geometry, the ambient density structure and the ambient flow velocity. The model assumes that these parameters are the same throughout the model domain. The bathymetry was found to be quite uniform along the shore, i.e., in the direction of the cross-flow. The shore profile dropped off sharply to a depth of around 6 m to 8 m, so that the use of a representative rectangular cross-section by the model was justified. However, there was a sandstone reef about 900 m offshore, where the depth reduced abruptly to about 5 m before falling off to 10 m and more. This reef meant that the model results beyond 900 m from the shore are valid only if the plume is above the reef; i.e., the plume depth is less than 5 m, when it reaches the reef.

The temperature and salinity were measured at three depths. The measurement period included a period of high flow in the Kelani Ganga. Strong stratification was observed during this period. Based on this data three representative density profiles were developed, one unstratified (uniform) and two stratified (medium and high). Considering the data coverage it could be concluded that sufficient information was available to derive these profiles. On the other hand the velocity was only measured for two weeks during the north-east monsoon. Therefore velocities during other seasons were assumed based on experience with other projects in the same area.

All this information was used to develop six ambient flow cases for simulation, as given in Table 3.1. Three were unstratified and three stratified, with different velocities. Six discharge conditions, shown in Table 2.1, were to be studied.

The results of these simulations were presented as contour plots of surface temperature. The flow direction was assumed to be northward. Southward flows would merely produce a mirror image of the results.

The dispersion of the cooling water discharge has to be studied for two reasons. Firstly, the increase in the sea temperature must be estimated in order to assess the environmental impact of the project. Secondly, it is important to minimise the re-circulation of the discharge back to the intake in order to obtain the maximum efficiency of the power plant. In the proposed plant the intake is located about 500 m offshore at a depth of 8 m and withdraws water from the bottom half of the depth.

The important weakness under these circumstances is the assumption of steady flow. A modification to the model to account for tidal flows indicates that the tidal re-circulation of the warm water may at times cause significant increases in the temperatures near the discharge.

Case B is for the second stage of the development. The excess temperature falls to 3 degrees within 90m and to 1 degree within 600m. The results for Case C show that good dilution is achieved. The excess temperature falls to 3 degrees within 150 m and to 1 degree within about 1000 m . Due to the higher discharge velocity, the effect of tidal re-circulation on these results will be less than for Case A .

In the coastal area, there is a tendency for a thicker mixing layer as thermal effluent increases. Many surveys and researches suggest that the mixing layer would hardly expand beyond a depth of 2 to 3m when the effluent flow is moderate and around 20m3/sec. When there exists a mixing layer of river water and marine water in the upper coastal water, thermal effluent would diffuse widely among the upper layer. One of the models recommended by USEPA for near field was applied in the present study. It is desirable to survey in detail on the flow regime ,watertemperature,and salinity in the coastal area for their evaluation by the models such as the thermal

ANNEX 13 補償調査(TEAMS)

FINAL REPORT

Submitted to

CEYLON ELECTRICITY BOARD

on the

EIA COMPENSATION RELATED STUDY

of the

150 MW COMBINED CYCLE POWER PLANT KERAWELAPITIYA

TEAMS

Consultants in Development

(Technology, Engineering, Agriculture & Management Specialists)

TEAMS (Pvt) Ltd. P. O. Box 262 Colombo, Sri Lanka

2nd July 1998

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CHAPTER 3: SOCIO-ECONOMIC STATUS OF RESIDENTS ALONG THE ACCESS ROAD

PART II: COSTS RELATED TO RESETTLEMENT AND LAND ACQUISITION

CHAPTER 4: INTAKE AREA

CHAPTER 5: ACCESS ROAD

Compensation Related Study and Socio-Economic Survey of the Proposed Area for Sea Water Intake and Discharge Pipelines and Access Road to Kerawelapitiya for Combined Cycle Power Plant

CHAPTER 1: INTRODUCTION AND METHODOLOGY OF WORK

The Ceylon Electricity Board (CEB) proposes to establish a 150 mw Combined Cycle Power Plant at Kerawalapitiya in the Muthurajawela reclaimed area, about 10 km north of Colombo in the Wattala Divisional Secretary's Division, in the Gampaha District.

The power plant consisting of possibly two Combustion Turbine Generation (gas) and one steam turbine including the fuel storage system, cooling water system, electricity generating equipment and high voltage switch gear, water treatment plant and waste treatment plant are to be sited on a 30 ha reclaimed land area.

The sea water intake and discharge pipelines and fuel pipes are to be sited on a 50 metre wide stretch of land located from between the two groynes on the beach, aligned in an easterly direction and turning south east towards the proposed head works.

The people living in this area, called the "Intake Area" have to be resettled in a new area.

The CEB also proposes to use Gunasekera Mawatha which proceeds east from Kerawalapitiya and joins the Colombo-Katunayake national road near the petrol station north of the Milk Food Factory.

1.2 Methodology of Work

The methodology adopted was slightly different from what was proposed by the consultants as adjustments were made to accommodate changed situations, realistic on the ground situation and what was considered as important by the Japanese Consultants. The procedure is described stepwise below.

1. Inspection and identifying the intake area and the transmission line route with the Japanese Consultants and CEB staff.

2. Mobilise staff. Meet Divisional Secretary, Wattala and (on his advise) the Member of Parliament of the area in view of the sensitivity of issues concerning displacement of people.

3. Design questionnaire to be administered for the socio-economic survey of both the intake area and access road.

4. Administer the questionnaire to households within approximately 150 metre wide "intake area" from the sea beach to the canal traversing the western boundary of the sand fill area.

5. Conduct field investigation to collect data on houses and valuable trees etc. and prepare distribution map (not to scale).

6. Administer questionnaire to households on either side of the Gunasekera Mawatha (access road) affected by widening the road to 10 metres (requirement of Japanese consultant to minimise damage).

7. Conduct field investigation to collect data on houses along access road (with position of all structures from Centre of road) and prepare distribution map.

8. Field inspection and interviews conducted with affected people and local officers by the socio-economist.

9. Field inspection and interview of local residents and knowledgeable people of the area by the valuer.

10. Continuous field visits, interviews with local residents and officials, inspection of suitable area for settlement, and gaining any in-depth understanding of the local political forces and activities in granting of state land.

11. Review publications in laws, regulations and guidelines related to acquisition compensation and compensation policy, and prepare report..

12. Prepare data result sheets of socio-economic survey, distribution maps and cost estimates.

13. Prepare Report.

1.3 General Geology

The Eastern limits of the survey area to the West of Kerawalapitiya was originally a marshland, now a reclaimed area filled with sea sand. The western limits of the survey area is in Palliyawatta and part of this area extends towards the sea through an area locally known as Dickowita, at which point two groynes have been built. (photo no. 01).

The generation plants are to be located in the reclaimed area at Kerawalapitiya and the intake and discharge pipe lines are to be laid across Palliyawatta, through the area called Dickowita, and located between the two groynes across the near exposed beach rock (or otherwise called the sand stone reef), out into the sea.

The proposed pipeline layout cuts across marshy area and broken up near-coast-beach rock opposite and in between the groynes. (photo no. 04)

This area in general is a low dune beach ridge which at this point has totally deteriorated. The stabilising coastal vegetation cover has been totally eroded away (photo no. 02 - looking northwards from the wrecked ship point). The temporary measure of sand piling to form an artificial dune ridge is ineffective to prevent erosion (photo no. 03) which continues at present during periods of high wave action. This effect will increase during severe stormy weather, as experienced during the south west monsoon. Any construction work across this stretch has to be done with due care. The possibility of instabilities, such as settling, flooding etc., due to any construction work should be given careful consideration.

The land fill site area at Kerawalapitiya, of which approximately 30 ha. are reserved for the Proposed Plant, has been filled to a level of 1.5m to 1.8m above sea level. The thickness of this sea sand bed overlying the Muthurajawela peaty strata (photo no. 05) is about 2.0m to 3.0m (Supplementary EIA Report).

In its original condition the area is likely to have been composed of a relatively thin soft alluvial cover of silt and clay overlying a peaty layer, varying in thickness, intercalcited with clay, peat and sand, all of which are unconsolidated.

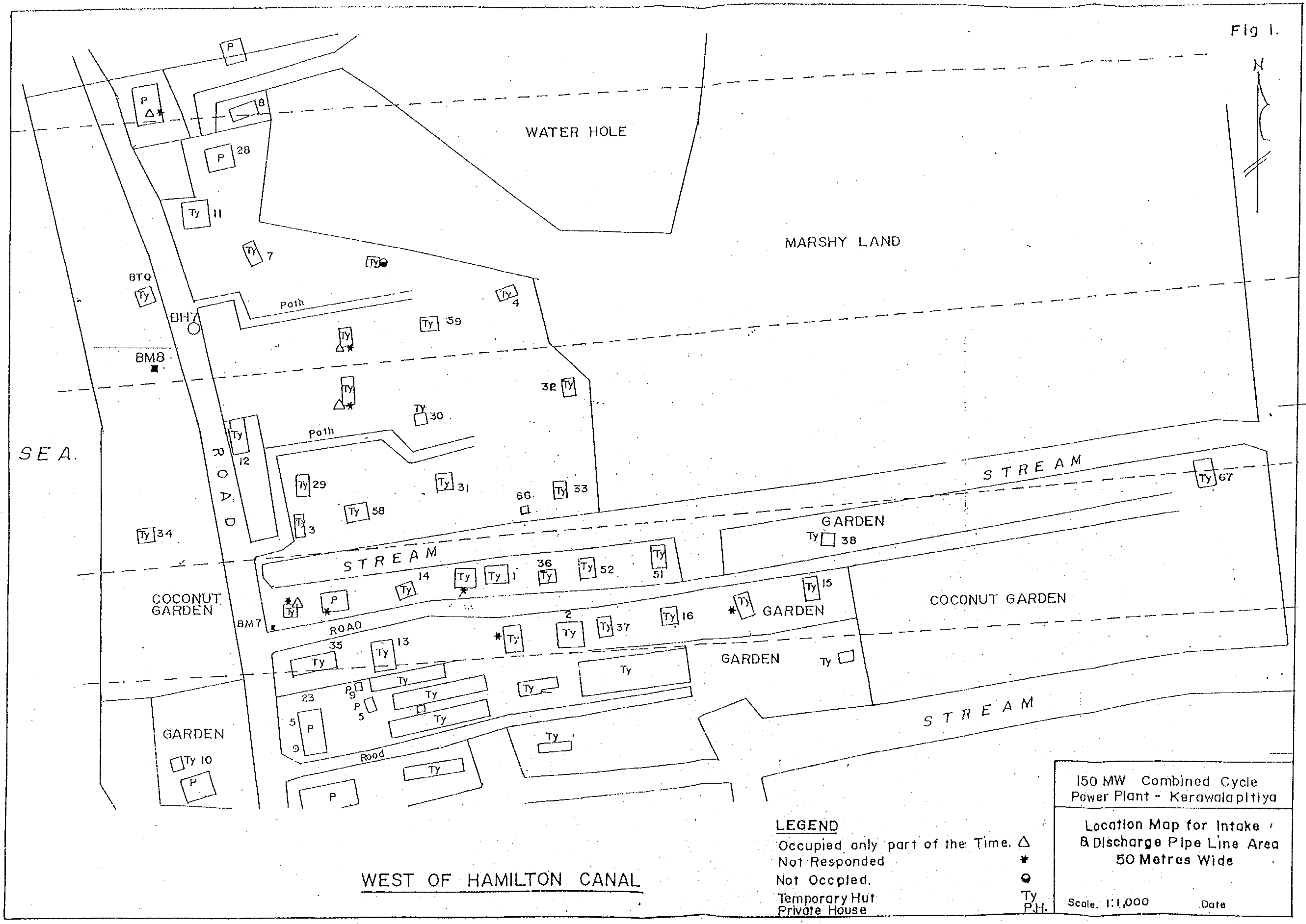
Fig I.
N
WATER HOLE
MARSHY LAND
SEA.
ROAD
Path
BTQ
BH7
BM8
BM7
STREAM
GARDEN
COCONUT GARDEN
COCONUT GARDEN
GARDEN
GARDEN
GARDEN
STREAM
STREAM
Road
WEST OF HAMILTON CANAL
LEGEND
Occupied only part of the Time. △
Not Responded *
Not Occpied.
Temporary Hut Ty
Private House P.H.
150 MW Combined Cycle Power Plant - Kerawalapitiya
Location Map for Intake & Discharge Pipe Line Area 50 Metres Wide
Scale. 1:1,000
Date

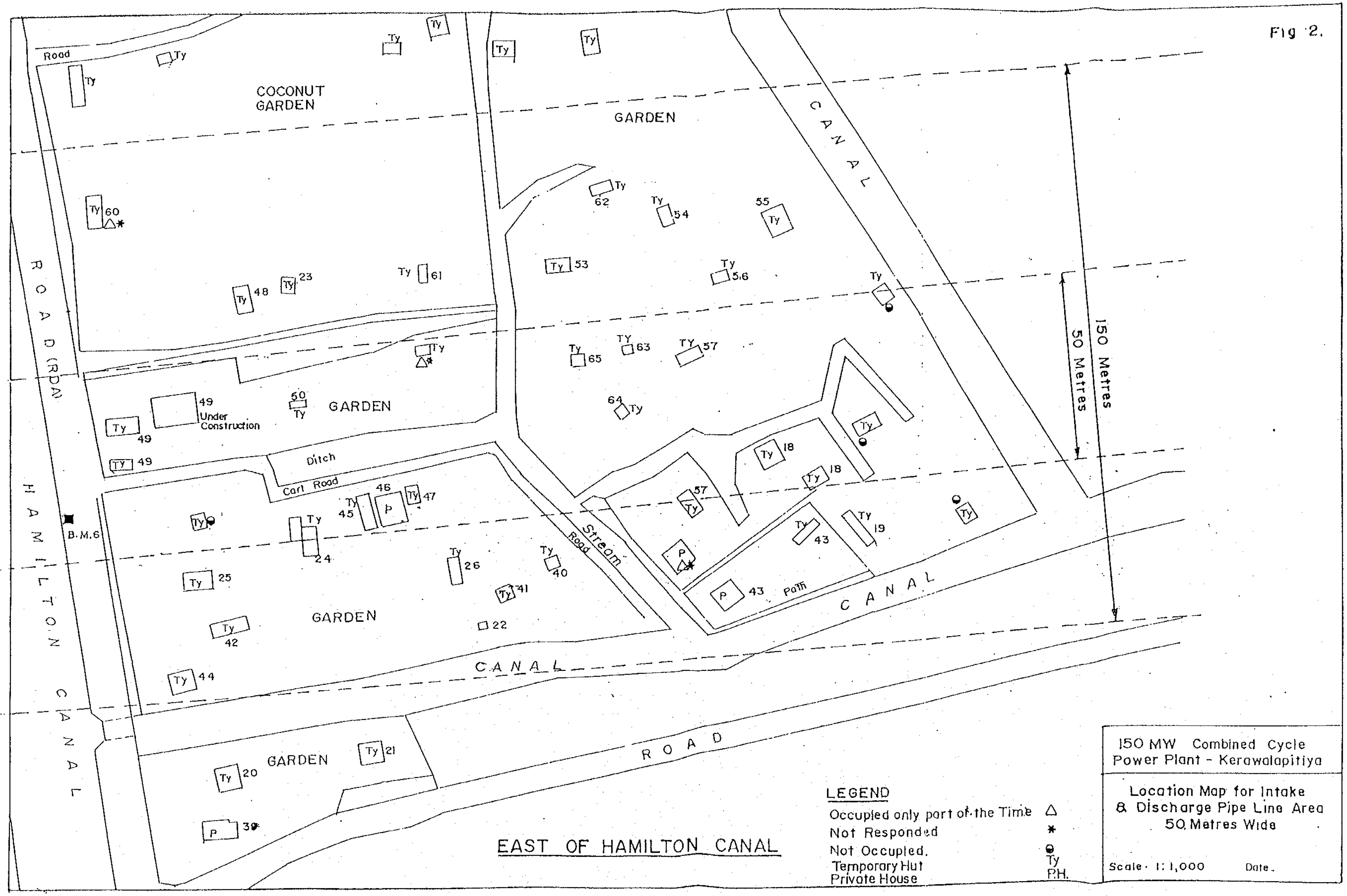
Fig 2.
Road
COCONUT GARDEN
GARDEN
CANAL
ROAD (RDA)
HAMILTON CANAL
B.M.6
Ditch
Cart Road
Under Construction
Stream
Road
Path
CANAL
ROAD
150 Metres
50 Metres
LEGEND
Occupied only part of the Time △
Not Responded *
Not Occupied.
Temporary Hut Ty
Private House P.H.
EAST OF HAMILTON CANAL
150 MW Combined Cycle Power Plant - Kerawalapitiya
Location Map for Intake & Discharge Pipe Line Area 50 Metres Wide
Scale - 1:1,000
Date.