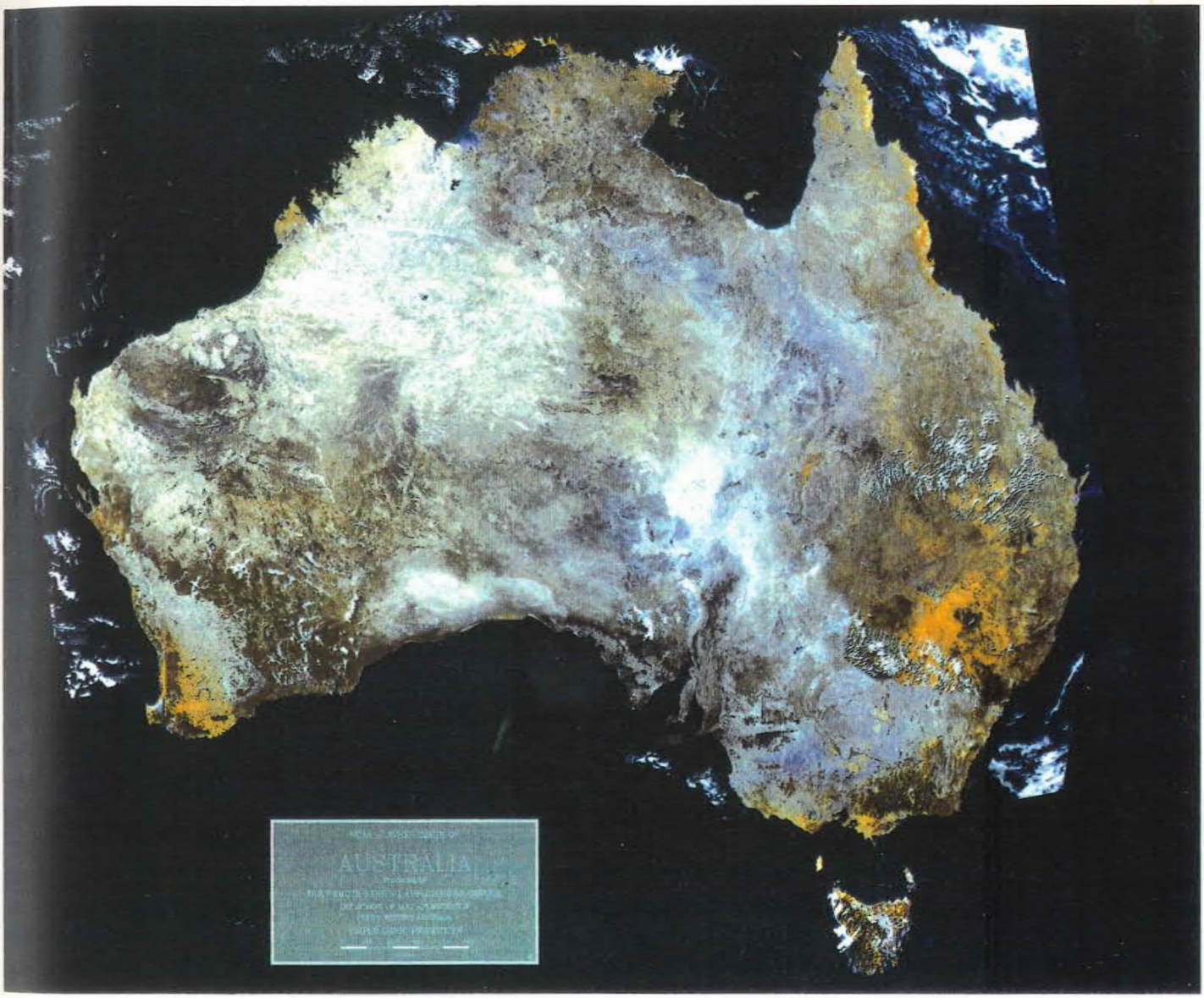
Western Australian Satellite Technology and Applications Consortium (WASTAC)

Annual Report Year ending 31st December 1989



Members:

* **Western Australian Department of Land Administration**
* **Curtin University of Technology**
* **Bureau of Meteorology**
* **CSIRO**

Annual Report Year ending 31st December 1989

1. **General:**

WASTAC consists of the CSIRO, Bureau of Meteorology, Department of Land Administration and Curtin University of Technology. The Consortium was formed during 1985 with the objective of establishing a NOAA/AVHRR Earth Observation Satellite data receiving, processing and archive facility in Perth to service the resource management needs of the State. Facilities were officially commissioned on 3rd July 1987 by the Federal Minister for Science and the State Minister for Lands. Operational data was not received until December 1st 1987. From 1st December 1987 to 31st December 1988 some 390 passes were archived.

A legal agreement stating the objectives, responsibilities and financial arranges of the Consortium members was negotiated during 1987 and 1988, with the final Deed being signed on 24th January 1989.

The objectives are:

"(a) to acquire operate and maintain the facility;

(b) to maintain an archive of remotely sensed data acquired by the Facility from satellites of the National Oceanic and Atmospheric Administration (hereinafter called "NOAA");

(c) to provide remotely sensed data for the day-to-day operational requirements of the Bureau;

(d) to provide facilities and remotely sensed data for the parties here to conduct research and development projects from time to time;

(e) to provide in accordance with the provisions of this Deed remotely sensed data to members of the Consortium for their own requirements or purposes or for supply by them to those to whom they may be responsible or for sale by them to their respective customers or clients as the case may be on terms and conditions determined by the Board of Management hereinafter referred to:"

A copy of the Deed is at appendix 1. For information on pre-WASTAC data archive refer Pearce (1989).

2. WASTAC Board

The Board for 1989 comprised:

DOLA (archive):	Mr H. J. Houghton (Chairman), Mr R. Stovold (Secretary)
CSIRO:	Mr A. Pearce (Oceanography), Dr A. Gabell (Exploration Geoscience)
Curtin University:	Assoc. Prof. M Lynch, Dr D. Myers
Bureau of Meteorology:	Mr L. Broadbridge, Mr R Quigley

3. Operational Status

WASTAC facilities consist of antenna and antenna controller at Curtin University of Technology, process computer, disk and magnetic tape drive at Bureau of Meteorology with a microwave link and dial up link between the two sites for realtime satellite data relay and acquisition scheduling respectively. Photographic slides of each pass are recorded by Bureau staff and the digital record and slides passed to DOLA (Remote Sensing Applications Centre) for archive, indexing and distribution. During the year a microwave link was successfully installed between Curtin University and the Bureau allowing remote operation and programming of the antenna.

As of January 1989 the Dual computer and disks were 4 years old and had a history of un-reliability. Due to increasing problems in both hardware and software combined with a lack of local maintenance support it was decided to examine options to provide users (particularly the Bureau of Meteorology) with a more satisfactory operational system.

In June 1989 PCM Electronics (Melbourne) were commissioned to design and construct a NOAA Receiver Interface (formatter) compatible with a new computer environment. Delivery of this component is scheduled for May 1990.

Resulting from equipment failures acquisitions were not possible for periods during June, October and December. Despite these problems, and due to the dedicated efforts of Rod Quigley (Bureau) and Ron Craig (DOLA RSAC) over 620 passes were recorded for the year, with night passes regularly acquired from June 1989, and special passes programmed in response to particular requests.

The archive is currently on 6250 b.p.i. magnetic tape each tape containing two passes. This media is expensive and causes storage problems (space and tape exercising). WASTAC is proposing higher density storage using video cassette (8mm) tapes with a capacity to store 20 passes resulting in considerable media cost and storage reductions. This conversion would mean WASTAC archive equipment was compatible with DOLA - RSAC facilities. DOLA - RSAC maintain a "quick look" 35mm slide archive and database of acquisitions. Orders for digital data are provided on 6250 or 1600 b.p.i. magnetic tape in raw or SHARP (band interleaved or band sequential internationally compatible) format.

WASTAC computer and peripheral upgrade is scheduled for May 1990.

4. Applications:

While the major purpose of WASTAC is to provide a reliable and regular supply of NOAA/AVHRR and TOVS data to its members, each Consortium member is responsible for developing applications. Significant progress in several applications has occurred and a number of "one-off" applications serviced.

4.1 *CSIRO:*

Oceanography - study of ocean circulation and sea surface temperature as influenced by the Leeuwin Current. WASTAC provides the regular data necessary to derive this information. Pearce (1988) and Prata (1986) describe these techniques.

The Leeuwin Current is a warm, relatively strong boundary current which flows southward off the Western Australian coast (in contrast with the cool northward currents found off the west coasts of southern Africa and South America). It is responsible for the presence of coral reefs off our coast, and for the transport of tropical marine larvae into southern waters. It flows most strongly during the autumn and winter months, and there is evidence that it weakens during periods of El Nino/Southern Oscillation (ENSO) events (Pearce and Phillips 1988); these authors have also shown that the annual settlement of rock lobster larvae along the West Australian coast seems to be associated with fluctuations in the Leeuwin Current.

Following an early satellite study of the Leeuwin Current (Legeckis and Cresswell 1981), locally-received NOAA/AVHRR satellite imagery has been used to examine the structure and seasonality of the Leeuwin Current (Prata et al. 1986, Pearce 1989). The warm tropical water in the Current can be monitored in AVHRR thermal bands 4 and 5, which also permit the absolute temperature of the sea to be computed using established algorithms (Pearce, Prata and Manning 1989).

The Leeuwin Current is clearly evident as a band of warm water extending southwards along the West Australian continental shelf from Northwest Cape (22 S), around Cape Leeuwin and eastwards into the Great Australian Bight. While the flow generally follows the edge of the shelf as a current jet, it periodically meanders away from the coast in large "waves" which can become detached as separated warm-core eddies. Associated with these waves are both shorewards and offshore currents, confirmed by current measurements using free-drifting buoys and current moorings along the shelf-break (Pearce, Phillips and Crossland, 1990); these zonal currents may contribute to cross-shelf exchange of water masses and hence marine larvae.

Collaborative and/or funded work between the CSIRO and other organisations has included a study of the climatology of the Leeuwin Current (Marine Sciences and Technology grant, Prata et al., 1986), an analysis of eddy pairs along the south coast (with the Australian National University, Griffiths and Pearce 1985a,b), observations of a nearshore plume (with the University of W. Australia, Hearn and Pearce 1985), a study of the mesoscale variability off the west coast (CSIRO/Australian National University grant, Pearce and Griffiths, in prep.), and the influence of the Leeuwin Current on the Abrolhos Islands (CSIRO/University of W. Australia grant, in prep.).

Exploration Geoscience/Oceanography - developed a proposal for an operational NOAA/AVHRR sea surface temperature distribution system for Western Australia targeting the fishing industry. This application requires further research and development and a reliable data source before the market can be successfully exploited. A proposal summary is at Appendix 2. Geological studies in the Canning Basin and Kimberley have been undertaken.

4.2 *Bureau of Meteorology:*

System reliability is essential before operational use of NOAA data is possible. The data will be down loaded (realtime) to Melbourne for use in the Bureau's forecasting service.

4.3 *Curtin University of Technology:*

Various atmospheric and oceanographic research studies are supported with NOAA data.

Remote Sensing of Aerosol Optical Depths - This is a collaborative research project with the Naval Postgraduate School Monterey supported by the Surveillance Research Laboratory, Defence Science and Technology Organisation (DSTO), Salisbury, SA. The intention is to use AVHRR data together with an estimation of Rayleigh scattering, derived from atmospheric thermodynamic profiles, to determine the scattering aerosol component and hence the aerosol optical depth. Work will concentrate initially over ocean regions. Such data will be used to estimate atmospheric visibility but additionally has the potential to be applied as a correction to visible channel readiness.

Retrieval of Atmospheric Temperature and Moisture Profiles using the NOAA TOVS and MSU sensors - Retrieval research is a joint project with the CIMSS, Space Science and Engineering Center (SSEC), University of Wisconsin supported by the Radio Wave Propagation Group, Environmental Research Laboratory, DSTO, Salisbury, SA. The ability of the TOVS sensor to recover vertically resolved information on atmospheric temperature and moisture is under evaluation. A synthetic retrieval package has been constructed and used extensively to investigate retrieval performance. A data set comprising radiosondes, released from HMAS COOK and coincident NOAA satellite data recorded in the Indian Ocean region are being employed to study the quality of retrieved products from real atmospheres.

Cloud Climatology - Climate models increasingly are demanding improved knowledge of cloud systems. This project is being undertaken jointly with Dr Paul Menzel, NOAA/NESDIS Satellite Applications Laboratory, Madison, Wisconsin. The approach using the carbon dioxide channels on the NOAA TOVS to estimate cloud heights, cloud amounts and cloud emissivity. Present activities involve software development and evaluation. Once operational the intention is to build a cloud climatology for the Indian Ocean region.

Ozone Estimates from NOAA TOVS Data - the 9.6 micron channel on the TOVS instrument senses the ozone thermal emission. While the sensor was not designed to measure ozone (better sensors exist) its spatial coverage, observation frequency and relative simplicity make it attractive to investigate further. For example ozone maps and ozone dispersion might be possible products which could have value in tracking the motion of the ozone hole, and possibly forecasting UV exposure on a daily basis. In order to measure the total column of ozone it is essential initially to have good quality temperature and moisture profiles.Normalisation of the ozone level estimated from the TOVS would be possible using data from the NASA Automated Dobson spectrometer operated in Perth.

Sea Surface Temperature (SST) - A program to evaluate the accuracy of SST retrievals, especially in tropical and subtropical regions, has been underway for several years. Activities include deep ocean cruises and the deployment of ship-based radiometric and temperature measuring equipment, as well as radiosonde releases to evaluate atmospheric parameters. This work is now being extended to form part of a study of air-sea thermodynamics.

4.4 *DOLA - Remote Sensing Applications Centre*

The major applications have been for demonstration purposes or disaster monitoring. The appointment of a scientist conjointly with CSIRO will strengthen the research component for renewable resource management purposes. Nonetheless several studies have been successfully undertaken.

Sea surface temperature studies - to assist CALM surveys of dugong habitat, Shark Bay and the relationship with ocean temperature gradients.

Cyclone damage assessment - pre and post cyclone assessments of vegetation damage in the Pilbara for several state authorities.

Drought Studies - use of historic NOAA data to validate NOAA data vegetation indices with known drought events.

Geological Mapping - using night thermal data, enhanced NOAA information for various areas of Australia have been provide to a number of mining companies.

Australian Mosaic - RSAC has produced an Australian mosaic in picture and digital format for "National Geographic" and in response to an Australia - wide demand.

Bushfire Monitoring - during severe bushfires in the Kimberley region of the State, NOAA data was used to track extent and spread. A study of fire fuel loads (biomass) was commenced in collaboration with the local Bushfires Board.

5. **Consultancies**

With increasing interest by the scientific community and general public in global change WASTAC commissioned Dr K. McCracken (former Director, CSIRO Office of Space Science Applications and member Australian Space Board) to prepare a position paper on the role of remote sensing technology, and specifically data from the Earth Observation System of the mid - 1990's, in providing baseline earth system science data. The objective was to gain a perspective of WASTAC's future role and research strategy. The study will be completed in early 1990, a summary statement is at Appendix 3.

6. **Initiatives**

In addition to the Earth System Science Centre investigation described at Appendix 2, WASTAC provided input to the Australian Liaison Committee on Remote Sensing by Satellite (ALCORSS) concerning NOAA data format and exchange. A summary of that report is at appendix 4.

DOLA and CSIRO have recognised the need to develop research and application strategies and accordingly have jointly appointed Dr Richard Smith to undertake studies into drought effect and prediction and bushfire modelling using NOAA data and other complementary information. This appointment is for an initial period of 3 years.

The Consortium have also responded to an announcement of opportunity by the Australian Space Board to establish a Space Industry Development Centre. This proposal was developed in cooperation with private industry (Steedman Science and Engineering, Geoscan and World Geoscience), and addresses coastal zone and tropical waters monitoring and management.

In November the Chairman attended an International NOAA/AVHRR Workshop in Argentina. The workshop addressed technical issues of calibration and navigation, and discussed future NOAA and European Space Agency Satellite programmes and their impact. A summary is at appendix 5.

7. **Assets Register**

As of 31st December 1989, WASTAC equipment consisted of:

1) *Curtin University of Technology (Kent St Bentley)*

1 x NOAA Receiving System (PCM Spec. 180/85/1) comprising:

1 - Antenna Mount comprising:

Antenna With RHC Feed
Tracking Mount
Trial Motor Control Panel
Manual Control Panel
Signal Interface

1 - LNC
1 - Antenna Controller
1 - Decoder - Demodulator
1 - NOAA Formatter Card
1 - Manual over-ride module

1 x Set of Handbooks:

5 off installation manuals
5 off maintenance manuals
30 off operating manuals

1 set of Spare Gear Comprising:-

1 - DC Servo Motors, Model STMOT-1
1 - Dual Worm Gear Reducer, Model STGER
1 - Bearings Kits, No. STBER-1
1 - Reed Switch - Magnetic kit, No. STSW - 1
1 - Shaft Encoder, Model STSE-1
2 - Bearings seals kit, STBS-1
2 - Gaskets Kit, STG-1
1 - Belt, Azimuth encoder, STBE-1
2 - Motor control board, STPM-280
1 - Power supply module, STPS-1
1 - 10 Transistor Kit, STTC-1
2 - Relay Type, STR-1
1 - Complete Module, Mitec Model Stlna-2
1 - Power supply module, No. STPOW-1
1 - Cooling Fan, Model STFAN-1
1 - Power Supply Kit, No. STJPOW-3
1 - Power Supply Kit, No. STPOW-4

1 x Microwave Transmitter (Macom) and Cabling (Installed June 1990)

1 x Dial up modem coupler

2) *Bureau of Meteorology (Wellington St, Perth)*

1 x Microwave Receiver (Macom) and Cabling (installed June 1989)

1 x Control Computer comprising:

1 - Dual Systems Chaparral 4 Computer (68020 processor rack mounted)

2 - Fujitsu 337 F disk drives (each 300 megabyte)

1 - Alpha numeric Terminal

1 - 8 bit colour terminal (VGA screen with colour card)

1 - CDC 92185 1600/6250 b.p.i. Magnetic Tape Drive Keystone 46/180, Model serial No. 13363 and interface.

1 - Dial-up modem coupler.

Software DUALIX V2.2 Release 1.0, SCHED and ACQR.

3. *Remote Sensing Applications Centre (DOLA): (Jardine House, Perth)*

WASTAC NOAA/AVHRR archive (Magnetic Tapes W0 to W 520 inclusive to 31st December 1989).

Support services provided by DOLA - RSAC and the Bureau of Meteorology include at least one man year of technical support, DOLA - RSAC archiving facilities - SUN 4/280 S computer and peripherals. A complete listing of NOAA passes recorded during the year is at appendix 6.

8. **Annual Budget**

The Board resolved at its 16th May 1989 Meeting to purchase a NOAA interface formatter board compatible with a replacement UNIX - based computer (and peripherals) with appropriate software; while contributions to meet running costs were established at $10,000 per annum per member and were approved by the 18th September meeting.

Estimated expenditure was based on the following information:

	Item	*Per annum*
1)	Telecom Rental	2000
2)	Magnetic Tapes	9000
3)	Tape drive maintenance contract	2500
4)	Telecommunications License of facility	500
5)	Photographic quicklook costs	3000
6)	Consultants (in lieu of maintenance contract for DUAL computer)	5000
7)	Sundries, consumable	5000
8)	Travelling - airfares	5000
9)	Provision for equipment replacement	8000
	Total	*$40000*

WASTAC Budget estimate for 1990: $40,000
(Contribution of $10,000 per member)

9. **Financial Statement:** **(Appendix 7)**

Major running expenses for the year included magnetic tape drive maintenance, film processing for "quick look" images, magnetic tapes for archive and staff expenses (not charged to WASTAC). The microwave link ordered in 1987 was finally successfully installed and the outstanding capital expense retired. A consultancy to Jellore Technologies for an Earth System Science Centre study was funded by the State Government through the Technology Industry Development Authority to an amount of $10,000.

Major revenue was through member contributions, with some data sales, mainly to mineral exploration companies.

10. **Audit Report and Recommendations** **(Appendix 8)**

The Curtin University Auditor raised a number of queries concerning WASTAC's operations. The following summary clarifies audit queries and recommendations relevant to the Deed between Consortium members (Appendix 1):

1) WASTAC appoint an Auditor: The Board resolved to appoint the Curtin University auditor to review the annual financial statements. Financial statements are currently prepared by Curtin University consequently this action was felt to be appropriate. Clauses 7(d) and 18(e) of the Deed.

2) Annual Report: To be prepared each year ending 31st December Clause 18(f). Note the Deed between Consortium members was formally signed on 24th January 1989, consequently the inaugural Annual Report was for the year ending 31 December 1989.

3) Annual Budget: Clause 18(h). An Annual Budget for 1990 was prepared and agreed at the Board's 18th September meeting and is contained in section 8.

4) Equal sharing of Costs (Clause 8): Invoices for outstanding contributions were issued in September 1989. Fees for 1990 were established at the Board's September 1989 meeting at $10,000 per member based on budget estimates.

5) Expenditure in Excess of $10,000. Clause 17(a)(i). Purchase of one way Video link. This equipment was originally ordered in 1986 prior to the Deed and at the time of original equipment order. Due to problems of supply, delays in installation and change of supplier the equipment was only installed during 1989. Equipment upgrades currently proposed were unanimously endorsed by the Board at its 16th May 1989 meeting.

6) Revenue/Expenditure Invoicing: Clause 6(a)(vii). All invoices are now raised by Curtin University.

7) Earth System Science Centre: Letters at appendix 9 details the terms of a consultancy funded by TIDA and administered by WASTAC for a ESSC proposal. A separate expenditure item has been maintained by Curtin University for expenses against this item.

8) Assets Register: A detailed listing of assets and their location is now maintained by the Secretariat and is reported at Section 7. All assets are recorded in Board minutes, correspondence or original purchase records.

9) Moneys from CSIRO. CSIRO have been requested to provide details concerning payments to WASTAC in 1988 and early 1990. Payments relate to credits from original equipment purchase and an amount for payment of a replacement microwave link.

H J HOUGHTON
Chairman
2nd April 1990

References:

Griffiths, R.W. and A.F. Pearce (1985a). Satellite images of an unstable warm eddy derived from the Leeuwin Current. Deep-Sea Res. 32(11), 1371-1380.

Griffiths, R.W. and A.F. Pearce (1985b). Instability and eddy pairs on the Leeuwin Current south of Australia. Deep-Sea Res. 32(12), 1511-1534.

Hearn, C.J. and A.F. Pearce (1985). NOAA satellite and air-borne sensing of a small-scale coastal tidal jet. Aust. J. Mar. Freshw. Res. 36, 643-653.

Legeckis, R. and G.R. Cresswell (1981). Satellite observations of sea-surface temperature fronts off the coast of western and southern Australia. Deep-Sea Res. 28, 297-306.

Pearce, A.F. (1989). A catalogue of NOAA-AVHRR satellite imagery received in Perth, Western Australia, 1981-1987. CSIRO Marine Lab. Rep. 203, 36pp.

Pearce, A.F. and B.F. Phillips (1988). ENSO events, the Leeuwin Current, and larval recruitment of the western rock lobster. J. Cons. int. Explor. Mer. 45, 13-21.

Pearce, A.F., A.J. Prata and C.R. Manning (1989). Comparison of NOAA/AVHRR-2 sea surface temperatures with surface measurements in coastal waters. Int. J. Remote Sensing 10(1), 37-52.

Pearce, A.F., B.F. Phillips and C.J. Crossland (1990). Oceanic processes, puerulus settlement and recruitment of the western rock lobster Panulirus cygnus. Proc. Boden Research Conf., Thredbo NSW, February 1990.

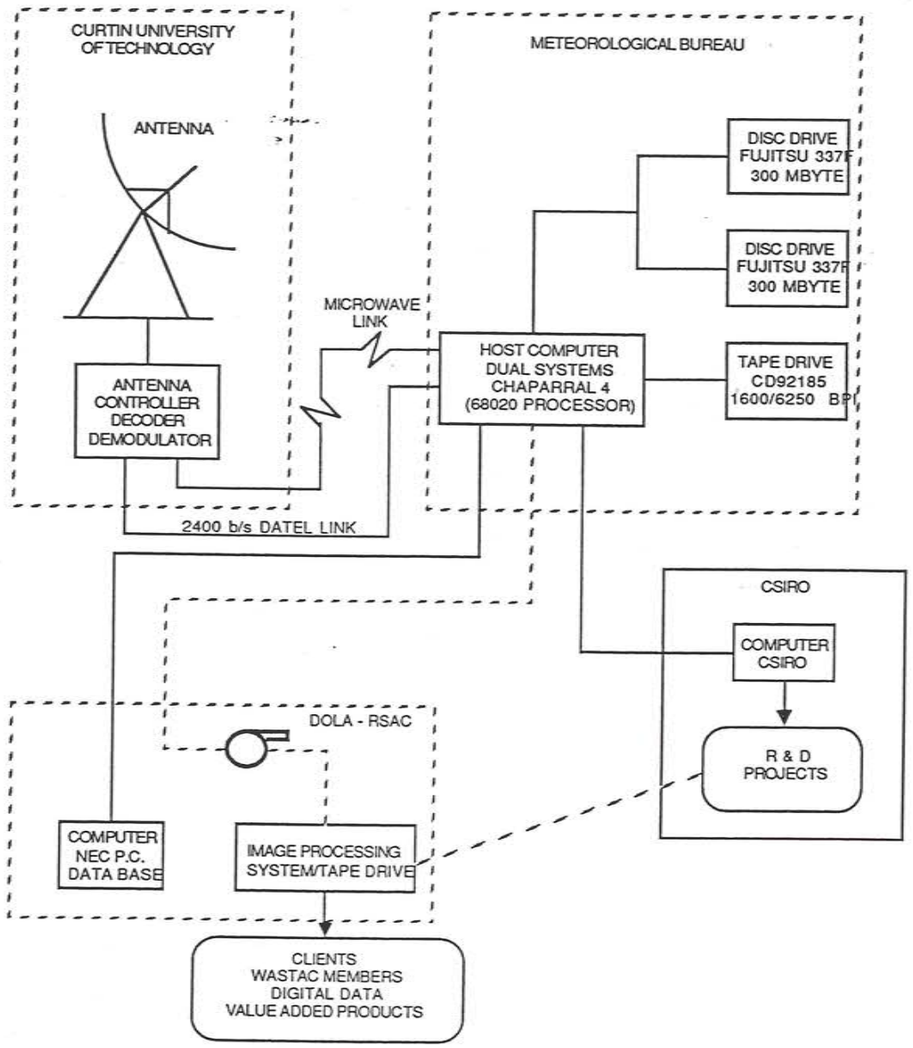
Pearce A.F. and R.W. Griffiths (in prep). The surface structure of the Leeuwin Current : satellite imagery and laboratory models. To be submitted to J. Geophys. Res.

Prata, A.J., A.F. Pearce, J.B. Wells and J.M. Carrier (1986). Satellite sea surface temperature measurements of the Leeuwin Current. Proc. First Austr. AVHRR Conf. Perth, 22-24 October 1986, 237-247.

Appendices:

1. WASTAC Deed.
2. Development of an Operational Satellite image Distribution System for Western Australia.
3. Earth System Science Centre Summary Statement.
4. Report to ALCORSS (January 1989) - NOAA/AVHRR Data Archiving and Distribution.
5. International NOAA/AVHRR Workshop - Bariloche Argentina November 1989.
6. WASTAC Acquisitions 1989.
7. Financial Statement as of 31st December 1989.
8. Audit Report and Recommendations.
9. Earth System Science Centre Consultancy - Terms.

WASTAC NOAA - AVHRR FACILITY



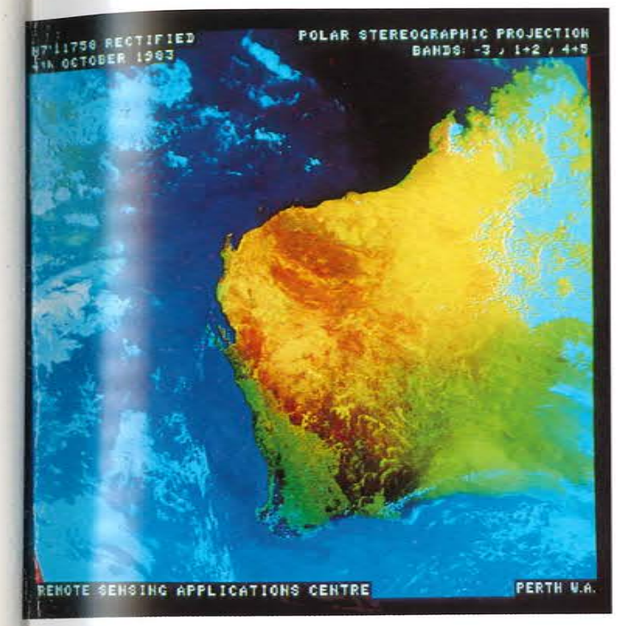
WA SATELLITE TECHNOLOGY & APPLICATION CONSORTIUM (WASTAC)

NOAA - AVHRR SATELLITE RECEIVING PROCESSING FACILITY
(OPERATIONAL JUNE 1987)

MEMBERS: DEPT. OF LAND ADMINISTRATION (RSA), CSIRO, CURTIN UNIVERSITY OF TECHNOLOGY, METEOROLOGICAL BUREAU

WASTAC

Western Australian Satellite Technology and Applications Consortium



NOAA SATELLITE IMAGE OF WESTERN AUSTRALIA
This is a coloured image depicting the regional overview of agricultural and pastoral regions. Image distortions have been removed and rectified to a polar stereographic projection. NOAA was launched to collect environmental data, advantages being regional coverage and a diversity of applications.

INTRODUCTION

The Western Australian Satellite Technology and Applications Consortium (WASTAC) comprising the Curtin University of Technology (CUT), CSIRO, Department of Land Administration (DOLA) and the Bureau of Meteorology, has been established specifically to acquire and operate a satellite tracking station for the reception of National Oceanic and Atmospheric Administration (NOAA) satellite data.

WASTAC will acquire, archive, computer process and analyse NOAA data. Products can be supplied in computer compatible tape format or as a photographic image.

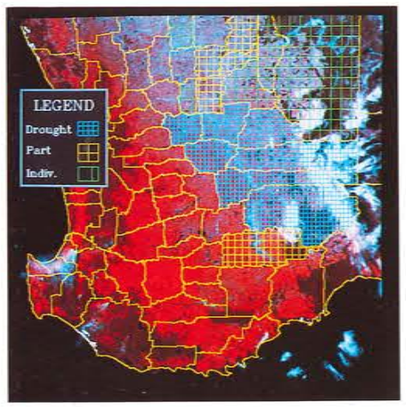
PRIME ACTIVITIES

- Establish and maintain the NOAA facility.
- Maintain an archive of remotely sensed data from the NOAA receiver, specifically Advanced Very High Resolution Radiometer Data (AVHRR) and TIROS Operational Vertical Sounder (TOVS) data.
- Provide data for operational requirements of the Commonwealth Bureau of Meteorology. Also, use the data for research, applications and education.
- Provide remotely sensed data to customers of the Consortium.

Depending on the application, NOAA data can be used in a pictorial format or analysed using interactive computer systems. The choice is up to the user.

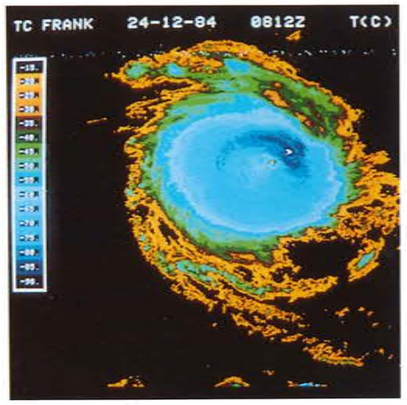
APPLICATIONS:

- Fire mapping
- Flood monitoring
- Drought and vegetation assessment
- Sea surface temperature
- Weather forecasting
- Geological



DROUGHT DETECTION—1985
Shire boundary detail integrated with NOAA imagery of the south-west of the State depicting spatial extent of drought for the winter of 1985. Drought affected areas appear inland (white) in contrast to healthier moist crops and pasture (red).

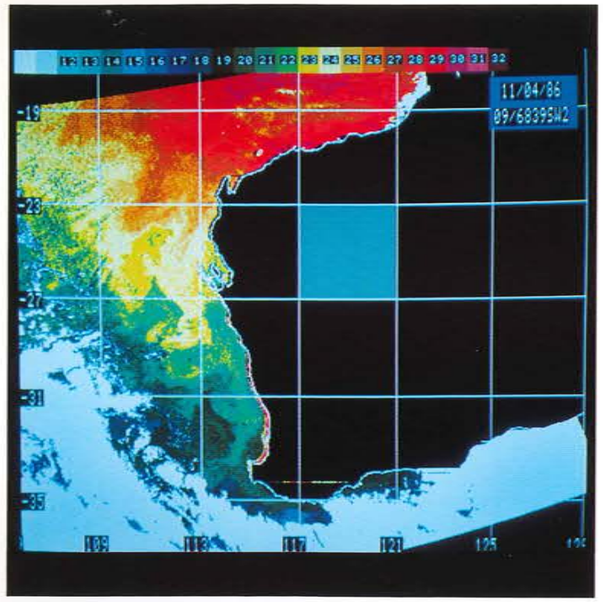
Regional weather and vegetation cover information merged with local agricultural and farm detail provides a valuable analysis package for drought assessment, seasonal crop progress and crop yields.



CYCLONE MONITORING
Brightness temperatures derived from an AVHRR image of Tropical cyclone Frank, December, 1984. Coldest temperatures (blue) indicate regions of highest cloud and greatest convective activity. Estimates of tropical cyclone position, intensity and movement can be monitored four times per day. Meteorologists face a demanding task predicting the movement and intensity of tropical cyclones.

WASTAC members:

Bureau of Meteorology
G.P.O. Box 1289K,
Melbourne, Vic. 3001.
Western Australian Department of Land Administration, Jardine House
184 St. George's Terrace
Perth, W.A. 6000.
Curtin University of Technology
Kent Street, Bentley, W.A. 6102.
CSIRO, Private Bag P.O.,
Wembley, W.A. 6014.



FISHING WITH NOAA/AVHRR
Sea surface temperature measurements derived from the AVHRR on board the NOAA satellites have been used to delineate ocean fronts. These fronts are often associated with enhanced biological activity and indicate conditions suitable for locating schools of bluefin tuna.

The NOAA image of W.A. dated 26.3.86 depicts the warm Leeuwin current swirls (green) among the cooler water (blue) of the Indian Ocean. The sea surface temperature data enables fishing operations to locate valuable catches of fish.

Oceanographers derive considerable benefit from satellite measurements of sea surface temperature.

NOAA SENSOR SPECIFICATIONS

- Sun synchronous, near polar orbit 833-870 kilometres high.
- Orbital view about 2,700 km wide.
- Two satellites operational, currently NOAA-9 and NOAA-10.
- The Advanced Very High Resolution Radiometer (AVHRR) provides data twice daily.
- AVHRR/2 ground resolution is 1.1 km.
- AVHRR/2 has 5 spectral bands.

BAND	WAVELENGTH (Microns)
1	0.58-0.68
2	0.725-1.10
3	3.55-3.93
4	10.3-11.30
5	11.5-12.5 (NOAA-7 and NOAA-9 only)

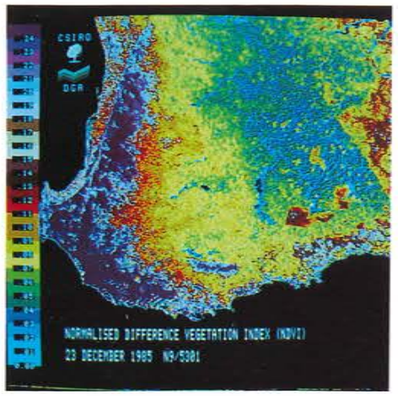
BAND 1
Visible, reflected light. Measures albedo; defines snow and ice features; terrain features; vegetative cover; and meteorological (cloud) features.

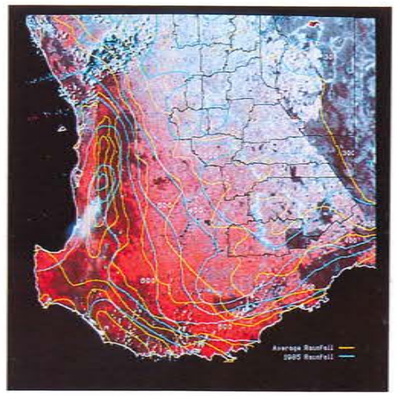
BAND 2
Near-infrared, reflected infrared. Defines snow and ice conditio and melt; allows vegetation assessment (highly sensitive to the presence of chlorophyll); and meteorological (cloud) monitoring.

BAND 3
Thermal mid-infrared. Sensitive to extreme heat sources; forest fire detection; sea surface temperature analysis; and night-time cloud mapping.

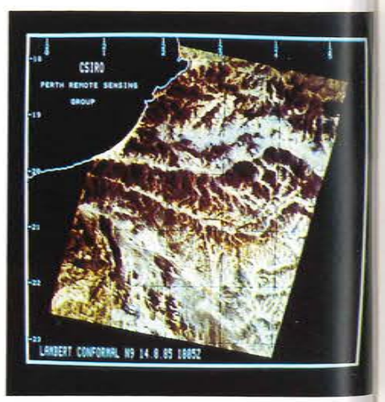
BAND 4
Thermal infrared. Day and night land temperatures; volcanic plumes; meteorological cloud features; and river, lake, and ocean surface temperatures.

BAND 5
Thermal infrared. Day and night land temperatures; volcanic plumes; meteorological cloud features; and river, lake, and ocean temperatures.





VEGETATION MONITORING
Vegetation indices can be computed and used operationally to assess climatic effects on vegetation and crops. The coloured image (left) covering the agricultural portion of the State is a normalised difference vegetation index dated 23rd December, 1985. Blue areas represent inland dry vegetation. Healthier actively transpiring vegetation in wetter regions is coloured dark purple. Vegetation condition is related to the reflectance of chlorophyll in green leaves in the visible and near infrared bands of the NOAA/AVHRR sensor. Land cover assessment and monitoring of critical fire fuel condition is practical using NOAA data. Additionally, regional fire and flood positions can be accurately determined and monitored.



GEOLOGICAL TARGETS
An AVHRR image of the Canning Basin in the dry north-west of W.A., re-mapped to a Lambert Conformal Projection. This night-time image shows palaeodrainage channels detected from differences in the thermally emitted surface radiation.

Identification of fossil drainage systems has assisted exploration for minerals, while geological structure recognition aids exploration for hydrocarbons and groundwater aquifers.

FURTHER INFORMATION
For further information specific to the WASTAC Consortium, contact:
Remote Sensing Applications Centre, Department of Land Administration
8th Floor, Jardine House, 184 St. George's Terrace
Perth, Western Australia 6000.
Telephone: (09) 323 1520. Telex: AA93784. Fax: (09) 321 8576.

APPENDIX 1

1989

CURTIN UNIVERSITY OF TECHNOLOGY

AND

THE MINISTER FOR LANDS

AND

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION

AND

THE COMMONWEALTH OF AUSTRALIA

DEED

CONVEYANCER
CROWN LAW DEPARTMENT
PERTH

TELEPHONE : (09) 327 1711
CLD : CURTINP/DST11

THIS DEED is made the 24 day of January 1989

BETWEEN:

CURTIN UNIVERSITY OF TECHNOLOGY a body corporate established by the Curtin University of Technology Act 1966 of Bentley in the State of Western Australia (hereinafter called "CURTIN") of the first part

THE MINISTER FOR LANDS a body corporate constituted by the Land Act 1933 of 60 Beaufort Street, Perth in the said State (hereinafter called "LANDS") of the second part

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION a body corporate established under the Science and Industry Research Act 1949 (Commonwealth) of Private Bag P.O. Wembley in the said State (hereinafter called "CSIRO") of the third part AND

THE COMMONWEALTH OF AUSTRALIA of C/- Director of Meteorology, 150 Lonsdale Street, Melbourne in the State of Victoria (hereinafter called "the Commonwealth") of the fourth part.

WHEREAS:

A. The Commonwealth-

(i) has, by its Parliament, power to make laws for the peace, order and good government of the Commonwealth with respect to meteorological observations,

(ii) is a contracting State to the Convention of the World Meteorological Organisation the purposes of which include the facilitation of worldwide meteorological networks, the promotion of centres for meteorological services, the rapid exchange of meteorological information and the application of meteorology to human activities, and

(iii) has, by the Meteorology Act 1955 established the Commonwealth Bureau of Meteorology ("the Bureau") to perform certain functions

in meteorological matters under the charge of the Director of Meteorology ("the Director") and has given the Director certain powers including the taking and recording of meteorological observations and the transmission of related reports and information.

B. For the purpose of discharging certain of their respective statutory functions the parties hereto are desirous of forming a consortium for the establishment operation and maintenance in Perth for their mutual benefit of a permanent operational automated Satellite Tracking Station for the reception processing analysis archiving and dissemination of remotely sensed data from satellites of the National Oceanic and Atmospheric Administration (hereinafter called "the Facility").

C. Each of the parties hereto has contributed the sum of SEVENTY FIVE THOUSAND DOLLARS ($75,000) for the establishment of the Facility and CSIRO has contributed an additional sum of NINETEEN THOUSAND NINE HUNDRED AND NINETY SIX DOLLARS ($19,996).

NOW THIS DEED WITNESSES as follows :-

1. The parties hereto hereby associate themselves in a joint venture (hereinafter called "the Consortium") in the manner and subject to the terms and conditions hereinafter provided for a term of five (5) years from the date of this Deed for the following purposes :-

(a) to acquire operate and maintain the Facility;

(b) to maintain an archive of remotely sensed data acquired by the Facility from satellites of the National Oceanic and Atmospheric Administration (hereinafter called "NOAA");

(c) to provide remotely sensed data for the day-to-day operational requirements of the Bureau;

(d) to provide facilities and remotely sensed data for the parties hereto to conduct research and development projects from time to time;

(e) to provide in accordance with the provisions of this Deed remotely sensed data to members of the Consortium for use by them for their own requirements or purposes or for supply by them to those to whom they may be responsible or for sale by them to their respective customers or clients as the case may be on terms and conditions determined by the Board of Management hereinafter referred to;

2.__ The parties shall carry on business hereunder under the names and styles of "THE WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM" and "WASTAC." CSIRO shall make application for and do all things necessary to have the said names registered as Business Names in Western Australia.

3.__ The Facility shall be comprised of -

(a) an Antenna and Antenna Controller presently located at the premises of CURTIN at Bentley;

(b) a Control Computer presently located at the premises of the Bureau at 127 Wellington Street, Perth;

(c) an Archive presently located at the Remote Sensing Applications Centre of LANDS at 184 St. George's Terrace, Perth.

(d) all other property (real and personal) apparatus equipment materials and things hereafter acquired by the Consortium for the purposes of this Deed.

4.__ The location of the Facility or any part thereof may be varied at any time and from time to time by agreement of all the parties hereto.

5.__ Each member of the Consortium shall-

(a) permit all other members of the Consortium to have reasonable access at all reasonable times to such portion of the Facility as shall be upon the premises of or under the control of that member and shall notify all other members seeking access as aforesaid of all conditions (if any) subject to which access will be permitted;

(b) keep such portion of the Facility as shall be upon its premises or under its control available and accessible continuously throughout each and every day and night during the continuance of this agreement for the purpose of carrying out any necessary maintenance or repairs thereto;

(c) at all times act in good faith in the interests and for the benefit and advancement of the Consortium and shall not at any time engage in unfair competition with other members of the Consortium.

6.__ The respective responsibilities of the parties hereto shall be as follows :-

(a) CURTIN through its Division of Engineering and Science shall within a reasonable time or at such other time or times as shall be appropriate in the circumstances -

(i) provide a suitable site with horizon-to-horizon traverse for the Antenna system of the Facility;

(ii) provide a suitable room for housing the control equipment and such other facilities as shall be requisite and necessary for effective acquisition of data by the Facility;

(iii) permit all necessary maintenance personnel to have access to the Facility at all times;

(iv) undertake the construction and supervision of all siteworks relative to the installation of the Antenna system and ancillary matters.

(v) provide temporary emergency assistance and support facilities in the event of a calamity;

(vi) supply suitably qualified staff to attend to specialised repairs of the Facility from time to time.

(vii) carry out all administrative financial and reporting obligations of the Consortium

(b) LANDS through the Remote Sensing Applications Centre of the Department of Land Administration shall within a reasonable time or at such other time or times as shall be appropriate in the circumstances -

(i) provide archival facilities for the data acquired by the receiving equipment of the Facility;

(ii) arrange the physical transfer of data acquired by the Facility to the archive;

(iii) provide facilities for the translation of the archival tape into various other CCT tape densities;

(iv) operate a centre for the distribution of data acquired by the Facility;

(v) implement and maintain on the Facility's computer a data base pertaining to the archived data and products derived therefrom;

(vi) implement maintain and distribute a "quicklook" library of all data acquired by the Facility.

(c) CSIRO through the Western Australian Remote Sensing Group within the Division of Exploration Geoscience shall within a reasonable time or at such other time or times as shall be appropriate in the circumstances -

(i) design write and implement in conjunction with the Bureau all software for the Facility's Control Computer as shall be necessary for the extraction display and archival of the remotely sensed data by the Facility;

(ii) assist members of the Consortium with their product development and maintenance of computer software;

(iii) be responsible for matters of a scientific nature in connection with the Facility as shall be necessary to ensure integrity of the remotely sensed data;

(iv) be responsible for products derived from the remotely sensed data by the Facility for use by third parties;

(v) liaise with NOAA and the National Environmental Satellite Data and Information Service with respect to the status of their respective satellite or satellites and the calibration and

performance of relevant instruments and for this purpose shall maintain a regular dialogue via the Electronic Bulletin Board.

(d) The Commonwealth through the Bureau shall within a reasonable time or at such other time or times as shall be appropriate -

(i) provide suitable accommodation and environment for the Control Computer of the Facility at the office of the Bureau at 127 Wellington Street, Perth;

(ii) provide proper continual and uninterrupted operation of those portions of the Facility under the control of the Bureau or for which the Commonwealth is responsible;

(iii) subject to Clause 16 hereof and to the full extent of resources reasonably available in Western Australia repair and maintain the Tracking Antenna the Microwave Link and the Control Computer of the Facility with power to recover additional costs from other members of the Consortium;

(iv) administer the provision of consumable items necessary for the proper operation of the Facility (including without limitation computer tapes and photographic film) and recover the cost of such items from the Consortium;

(v) design write and implement in conjunction with CSIRO all software for the Facility's Control Computer as shall be necessary for the extraction display and archival of the remotely sensed data by the Facility;

(vi) co-ordinate the implementation of the objects of the Consortium.

7. (a) The ownership and property in the Facility and all things comprising the Facility and incidental or ancillary thereto shall be held by all parties hereto as tenants in common in equal shares.

(b) The Archive together with the copyright therein shall be the property of the members of the Consortium as tenants in common

in equal shares. The expression "Archive" when used herein shall mean the medium upon which or whereby the data is for the time being stored.

(c) Each member of the Consortium shall keep proper and adequate records and accounts of all costs properly incurred by it in carrying out its responsibilities pursuant to Clause 6 hereof.

(d) The Board shall appoint an auditor to conduct an audit of the accounts of all or any of the members of the Consortium pursuant to subclause (c) hereof.

(e) Except as expressly herein provided to the contrary the respective responsibilities and functions of each of the members of the Consortium pursuant to Clause 6 hereof shall be deemed to be of equal value so that no member shall be considered as contributing to the Consortium more or less by way of responsibility functions or effort than any other member or members and no accounting shall be required or taken between them.

(f) Each member of the Consortium shall be entitled to receive such number of tapes of the data as the Board shall determine from time to time.

(g) Nothing in this Deed shall be taken as precluding the Bureau from supplying images for meteorological purposes to the public or the media free of charge in conformity with the functions of the Bureau under the Meteorology Act 1955 and its established procedures and operations.

(h) No member of the Consortium shall make a profit from the sale or supply of Archive acquired by the Consortium PROVIDED HOWEVER that each member shall in utilising the data in accordance with Clause 1 hereof be entitled to make to its

consumers such charge for the value added to the data by that member as shall be appropriate in the circumstances.

8. Unless otherwise provided herein all costs expenses and outgoings both of a capital or revenue nature shall be borne by the parties hereto in equal shares.

9. Neither this Deed nor the interest or obligations of any one or more of the parties hereto shall be capable of being assigned transferred mortgaged charged encumbered subcontracted or sublet in whole or in part without the prior agreement or consent in writing of all parties hereto.

10. Each party hereto shall employ and pay such personnel as shall be necessary for the proper performance of its respective obligations hereunder and such personnel shall remain at all times and for all purposes the servants or employees of that party. The Consortium shall not be the employer of any personnel.

11. (a) CURTIN LANDS and CSIRO acknowledging the power of the Parliament of the Commonwealth to make laws relating to meteorology, the Commonwealth's espousal of the purposes of the World Meteorological Organisation and acknowledging the functions of the Bureau IT IS MUTUALLY AGREED by the parties hereto that execution by the Commonwealth of this Agreement does not constitute an endorsement by it of the involvement of the other parties in a meteorological satellite data service other than in pursuance of the Director's powers under the Meteorology Act 1955 to make arrangements for taking recording communicating and receiving meteorological observations reports and information,

(b) to the intent of subclause (a) above, CURTIN LANDS and CSIRO acknowledge that this Agreement is without prejudice to and subject to

(i) the power of the Parliament of the Commonwealth to make laws for the peace order and good government of the Commonwealth with respect to meteorological

observations PROVIDED THAT the same shall not vary or abrogate this Agreement either wholly or in part, and

(ii) the power of the Director in performing the functions of the Bureau to establish an automated tracking station or stations in addition to and separate from the Facility,

(c) notwithstanding anything to the contrary contained in this Agreement CURTIN LANDS and CSIRO shall not release in real time other than to another member of the Consortium any data to be used for meteorological purposes obtained through the Facility without the consent of the Director or his delegate first had and obtained on each occasion,

(d) the expression "real time" when used herein shall mean within twenty four (24) hours after the receipt by the Facility of the data referred to.

12. In determining the fees and charges to be paid by consumers for the provision of data by members of the Consortium the parties hereto shall take into account the matters contained in Clause 11 hereof.

13. The Facility shall be so designed constructed operated and maintained as to be sufficiently robust and flexible in a technical engineering sense to meet the stringent round-the-clock requirements of the Bureau at all times.

14. If in the opinion of the Director of Meteorology a cyclone gale storm or any other weather condition likely to endanger life or property is threatened or imminent the Bureau shall have absolute priority of access to the Facility until the Director is satisfied that any such weather condition as aforesaid or the threat thereof has passed.

15. The Bureau shall bear all charges for the use of the Facility when used exclusively for the requirements of the Bureau under Clause 14.

16. The members of the Consortium shall contribute in proportion to their respective interests in the Consortium towards the cost of replacement or

reinstatement of the Facility or any part thereof or any equipment apparatus property or material comprising the same which may be lost damaged or destroyed.

17. (a) The Facility will be managed by a Board of Management ("the Board") consisting of eight members two of whom shall be nominated in writing by each of the parties hereto. A substitute member shall also be nominated by each party hereto.

(b) The Board will elect one of its members to be Chairperson to serve for a period of two years. The Chairperson will have the same voting rights as the other Board members. Each member shall have one vote.

(c) (i) Resolutions of the Board shall be by simple majority of members present and voting at a meeting EXCEPT in the following cases which require a unanimous resolution namely-

(A) discussions involving expenditure in excess of $10,000

(B) variation of the scope of the Consortium's activities

(C) admission of new members of the Consortium

(D) any additional matters determined by the Board.

Only members and substitute members may vote upon a resolution.

(ii) Four members (being one member from each party hereto) shall constitute a quorum for any meeting of the Board.

(iii) Absent members may vote by proxy.

(d) The Board shall have no power or authority to make any contract or agreement or to give any legally binding undertaking or warranty on behalf of or in the name of the parties hereto or any of them;

(e) The Board may permit other persons to attend Board meetings but such persons shall not vote upon any matter.

18. The Board will be responsible for :

(a) Making recommendations for the acquisition, installation, testing and acceptance of the Facility;

(b) The overall management and operation of the Facility;

(c) Arrangements for the maintenance and replacement of the Facility equipment;

(d) Negotiation of agreements and arrangements with organisations not parties to this Agreement;

(e) The maintenance of appropriate financial records for the Consortium with respect to the Facility. Auditors shall be appointed annually at the first Board meeting of the calendar year to audit the annual accounts of the Consortium.

(f) The preparation of an annual report on all aspects of the Consortium's activities with respect to the Facility by 1st March each year;

(g) Setting of conditions and charges for the provision to consumers of data acquired by the Facility;

(h) Preparation of an annual budget and approval of expenditure of Consortium funds;

(i) The consideration of proposals for the enhancement of the Facility and reporting thereon to the parties hereto.

19. Any party hereto may withdraw from the Consortium and this Agreement upon giving twelve (12) months' notice in writing to all other parties hereto of its intention so to do and subject to payment by that party of all monies due and payable by it in respect of its share of the outgoings and expenses of the Consortium up to the date of withdrawal.

20. Upon receipt of notice of a party's intention to withdraw from the Consortium the remaining parties hereto shall meet and determine whether:

(a) the Consortium shall be dissolved or

(b) the remaining parties shall continue to carry on the Consortium pursuant to this Deed or

(c) a new party or parties shall be invited to join the Consortium and, if so, the terms and conditions to be attached to the said invitation.

21. Upon a dissolution of the Consortium all property and monies of the Consortium remaining after the payment and satisfaction of all outstanding debts liabilities obligations and expenses of the Consortium shall be divided equally among the parties hereto.

22. Upon the withdrawal of any party hereto from the Consortium the liability of that party to contribute to future outgoings and expenses of the Consortium incurred or accruing after the date of withdrawal shall cease at that date. The nett value of that party's share of the assets and property of the Consortium shall be determined and paid to it at the expiration of the term of this Deed.

23. Any new party to the Consortium shall upon joining the Consortium execute a deed of covenant with the existing parties to the Consortium to observe perform and be bound by the provisions of this Deed and shall make such contribution to the capital and assets of the Consortium as the existing parties may determine.

24. No relationship of employment agency or partnership shall be created or be deemed to exist between the parties hereto or any one or more of them.

IN WITNESS whereof the parties hereto have executed this Deed on the day and year first hereinbefore written.

THE COMMON SEAL of CURTIN UNIVERSITY OF TECHNOLOGY was hereunto affixed on the 15th day of December 1988 by the authority of the Vice-Chancellor)

Vice-Chancellor

Administrative Secretary

THE COMMON SEAL of the MINISTER FOR LANDS was hereunto affixed by me :)

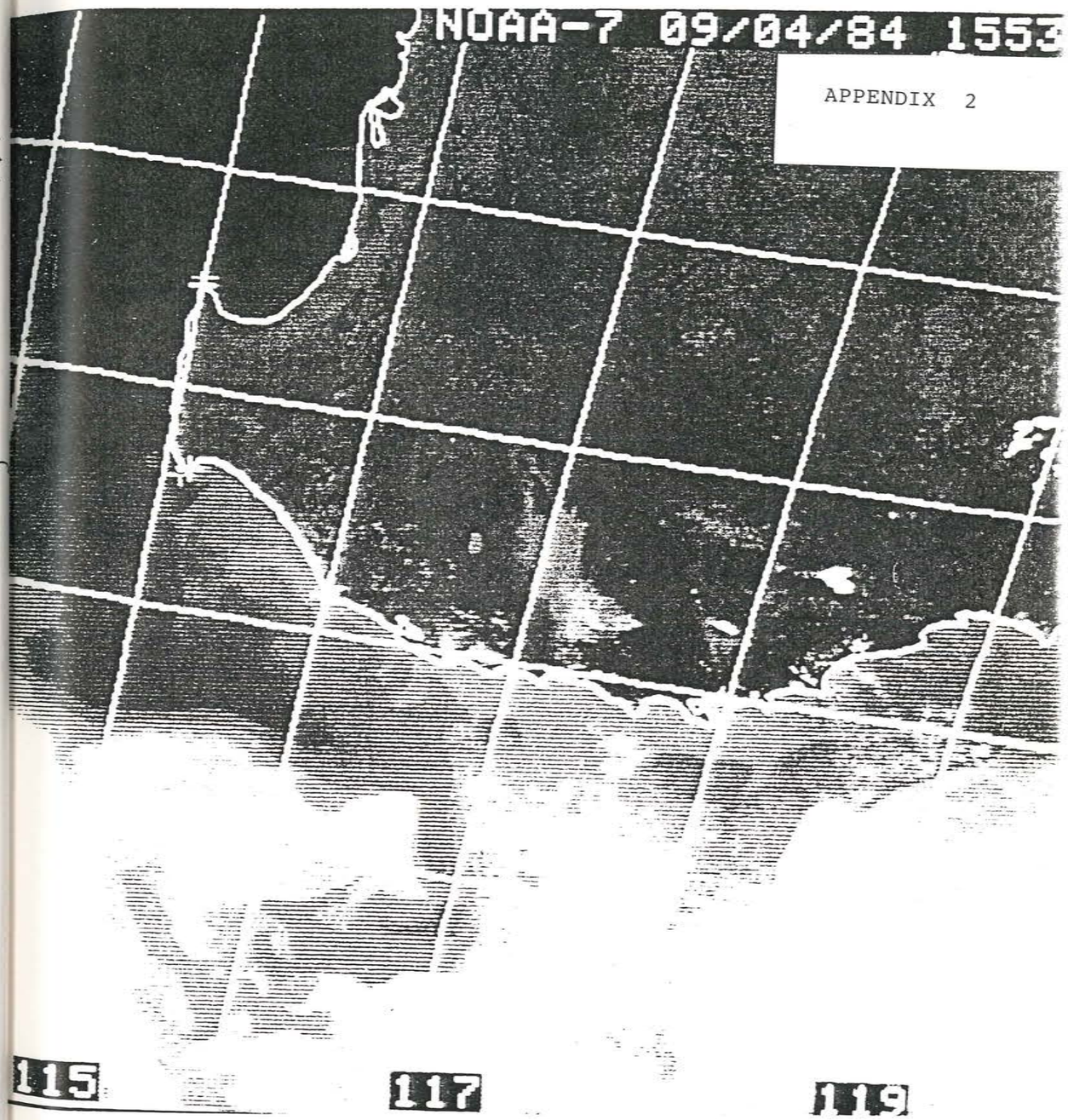
Minister for Lands
in the presence of :

EXECUTIVE OFFICER
MINISTER FOR LANDS

THE COMMON SEAL of THE COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION was hereunto affixed in the presence of :)

SIGNED SEALED AND DELIVERED for and on behalf of THE COMMONWEALTH OF AUSTRALIA by John William Zillman the Director of Meteorology for the time being in the presence of :)

DEVELOPMENT OF AN OPERATIONAL SATELLITE IMAGE DISTRIBUTION SYSTEM FOR WESTERN AUSTRALIA



CSIRO W A Remote Sensing Group

DISCUSSION DOCUMENT

DEVELOPMENT OF AN OPERATIONAL SATELLITE IMAGE DISTRIBUTION SYSTEM FOR WESTERN AUSTRALIA

BACKGROUND

The Western Australian Satellite Technology and Applications Consortium (WASTAC), comprising CSIRO, Department of Lands Administration, Curtin University and the Bureau of Meteorology, has the capability of receiving image data from up to 4 AVHRR passes, each day, covering 90% of the Australian coastline. These data can be processed to show Sea Surface Temperatures (SSTs) on geometrically rectified grids, for subscenes of specific interest to a particular marine industry. These images may be transmitted, by various means, in "near real-time" to enable management decisions specific to the relevant marine operations.

There are normally two NOAA satellites which scan every part of the earth's surface twice per day (Schwalb, 1978). The Advanced Very High Resolution Radiometer (AVHRR) on these satellites provide image data from which the average SST of the ocean, over one kilometre square pixels, can be computed to within 0.5°C (Prata et al., 1986). Strictly, this is the ocean skin temperature, but given normal ocean conditions such measurements reflect the upper 250 metres of ocean water movements (Godfrey and Ridgeway, 1985). Studies in other parts of the world have shown a relationship between SST and structure to fish catch. (Fielder et al. 1984 and Laurs et al. 1984).

For Australia, with 12,000 km of coastline and fisheries that are diverse and quite widespread, satellites are potentially important and may offer substantial economic benefits. Figure 1 shows the total acquisition elipse which can be received from the facility located in Perth and a typical NOAA swath over Western Australia. The area of the frontispiece is highlighted.

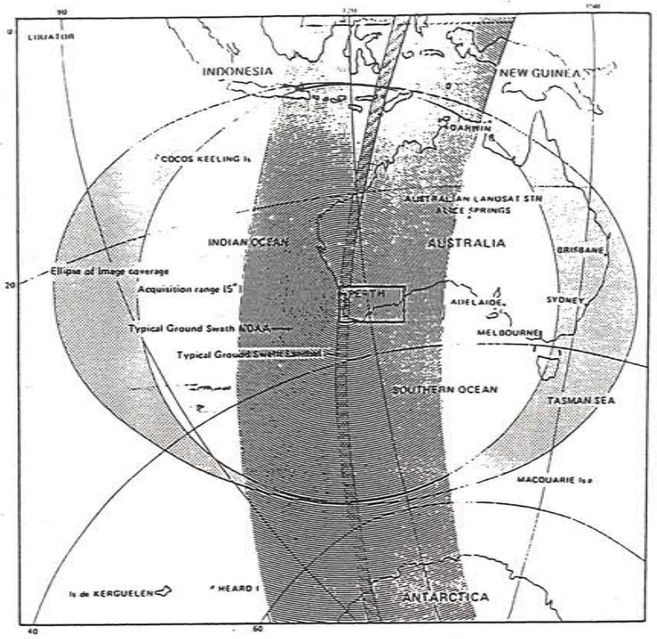


Figure 1. Acquisition elipse, NOAA swath and the area shown on frontispiece.

AIMS

1. To set up the mechanisms to routinely make available NOAA-AVHRR data from the WASTAC Facility to the Fishing Industry. This involves the establishment or updating of image processing software, hardware and communications links.

2. To draw together groups of companies to contribute to those modules of the project which will have direct relevance to their fishing operations.

3. To draw together companies which may contribute to the processing, communication or entrepreneurial aspects.

4. To attract "seed" funding from Government Research Grants covering the designated high priority categories of "Remote Sensing", "Maritime Resources" and "Communications".

5. To facilitate Fishing or Oceanography Research dependant upon the analysis of temporally relevant satellite data.

PROCEDURES

There are four separate processes that must be implemented to achieve the first Aim:

1. The down-loading of raw data from the WASTAC Receiving Facility.

2. Selection of cloud-free acquisitions, processing to SST and preparation of image file for transmission.

3. Transmission of digital or photographic products to remote users.

4. Interpretation and/or enhancement of images by skippers/managers.

Step 1

The WASTAC receiver is currently receiving data and the standard formats are being adopted to enable the use of these images for meteorological and other uses. At this point data covering the areas of interest need to be viewed and separated from the total acquisition and stored in a format suitable for processing.

Step 2

The processing stage involves calibration, geometric rectification, derivation of SSTs, subsetting requested areas and then either production of a photographic or digital product.

Step 3

Where a photographic product is required these would be despatched by mail or courier in a form to be determined. The digital product would be sent via modems connected to telephone, or satellite links, to either fishing ports or to shipboard receivers.

Step 4

Involves minor interpretive instruction for photographic products but a more complex procedure is envisaged for digital data. The reception of digital data will require a PC, linked to a modem, with specially adapted software to enable interactive enhancement, roaming, zooming and dynamic comparisons.

Due to the nature of the fishing industries it is considered important to modularise the project. This would optimise computer processing time and also enable tailoring of segments of images to be specifically enhanced to the preferred requirement of the participants. A module covers a specific area, for which regular (determined by the nature of the industry) acquisitions would be processed and supplied. Each module could encompass up to approximately 500 km square centred on a major fishing location e.g. Esperance, Albany, Fremantle, Dongara, etc. A single company may wish to take up more than one module.

The cost of a module should reflect the true cost of the data and subsequent processing. It would be misleading to subsidize data cost but there should also be no attempt to recover capital cost of the WASTAC Facility. Different modules obviously reflect different fishing operations some of which may require concentrated coverage for intense periods, others may only require 1 or 2 passes each week throughout a season. These requirements must be determined by industry representatives.

ORGANISATION

CSIRO could undertake to:

1. negotiate with groups or companies to define the modules, satisfy research status criteria and act as the secretariat;

2. define tasks and write specifications to establish an operational facility;

3. appoint contractors or allocate appropriate technicians or scientists, to achieve these tasks;

4. keep participants informed of developments in other remotely sensed data sets, i.e. Airborne Scanning Ocean Colour satellites, etc. as data becomes available and to perform research tasks in line with its charter, and;

5. oversee the transfer of the technology developed into operational hands, with or without equity at an agreed time.

CITED LITERATURE

Godfrey, J.S. and Ridgeway, K.R., 1985. The Large Scale Environment of the Poleward Flowing Leeuwin Current, Western Australia: Longshore Steric Height, Gradients, Wind Stresses and Geostrophic Flow. Journal of Physical Oceanography, V15 N5, pp 489-495.

Feidler, P.C., Smith, G.B. and Laurs, R.M., 1984. Fisheries Applications of Satellite data in the Eastern North Pacific. Marine Fisheries Review V46, N3, pp 1-13.

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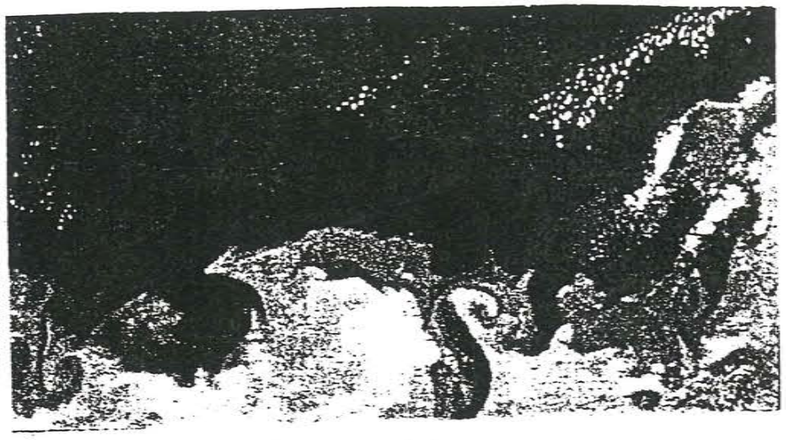


Figure 2(A).
Raw data showing Eddy feature near Bremer Bay

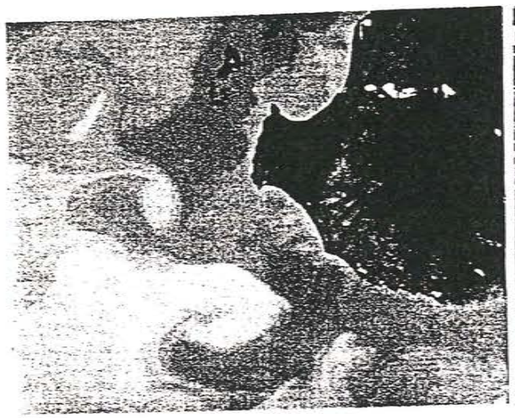


Figure 2(B).
Unprocessed raw data (512x512)

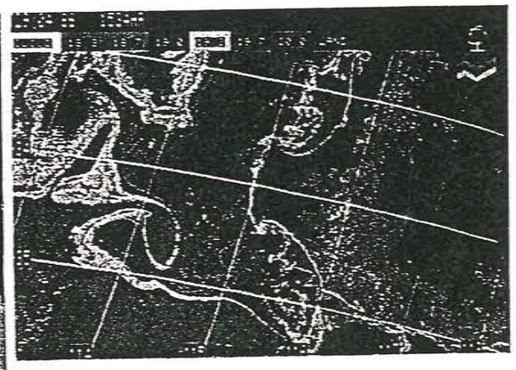


Figure 2(C).
SST and geolocation overlay ready for transmission

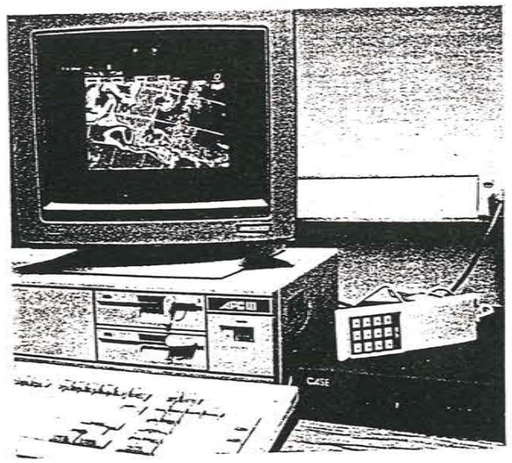
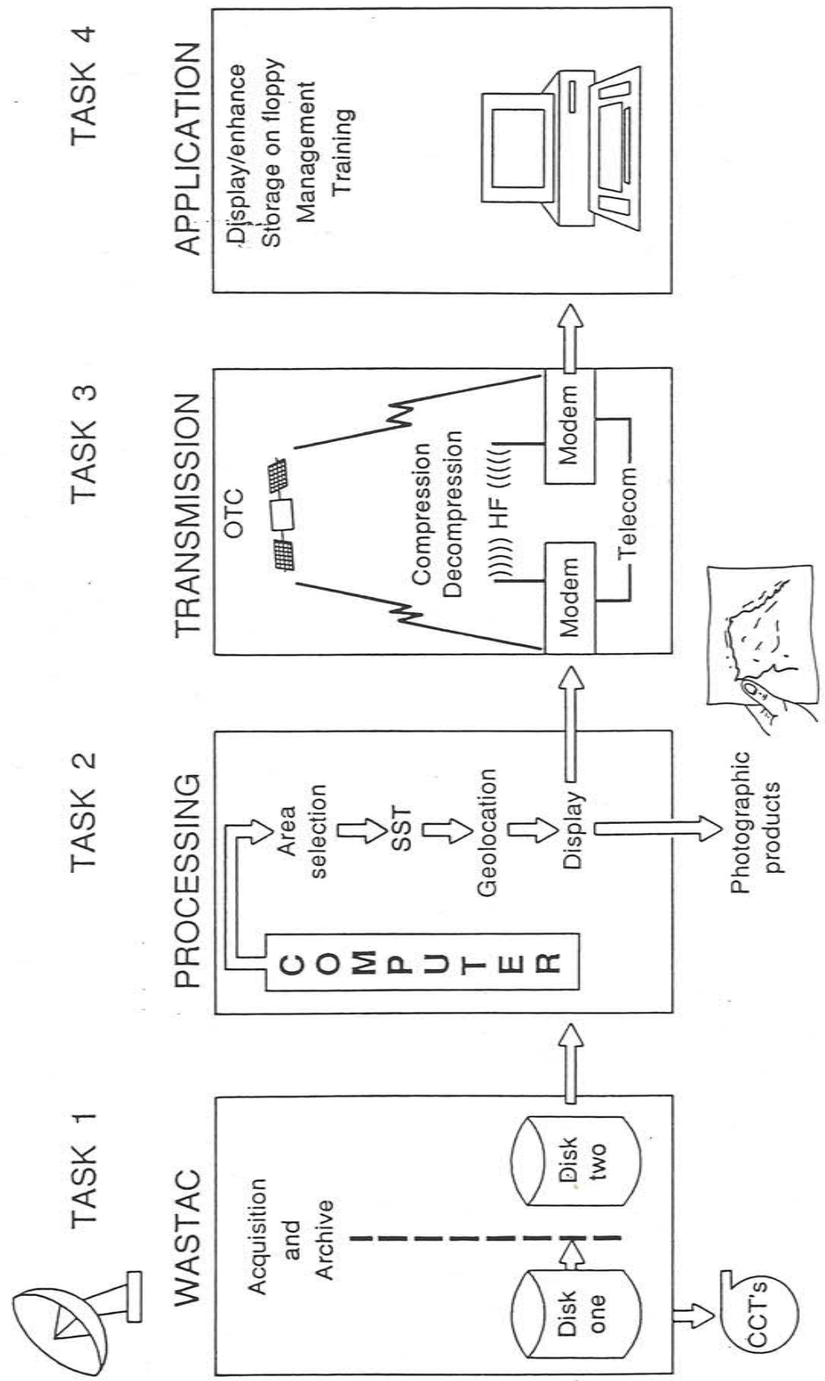


Figure 2(D).

Transmitted image on Personal computer and the telephone modem link. This image is then stored on floppy disk for subsequent redisplay



PREDICTING AND MANAGING GLOBAL CHANGE

PREPARING FOR THE NEEDS OF THE FUTURE

A Strategic Plan for a Western Australian Earth System Science Centre based upon Comparative Advantage and National Need

Developed by the Western Australian Satellite Technology Applications Consortium (WASTAC) 1990

Members:

* **Western Australian Department of Land Administration**
* **Curtin University of Technology**
* **Bureau of Meteorology**
* **CSIRO**

Supported by Technology Industry Development Authority

1. EXECUTIVE SUMMARY

THE WESTERN AUSTRALIAN EARTH SYSTEM SCIENCE CENTRE

The Need

There is an urgent need to understand those factors which contribute to global environmental change, and more particularly, those which influence the Australian environment.

The Vision

To develop an applied research community of international standing in the measurement and prediction of global environmental change and its consequences.

The Task

To develop an understanding of key features of global environmental change, and to develop operational methods to measure it and predict its consequences.

The Geographic Opportunity

Perth is ideally located to make a major contribution to the science and technology of this task. It is located in proximity to three areas which have major yet little understood influence on the national, and the world climate. Those areas are the Indonesian - NW Australia "hot spot"; the Indian Ocean; and the circumpolar atmospheric & oceanic circulation.

The Human Resource

Perth already has the greatest strength in Remote Sensing in the nation, with personnel in State, Federal (CSIRO and Meteorological Bureau), University, and private organisations.
The co-ordination between these organisations is already excellent, and there is a demonstrated history of commercialisation of the research and development in remote sensing.

The Technical Opportunity

The three major international space agencies will fly new generation satellite missions to address the problem of measuring climate change in the 1990's. Calibration of satellite data is vital on a world wide basis, and Perth, because of its proximity to the regions mentioned above, could achieve "favoured collaborator" status. This would greatly assist in the development of products with a world wide market.

The Social and Economic Benefits

The ESSC will provide the world wide linkages, the access to data, and the intellectual knowledge to assist the public and private sectors to anticipate and manage environmental change. As such, it will provide value-added products of world-wide applicability.

The Strategic Goals

* To quantify the responses of the new generation of remote sensing instruments to the vegetation, and terrain types of Western Australia and the tropics to the north, and therefore develop optimum vegetation indices.

* To establish state-of-the-art capability to interpret sea surface temperatures and wind stress in the region of Western Australia and use them to develop an understanding of the effect of the Indian Ocean upon El Nino; and upon the NW-SE cloud band, and its influence on the climate of continental Australia.

* To quantify the performance of the new generation of meteorological sensors, with particular emphasis upon those that measure surface air temperature, tropospheric air temperature, and tropospheric water vapour over land and ocean.

Looking Back and Looking Forward

Research into, and management of global change is vitally dependent upon the possessors of adequate baseline data. Further, the newer forms of data (eg satellite) must be acquired over a sufficiently long period to be able to assess their accuracy and to optimise their use. WASTAC has already started the process through developing long term archives of data from existing earth observation satellites.
Consequently, an important function of the ESSC will be the maintenance of adequate data archives to address the stated strategic goals.

The Resources

The ESSC will require progressive installation of equipment for satellite interrogation, processing and research and, more importantly, the intellectual resource necessary to analyse and apply these data to the global change issues of the 1990's. The proposal calls for these resources to be in place by the mid 1990's when satellites from the Earth Observation System programme are scheduled for launch. It is imperative that this occur, otherwise the research, social and commercial benefits envisaged will not be realised. Estimated ESSC funding is $20 million over five years with some revenue projected from year three onwards.

REPORT TO ALCORSS - NOAA/AVHRR DATA ARCHIVING AND DISTRIBUTION

1. INTRODUCTION

The July 1988 ALCORSS meeting resolved that a Working Party be convened to examine NOAA/AVHRR data Archiving and distribution format for information received in Australia. The Terms of Reference were to:

- determine archive and distribution policies currently used by Australian ground stations

- report on a recommended archive for Australia and its Exclusive Economic Zone (EEZ)

In August 1988 information was requested from all known NOAA/AVHRR Stations as detailed on attachment 1.

1.1 The responses were summarised and are recorded at attachment 2, with a coverage map at attachment 3.

2. DISCUSSION

2.1 Coverage

The coverage map indicates that Australia and its EEZ is totally covered from existing stations in Melbourne, Hobart, Townsville and Perth. Additional stations at Alice Springs, Darwin and Casey in Antarctica slightly extend that coverage and provide some backup.

2.2 Archive Policy

Most station archive policies are a compromise between the prime station operator's purposes (demand) and budget limitations, however there is at least one high elevation cloud free pass archived per week for the entire region. Several sites indicated an intention to record all passes and archive daily.

2.3 Archive Storage Format

All archives record full resolution data and include all necessary orbit ephemeris data and calibration information, in HRPT format. These archives are currently either on 1600 or 6250 b.p.i. density magnetic tape with a move to 8 mm 2 giegabyte storage media (EXABYTE) at Townsville, Perth and Hobart (existing).

2.4 Data Distribution Format

There are several formats used for data distribution: ZIP (Zero Image Processing), DISMP, SHARP and a McDonald Dettwiler format. Major influences are currently the constraints of existing user's equipment and application requirement (ie. many applications do not need calibration data). Distribution to major research facilities (which in turn are receiving facilities) seems to favour ZIP format; ie. a direct copy of the original archive with no unpacking or reformatting - this is normally done by the user.

2.5 Future Requirements

The main comments relate to:

- *user survey to define needs and archive frequency
- charging policy
- archive form, centralised, decentralised
- support, in the form of software (for other user sites), to read distributor's format
- cheaper, higher density storage recommend

*Such a survey is more directed to specific uses, projects where a value added output may be required. Surveys are more likely to be instigated by individual facility operators.

3. Recommendations

It has been concluded that all stations exist to satisfy a primary purpose - research or weather forecasting. Any additional requirement must cause minimal impact on the operations of the facility. Consequently as a minimum, the following recommendations are made.

3.1 Each facility archive the optimum overhead day and night pass each week (ideally daily).

3.2 The archive be in HRPT format; ie. zero level (currently the case at all existing facilities)

3.3 Data distribution between facilities be in zero level and at nominal cost (media plus time) for research purposes.

3.4 The SHARP format be adopted as the favoured format for distribution to users, its use to be encouraged by making available the necessary software to generate SHARP from zero level archives (refer also to letter from ESA - EARTHNET attachment 4) at this stage available in the C-language suitable for VAX Computers.

3.5 Consideration be given to a common format quick-look archive which can be copied to a central site such as ACRES; ie. a 512 x 512 single band (band 2 day, band 5 night) file for each archived pass regularly forwarded to ACRES for microfiche output similar to the existing LANDSAT micro image fiche. Digital data base?

3.6 ACRES act as a central contact point for information on data available through each facility.

3.7 A ~~uniform~~ pricing policy is essential for data sales. The prices must be consistent with prices for similar products from ESA and NOAA. These are currently approx. $480.00 and $150.00 for a typical 16 minute pass respectively. Australian charges vary, depending on the application ($50 - $200). The basis of charging should be to recover, in part, operating costs. in S. model.

3.8 The use of high capacity (low cost) storage media would reduce cost and encourage facilities to acquire a minimum long term archive.

3.9 Secondary sale of data will require consideration of royalty payment, conditions of use (difficult given AVHRR data is public domain). Such considerations are more relevant to value-added products rather than the raw data.

CONCLUSION

The importance of a long-term NOAA/AVHRR archive over Australia and its EEZ is acknowledged as a data source for a multitude of studies relating to macro - level changes in climate, oceans and land resources. These uses are very obviously "public good" and accordingly ALCORSS should support positive action to implement the recommendations of the Working Party. The security of a NOAA/AVHRR archive is a national responsibility which can be achieved through ACRES in close collaboration with the operators of Australian facilities.

H. J. Houghton

H. J. HOUGHTON
NOAA/AVHRR WORKING PARTY CONVENOR

January 27, 1989

ATTACHED:

1. Letter to NOAA/AVHRR Station Operators
2. Summary of responses received
3. NOAA/AVHRR Coverage Map of Australia
4. Letter from ESA (Earthnet Programme Office) concerning SHARP format
5. NOAA data distribution format

Department of
LAND ADMINISTRATION

Your Ref:

Our Ref: 1974/981
HJH:AEW

Telephone Enquiries: (09) 323 1520

NOAA/AVHRR DATA ARCHIVING AND DISTRIBUTION

At the Australian Liaison Committee On Remote Sensing by Satellite (ALCORSS) Meeting, July 1988, it was resolved to form a Working Party to address the issues of NOAA/AVHRR data archiving and data distribution format. As Convenor of that Working Party I am writing to solicit your input initially for a discussion paper.

Currently there are a number of organisations within Australia archiving and distributing NOAA/AVHRR data. The attached map shows the approximate coverage from each existing and proposed facility and the extent of overlap. Obviously, each recording facility has its own requirements of coverage and use, however, for long term archive purposes some optimisation of coverage would seem appropriate.

Consequently, ALCORSS are seeking information from both the NOAA/AVHRR data receivers and users to assist in defining:

- a data distribution format for digital NOAA/AVHRR information,

- an optimum, economic and regular archive for Australia and its Exclusive Economic Zone.

Initially, the following information is sought;

1. Location and coverage, including a map if possible, showing acquisition horizon at zero degrees elevation

2. Archive policy (ie no archive, short term archive, best overhead day pass per week, etc) including recording/archiving capability

3. Main archive storage format and pre-processing capability

4. Format used for distribution of digital data to clients

5. Comments on future Australian requirements of an archive and methods of achieving optimal coverage.

.../2/

Telephone: (09) 323 1222 • Fax: (09) 323 1201 • Telex: Lands AA 93784 • Telegram: Landwest Perth
'CENTRAL GOVERNMENT BUILDINGS' CATHEDRAL AVENUE, PERTH. 6001.

OBJECTIVE:

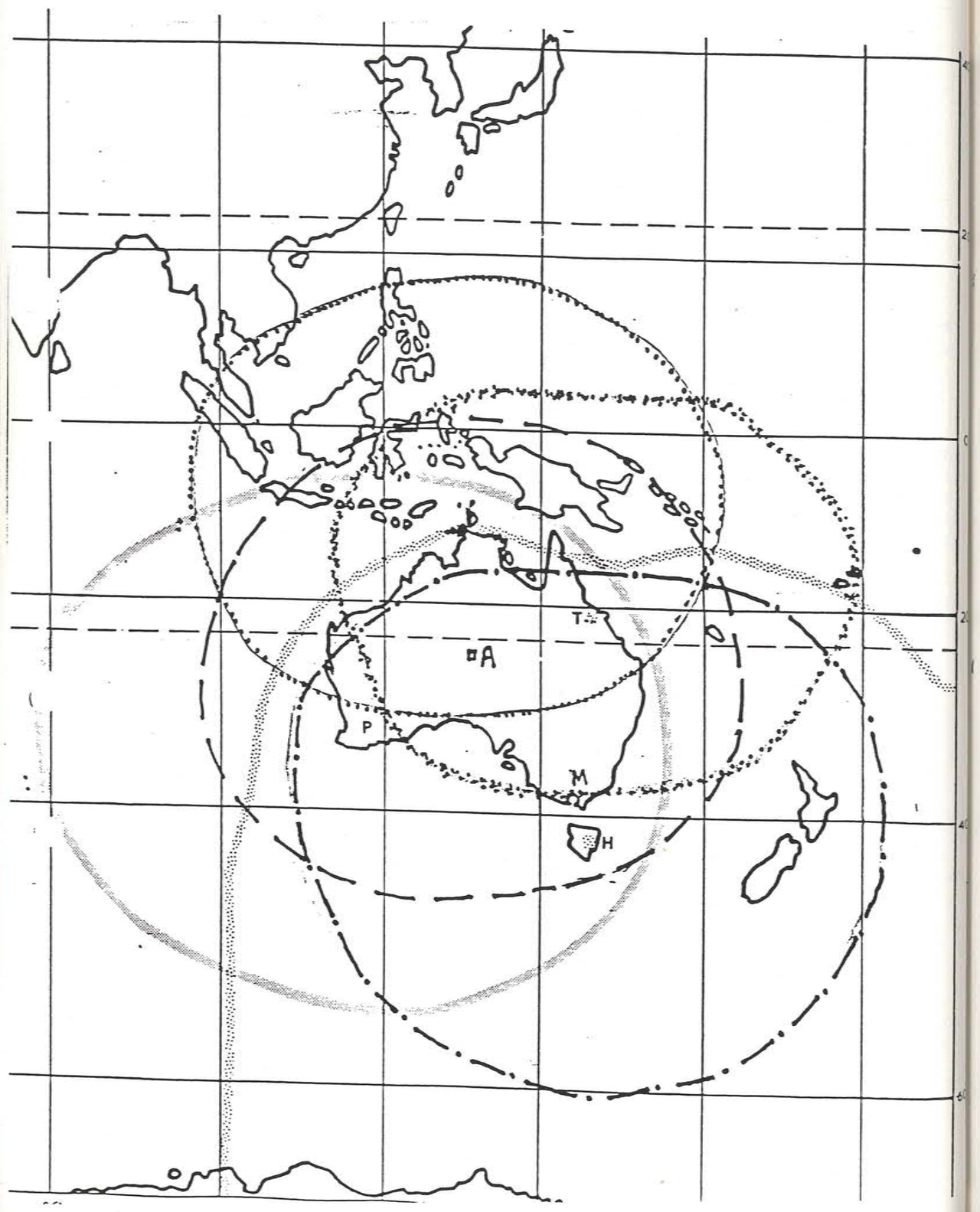
1. DEFINE NOAA/AVHRR DATA ARCHIVING AND DISTRIBUTION FORMAT

2. DEFINE AN OPTIMAL ECONOMIC ARCHIVE COVERING AUSTRALIA

FACILITY	LOCATION/COVERAGE	ARCHIVE POLICY	ARCHIVE STORAGE FORMAT	PRE PROCESSING	DATA DISTRIB.FORMAT	FUTURE ARCHIVE REQUIREMENT	COMMENTS
CSIRO (1) HOBART (Div of Oceanography (MILLSOM)	HOBART (coverage map attached)	All M5,M10 and M11 passes daily. Commenced Apl.86. Rolling 2 wk archive on 6250 bpi tape	1.Old archive in 6250 bpi CCT (3 night bands) Recent passes on EXABYTE 8mm cassette. (all bands). 30 passes per tape	None - Storage in Zip format	Zip or DISIMP	Key is for Perth, Hobart & Townsville to consolidate and coordinate activities with ACRES as a future quick-look archive.	.Archive via EXABYTE Video Cassette recorder. .Recommend to use UNIX & EXABYTE
(2) James Cook University Townsville John Lilleyman	James Cook University Townsville Lat:19.33305°S Long:146.75723°E	One cloud free high elevation pass per week - later this year all passes using a VHS tape based system	1600/3200 bpi CCT in HRPT format. 1s orig packed 10 bit stream minus pre & post sync sequences	Limited-using SLIP/DISIMP on Arlunya,with an APOLLO being developed None	.SLIP/DISIMP at 1600 bpi on CCT .RAW HRPT Future format in SLIP/DISIMP on VHS or 8mm Video tape.	Future archive in the same format is supported.	.Standardise pricing across Australia .Royalties for reselling raw & value-added data .Consideration of NOAA distribution format
CDSSA(3) J Kingwell		To be determined independently by each facility.				Cover entire continent inc Tas. Norfolk & Lord Howe Is-One day & one night pass per day. Establish a "Central User Service" with supplied data(weekly or monthly)from all facilities in a common unspecified format.	Two tier pricing system 1.In house client based charges. 2."Central service system of basic costs plus overheads.Basic costs revert to receiving station owners. Recommend an on line electronic cataloguing system.
School of Earth Science Flinders Uni (J F Brandwyt)	Lat:35°1'8"S Long:138°34'2"E coverage map attached Flinders University site	Present: Nil Future:Short term Archiving-One pass per day (5 days) in raw format	9 track tape (raw data)	In house	Not decided. Have facilities to format into 5 1/4" disks in 360K (1 band), 720k & 1.2 Mbytes in IBM format, 880 kb AMIGA format		Possible future distribution to outside users Facility is small and used for on-campus research. Will adhere to common formats if programming support supplied.
WASTAC Perth	Curtin University Campus-Bentley Lat:32°0'29"S Long:115°53'34"E ± 4 metres	At present in the semi operational mode,1 pass per day (afternoon) with special client requests on demand. By Nov/Dec 4 passes per day, 2 day & 2 night.	6250 bpi 9 track CCT: HRPT format-orig packed 10 bit stream minus pre & post sync sequences.	Conversion of raw HRPT data to ESA SHARP format	SHARP on 1600 or 6250 bpi	Coordinated Australia wide coverage of data in HRPT format archived by individual agencies with a centralised (ACRES) quick look reference system. - 1 day/night pass per day.	
Bureau of Meteorology Perth (WASTAC) & Melbourne Contact: J le Marshall	Melbourne. Darwin & Casey in next 2 years. WASTAC (See under WASTAC	By Oct 88 all HRPT data is to be recvd at Melb & processed. Data from both satellites (inc TOVS data) will be archived for 2 months on 6250 BPI-selected passes kept in the long term.	6250 BPI tapes initially with possibility of 8mm cartridges or high density sag tapes. Preferred format is SHARP	Using FACOM mainframe processing done in real time using the McIDAS system software for value added processing under development(vege sea surface temp and sea ice	CCT or hardcopy. SHARP format in the future.	Comments: 1. Conduct a new AVHRR user survey. 2. Bureau would like to participate in national coordination arrangements on matters such as policy marketing, definition of products. 3. Storage requirements of all receivers needs to be evaluated. Future storage could be on optical disk, video cartridges. 4. Charging policy-raw data should have no charge, however, cost recovery for value added processing is reasonable.	
ACRES (AUSLIG) Belconnen ACT	Alice Springs Coverage -refer to map.	To be determined	McDonald Dettwiler Format CCT or photographic format. Options: .CCT 1600 or 6250 BPI BIL or BSQ . Georeferenced Refer to attachment on main letter.	Levels 0,1,4,5 or 6 .Refer to Attachment	CCT or hardcopy - McDonald Dettwiler format	.Range of standard processed AVHRR products . Centralised catalogue service	. User Demand Survey TO DEFINE PRODUCT RANGE . Consider Coordination with other AVHRR Receivers.
CSIRO Melbourne (Div of Atmospheric Research) M Dilley	Aspendale Melbourne	One day pass per month	1600 bpi all bands DISIMP format	As per James Cook on Hewlett Packard.	SLIP/DISIMP 1600 bpi	Higher density storage device	Charging Policy recover of operating costs

AUSTRALIAN NOAA/AVHRR SATELLITE COVERAGE (APPROXIMATE)

A: Alice Springs (Proposed)
D: Darwin (Proposed)
H: Hobart
M: Melbourne
P: Perth
T: Townsville



esa

EARTHNET PROGRAMME OFFICE

Keith Muirhead,
Earthnet Programme Office,
ESA/ESRIN,
via Galileo Galilei,
00044 Frascati, ITALY
phone: +39(6) 94180 353
telex: 610637 ESRIN I
email: KMUIRHEA@ESRIN

21st September 1988

Dr R.L. Craig,
Remote Sensing Applications Centre,
Department of Land Administration,
Central Government Buildings,
Cathedral Avenue,
Perth, W.A. 6001,
Australia

Dear Dr Craig,

Thank you for your letter of 8th August to Dr Fusco concerning the SHARP format. We would like to heartily applaud your initiative in introducing SHARP to Australia and wish you success in your efforts to persuade other AVHRR distributors to implement this standard. You obviously feel, as we do, that a common distribution format can only be to the benefit of everyone and SHARP has all the necessary bits and pieces to serve this function.

As a simple test for compatability I have provided one of our tapes - a Maspalomas acquisition covering the Mediterranean Sea and North Africa. If you spot any discrepancies in relation to your own format, please let us know. It would be useful for us to conduct a similar examination of your data so an Australian scene would be greatly appreciated. A cloud-free Perth would be particularly welcome because I was born in the original Perth, in Scotland, and have never seen the errant offspring.

Finally, can you please let us know what machine you use for SHARP formatting. Experience has taught us that it will be necessary to maintain a number of slightly different versions of the software (which was written by DFVLR, Oberpfaffenhöfen). At present it runs operationally on Perkin Elmer and SUN machines, and we are looking to a VAX-compatible version. The next release, by the way, will include TOVS processing.

We look forward to hearing from you.

Yours sincerely,

Keith Muirhead

copy: L. Fusco
enclosures: one SHARP cct

Extract: NOAA Polar Orbiter Data User's Guide.

0, then that channel was not selected. If the byte is set to 1, then that channel has been selected. The channel number is indicated by the position of the byte (e.g., Channel 4 would be found in byte 4 of the field). However, channel select HIRS data are not ordered chronologically from 1 to 20. They are in the order indicated in Section 4.1.2.1 (i.e., byte 2 would indicate Channel 17, etc.).

Table 2.1.1-1 contains the character code conversion from hexadecimal to ASCII code. This may be useful when reading the TBM Header Record.

The format of the Data Set Header is described in Section 2.0.2. Note that the Data Set Header Record will always contain the same number of bytes as a full channel data record. For full data set copies, the format of each type of data record is described in Sections 3 and 4 for AVHRR and TOVS, respectively.

2.2 Level 1b Data Record Formats

This section describes two general types of data formats which can be obtained from SDSD. The first format is the most commonly used and is called the packed data format. The packed format is the format in which the data are archived by SDSD. It takes up the least amount of tape but is more difficult to use because of it's compressed nature. This format is described in Section 2.2.1. The second format is known as the "16-bit unpacked format" and is described in Section 2.2.2. It consists of the video (channel) data being "unpacked" into two 16-bit words in four bytes (32 bits), right justified. Originally, this format was available for the Level 1b channel selection only. It is now available for all channels (i.e., you can request that all channels be unpacked instead of just one or two).

2.2.1 Packed Data Format

The packed data format is the standard format in which the data are received from NESDIS and in which they are ultimately archived by SDSD. It is the default if the user does not request a specific format. Because of the sheer volume of satellite data, the packed data format is preferred for storing large quantities of data. However, due to the method of packing it is more difficult to write software to handle this data. Basically, the packed data format contains the data arranged with as few spaces or gaps between the data elements as possible. This means that it is usually not possible to directly read the data on word or half-word boundaries.

In the case of the AVHRR data, the video (channel) data are packed as three 10-bit samples in four bytes, right-justified. The first two bits of each four-byte group are zero. The channels are interleaved, so the samples have the following order: scan point 1 (Channels 1, 2, 3, 4, 5), scan point 2 (Channels 1, 2, 3, 4, 5), etc. The detailed packed data format can be found in Section 3.1.2.1 for GAC data and in Section 3.2.2.1 for LAC/HRPT data. Appendix B should be helpful in unpacking this data format. Figure 2.2.1-1 illustrates the packed data format for AVHRR data.

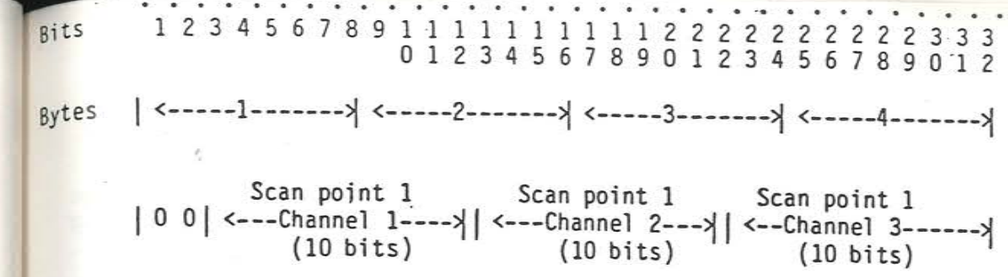


Figure 2.2.1-1 Packed AVHRR Data Format

Since the TOVS data are generated by three distinct instruments, their packed data format is more complex and will not be discussed here. For detailed information on the TOVS packed data format, refer to Sections 4.1.2.1, 4.2.2.1, and 4.3.2.1 for the HIRS/2, SSU, and MSU data, respectively.

2.2.2 16-bit Unpacked Data Format

The 16-bit unpacked data format is an ideal format for the occasional satellite data user with a small area and period of interest. The video data are unpacked into two 16-bit words (Integer*2 words, FORTRAN 77 standard) in four bytes using SDSD's software. The channel data are contained in the ten least significant bits and the six most significant bits are zero-filled. This unpacked data format requires more storage on magnetic tape but considerably less investment in software development. The specific formats for the 16-bit unpacked data format vary according to data type and are fully described in the "Full Data Set Copy" subsection for each data type in Sections 3 and 4. Figure 2.2.2-1 illustrates the 16-bit unpacked data format for AVHRR data.

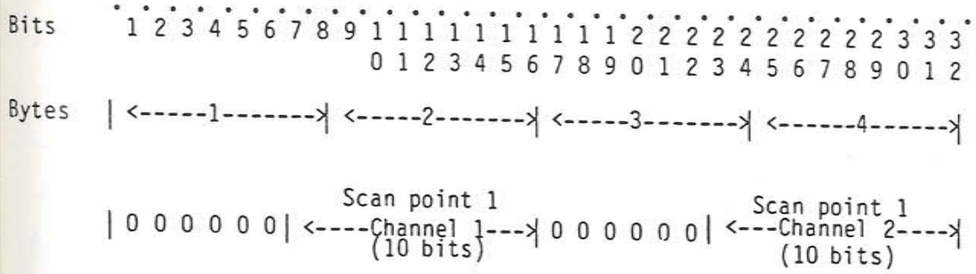


Figure 2.2.2-1 16-bit Unpacked AVHRR Data Format

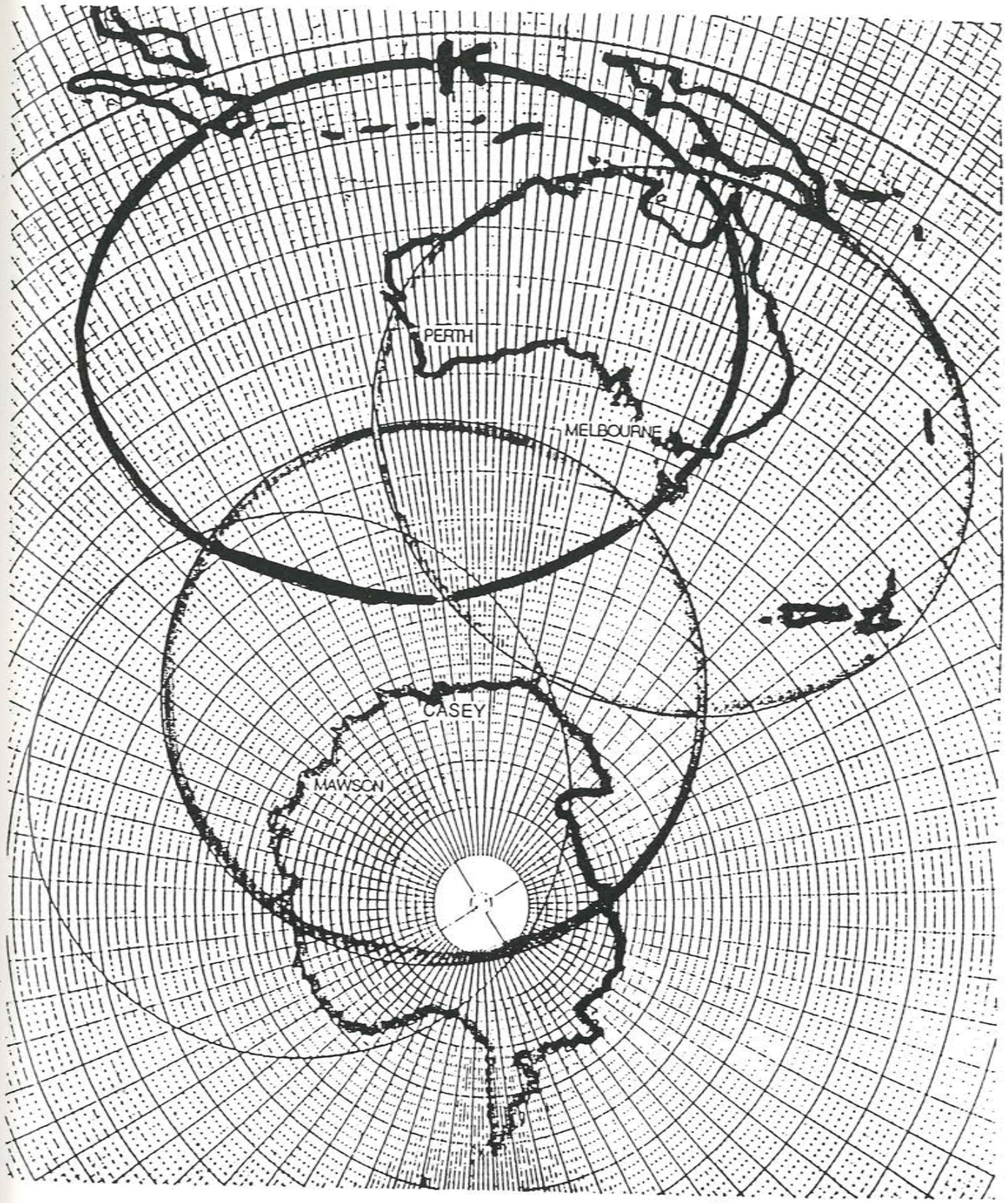
2.3 Data Volume per Tape

This section contains information concerning the size of data records for each instrument, the amount of data (in minutes) which will fit on either 9-track 1600 BPI or 6250 BPI CCTs, and the normal lengths (in minutes) of each type of data set. The approximate amount of data requested can also be computed by determining the number of minutes over a specific area using the spinner described in Section 1.2.

Table 2.3-1 shows the record length (in bytes) for each type of instrument, depending on whether the data desired is full copy or channel select. It also shows the number of records per scan and number of scans per minute for each instrument.

Tables 2.3-2 and 2.3-3 contain the number of minutes of each type of Level 1b data (full copy or channel select) in the packed and unpacked data format which can be written onto a 9-track 1600 BPI and 6250 BPI CCT, respectively. The following assumptions were made in order to generate these tables: 1) a CCT contains 2200 feet of tape (this helps compensate for the variable length of leader and for tapes which are actually less than the nominal 2400 feet), 2) the inter-record gap is 0.30 inches and 0.60 inches for a 6250 BPI and 1600 BPI CCT, respectively. Refer to Section 2.2 for more information on select options.

Typical lengths of data sets in minutes are approximately 110 minutes for GAC and all TOVS data sets, 11 to 13 minutes for HRPT, and 10 minutes for LAC.



NOAA/AVHRR 2nd International Workshop November 27 - 29th 1989, Bariloche, Argentina (H. J. Houghton)

1. Representatives from Australia, U.S.A., Argentina, Chile and Europe attended the Workshop to discuss the existing NOAA/AVHRR satellite programme, its future, data processing and applications. A list of attendees is attached as appendix 1. This report summarises discussions and major recommendations to NOAA, a complete record is to be forwarded by M. Matson (NOAA) later this month.

2. It was resolved that the proceedings of the Workshop be widely circulated through international journals (Photogrammetric Engineering and Remote Sensing) and national newsletters (Australia: COSSA and WARS).

3. General Information

3.1 A number of publications were tabled by NOAA representatives. These are to be circulated to attendees, together with all ongoing NOAA newsletters. A list of NESDIS Product Oversight Panels contact points is at Appendix 2.

* Automatic Picture Transmission (APT) Information Notes 80-2 Satellite Updates:
contact: Nancy Everson
NOAA/NESDIS
World Weather Bldg Room 601
Washington D.C.
20233 U.S.A.

* NESDIS Publication 45 (June 1989) Post NOAA-K, L and M.

* NESDIS Publication 107 and errata sheet for NOAA-10

* NOAA Satellites Into the 21st Century - John Hussey (NESDIS).

3.2 Status:

AVHRR Operational Status and Proposed schedule.

NOAA-9 (pm) Still used: ozone and Earth Radiation Budget purposes (non-operational). Good data, Melbourne is still tracking. NOAA-9 has good radiometer.

NOAA-10 (am) Operational 406 Mhz, search and rescue and ERBE failed.

NOAA-11 (pm) Launched Sept. 24th 1988 Operational. 19th Sept 1989 a roll gyro failed.

Proposed:

NOAA-D (am)	February 7th 1990 (no split band)	Thermal
NOAA-I (pm)	April 1991	
NOAA-J (am)	September 1992	
NOAA-K (pm)	November 1993 (5 Channel, split band 3)	
NOAA-L (am)	April 1995	
NOAA-M (pm)	June 1996	

After 1996 the European Space Agency will be responsible for am flights, ESA-EPOP, transmitting continuous broadcast (S-Band), 9.30 to 10.30am local time overpass. NASA/EOS and EOS free flyer for pm passes after 1996.

3.3 Navigation:

Discussion on the quality of supplied T-Bus data, and a move to generate digital T-Bus data (from 1978) based on the best ephemeris model. Need to make these data available daily, easily via an electronic bulletin board or fax. Need for a technical manual, archive of parameters and corrections and public domain software. There is a NOAA- Navigation oversight panel who will consider these issues.

3.4 Calibration:

A Radiometric meeting is proposed fro 17-18 January 1990, World Weather Bldg Washington to consider SST Calibration, prelaunch sensor calibration , AVHRR - SPOT, calibration results, calibration drift for NOAA-6, 7 and 9, radiation transfer model. Proceedings are to be published. Contact Peter Abel Ph: 301 763 8136. Telemail U.S.A. PABEL/ORA/NESDIS.

Since launch the radiometric characteristics for NOAA-11, Channel 1 and 2 have dropped 28% and 32% respectively. Post launch calibration data for NOAA-11 have not yet been published. There is a Calibration Oversight Panel at NESDIS.

3.5 Data Reception:

HRPT Stations:

South America: (Chile north of Santiago) 33° S 71° W coverage 15° S to 54° S using an ex-NASA 12 metre dish.

Argentina - Buenos Aires (Hewlett Packard 1000 System) 35° 16'S 58° W, coverage 10° S to 55° S.

Brazil - Rio de Janerio (south) 22° S.

Station at Panama City operated by U.S. Airforce, data through NOAA.

Easter Island (Chile) - proposed (no funds) 27° S, 109° E.

Fiji (Australia) proposed.

Luigi Fusco (ESA) explained the European facilities and networking.

3.6 User Products:

SHARP formatted data from ESA L. Fusco acknowledged a processing overhead but stressed the need for a SHARP type format for International data exchange. NOAA use their "1B" format, most countries record HRPT data, although Chile store on analogue tapes.

The Committee on Earth Observation Satellites (CEOS) has two working groups -

* Calibration and Validation
* Data

The latter group is considering formats - using standards established by Landsat (SHARP is consistent with these standards), catalogues (Bill Carricott-NOAA) and User Interface (Minyon - NOAA). Proposed that standards for AVHRR interchange be referred to CEOS.

3.7 Operational Products (Refer attachment 2)

Winds: Cloud vector motion at low middle and high levels 60° S to 60° N over oceans, produced interactively and distributed via GTS fax map form.

Soundings: NOAA vertical temperature profiles (over GTS) text format for national weather service also TOVS (Sharp will include processed TOVS data for use in calibration of AVHRR data).

Ozone: Images and computer output - NASA/NOAA 10 year data set held by NASA.Al Arking has a video of this data set.

Land: NDVI (GAC data - digital) and snow cover over the Northern Hemisphere back to 1966, and Antartica sea ice.

Precipitation: Derived from geostationary satellite data, temperature of cloud tops and estimated rainfall. Not a global product.

Oceans: SST global data set. Larry Stowe has an experimental data set over ocean areas, aerosols, atmospheric thickness.

Clouds: Jamie Hawkins, Products Systems Branch (NOAA), Federal Building 4, Room 3041. Since 1983 (July) ISSCP Ms Lola Olson NASA Climate Data Centre.

In Europe (ESA) are developing a fire map product in collaboration with Dr K.D. Singh to produce detail over Indonesia, New Guinea and Malaysia for input to a Global model.

Other applications include ESA - Meteosat SST products and NDVI cover. Land surface temperature (to SST accuracies using day - night pairs and ground temperature control sites - research project by CSIRO.

The EDC (Doug Bennie) provide data sets not held or available through NOAA. Their main activity is geometric registration of data sets and cloud - free data compositing.

NDVI maps of North Africa in near real time for plague locust identification. NDVI maps over Brazil for locust outbreak. Operational fire danger modelling over central U.S.A. States.

3.8 Scheduling:

NOAA will schedule non-U.S.A. coverage on request. No obligation to purchase. Refer Attachment 3.

3.9 Archive:

Chile: analogue tape. Afternoon pass, above 20°, 7 days/week, no night passes (except 6 months in archive).

NOAA: 1978 - 85 high resolution data is of dubious quality, GAC is available since 1978. NOAA archive all passes. LAC and GAC are complete since 1985.

3.10 NOAA's Climate and Global Change Programme links to the ESSC - NASA research proposals. In Australia David Johnson - Canberra Geologist/Geophysicist and Robin Gallagher CRA are involved with global data sets over Australia.

4. Global Change Atlas: Dr B. Pfeiffer
Senior ISY Official
ESA-ESTEC-Code H/ISY
NOORDWIJK, THE NETHERLANDS

Projects proposed by the panel of experts on Earth Science and Technology (objectives and Planning) leading to the 1992 International Space Year.

Sea Surface Temperature: NASDA (Japan) Seiji Tanaka (STA)
BNSC (UK) Dr Llewellyn - Jones (RAL)

Generate improved algorithms and data exchange procedures, merged data sets of selected areas by 1992.

Rate of Deforestation

Improved reliability of space data in measuring forest extent, classification and change (AVHRR, Landsat, SPOT, and SAR data).

Intended 1992 Results - Composite maps of tropical vegetation indices of agreed format and media.
Lead persons: Dr M. Barbosa (INPE)
Prof. Guerriero (ASI)

Productivity of the Global Ocean

To distribute the CZCS Global Ocean Chlorophyll data set to begin multi-national development of improved processing algorithms.

Intended 1992 Result: Historical CZCS archive, ongoing data base of global pigment distributions and related data. (wind speeds, wave height spectra).
Canada (CSSA) and EEC (JRC).

Global Consequences of Land Cover Change

Establish the foundation for the prediction of the consequences of land cover change and by 1992 assess change trends in selected areas.

1992 Result: Thematic maps of selected areas for each year 1975 to 1989. Numerical analysis of data. Lead agencies (potential)
USSR/Australia/Brazil

5. P.C. Technology. Peru have an MDA Meridian System.Chile and Argentina operate ERDAS systems with developed modules to display and process AVHRR data.

IDIDAS software by NOAA VSN4 (will be in C language) (requires a letter to Michael Matson) re availability and documentation). Includes "A PC Based Interactive Graphics System to Perform Satellite - derived Oceanographic Thermal Analysis" Marcia Weaks, Kim Buttleman and W.B. Campbell.

6. Future Systems AVHRR, AMRIR.
NOAA -K, L, M and AMRIR phase A and B studies are complete. AVHRR Channel 2 will be narrower to help vegetation index calculation. Channel 3 will be 3.8 micrometre, night and 1.6 micrometre day for cloud and snow cover discrimination.

Post NOAA - K, L & M:

* NOAA will continue afternoon Metsat service with a NOAA - N (sames as K, L and M) and a complete new series beginning at NOAA - O.

* Europe will assume responsibility for morning Metsat service with the EPOP series in 1997 (includes a AVHRR type sensor - to be defined June 1990). No tape recorder, outside direct read out stations TDRSS will be used.

* NASA to assume responsibility for developing a prototype operational instrument on NPOP.

* NPOP, EPOP and NOAA-O series to have standardised instrument interfaces.

Proposed Post K, L, M, sensors:

- Advanced MSU
- AMRIR to replace AVHRR and HRIS
- Global Ozone Monitoring Radiomet (GOMR)
- New operational Common Interface Instrument for NOAA-O and EPOP.
NASA Prototype Operational instruments for NPOP's:

  - Altimeter
  - Scatterometer
  - Passive Microwave Images
  - Ozone and Trace Gas Limb Scanner
  - Advanced Infrared Sounder
  - Earth Radiation Budget Instrument

7. Specifications for AMRIR (Advanced Medium Resolution Imaging Radiometer)

CHANNEL	BAND SPEC.	50% RESPONSE	S/N
1	665.0 ± 2.0 to give better information on aerosols	655.00 ± 1nm	10:1
2	855.0 ± 2.0 Out of water vapour contamination	840 ± 2 870 ± 2	10:1
3	1.61 ± 0.01 micron	1.58 ± 0.01 1.64 ± 0.01	20:1
* 4	1030 ± 40 cm^{-1} Total ozone	Total 50% BW 25cm^{-1}	0.2° K
5	2210 ± 4.4 cm^{-1}	" 15cm^{-1}	0.2° K
6	2250 ± 4.4 cm^{-1}	" 15cm^{-1}	0.2° K
7	735 ± 1.8cm^{-1}	" 9cm^{-1}	0.2° K
8	3.72 ± 0.06 micron fire discrimination	3.63 ± 0.06 3.83 ± 0.06	0.1° K
9	4.01 ± 0.06 micron SST Improvement	3.92 ± 0.06 4.10 ± 0.06	0.1° K
10	10.8 ± 0.06	10.3 ± 0.06 11.3 ± 0.06	0.1° K
11	12.0 ± 0.06	11.50 ± 0.06 12.50 ± 0.06	0.1° K

System Features:

Replaces two instruments with one (Mass and power)

4 year life verses 2 years for AVHRR/HIRS

Designed for flight on the next generation of satellites.

Imaging Features:

Increase spatial resolution from 1100 to 800 metres.

Visible channel calibration for quantitative applications.

Dedicated channels for fire detection and snow/cloud discrimination.

Additional Channel for SST (split window at 3.8 micron)

Increased radiometric precision from 10 bit to 12 bit (improves sensitivity for aerosol, radiation budget, and SST calculation)

(Note: with spartial Improvement plus name coverage, pixel increase to 2800)

Sounding Features:

Increased spatial 21.0 km to 3.75 km.

Increased geographic coverage from 47° to 56°.

Programatic Features:

ITT and Westinghouse have developed phase B designs

8. Recommendations:

8.1 Navigation:

Define best ephemeris model for navigation

If not NOAA model explore other sources

Ephemeris daily via Bulletin Board

retrospective parameters for T-Bus

Technical manual for these new navigation parameters

Produce public domain navigation software.

Report on international navigation models to be finalised by the 1st AVHRR Workshop working party (F. Prata).

8.2 Calibration:

Proceeding of January 1990 NOAA meeting to be distributed

No global calibration tables exist

Produce past launch calibration data for NOAA-11

8.3 Data Reception:

Map of known HRPT Stations (digital)

Table of address, etc

NOAA should continue to disseminate details on AMRIR progress to ease transition.

encourage user discussion on possible problems caused by changes.

8.4 Data Processing

Questionnaire on data ingestion and processing software available

Post K, L, M, simulation data for ground station processing testing (not for spectral evaluation)

8.5 Scheduling and Archiving

Standard data archive

Data Exchange format, encourage the development of a flexible standard, including a standard P.C. image format.

NOAA-K, L, M split channel switching by programme not terminator.

H J Houghton

H J HOUGHTON
Manager
Remote Sensing Applications Centre

6th December 1989

Report on the 2nd AVHRR International Workshop
Bariloche, Argentina
November 27 - 29, 1989

Highlights

1. The goals of the meeting were: (a) review the current AVHRR status and launch schedule, (b) discuss AVHRR navigation and calibration, (c) discuss AVHRR data reception, processing, operational products, and archival, (d) examine PC image processing technology, and (e) review NOAA-K,L,M and AMRIR.

2. The Latin American Society of Remote Sensing Specialists (SELPER) sponsored the workshop.

3. Sixteen invited participants attended the meeting, representing Australia, the European Space Agency, Argentina, Chile, the U.S. Geological Survey, Louisiana State University, the University of Nebraska, NASA, and NOAA.

4. To improve the AVHRR navigation, the international users requested NESDIS identify the best ephemeris model and use it.

5. The international users recommended NESDIS update the ephemeris data daily and distribute this information via the Electronic Bulletin Board or by facsimile machine.

6. The NOAA-11 AVHRR post-launch calibration information is needed by the user community. It has been over a year since the launch of NOAA-11, but this information has not been distributed by NESDIS.

7. The international users recommended NESDIS prepare a map with addresses of HRPT ground stations. The users felt this would aid NESDIS in distributing information affecting the ground stations and receeiving feedback from HRPT stations.

8. Simulated AMRIR data will be needed by the users to evaluate the impact of the new format on data processing at HRPT stations.

9. The international users recommended the NOAA-K,L,M 3.8 micrometer channel be left on at all times for the morning satellites, instead of being turned off for the 1.6 micrometer channel during daylight hours for snowmapping. The users need the 3.8 micrometer channel for fog detection, fire mapping, and mineral exploration. Since the snowmapping would be done using the afternoon satellite, the users do not see the need for turning on the 1.6 micrometer channel for the morning satellites, except in the case of a failure of the afternoon satellite.

10. With the new emphasis on using satellite data to support the global change program, the users recommended AVHRR data set continuity be maintained throughout changes in the NOAA polar satellite program.

11. The South American AVHRR users want NOAA to know they consider the TIROS-N satellites to be the "poor peoples' satellite." Because of NOAA's open access to AVHRR data, many South America countries are able to join the international community in developing satellite products to support their economies.

12. The international users believe with SPOT and Landsat fees increasing, more countries will be turning to AVHRR data for their remote sensing needs.

Actions Taken or Planned

The meeting participants asked the NESDIS Product Oversight Panels to address the following items:

1. Determine best ephemeris model for AVHRR navigation.
   Action: Navigation Oversight Panel

2. Determine if a digital TBUS archive from 1978 to the present can be created.
   Action: Navigation Oversight Panel

3. Determine if daily ephemeris data can be put on the Electronic Bulletin Board.
   Action: Navigation Oversight Panel

4. Determine if attitude information is in the level 1B data.
   Action: Navigation Oversight Panel

5. Publish and distribute NOAA-11 post-launch calibration information.
   Action: Calibration Oversight Panel

In addition, the participants requested NESDIS address the following issue:

1. Create a map and address list of HRPT stations.
   Action: NESDIS Data Collection and Distribution Branch

Michael Matson (NOAA) will provide status reports to the meeting participants on the actions listed above.

Although this meeting was somewhat smaller than the 1st International AVHRR Workshop, the enthusiasm of the participants about the value of AVHRR data was just as great. NOAA has tremendous international support for its open access to AVHRR data, and if they ever need support for the program the international community would quickly respond. South America is using AVHRR data but looks to NOAA for further technical support. Chile has a robust AVHRR program supporting their fisheries program and Brazil is using AVHRR data for operational fire monitoring in support of deforestation evaluations. Argentina's program is primarily associated with meteorological support. They do have a PC image processing system and the NESDIS Interactive Processing Branch will be sending them a copy of the IDIDAS software so they can use AVHRR data on it. The President of SELPER asked how the South American countries could receive AVHRR technical support from the United States. Michael Matson suggested they contact the NESDIS International Affairs Office for information about Science and Technology exchange agreements.

Australia is actively involved in many applications of AVHRR data including geologic mapping, volcanic ash detection for aviation warnings, land surface temperatures, fire hazards, precipitation, vegetation monitoring, and sea surface temperature studies. The U.S. Geological Survey is working with fire fuel loading using the vegetation index, vegetation monitoring in Africa for locust outbreaks, and supporting river basis snow mapping in North America. Louisiana State University is using the AVHRR sea surface temperature data to support oil operations in the Gulf of Mexico and for studying sediments in the delta area of the Mississippi River. The University of Nebraska is using the vegetation index for climate analysis. ESA is active in AVHRR data archival, data exchange methodologies, and European and African HRPT station networking and coordination.

Copies of NOAA information on the current NOAA polar satellites, NOAA-K,L,M, and the NOAA "free flyer" polar satellites is attached to this report.

POLAR ORBITING SATELLITES

- **NOAA-9 (PM)** *STILL USED FOR OZONE & EARTH RADIATION BUDGET*
- **NOAA-10 (AM)** *OPERATIONAL; 406 MHZ S & R AND ERBE FAILED*
- **NOAA-11 (PM)** *LAUNCHED SEPT. 24, 1988; OPERATIONAL*

CURRENT POLAR-ORBITING SATELLITE INSTRUMENTS

AVHRR - Advanced Very High Resolution Radiometer
HIRS - High Resolution Infrared Sounder
SSU - Stratospheric Sounding Unit
MSU - Microwave Sounding Unit
SEM - Space Environment Monitor
ERBE - Earth Radiation Budget Experiment
SBUV - Solar Backscatter Ultraviolet
DCS - Data Collection System (ARGOS)
SAR - Search and Rescue (SARSAT)

POLAR ORBITING SATELLITE LAUNCHES

- **NOAA-D (AM)** FEBRUARY 7, 1990
- **NOAA-I (PM)** APRIL 1991
- **NOAA-J (AM)** SEPTEMBER 1992
- **NOAA-K (PM)** NOVEMBER 1993
- **NOAA-L (AM)** APRIL 1995
- **NOAA-M (PM)** JUNE 1996

PROPOSED POST NOAA K,L,M PROGRAM

- NOAA to continue afternoon Metsat service with a NOAA-N (same as NOAA K,L,M) and a competed new series beginning at NOAA-O.
- Europe to assume responsibility for morning Metsat service with EPOP series in 1997.
- NASA to assume responsibility for development of prototype operational instruments on NPOP.
- NPOP's, EPOP's, and "NOAA-O" series to have standardized instrument interfaces.

NOAA K,L,M POLAR-ORBITING SATELLITE INSTRUMENTS

AVHRR/3 - Advanced Very High Resolution Radiometer
HIRS - High Resolution Infrared Sounder
AMSU A, B - Advanced Microwave Sounding Units
SEM - Space Environment Monitor
SBUV - Solar Backscatter Ultraviolet
DCS - Data Collection and Location System (ARGOS)
SAR - Search and Rescue (SARSAT)

BENEFITS OF AMRIR VS. AVHRR/HIRS

SYSTEM

- REPLACES TWO INSTRUMENTS WITH ONE (MASS AND POWER)
- DESIGNED FOR FOUR YEAR LIFETIME VS. 2 YEARS FOR AVHRR/HIRS
- SPECIFICALLY DESIGNED FOR FLIGHT ON NEXT GENERATION SPACECRAFT

IMAGING

- INCREASED SPATIAL RESOLUTION FROM 1100 METERS TO 800 METERS
- VISIBLE CHANNEL CALIBRATION FOR QUANTITATIVE APPLICATIONS
- UPGRADED BLACK BODIES FOR IMPROVED THERMAL CALIBRATION
- DEDICATED CHANNELS FOR FIRE DETECTION AND SNOW/CLOUD DESCRIMINATION
- AN ADDITIONAL CHANNEL FOR SST DETERMINATION (SPLIT WINDOW AT 3.8 MICRON)
- INCREASED RADIOMETRIC PRECISION FROM 10 BIT TO 12 BIT (IMPROVES SENSITIVITY FOR AEROSOL, RADIATION BUDGET, AND SST DETERMINATIONS)

SOUNDING

- INCREASED SPATIAL RESOLUTION FROM 21.0 KM TO 3.75 KM (MORE CLOUD FREE RETRIEVALS)
- INCREASED RETRIEVAL YIELD AND ACCURACY IN PARTLY CLOUDY REGIONS
- INCREASED WINDOW CHANNEL CAPABILITY
- INCREASED GEOGRAPHIC COVERAGE (FROM 49 DEG SCAN TO 56 DEG)
- ABSOLUTE COALIGNMENT WITH IMAGING CHANNELS
- DESIGNED FOR COREGISTRATION WITH AMSU FIELDS OF VIEW (PRECISELY ONE QUARTER AMSU-B FOV)

PROGRAMMATIC

- ITT AND WESTINGHOUSE HAVE DEVELOPED PHASE B DESIGNS
- ALLOWS FOR RECOMPETITION OF IMAGER/IR SOUNDER RATHER THAN CONTINUING PRESENT SOLE SOURCE ARRANGEMENT

PROPOSED POST NOAA K,L,M INSTRUMENTS

- New Operational Common Interface Instruments for NOAA-O series and EPOP's

  -Advanced Microwave Sounding Unit (AMSU) upgraded for upper atmosphere soundings
  -Advanced Medium Resolution Imaging Radiometer (AMRIR) replaces AVHRR and HIRS
  -Global Ozone Monitoring Radiometer (GOMR) upgrades capabilities of SBUV with added mapping capability

- NASA Prototype Operational nstruments for NPOP's

  -Altimeter
  -Scatterometer
  -Passive Microwave Imager
  -Ozone and Trace Gas Limb Scanner
  -Advanced Infrared Sounder
  -Earth Radiation Budget Instrument

POST NOAA K,L,M PROGRAMMATIC AND INSTRUMENT STUDY STATUS

GOMR STUDY COMPLETED BY HONEYWELL/PERKIN ELMER, MAY 1989

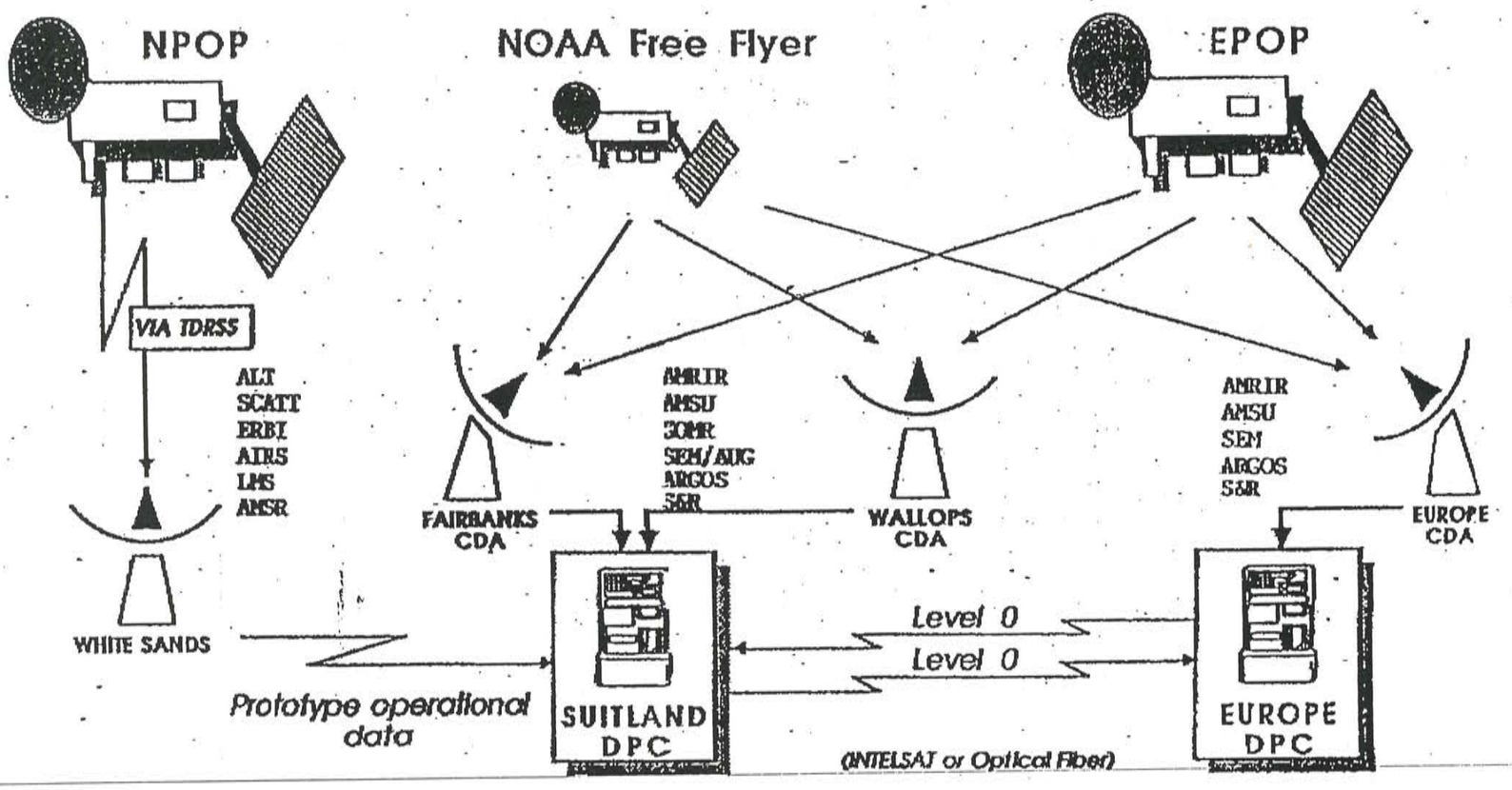
AMSU-A STUDY ON MODIFICATIONS FOR UPPER ATMOSPHERE SOUNDINGS COMPLETED BY AEROJET GENERAL CORP., JUNE 1989

AMRIR PHASE A/B STUDIES TO BE COMPLETED BY ITT AND WESTINGHOUSE, OCTOBER 1989

ADVANCED HRPT STUDY COMPLETED BY ORI CORP., JULY 1989 (NESDIS TECHNICAL MEMO #45)

BUDGET SUBMITTED FOR FY91 PHASE C/D START FOR COMMON INTERFACE INSTRUMENTS FOR EPOP, NOAA-N "CLONE", NEW NOAA-O SERIES, AND SUPPORTING GROUND SYSTEM

SEPT '89



PROPOSED PLATFORM GLOBAL OPERATIONAL DATA FLOW

ADVANCED MEDIUM RESOLUTION IMAGING RADIOMETER (AMRIR)

James C. Fischer
Advanced Systems Division
National Environmental Satellite, Data and Information Service

The AMRIR has been specified and designed to replace and improve the Advance Very High Resolution Radiometer (AVHRR) and the High resolution Infrared Radiometer Sounder (HIRS). The AMRIR contains the six spectral channels that were contained in the AVHRR, NOAA K, L, M version, AVHRR/3, with some minor adjustments to the spectral bands. In addition to the six AVHRR channels that are contained in the AMRIR, there have been added three sounding channels, a total ozone channel and an additional sea surface temperature channel. Simulation of sounding data has shown that this combination of channels, when combined with the twenty AMSU channels, offer a sounding accuracy that is comparable to the HIRS/AMSU combination on NOAA K, L, M series.

The spectral characteristics of the AMRIR are as follows:

CHANNEL	CENTER FREQUENCY	50% RESPONSE BW	S/N
1	665.0 ±2.0 nm	655.0 ±1.0 nm 675.0 ±1.0 nm	10:1
2	855.0 ±2.0 nm	840.0 ±2.0 nm 870.0 ±2.0 nm	10:1
3	1.61 ±0.01 micron	1.58 ±0.01 micron 1.64 ±0.01 micron	20:1
4	1030 ±4.0 cm^{-1}	Total 50% BW 25 cm^{-1}	0.2°K
5	2210 ±4.4 cm^{-1}	Total 50% BW 15 cm^{-1}	0.2°K
6	2250 ±4.4 cm^{-1}	Total 50% BW 15 cm^{-1}	0.2°K
7	735.5 ±1.8 cm^{-1}	Total 50% BW 9 cm^{-1}	0.2°K
8	3.72 ±0.06 micron	3.63 ±0.06 micron 3.83 ±0.06 micron	0.1°K
9	4.01 ±0.06 micron	3.92 ±0.06 micron 4.10 ±0.06 micron	0.1°K
10	10.8 ±0.06 micron	10.30 ±0.06 micron 11.30 ±0.06 micron	0.1°K
11	12.0 ±0.06 micron	11.50 ±0.06 micron 12.50 ±0.06 micron	0.1°K

The instantaneous field-of-view (IFOV) at nadir for channels 1, 2, 3, 8, 9, 10 and 11 is 800 meters. The signal-to-noise specified for these channels is for the 800 meter IFOV. The IFOV for channels 4 through 7 is specified at 3.75 km. The 3.75 km IFOV for channels 4 through 7 is derived from the requirement that the AMRIR IFOV be one fourth the IFOV of the AMSU-B. The signal-to-noise for channels 4 through 7 is based on a 3.75 km IFOV.

The selection of the spectral bands, IFOV and signa.-to-noise was based on the following requirements for the various channels:

Channel 1 - Products derived from this channel include visible imaging products such as clouds, snow, ice, vegetation, hydrology, water and floods. Quantitative products include Earth radiation budget and aerosols. This channel is a replacement for the AVHRR channel 1 with the spectral bandwidth being narrower to provide better information on aerosols.

Channel 2 - Products derived from this channel include visible imaging products such as clouds, snow, ice, vegetation, hydrology, water and floods. Quantitative products, include Earth radiation budget and aerosols. This channel is a replacement for the AVHRR channel 2 with the spectral bandwidth being narrower to provide better information on aerosols and to avoid water vapor contamination from the water vapor line at 890 nm.

Channel 3 - Purpose of this channel is for snow/cloud discrimination. Channel is identical to channel 3A on the AVHRR/3.

Channel 4 - Total Ozone monitoring channel. Carryover from the HIRS and is equivalent to channel 9 of the HIRS. Provides ozone information in the infrared region that is not available from SBUV data.

Channel 5 - Atmospheric sounding channel. Equivalent HIRS channel is 14. This channel is used in conjunction with channels 4, 6, 7 and the window channels 8, 9, 10 and 11 to provide atmospheric soundings.

Channel 6 - Atmospheric sounding channel. Equivalent HIRS channel is 15. This channel is used in conjunction with channels 4, 5, 7 and the window channels 8, 9, 10 and 11 to provide atmospheric soundings.

Channel 7 - Atmospheric sounding channel. No equivalent HIRS channel. This channel was selected to provide maximum information and high accuracy with minimum spectral regions for atmospheric sounding. This channel is used in conjunction with channels 4, 5, 6 and the window channels 8, 9, 10 and 11 to provide a sounding

product which is of higher accuracy than the HIRS/MSU combination on pre-NOAA K era satellites. The combination of AMRIR/AMSU provides temperature soundings comparable to that of HIRS/AMSU combination.

Channel 8 - Window channel used for measuring sea surface temperature and temperature sounding. This channel, used in conjunction with channel 9, will provide a sea surface temperature accuracy of 0.5'K. Equivalent channel on AVHRR/3 was 3B.

Channel 9 - Window channel used for measuring sea surface temperature and temperature sounding. This is a new channel and there is not an equivalent channel on the AVHRR/3. This channel was added to provide an improvement to the accuracy of sea surface temperature from the AVHRR/3 of 0.75'K to a estimated accuracy of 0.5'K.

Channel 10 - Window channel used for infrared imaging, sea surface temperature, temperature sounding and nighttime clouds. Equivalent channel on the AVHRR/3 was channel 4.

Channel 11 - Window channel used for infrared imaging, sea surface temperature, temperature sounding and nighttime clouds. Equivalent channel on the AVHRR/3 was channel 5.

The AMRIR has been specified to improve the overall capability of the AVHRR and the HIRS. Some of the major additional benefits of the AMRIR are as follow:

-- Increased imaging spatial resolution from 1100 meters to 800 meters.

-- Increased radiometric sensitivity, AMRIR will have a 12-bit digital resolution versus 10-bit for the AVHRR.

-- Increased sounding spatial resolution from 21 kilometers for the HIRS to 3.75 kilometers for the AMRIR.

-- Improved thermal calibration.

-- Visible calibration will be available in the AMRIR whereas the AVHRR had no visible calibration.

-- Absolute coalignment of imaging and sounding channels.

-- Increased sensitivity in the window channels for 0.1'K in the AMRIR versus 0.25'K in the AVHRR.

-- Increased geographic coverage for soundings, AMRIR scans out to 56° from nadir versus 49° for HIRS.

-- Specifically being designed for co-registration with the AMSU-B fields-of-view.

The AMRIR is anticipated to begin phase C/D activities in 1990 with the first flight scheduled for 1997.

BENEFITS OF AMRIR VS. AVHRR/HIRS

SYSTEM

- DESIGNED FOR FOUR YEAR LIFETIME VS. 2 YEARS FOR AVHRR/HIRS
- SPECIFICALLY DESIGNED FOR FLIGHT ON NEXT GENERATION SPACECRAFT RATHER THAN HAVING TO ADOPT 20 YEAR OLD TECHNOLOGIES

IMAGING

- INCREASED SPATIAL RESOLUTION FROM 1100 METERS TO 800 METERS
- VISIBLE CHANNEL CALIBRATION FOR QUANTITATIVE APPLICATIONS
- UPGRADED BLACK BODIES FOR IMPROVED THERMAL CALIBRATION
- DEDICATED CHANNELS FOR FIRE DETECTION AND SNOW/CLOUD DESCRIMINATION
- AN ADDITIONAL CHANNEL FOR SST DETERMINATION (SPLIT WINDOW AT 3.8 MICRON)
- INCREASED RADIOMETRIC PRECISION FOROM 10 BIT TO 12 BIT (IMPROVES SENSITIVITY FOR AEROSOL, RADIATION BUDGET, AND SST DETERMINATIONS)

SOUNDING

- INCREASED SPATIAL RESOLUTION FROM 21.0 KM TO 3.75 KM (MORE CLOUD FREE RETRIEVALS)
- INCREASED WINDOW CHANNEL SENSITIVITY FROM 0.25 K TO 0.1 K
- INCREASED GEOGRAPHIC COVERAGE (FROM 49 DEG SCAN TO 56 DEG)
- ABSOLUTE COALIGNMENT WITH IMAGING CHANNELS
- DESIGNED FOR COREGISTRATION WITH AMSU-B FIELDS OF VIEW (PRECISELY ONE QUARTER AMSU-B FOV)

PROGRAMMATIC

- ALLOWS FOR RECOMPETITION OF IMAGER/IR SOUNDER RATHER THAN CONTINUING PRESENT SOLE SOURCE ARRANGEMENT

W201	N11 1196	18-12-88	0645		43 W			
	N10 11705	18-12-88	2303		57 E			
W202	N11 1210	19-12-88	0635		54 E			
	N11 1224	20-12-88	0625	3 headers	68 W			
W203	N11 1238	21-12-88	0615		84 W			
	N11 1245	21-12-88	1737	NIGHT	74 W			
W204	N11 1252	22-12-88	0605		77 E			
	------1 line file--------							
	------1 line file--------							
	N11 1337	28-12-88	0645		42 W		4600	0
W205	N11 1351	29-12-88	0635		53 W		4600	0
	------1 line file--------							
	N11 1365	30-12-88	0625		67 W		4600	0
W206	N11 1379	31-12-88	0615		82 W		4600	0
	N11 1393	1-01-89	0609		77 E		4600	0
W207	N11 1407	2-01-89	0555		61 E		4600	1
	N11 1421	3-01-89	0543		49 E		4600	0
W208	N11 1435	4-01-89	0533		39 E		4600	0
	N11 1450	5-01-89	0704		28 W		4600	0
W209	N11 1464	6-01-89	0654		34 W		4600	0
W210	N11 1492	8-01-89	0636		54 W		4600	0
	N11 1506	9-01-89	0626		67 W		4600	0
W211	N11 1520	10-01-89	0616		83 W		4600	0
	N11 1527	10-01-89	1738	NIGHT	73 W		4600	0
W212	N11 1534	11-01-89	0606		77 E		4600	0
	N11 1541	11-01-89	1728	NIGHT	86 W		4600	0
W213	N11 1548	12-01-89	0556		62 E		4600	1
	N11 1562	13-01-89	0546		49 E		4600	0
W214	N11 1576	14-01-89	0536		39 E		4600	0
	N11 1590	15-01-89	0526		31 E		4600	0
W215	N11 1605	16-01-89	0656		34 W		4600	0
	N11 1633	18-01-89	0636		52 W		4600	0
W216	N11 1647	19-01-89	0636		64 W		4600	0
	N11 1661	20-01-89	0616		75 W		4600	0
W217	N11 1668	20-01-89	1738	NIGHT	69 W		4600	0
	N11 1675	21-01-89	0606		72 E		4600	1
W218	N11 1689	22-01-89	0556		60 E		4600	0
	N11 1703	23-01-89	0546		48 E		4600	0
W219	N11 1717	24-01-89	0536		39 E		4600	0
	-----1 line file---------							
	-----1 line file---------							
	N11 1731	25-01-89	0526		31 E		4600	0
W220	N11 1746	26-01-89	0656		34 W		4600	1
	N11 1760	27-01-89	0646		42 W		4600	0
W221	N11 1774	28-01-89	0636		53 W		4600	0
	N11 1788	29-01-89	0626		66 W		4600	0
W222	N11 1802	30-01-89	0616		81 W		4600	0
	N11 1816	31-01-89	0606		75 E		3833	0
W223	N11 1823	31-01-89	1728	NIGHT	81 W		4600	3
	N11 1830	01-02-89	0556		60 E		4600	0
W224	N11 1844	02-02-89	0546		47 E		4600	0
	------1 line file--------							
	------2 line file--------							
	N11 1858	03-02-89	0536		38 E		4600	0
W225	N11 1872	04-02-89	0526		30 E		4600	0
	N11 1886	05-02-89	0516		24 E		4600	0
W226	N11 1887	05-02-89	0657		35 W		4600	4
	N11 1900	06-02-89	0506		19 E		4515	0
W227	N11 1901	06-02-89	0646		44 W		4600	0
	N11 1915	07-02-89	0636	2 headers	55 W		4600	0
W228	N10 12430	07-02-89	2244		36 E		4600	0
	N11 1929	08-02-89	0626		69 W		4600	0
W229	N11 1943	09-02-89	0616		82 W		4600	1
	N11 1950	09-02-89	1738	NIGHT	73 E		4600	0
W230	N11 1957	10-02-89	0606		74 E		4600	1
	N11 1971	11-02-89	0556		59 E		4600	0
W231	N11 1985	12-02-89	0546		47 E		4600	0
	N11 1999	13-02-89	0536		38 E		4600	0
W232	N11 2013	14-02-89	0526		30 E		4600	0

	N11 1929	08-02-89	0626		69 W	4600	0	
W229	N11 1943	09-02-89	0616		82 W	4600	1	
	N11 1950	09-02-89	1738	NIGHT	73 E	4600	0	
W230	N11 1957	10-02-89	0606		74 E	4600	1	
	N11 1971	11-02-89	0556		59 E	4600	0	
W231	N11 1985	12-02-89	0546		47 E	4600	0	
	N11 1999	13-02-89	0536		38 E	4600	0	
W232	N11 2013	14-02-89	0526		30 E	4600	0	
	N11 2027	15-02-89	0516		24 E	4600	0	
W233	N11 2028	15-02-89	0656		36 W	4600	0	
	N11 2041	16-02-89	0506		19 E	4517	0	
W234	N11 2042	16-02-89	0646		44 W	4600	0	
	N10 12558	16-02-89	2246		38 E	4600	0	
W235	N11 2056	17-02-89	0636		55 W	4600	0	
	N11 2070	18-02-89	0626		69 W	4596	0	
W236	N11 2084	19-02-89	0615		83 W	4600	0	
	------1 line file--------							
	N11 2091	19-02-89	1737	NIGHT	74 E	4600	0	
W237	N11 2098	20-02-89	0605		74 E	4600	0	
	N10 12615	20-02-89	2258		50 E	4600	0	
W238	N11 2112	21-02-89	0555		59 E	4600	0	
	N11 2126	22-02-89	0545		47 E	4600	0	
W239	N11 2140	23-02-89	0535		37 E	4600	0	
	N11 2154	24-02-89	0525		30 E	4600	0	
W240	N11 2169	25-02-89	0655		36 W	4600	0	
	N10 12686	25-02-89	2248		40 E	4600	0	
W241	N11 2182	26-02-89	0515		19 E	4545	0	
	N11 2183	26-02-89	0645		45 W	4600	0	
W242	N11 2197	27-02-89	0635		56 W	4600	0	
	N11 2211	28-02-89	0625		70 W	4600	0	
W243	N11 2225	1-03-89	0615		88 W	4600	0	
	N11 2232	1-03-89	1737	NIGHT	76 W	4600	0	
W244	N11 2239	2-03-89	0605		73 E	4600	0	
	N11 2253	3-03-89	0555		58 E	4600	0	
W245	N11 2267	4-03-89	0545		45 E	4600	0	
	N11 2310	7-03-89	0655		37 W	4600	0	
W246	N11 2324	8-03-89	0645		46 W	4600	0	
	N11 2338	9-03-89	0635		57 W	4600	0	
W247	N11 2352	10-03-89	0624		69 W	4600	0	
	N11 2366	11-03-89	0614		76 W	4600	0	
W248	N11 2380	12-03-89	0604		70 E	4600	0	
	N11 2387	12-03-89	1726	NIGHT	80 E	4600	0	
W249	N11 2394	13-03-89	0554		57 E	4600	2	
	N11 2408	14-03-89	0544		46 E	4600	0	
W250	N11 2422	15-03-89	0534		36 E	4600	0	
	N11 2437	16-03-89	0705		30 W	4600	0	
W251	N11 2451	17-03-89	0654		37 W	4600	0	
	N11 2465	18-03-89	0644		47 W	4600	0	
W252	N11 2479	19-03-89	0634		59 W	4600	0	
	N11 2493	20-03-89	0624		74 W	4600	0	
W253	N11 2500	20-03-89	1746	NIGHT	64 W	2069	0	
	N11 2507	21-03-89	0613		88 E	4600	0	
W254	N11 2514	21-03-89	1736	NIGHT	80 W	4600	0	
	------1 line file--------							
	N11 2521	22-03-89	0603		71 E	4600	0	
W255	N11 2535	23-03-89	0553		56 E	4600	1	
	------1 line file--------							
	------1 line file--------							
	N11 2549	24-03-89	0543		44 E	4600	0	
W256	N11 2563	25-03-89	0533		35 E	4600	0	
	N11 2578	26-03-89	0703	no eof	31 W	4600	0	
W257	N11 2592	27-03-89	0653		38 W	4600	1	
	N11 2606	28-03-89	0643		48 W	4600	0	
W258	N11 2620	29-03-89	0633		60 W	4600	1	
	N11 2634	30-03-89	0622		73 W	4600	0	
W259	N11 2662	01-04-89	0602		66 E	1970	0	
W260	N11 2669	01-04-89	1724	NIGHT	77 E	4600	0	
	------1 line file--------							

W260	N11 2669	01-04-89	1724	NIGHT	77 E	4600	0	
	------1 line file--------							
	------1 line file--------							
	------1 line file--------							
	N11 2676	02-04-89	0552		55 E	4600	0	
W261	N11 2690	03-04-89	0541		44 E	4600	0	
	N11 2704	04-04-89	0531		35 E	4600	0	
W262	N11 2719	05-04-89	0702		31 W	4600	0	
	N11 2733	06-04-89	0652		38 W	4600	0	
W263	N11 2747	07-04-89	0641		48 W	4600	0	
	N11 2761	08-04-89	0631		60 W	4600	0	
W264	N11 2775	09-04-89	0621		75 W	4600	0	
	N11 2789	10-04-89	0611		84 E	4600	0	
W265	N11 2796	10-04-89	1733	NIGHT	83 W	4600	0	
	N11 2803	11-04-89	0601		69 E	4600	0	
W266	N11 2810	11-04-89	1723	NIGHT	78 E	4600	0	
	N11 2817	12-04-89	0550		54 E	4600	0	
W267	N11 2831	13-04-89	0540		43 E	4600	0	
	N11 2845	14-04-89	0530		34 E	4600	1	
W268	N11 2860	15-04-89	0701		32 W	4600	0	
	N11 2874	16-04-89	0650		40 W	4600	0	
W269	N11 2888	17-04-89	0640		50 W	4600	0	
	N11 2902	18-04-89	0630		62 W	4600	0	
W270	N11 2916	19-04-89	0620		76 W	4600	0	
	------1 line file--------							
	------1 line file--------							
	------1 line file--------							
	------1 line file--------							
	------1 line file--------							
	N11 2923	19-04-89	1741	NIGHT	66 W	4600	0	
W271	N11 2930	20-04-89	0609		78 E	4600	0	
	N11 2944	21-04-89	0559	CYCLONE	64 E	4600	0	
W272	N11 2958	22-04-89	0549		52 E	4600	0	
	N11 2972	23-04-89	0539	3 hdr recs	42 E	4600	0	
W273	N11 2986	24-04-89	0528		33 E	4600	0	
	------3 line file--------							
	N11 3001	25-04-89	0659		32 W	4600	0	
W274	N11 3015	26-04-89	0649		40 W	4600	1	
	------1 line file--------							
	------1 line file--------							
	------1 line file--------							
	N11 3029	27-04-89	0638		49 W	4600	0	
W275	N11 3043	28-04-89	0628		62 W	4600	1	
	------1 line file--------							
	N11 3057	29-04-89	0618		77 W	4600	0	
W276	N11 3064	29-04-89	1740	NIGHT	69 W	4600	6	
	------1 line file--------							
	------1 line file--------							
	N11 3071	30-04-89	0607		81 E	4600	0	
W277	N11 3078	30-04-89	1729	NIGHT	80 W	4600	8	
	N11 3085	1-05-89	0557		58 E	4600	1	
W278	N11 3099	2-05-89	0547		46 E	4600	0	
	N11 3113	3-05-89	0537		37 E	4600	0	
W279	N11 3128	4-05-89	0707	no header	29 W	4600	0	
	N11 3142	5-05-89	0657		36 W	4600	0	
W280	N11 3156	6-05-89	0647		45 W	4600	1	
	N11 3170	7-05-89	0637	2 headers	57 W	4600	2	
W281	N11 3198	9-05-89	0616		78 E	4600	0	
	N11 3205	9-05-89	1738	NIGHT	72 W	4600	1	
W282	N11 3212	10-05-89	0606		69 E	4600	0	
	N11 3226	11-05-89	0555		57 E	4600	0	
W283	N11 3240	12-05-89	0545		45 E	4600	0	
	N11 3254	13-05-89	0535		35 E	4600	1	
W284	N11 3268	14-05-89	0525		28 E	4600	0	
	N11 3283	15-05-89	0655		38 W	4600	0	
W285	N11 3297	16-05-89	0645		47 W	4600	0	
	------1 line file--------							
	------1 line file--------							

	------1 line file--------							
	------1 line file--------							
	N11 3311	17-05-89	0634		58 W	4600	0	
W286	N11 3325	18-05-89	0624		72 W	4600	2	
	N11 3339	19-05-89	0614		84 E	4600	1	
W287	N11 3346	19-05-89	1736	NIGHT	82 W	4600	1	
	------1 line file--------							
	------1 line file--------							
	N11 3353	20-05-89	0603		69 E	4600	0	
W288	N11 3360	20-05-89	1725	NIGHT	79 E	4600	28	
W289	N11 3381	22-05-89	0543		42 E	4600	0	
	N11 3395	23-05-89	0533		34 E	4600	0	
W290	N11 3410	24-05-89	0703		31 W	4600	0	
	N11 3424	25-05-89	0653		39 W	4600	0	
W291	------1 line file--------							
	N11 3438	26-05-89	0643		49 W	4600	0	
	------1 line file--------							
	------1 line file--------							
	N11 3452	27-05-89	0632		62 W	4600	0	
W292	N11 3466	28-05-89	0622		79 W	4600	0	
	N11 3480	29-05-89	0611		80 E	4600	0	
W293	N11 3487	29-05-89	1733	NIGHT	79 W	4600	0	
	N11 3494	30-05-89	0601		63 E	4600	0	
W294	N11 3501	30-05-89	1723	NIGHT	72 E	4600	3	
	N11 3508	31-05-89	0551		52 E	4600	0	
W295	N11 3522	1-06-89	0541		39 E	4600	0	
	N11 3536	2-06-89	0531		32 E	4600	0	
W296	N11 3550	3-06-89	0520		25 E	4600	0	
	N11 3551	3-06-89	0701		34 W	4600	0	
W297	N11 3564	4-06-89	0510		20 E	4482	1	
	N11 3565	4-06-89	0650		42 W	4600	0	
W298	N11 3579	5-06-89	0640		54 W	4600	3	
	N11 3593	6-06-89	0630		68 W	4600	0	
W299	N11 3614	7-06-89	1741	NIGHT	69 W	4600	0	
	N11 3621	8-06-89	0609		73 E	4600	0	
W300	N11 3649	10-06-89	0549		48 E	4600	1	
	N11 3663	11-06-89	0539		37 E	4600	0	
W301	N11 3677	12-06-89	0528		30 E	4600	0	
	N11 3692	13-06-89	0659		36 W	4600	0	
W302	N11 3818	22-06-89	0526	NOISY	28 E	4600	0	
	N1014343	22-06-89	1140	NIGHT	54 E	4600	0	
W303	N11 3847	24-06-89	0646	NOISY	47 W	4600	0	
	N11 3861	25-06-89	0635	NOISY	57 W	4600	1	
W304	N11 3868	25-06-89	1757	NIGHT	49 W	4600	0	
	N1014393	25-06-89	2329	NOISY	66 W	4600	1	
W305	N11 3875	26-06-89	0625		73 W	4600	0	
	N11 3882	26-06-89	1747	NIGHT	64 W	4600	0	
W306	N11 3889	27-06-89	0614		87 E	4600	0	
	N11 3896	27-06-89	1736	NIGHT	81 W	4600	0	
W307	N11 3903	28-06-89	0604		69 E	4600	0	
	N11 3917	29-06-89	0554		54 E	4600	1	
W308	N11 3924	29-06-89	1716	NIGHT	61 E	4600	0	
	N11 3931	30-06-89	0544		43 E	4600	2	
W309	N11 3938	30-06-89	1706	NIGHT	47 E	4600	0	
	N11 3945	01-07-89	0533		32 E	4600	0	
W310	N11 3952	01-07-89	1655	NIGHT	38 E	4600	0	
	N11 3960	02-07-89	0704		33 W	4600	0	
W311	N1014500	03-07-89	1235	no eof	43 E	4600	0	
	N11 3980	03-07-89	1635	NIGHT 3 hd	24 E	4600	0	
W312	N11 3989	04-07-89	0643		53 W	4600	1	
	N11 3995	04-07-89	1805	NIGHT	45 W	4600	0	
W313	N11 4002	05-07-89	0632		65 W	4599	2	
	N11 4009	05-07-89	1755	NIGHT	55 W	4600	4	
W314	N11 4016	06-07-89	0622		79 W	4600	0	
	N11 4023	06-07-89	1744	NIGHT	72 W	4600	3	
W315	N11 4030	07-07-89	0612		78 E	4600	0	
	N11 4037	07-07-89	1734	NIGHT	85 E	4600	1	

W315	N11 4030	07-07-89	0612		78 E	4600	0	
	N11 4037	07-07-89	1734	NIGHT	85 E	4600	1	
W316	------1 line file--------							
	N11 4044	08-07-89	0601		61 E	4600	0	
	N11 4051	08-07-89	1723	NIGHT	68 E	4600	1	
W317	N11 4058	09-07-89	0551		48 E	4600	1	
	N11 4065	09-07-89	1713	NIGHT	56 E	4600	0	
W318	N11 4072	10-07-89	0541		38 E	4600	0	
	N11 4079	10-07-89	1703	NIGHT	45 E	4600	1	
W319	N11 4086	11-07-89	0531		30 E	678	0	
W320	N11 4100	12-07-89	0520		24 E	4600	0	
	N11 4115	13-07-89	0650		45 W	4600	0	
W321	N11 4121	13-07-89	1633	NIGHT	23 E	4600	0	
	N11 4129	14-07-89	0640		55 W	4600	0	
W322	N11 4136	14-07-89	1802	NIGHT	47 W	4600	0	
	N11 4143	15-07-89	0630		70 W	4600	0	
W323	N11 4150	15-07-89	1752	NIGHT	61 W	4600	2	
	N11 4157	16-07-89	0619		88 W	4600	2	
W324	N11 4164	16-07-89	1741	NIGHT	76 W	4600	1	
	N11 4171	17-07-89	0609		71 E	4600	0	
W325	N11 4178	17-07-89	1731	NIGHT	76 E	4600	0	
	N11 4185	18-07-89	0559		57 E	4600	0	
W326	N11 4192	18-07-89	1721	NIGHT	67 E	4600	0	
	N11 4199	19-07-89	0548	shrt rec	46 E	3473	1	
W327	N11 4206	19-07-89	1710	NIGHT	53 E	2237	0	
	N11 4213	20-07-89	0538		36 E	4600	0	
W328	N11 4220	20-07-89	1700	NIGHT	41 E	4600	0	
	N11 4227	21-07-89	0528		29 E	4600	0	
W329	N11 4234	21-07-89	1650	NIGHT	33 E	4600	0	
	N11 4241	22-07-89	0518		23 E	4600	0	
W330	N11 4248	22-07-89	1640	NIGHT	27 E	4600	1	
	N11 4256	23-07-89	0647		47 W	2237	0	
W331	N11 4263	23-07-89	1810	NIGHT	40 W	4600	0	
	N11 4270	24-07-89	0637		60 W	4600	0	
W332	N11 4277	24-07-89	1759	NIGHT	52 W	4600	1	
	N11 4284	25-07-89	0627		76 W	4600	2	
W333	N11 4291	25-07-89	1748	NIGHT	64 W	4600	0	
	N11 4298	25-07-89	0616		77 E	4600	0	
W334	N11 4326	28-07-89	0556		54 E	4600	0	
	N11 4333	28-07-89	1718	NIGHT	62 E	4600	0	
W335	N11 4340	29-07-89	0545		42 E	4600	0	
	N11 4347	29-07-89	1707	NIGHT	49 E	4600	1	
W336	N11 4354	30-07-89	0535		34 E	4600	0	
	N11 4361	30-07-89	1657	NIGHT	40 E	4600	0	
W337	N11 4369	31-07-89	0705		32 W	4600	0	
	N11 4375	31-07-89	1647	NIGHT	31 E	4600	1	
W338	N11 4383	01/08/89	0655		41 W	4600	0	
	-------1 line file--------							
	-------1 line file--------							
	N11 4397	02/08/89	0644		52 E	2237	0	
W339	N11 4403	02/08/89	1627	NIGHT	20 E	4490	2	
	N11 4404	02/08/89	1806	NIGHT	45 W	4600	0	
W340	N11 4411	03/08/89	0634		67 W	4600	0	
	N11 4425	04/08/89	0624		79 W	4600	0	
W341	N11 4432	04/08/89	1745	NIGHT	69 W	4600	3	
	N11 4439	05/08/89	0613	shrt rec	75 E	3761	2	
W342	N11 4446	05/08/89	1735	NIGHT	88 W	4600	1	
W343	-------3 line file--------							
	N11 4453	06/08/89	0603		62 E	4600	0	
	-------1 line file--------							
	N11 4460	07/08/89	1725	NIGHT	70 E	4600	0	
W344	N11 4467	07/08/89	0553		48 E	4600	0	
	N11 4474	07/08/89	1715	NIGHT	56 E	4600	1	
W345	N11 4481	08/08/89	0542		38 E(no photos)	1466	0	
	N11 4495	09/08/89	0532		30 E	4600	0	
W346	N11 4510	10/08/89	0702		36 W	4600	3	
	N11 4516	10/08/89	1644	NIGHT	29 E	4600	0	
W347	N11 4524	11/08/89	0652		45 W	4600	0	

W346	N11 4510	10/08/89	0702		36 W	4600	3		
	N11 4516	10/08/89	1644	NIGHT	29 E	4600	0		
W347	N11 4524	11/08/89	0652		45 W	4600	0		
	N11 4538	12/08/89	0641		55 W	4600	2		
W348	N11 4545	12/08/89	1803	NIGHT	48 W	4600	0		
	N11 4552	13/08/89	0631		71 W	4600	0		
W349	-------0 line file?------								
	N11 4566	14/08/89	0620		84 E	4600	2		
	N11 4580	15/08/89	0610		69 E	4600	0		
W350	N11 4608	17/08/89	0549	no header	45 E	4600	1		
	N11 4622	18/08/89	0539		35 E	4600	1		
W351	N11 4636	19/08/89	0528		28 E	4600	0		
	N11 4651	20/08/89	0659		38 W	4600	0		
W352	N11 4658	20/08/89	1821	NIGHT	33 W	4338	5		
	N11 4665	21/08/89	0648		48 W	1827	1		
W353	N11 4672	21/08/89	1810	NIGHT	41 W	4600	0		
	N11 4679	22/08/89	0638		59 W	4600	1		
W354	-------1 line file-------								
	-------1 line file-------								
	N11 4693	23/08/89	0627		75 W	3628	0		
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	N11 4700	23/08/89	1749	NIGHT	67 W	4600	0		
W355	N11 4707	24/08/89	0617		84 E	4600	0		
	N11 4714	24/08/89	1739	NIGHT	78 W	4600	2		
W356	N11 4721	25/08/89	0607		64 E	3986	0		
	N11 4728	25/08/89	1729	NIGHT	76 E	4600	1		
W357	N11 4735	26/08/89	0556		53 E	4600	0		
	N11 4742	26/08/89	1719	NIGHT	62 E	4600	0		
W358	-------1 line file-------								
	N11 4749	27/08/89	0546		41 E	4600	0		
	N11 4756	27/08/89	1708	NIGHT	48 E	4600	0		
W359	N11 4763	28/08/89	0536		33 E	4600	0	1P	
W360	N11 4770	28/08/89	1658	nisht	39 E	4600	0		
	N11 4784	29/08/89	1649	nisht	31 E	1893	0		
W361	N11 4777	29/08/89	0526		26 E	4600	0		
	N11 4791	30/08/89	0515		20 E				
W362	N11 4798	30/08/89	1638	nisht	25 E	4600	0		
	N11 4806	31/08/89	0645		52 W	4600	1		
W363	-------1 line file-------								
	N11 4820	01/09/89	0634		64 W	4600	0		
	N11 4827	01/09/89	1756	nisht	55 W	4600	0		
W364	N11 4834	02/09/89	0624		78 W	4600	0		
	N11 4841	02/09/89	1746	nisht	72 W	4600	0		
W365	-------1 line file-------								
	N11 4848	03/09/89	0613		79 E	4600	0		
	-------2 line file-------								
	N11 4855	03/09/89	1735	nisht	82 W	4600	0		
W366	N11 4862	04/09/89	0603		60 E	4600	0		
	-------1 line file-------								
	N11 4869	04/09/89	1725	nisht	69 E	4600	9		
W367	N1015424	06/09/89	1145		63 E	4600	0		
	-------1 line file-------								
	N11 4897	06/09/89	1704	nisht	45 E	258	0		
W368	N11 4905	07/09/89	0713		28 W	4600	2		
	-------1 line file-------								
	N11 4911	07/09/89	1655	nisht	36 E	4600	1		
W369	N11 4912	07/09/89	1836	nisht	24 W	4600	0		
	N11 4918	08/09/89	0522		24 E	4600	0		
W370	N11 4919	08/09/89	0703		35 W	4600	0		
	-------1 line file-------								
	N11 4925	08/09/89	1644	nisht	29 E	4600	0		
W371	N11 4926	08/09/89	1825	nisht	30 W	4600	3		
	N11 4932	09/09/89	0512		19 E	4430	3		
W372	N11 4933	09/09/89	0652		44 W	4600	9		
	-------1 line file-------								
	N11 4939	09/09/89	1634	nisht	23 E	4600	1		
W373	-------1 line file-------								
	N11 4940	09/09/89	1814	nisht	38 W	4600	1		
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
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	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	-------1 line file-------								
	N11 4947	10/09/89	0642		56 W	4600	0		
W374	N11 4954	10/09/89	1804	nisht	48 W	4600	1		
	N11 4961	11/09/89	0631		70 W	4600	3		
W375	N11 4968	11/09/89	1753	nisht	60 W	4600	0		
	-------1 line file-------								
	N11 4975	12/09/89	0621		78 E	4600	0		
W376	N11 4982	12/09/89	1743	nisht	76 W	4600	0		
	N11 4996	13/09/89	1732	nisht	93 E	4593	0		
W377	N11 4995	13/09/89	1555	nisht	9 E	3356	0		
	N11 5003	14/09/89	0600		56 E	4600	0		
W378	N11 5009	14/09/89	1545	nisht	6 E	2818	0		
	N11 5010	14/09/89	1722	nisht	44 E	4600	0		
W379	N11 5017	15/09/89	0550		45 E	4600	0		
	N11 5023	15/09/89	1536	nisht	4 E	2260	1		
W380	N11 5024	15/09/89	1712	nisht	53 E	4600	0		
	N11 5031	16/09/89	0539		35 E	4600	0		
W381	N11 5032	16/09/89	0720		24 W	4600	0		
	N11 5038	16/09/89	1701	nisht	42 E	4600	0		
W382	N11 5045	17/09/89	0529		28 E	4600	1		
	N11 5046	17/09/89	0710		30 W	4600	9		
W383	N11 5052	17/09/89	1651	nisht	33 E	4600	7	1P	
	N11 5053	17/09/89	1832	nisht	26 W	4600	0		
W384	N11 5059	18/09/89	0519		22 E	4584	0		
	N11 5060	18/09/89	0700		38 W	4600	0		
W385	N11 5066	18/09/89	1641	nisht	27 E	352	0		
	N11 5067	18/09/89	1821	nisht	32 W	4600	0		
W386	N11 5080	19/09/89	1631	nisht	22 E	4545	0		
	-------1 line file-------								
	-------1 line file-------								
	N11 5081	19/09/89	1811	nisht	40 W	4600	0		
W387	-------1 line file-------								
	N11 5088	20/09/89	0638		60 W	4600	0		
	N11 5102	21/09/89	0628		76 W	4600	0		
W388	N11 5109	21/09/89	1749	nisht	65 W	4600	0		
	N11 5116	22/09/89	0617		75 E	4600	0		
W389	-------1 line file-------								
	N11 5137	23/09/89	1728	nisht	79 E	2462	0		
	-------1 line file-------								
	N11 5144	24/09/89	0556		53 E	4600	0		
W390	N11 5172	26/09/89	0536		33 E	4600	0		
	N11 5165	25/09/89	1708	nisht	49 E	2130	0		
W391	N11 5179	26/09/89	1658	nisht	39 E	2175	0		
	N11 5180	26/09/89	1839	nisht	22 W	4600	1		
W392	N11 5186	27/09/89	0525		26 E	4600	0		
	N11 5193	27/09/89	1647	nisht	31 E	4600	0		
W393	N11 5194	27/09/89	1828	nisht	29 W	4600	12		
	N11 5201	28/09/89	0655		43 W	4600	0		
W394	N11 5207	28/09/89	1637	nisht	24 E	4600	1		
	N11 5208	28/09/89	1817	nisht	37 W	4600	0		
W395	N11 5214	29/09/89	0504		15 E	4173	0		
	N11 5221	29/09/89	1627	nisht	19 E	4393	0		
W396	N11 5222	29/09/89	1006	nisht	47 W	4600	11		

W395	N11 5214	29/09/89	0504		15 E	4173	0		
	N11 5221	29/09/89	1627	nisht	19 E	4393	0		
W396	N11 5222	29/09/89	1806	nisht	47 W	4600	11		
	N11 5229	30/09/89	0634		70 W	4600	1		
W397	N11 5271	3/10/89	0602		58 E	4600	0		
	N11 5278	3/10/89	1724	nisht	68 E	4600	0		
W398	N1015815	4/10/89	2257		56 E	4600	3		
	N11 5285	4/10/89	0552		45 E	4600	0		
W399	N11 5286	4/10/89	0735		20 W	4457	2		
	N1015822	4/10/89	1120	nisht	33 E	4598	0		
W400	N11 5292	4/10/89	1716	nisht	54 E	4600	0	2P	
	N11 5293	4/10/89	1858	nisht	16 W	4273	2		
W401	N1015829	4/10/89	2237		33 E	4600	13		
	N11 5299	5/10/89	0544		36 E	4600	1		
W402	N11 5300	5/10/89	0725		25 W	4600	0		
	N11 5306	5/10/89	1706	nisht	43 E	4600	1		
W403	N11 5313	6/10/89	0533		28 E	4600	1		
	N11 5314	6/10/89	0714		31 W	4600	0		
W404	N11 5320	6/10/89	1653	nisht	34 E	4600	0		
	N11 5321	6/10/89	1834	nisht	26 W	4600	0		
W405	N1015857	6/10/89	2152		12 E	3745	0		
	N11 5327	7/10/89	0521		22 E	3828	0		
W406	N11 5328	7/10/89	0701		38 W	4600	0		
	N1015865	7/10/89	1151	nisht	72 E	4600	0		
W407	--------1 line file--------								
	--------1 line file--------								
	N11 5334	7/10/89	1643	nisht	27 E	4600	0		
	N11 5335	7/10/89	1824	nisht	32 W	4600	0		
W408	N11 5341	8/10/89	0511		18 E	4398	0		
	N11 5342	8/10/89	0651		48 W	4599	0		
W409	--------1 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	N11 5348	8/10/89	1633	nisht	22 E	4501	0		
	N11 5349	8/10/89	1813	nisht	41 W	4600	0		
W410	--------1 line file--------								
	N1015886	8/10/89	2245		42 E	4600	0		
	--------1 line file--------								
	--------1 line file--------								
	N11 5355	9/10/89	0501		14 E	4125	0		
W411	N11 5356	9/10/89	0640		61 W	4600	1		
	N11 5357	9/10/89	0823		3 W	2808	0		
W412	--------1 line file--------								
	N11 5362	9/10/89	1633	nisht	17 E	4317	0		
	N11 5363	9/10/89	1802	nisht	52 W	4600	0		
W413	N1015900	9/10/89	2253		25 E	4569	0		
	N11 5369	10/10/89	0451		10 E	3673	0		
W414	N11 5370	10/10/89	0630		78 W	4600	0		
	--------1 line file--------								
	N11 5371	10/10/89	0812		8 W	3201	0		
W415	N11 5376	10/10/89	1613	nisht	14 E	3981	0		
	--------1 line file--------								
	N11 5377	10/10/89	1752	nisht	67 W	4600	0		
W416	N11 5383	11/10/89	0441		7 E	3169	0		
	N11 5384	11/10/89	0619		84 E	4600	4		
W417	N11 5385	11/10/89	0801		10 W	3637	0	1P	
	--------1 line file--------								
	N11 5390	11/10/89	1603	nisht	10 E	3574	0		
W418	N11 5391	11/10/89	1741	nisht	84 W	4600	0		
	N11 5392	11/10/89	1925	nisht	7 W	3002	0		
W419	--------2 line file--------								
	N11 5398	12/10/89	0609		68 E	4600	1		
	--------1 line file--------								
	N11 5405	12/10/89	1731	nisht	78 E	4600	0		
W420	--------1 line file--------								
	N1015943	12/10/89	2255	nisht	54 E	4592	0	1P	
	N11 5412	13/10/89	0558		52 E	4600	0		
W421	N11 5419	13/10/89	1720	nisht	64 E	4600	0	1P	

	N1015943	12/10/89	2255	nisht	54 E	4592	0	1P	
	N11 5412	13/10/89	0558		52 E	4600	0		
W421	N11 5419	13/10/89	1720	nisht	64 E	4600	0	1P	
	N1015957	13/10/89	2233		32 E	4600	1		
W422	--------1 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	N11 5426	14/10/89	0548		41 E	4600	0	1P	
	--------1 line file--------								
	N11 5427	14/10/89	0729		22 W	4600	3		
W423	N11 5433	14/10/89	1710	nisht	48 E	4600	0		
	N11 5440	15/10/89	0537		32 E	4600	0		
W424	N11 5441	15/10/89	0718		27 W	4600	0		
	N11 5447	15/10/89	1700	nisht	38 E	4600	1		
W425	N11 5461	16/10/89	1649	nisht	31 E	4594	0		
	--------2 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	N11 5462	16/10/89	1830	nisht	28 W	4600	0		
W426	N1016000	16/10/89	2306		70 E	4600	0		
	N11 5468	17/10/89	0515		21 E	4577	0		
W427	--------1 line file--------								
	N11 5469	17/10/89	0657		40 W	4600	0		
	N11 5475	17/10/89	1639	nisht	25 E	4600	0		
W428	N11 5476	17/10/89	1819	nisht	34 W	4600	0		
	N1016014	17/10/89	2243		42 E	4600	0		
W429	--------1 line file--------								
	--------1 line file--------								
	N11 5482	18/10/89	0507		16 E	4274	1		
	--------1 line file--------								
	--------1 line file--------								
	N11 5483	18/10/89	0647		51 W	4600	2		
W430	N11 5490	18/10/89	1809	nisht	43 W	4600	0	1P	
	--------1 line file--------								
	N11 5496	19/10/89	0457		13 E	3900	0		
W431	--------1 line file--------								
	--------1 line file--------								
	--------1 line file--------								
	N11 5497	19/10/89	0636		63 W	4600	0		
	--------1 line file--------								
	N11 5504	19/10/89	1758	nisht	55 W	4600	0		
W432	N11 5511	20/10/89	0626		82 W	4600	1		
	N11 5518	20/10/89	1748	nisht	70 W	4600	0		
W433	N11 5525	21/10/89	0615		75 E	4600	0	2P	
	N11 5532	21/10/89	1737	nisht	77 W	4600	0		
W434	N1016071	21/10/89	2254		52 E	4600	0		
	N11 5539	22/10/89	0605		63 E	4600	0		
W435	N11 5546	22/10/89	1727	nisht	73 E	4600	0		
	N11 5553	23/10/89	0554		49 E	4600	0		
W436	N11 5568	24/10/89	0725		23 W	4600	0		
	N11 5560	23/10/89	1718	nisht	57 E	4595	0	6P	
W437	--------1 line file--------								
	N11 5574	24/10/89	1706	nisht	45 E	4600	0		
	N11 5581	25/10/89	0534		31 E	4600	0		
W438	N11 5582	25/10/89	0714		28 W	4600	0	6P	
	N11 5588	25/10/89	1656	nisht	36 E	4600	0		
W439	N11 5589	25/10/89	1837	nisht	23 W	4600	0		
	--------1 line file--------								
	--------1 line file--------								
	N11 5595	26/10/89	0523		24 E	4600	0		
W440	--------1 line file--------								
	N11 5596	26/10/89	0704		35 W	4600	0		
	N11 5602	26/10/89	1645	nisht	29 E	4600	0		
W441	N11 5603	26/10/89	1826	nisht	29 W	4600	0		
	N11 5609	27/10/89	0513		19 E	4411	0		
W442	N11 5610	27/10/89	0653		44 W	4600	0		
	N11 5614	27/10/89	1635	nisht	23 E	4523	0		
W443	N11 5617	27/10/89	1815	nisht	37 W	4600	0		

	N11 5616	27/10/89	1635	nisht	23 E	4523	0	
W443	N11 5617	27/10/89	1815	nisht	37 W	4600	0	
	N11 5623	28/10/89	0503		15 E	1839	0	
W444	-------1 line file-------							
	N11 5624	28/10/89	0643		54 W	4600	0	
	N11 5631	28/10/89	1804	nisht	47 W	4600	0	
W445	N11 5637	29/10/89	0453		11 E	3768	0	3P
	N11 5638	29/10/89	0632		71 W	4600	0	
W446	N11 5645	29/10/89	1754	nisht	61 W	4600	0	10P
	N11 5652	30/10/89	0621		79 E	4600	0	
W447	N11 5659	30/10/89	1743	nisht	72 W	4600	0	
	N11 5666	31/10/89	0611		72 E	4600	0	
W448	N11 5673	31/10/89	1733	nisht	81 E	4600	0	
	N11 5680	01/11/89	0600		55 E	4600	0	
W449	N11 5687	01/11/89	1722	nisht	63 E	4600	0	
	N11 5694	02/11/89	0550		43 E	4600	1	
W450	N11 5701	02/11/89	1712	nisht	50 E	4599	1	
	N11 5708	03/11/89	0539		34 E	4600	0	
W451.	N11 5715	03/11/89	1702	nisht	40 E	4600	0	
	N11 5722	04/11/89	0529		27 E	4600	0	
W452	N11 5723	04/11/89	0710		32 W	4600	0	
	N11 5729	04/11/89	1651	nisht	31 E	4600	0	
W453	N11 5730	04/11/89	1832	nisht	27 W	4600	0	
	N11 5736	05/11/89	0519		21 E	4595	0	?P
W454	N11 5737	05/11/89	0659		40 W	4600	0	
	N11 5743	05/11/89	1641	nisht	26 E	4600	0	
W455	N11 5744	05/11/89	1821	nisht	33 W	4600	0	
	N11 5750	06/11/89	0509		17 E	4320	0	
W456	N11 5751	06/11/89	0648		50 W	4600	0	
	N11 5757	06/11/89	1631	nisht	20 E	4472	0	
W457	N11 5758	06/11/89	1810	nisht	43 W	4600	0	
	N11 5765	07/11/89	0638		64 W	4600	1	
W458	N11 5772	07/11/89	1800	nisht	54 W	4600	0	
	N11 5779	08/11/89	0627		75 W	4600	0	
W459	N11 5786	09/11/89	1749	nisht	69 W	4600	0	
	N11 5793	09/11/89	0616		81 E	4600	0	
W460	N11 5800	09/11/89	1738	nisht	81 W	4600	0	
	-------1 line file------							
	N11 5807	10/11/89	0606		61 E	4600	0	
W461	N11 5814	10/11/89	1728	nisht	72 E	4600	0	2P
	N11 5828	11/11/89	1717	nisht	58 E	4074	0	
W462	N11 5849	13/11/89	0534		31 W	4601	0	6P
	N11 5850	13/11/89	0716		28 W	4463	0	
W463	N11 5856	13/11/89	1657	nisht	36 E	4571	0	8P
	N11 5857	13/11/89	1837	nisht	23 W	4352	0	
W464	-------1 line file-------							
	N11 5863	14/11/89	0524		25 E	4375	0	
	N11 5864	14/11/89	0704		35 W	4600	0	
W465	N11 5870	14/11/89	1646	nisht	29 E	4600	0	3P
	N11 5871	14/11/89	1827	nisht	29 W	4586	0	
W466	-------2 line file-------							
	N1016413	14/11/89	2355		35 W	4600	0	
	-------1 line file-------							
	N11 5878	15/11/89	0654		44 W	4600	0	
W467	-------1 line file-------							
	N11 5884	15/11/89	1636	nisht	23 E	4573	0	
	N11 5885	15/11/89	1816	nisht	37 W	4600	0	
W468	N11 5892	16/11/89	0643		54 W	4600	0	
	-------1 line file-------							
	N11 5899	16/11/89	1805	nisht	47 W	4600	0	
W469	N11 5906	17/11/89	0632		71 W	4600	0	
	N11 5913	17/11/89	1754	nisht	60 W	4600	0	
W470	-------1 line file-------							
	-------1 line file-------							
	-------1 line file-------							
	-------1 line file-------							
	-------1 line file-------							
	N11 5927	18/11/89	1744	nisht	73 W	4600	0	

	-------1 line file-------							
	N11 5927	18/11/89	1744	nisht	73 W	4600	0	
	-------1 line file-------							
	N11 5934	19/11/89	0611		73 E	4600	0	
W471	-------1 line file-------							
	-------1 line file-------							
	N11 5948	20/11/89	0601		58 E	4600	0	
	N11 5955	20/11/89	1723	nisht	64 E	4600	0	
W472	N11 5962	21/11/89	0550		45 E	4600	0	
	N11 5963	21/11/89	0731		20 W	4370	0	
W473	N11 5969	22/11/89	1712	nisht	53 E	4600	0	
	N11 5976	22/11/89	0540		36 E	4600	0	
W474	N11 5977	22/11/89	0721		25 W	4600	0	
	N11 5983	22/11/89	1702	nisht	42 E	4600	0	
W475	N11 5984	22/11/89	1843	nisht	20 W	4590	0	
	N11 5991	23/11/89	0710		31 W	4600	0	
W476	N11 5997	23/11/89	1652	nisht	33 E	4600	0	
	N11 5998	23/11/89	1833	nisht	26 W	4600	0	
W477	N11 6005	24/11/89	0700		38 W	4600	0	
	-------1 line file-------							
	-------1 line file-------							
	N11 6011	24/11/89	1642	nisht	27 E	4600	0	
W478	N11 6012	24/11/89	1822	nisht	32 W	4600	0	
	N11 6019	25/11/89	0649		48 W	4600	0	
W479	N11 6026	25/11/89	1811	nisht	41 W	4600	0	
	-------1 line file-------							
	N11 6033	26/11/89	0638		61 W	4600	0	
W480	-------1 line file-------							
	N11 6040	26/11/89	1800	nisht	51 W	4600	0	
	N11 6047	27/11/89	0628		74 W	4600	0	
W481	N11 6054	27/11/89	1749	nisht	67 W	4600	0	
	N11 6061	28/11/89	0617		84 E	4600	0	
W482	N11 6068	28/11/89	1738	nisht	77 W	4600	0	
	N11 6075	29/11/89	0606		44 E	4600	0	
W483	-------2 line file-------							
	-------1 line file-------							
	-------1 line file-------							
	N11 6082	29/11/89	1728	nisht	77 E	4598	0	
	-------1 line file-------							
	N11 6089	30/11/89	0556		53 E	4600	0	
W484	N11 6096	30/11/89	1718	nisht	58 E	4600	0	
	-------1 line file-------							
	N11 6103	01/12/89	0545		39 E	4600	0	
W485	N11 6146	04/12/89	0654		44 W	4600	0	
	N11 6152	04/12/89	1636	nisht	24 E	4570	0	
W486	N11 6153	04/12/89	1816	nisht	37 W	4600	0	
	N11 6160	05/12/89	0644		55 W	4600	0	
W487	N11 6167	05/12/89	1806	nisht	48 W	4600	0	
	N11 6174	06/12/89	0633		71 W	4600	0	
W488	N11 6181	06/12/89	1755	nisht	60 W	4600	0	
	N11 6188	07/12/89	0622		76 W	4600	0	
W489	N11 6195	07/12/89	1744	nisht	77 W	4600	0	
	N11 6202	08/12/89	0612		74 E	4600	0	
W490	N11 6209	08/12/89	1733	nisht	79 E	4600	0	
	-------1 line file-------							
	N11 6216	09/12/89	0601		56 E	4600	0	
W491	N11 6223	09/12/89	1723	nisht	66 E	4600	0	
	N11 6244	11/12/89	0540		35 E	4600	0	
W492	N11 6245	11/12/89	0721		25 W	4600	0	
	-------1 line file-------							
	-------1 line file-------							
	N11 6251	11/12/89	1702	nisht	41 E	4600	0	
W493	-------1 line file-------							
	N11 6252	11/12/89	1843	nisht	21 W	4577	0	4P
	N11 6258	12/12/89	0530		28 E	4600	0	
W494	N11 6259	12/12/89	0710		31 W	4600	0	
	N11 6265	12/12/89	1652	nisht	31 E	4600	0	
W495	N11 6273	13/12/89	0659		39 W	4504	0	
	N11 6279	13/12/89	1641	nisht	26 E	4600	0	

W494	N11 6259	12/12/89	0710		31 W	4600	0	
	N11 6265	12/12/89	1652	night	31 E	4600	0	
W495	N11 6273	13/12/89	0659		39 W	4504	0	
	N11 6279	13/12/89	1641	night	26 E	4600	0	
W496	N11 6280	13/12/89	1821	night	33 W	4600	0	3P
	N11 6287	14/12/89	0649		48 W	4600	0	
W497	N11 6294	14/12/89	1811	night	41 W	4600	0	
	N11 6301	15/12/89	0638		61 W	4600	0	
W498	N11 6308	15/12/89	1800	night	53 W	4600	0	
	N11 6315	16/12/89	0627		78 W	4600	0	
W499	N11 6322	16/12/89	1749	night	65 W	4600	0	
	N11 6329	17/12/89	0617		77 E	4600	0	
W500	N11 6336	17/12/89	1738	night	85 W	4600	0	
	N11 6343	18/12/89	0606		66 E	4600	1	
W501	N11 6344	18/12/89	0748		14 W	4232	0	
	N11 6350	18/12/89	1728	night	72 E	4600	0	
W503	N11 6351	18/12/89	1911	night	10 W	3774	0	
	N11 6357	19/12/89	0555		51 E	4600	0	
W504	N11 6358	19/12/89	0737		17 W	4446	0	
	N11 6364	19/12/89	1717	night	60 E	4600	0	
W505	N11 6365	19/12/89	1900	night	14 W	4322	0	
	N11 6371	20/12/89	0545		41 E	4600	1	
W506	N11 6372	20/12/89	0726		22 W	4600	0	1P
	N11 6378	20/12/89	1707	night	47 E	4600	0	
W507	N11 6379	20/12/89	1849	night	18 W	4534	0	
	N11 6385	21/12/89	0534		32 E	4600	0	9P
W508	N11 6386	21/12/89	0715		27 W	4600	0	
	N11 6392	21/12/89	1657	night	38 E	4600	0	
W509	N11 6393	21/12/89	1837	night	23 W	4600	0	
	N11 6399	22/12/89	0524		25 E	4550	0	
W510	N11 6400	22/12/89	0704		34 W	0	0	30P
	N11 6406	22/12/89	1646	night	30 E	4600	0	
W511	N11 6407	22/12/89	1826	night	29 W	4600	0	
	N11 6414	23/12/89	0653		43 W	4600	0	
W512	N11 6420	23/12/89	1636	night	24 E	4598	0	
	N11 6421	23/12/89	1815	night	37 W	4600	0	
W513	N11 6428	24/12/89	0642		53 W	4600	0	1P
	N11 6435	24/12/89	1804	night	45 W	4600	0	
W514	N11 6442	25/12/89	0632		68 W	4600	0	
	N11 6449	25/12/89	1754	night	59 W	4600	0	
W515	N11 6456	26/12/89	0621		82 W	4600	0	1P
	N11 6463	26/12/89	1743	night	70 W	4600	0	
W516	N11 6470	27/12/89	0611		73 E	4600	0	
	N11 6477	27/12/89	1733	night	87 E	4600	0	
W517	N11 6484	28/12/89	0600		59 E	4600	0	
	N11 6491	28/12/89	1722	night	66 E	4600	0	
W518	N11 6498	29/12/89	0550		46 E	4600	0	
	N11 6499	29/12/89	0731		19 W	4598	0	
W519	N11 6505	29/12/89	1712	night	55 E	4600	0	
	N11 6512	30/12/89	0539		36 E	4600	0	
W520	N11 6513	30/12/89	0720		24 W	4598	0	
	-------1 line file------							
	N11 6569	03/01/90	0637		67 W	4600	0	
W521	N11 6576	03/01/90	1759	night	57 W	4600	0	
	N11 6583	04/01/90	0626		83 W	4600	0	
W522	-------1 line file-------							
	N11 6590	04/01/90	1748	night	75 W	4600	0	
	N11 6597	05/01/90	0616		72 E	4600	0	
W523	N11 6604	05/01/90	1737	night	80 E	4603	0	
	N11 6611	06/01/90	0605		59 E	4600	0	
W524	N11 6618	06/01/90	1727	night	68 E	4580	0	
	-------1 line file-------							
	N11 6625	07/01/90	0554		45 E	4600	0	
W525	-------1 line file-------							
	N11 6626	07/01/90	0736		19 W	4456	0	
	-------1 line file-------							
	N11 6632	07/01/90	1716	night	54 E	4600	0	
W526	N11 6639	08/01/90	0544		36 E	4598	0	
	N11 6640	08/01/90	0725		24 W	4584	0	

WA SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

FINANCIAL STATEMENT: YEAR ENDED 31 DECEMBER 1989

APPENDIX 7

MAINTENANCE ACCOUNT	$	$
Balance as at 31 December 1988		65,756.00
1989 Income		
1.1.1989 - 11.12.1989 (Previous Financial Statement)	12,927.00	
Geoimage Pty Ltd	250.00	
Newmont Aust. Ltd	230.00	13,407.00
		79,163.00
1989 Expenditure		
1.1.1989 - 11.12.1989 (Previous Financial Statement)	18,988.34	
Control Data - Equipment Maintenance (Jan - Mar 1990)	560.79	
Film Processing - December 1989	52.50	
Adjustment - Kokak Aust. Pty Ltd - Film	(1.00)	
Receiver Licence Annual Fee	183.00	
Contribution for Attendance at second NOAA/AVHRR Conference		
- H Houghton	2,970.00	22,753.63
Balance as at 31.12.1989		56,410.37

N.B. Interest for second half of financial year will be determined when accounts have been closed down - Mid-March 1990.

Invoices Issued But Not Yet Paid

Contribution towards Consortium on-going costs for period ending 30/6/89		
- CSIRO	10,000.00	
- Bureau of Meteorology	5,000.00	
Bureau of Meteorology (for period beginning 1/7/89)	10,000.00	
Department of Defence	215.00	25,215.00

MAJOR EQUIPMENT ACCOUNT	$	$
Balance as at 31 December 1988		28,789.90
1989 Income		
1.1.1989 - 31.12.1989 (Previous Financial Statement)	14,982.53	14,982.53
		43,772.43
1989 Expenditure		
1.1.1989 - 31.12.1989 (Previous Financial Statement)	42,374.00	
Adjustment - Microwave Link Purchase	1,261.00	43,635.00
Balance as at 31/12/1989		137.43

N.B. Account for additional $1,291 received on 11/12/89 due to increase in cost through US$ exchange rate fluctuation.

EARTH SYSTEM SCIENCE CENTRE		
1989 INCOME	$	$
1.1.1989 - 23.10.1989 (Previous Financial Statement)	10,000.00	10,000.00
1989 Expenditure		
1.1.1989 - 23.10.1989 (Previous Financial Statement)	3,365.65	
Jellore Technologies (Consultancy - Dr M G McCracken)	1,536.00	4,901.65
Balance as at 31/12/1989		5,098.35

N H Buckingham
ADMINISTRATIVE OFFICER
DIVISION OF ENGINEERING AND SCIENCE

6791K

CURTIN UNIVERSITY OF TECHNOLOGY

APPENDIX 8

TO: Professor J de Laeter, Deputy Vice-Chancellor
FROM: P J Perriam, University Auditor
SUBJECT: W A SATELLITE TECHNOLOGY AND APPLICATIONS CO
FILE:
DATE: 12 SI

An internal audit review of the above Consortium has recently been completed. The period covered by the review was primarily 1 January to 31 August 1989.

2. AUDIT SCOPE

2.1 The audit covered the activities of the Consortium relative to:

- the requisitioning and purchase of goods and services and the resultant expenditure thereon;
- the raising of charges for services performed and follow up to ensure that moneys due are received by the Consortium;
- the receipting, banking and correct accounting for moneys received;
- project budgeting and costing;
- recording and secure handling of equipment items purchased;
- the provision of accurate and timely management information to persons identified as having a need for such information;
- control of accountable forms;
- control of any change or petty cash floats held.

2.2 The review also examined the Deed establishing the Consortium to ascertain that it is within the guidelines specified by Council relative to Centres (Council Resolution C 8/86).

2.3 The review considered, relative to the Consortium, the requirement for Centres to seek re-approval by Council within five years of the date of initial approval.

3. AUDIT OBJECTIVES

To evaluate internal controls designed to ensure that:

- goods and services are obtained which are of adequate quality at an economic rate with such purchases receiving prior approval from a delegated officer;
- adequate charges are raised and collected for services performed by the Consortium on behalf of bodies both outside and within the University environment, in circumstances where it is appropriate to raise and collect such charges;
- all moneys received are correctly accounted for, promptly banked and protected from theft or misappropriation;

- project costs are adequately budgeted and costed to provide for, at a minimum, a breakeven situation;

- project expenses are expeditiously and correctly recorded against relevant projects;

- equipment items purchased are adequately recorded and securely held against loss or misappropriation;

- accountable forms are adequately secured and accounted for and utilised correctly;

- petty cash and/or change floats are held securely, adequately accounted for, and utilised correctly;

- relevant and accurate management information is provided to persons requiring such information, in a timely manner;

- the five year re-approval review is conducted in a timely manner and is supported by accurate and relevant data in the Council approved format.

4. AUDIT FINDINGS AND RECOMMENDATIONS

4.1 A summary of audit findings and recommendations for action appears at Attachment 1.

5. CONCLUSION

5.1 In general, adequate financial controls are in place to facilitate the efficient operations of the Consortium. However, adoption of the audit recommendations should assist in improving financial control and management of the Consortium in addition to ensuring compliance with the requirements of the Deed and University policy.

6. Your comments on the internal audit findings and recommendations, together with details of corrective action taken or proposed, would be appreciated please by 22 September 1989.

7. The cooperation and assistance of Assoc Prof M Lynch and Mr N Buckingham during the conduct of this audit was appreciated. Both officers have been advised previously of audit findings.

P J Perriam
UNIVERSITY AUDITOR

Copy to: Assoc Prof M Lynch, Applied Physics
Mr N Buckingham, Admin. Officer (Engineering & Science)

2897r

ATTACHMENT 1

SUMMARY OF FINDINGS AND RECOMMENDATIONS

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

1. COMPLIANCE WITH DEED

FINDING:

To date it appears that the Consortium has not complied with the following clauses of the Deed between Consortium members dated 24 January 1987.

1.1 Clauses 7 d) and 18 e) - appointment of an auditor.
1.2 Clause 18 f) - preparation of an annual report
1.3 Clause 18 h) - preparation of an annual budget.

EXPOSURE:

1.1 Management of the member organisations will not have the assurance that financial statements prepared on behalf of the Consortium present fairly the financial position and the results of operations of the Consortium.

1.2 Management of the member organisations may not be kept appraised of the operations and activities of the Consortium nor of its financial position and results of operations over the year covered by the report.

1.3 Financial planning for the future operations will not be facilitated.

RECOMMENDATION:

1.1 The Consortium appoint an auditor to review the annual financial statements prepared for the Consortium and provide the necessary audit certificate.

Whilst the financial statements are prepared at Curtin University it may be appropriate for the University's Internal Audit department to provide that service. That department is independent from University representatives on the Consortium Board of Management and the officer preparing the financial statements.

*A - Accepted
RI - Rejection Inappropriate
AM - Accepted with modification
CA - Consideration Accepted
CR - Consideration Rejected

SUMMARY OF FINDINGS AND RECOMMENDATIONS

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

RECOMMENDATION:

1.2 The University request that the Consortium provide an annual report, including an audited financial report, for each year ending 31 December. Such report to be provided in sufficient time to enable inclusion in the University's internal Annual Report. This would then provide compliance with the University's policy on reporting by Centres (E&GPC Doc. No. 4502/86 (Clause 6.5) of 17 February 1986 refers).

[N.B. EGPC Doc. No.4535/88, headed "Status Report on Centres", dated 13 July 1988 indicates at Attachment 1 that the Consortium is a Centre at Curtin University].

1.3 The University should request that the Consortium prepare an annual budget in accordance with the Deed.

The budget for the upcoming year should be agreed by members of the Board of Management at one of its meetings in the last quarter of the current year.

*A - Accepted
RI - Rejection Inappropriate
AM - Accepted with modification
CA - Consideration Accepted
CR - Consideration Rejected

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

2. MEMBER CONTRIBUTIONS

FINDING:

2.1 Clause 8 of the Deed provides that

> "all costs expenses and outgoings both of a capital or revenue nature shall be borne by the parties hereto in equal shares".

This is effected by each of the four member organisations of the Consortium making an agreed contribution (equal for all members) to the Consortium on an annual basis.

2.2 As at August 1989 it was noted that the following contributions for 1988/89 had not been made:

- Bureau of Meteorology	$15,000
- CSIRO	15,000
- Dept. of Land Administration	8,000

2.3 Also at that date fees for 1989/90 had not been agreed to by member organisations.

EXPOSURE:

There may be insufficient funds available to meet the ongoing operating costs of, and capital purchases desired by the Consortium. [Appendix A gives an indication of the financial position of WASTAC as at 28.08.89.]

RECOMMENDATION:

2.1 Every effort be made to ensure that outstanding fees for 1988/89 are paid in a timely manner.

2.2 Fees for 1989/90 be established during, or as a consequence of the budget setting process mentioned at recommendation 1.3.

*A - Accepted
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AM - Accepted with modification
CA - Consideration Accepted
CR - Consideration Rejected

SUMMARY OF FINDINGS AND RECOMMENDATIONS

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

3. EXPENDITURE IN EXCESS OF $10,000

FINDING:

3.1 Clause 17(a)(i)(A) of the Deed requires a unanimous decision of the Board of Management for expenditure in excess of $10,000.

3.2 A review of Board minutes for 1988 and 1989 did not provide evidence of such unanimous decision for the purchase of the following item:

M/A - Com MA 23cc 23 GHZ One way Video Link	$19,044.00
Voucher 28316)	
Requisition for Purchase 385629) refer	
Purchase Order 17235)	

EXPOSURE:

Should a unanimous decision not have been reached or not have been suitably documented, one or more Consortium members may argue that they have no obligation to contribute funds towards the purchase cost.

Unsuitable items may be purchased.

RECOMMENDATION:

Board of Management minutes should adequately document decisions as required by Clause 17(a)(i).

*A - Accepted
RI - Rejection Inappropriate
AM - Accepted with modification
CA - Consideration Accepted
CR - Consideration Rejected

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

4. REVENUE

FINDING:

4.1 Clause 6(a)(vii) of the Deed provides that Curtin University shall

"carry out all administrative financial and reporting obligations of the Consortium".

4.2 In effect this has resulted in the University

a) maintaining a cost centre for the Consortium on its general ledger (i.e. 1198);

b) raising purchase requisitions/orders for all purchases requiring same;

c) preparing allonges/cheque payment vouchers and processing payments through its expenditure system; and

d) preparing a monthly financial report to the Board of Management, via the Administrative Officer (Engineering & Science).

4.3 However, invoices are raised by the Secretary, WASTAC on WASTAC letterhead stationery. Such invoices are not serially numbered. No action is taken by the University until payment is made to the debtor and a receipt is issued by the Central Administration Cashier.

EXPOSURE:

Whilst the number of invoices raised in any year is small (i.e. 1988 (6), 1989 to August (8)), outstanding invoices could be lost sight of and moneys not received.

RECOMMENDATION:

The Consortium give consideration to having invoices raised via the University's computerised accounts receivable system. This would have the benefits of:

a) providing interest credits to the Consortium from the date the invoice is raised, rather than from the date cash is received;

b) a regular reminder to the debtor via issuance of a monthly statement;

c) follow up of long standing debts (i.e. over 60 days), with use of a debt collection agency if considered necessary; and

d) having all transactions for expenditure and revenue processed by the University.

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

5. EARTH SYSTEMS SCIENCE CENTRE

FINDING:

5.1 An amount of $10,000 has been provided by the Technology and Industry Development Authority (TIDA) for consultancy work associated with the proposed establishment of the above Centre.

It is understood that to date no formal agreement between WASTAC and TIDA has been tabled at a WASTAC Board meeting, but that a response from TIDA to a proposal by WASTAC has been received.

EXPOSURE:

Terms and conditions associated with the $10,000 funding may not be adhered to.

RECOMMENDATION:

5.1 As far as is practical terms and conditions associated with the funding should be formalised and should incorporate:

a) the end result or product that TIDA expects from the consultancy (e.g. reporting requirements);

b) any time constraints for production of the report;

c) any requirements for reporting on the expenditure of funds and auditing thereof, and

d) any requirements as to how the funds are to be spent.

5.2 Adequate records will need to be maintained by the University to ensure that expenditure against the TIDA funding can be readily determined.

*A – Accepted
RI – Rejection Inappropriate
AM – Accepted with modification
CA – Consideration Accepted
CR – Consideration Rejected

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

6. EQUIPMENT

FINDING:

6.1 Equipment Item No. 13588.00 Computer System Satellite Tracking Station, and accessories, is recorded on an Equipment List dated 01.09.89 for Cost Centre 1010 sub centre 01 (WASTAC) as being located in Building 204, Room 500.

From discussions it is understood that the computer system has been transferred and is now physically located at the Bureau of Meteorology.

6.2 It is understood that an assets register format for the Consortium has not been assembled to date.

EXPOSURE:

6.1 Inaccurate management information. Difficulty may arise in locating the equipment at the time of the annual stocktake.

6.2 Difficulties in complying with Clauses 7(a), 21 and 22 of the Deed.

RECOMMENDATION:

6.1 The Equipment List be updated to reflect the current location of the computer system.

6.2 An assets register for the Consortium as a whole be developed and implemented as soon as possible.

*A – Accepted
RI – Rejection Inappropriate
AM – Accepted with modification
CA – Consideration Accepted
CR – Consideration Rejected

SUMMARY OF FINDINGS AND RECOMMENDATIONS

AUDITABLE AREA: WASTAC FINAL REPORT ISSUED: Sept. '89

FINDINGS, EXPOSURE, RECOMMENDATIONS, MANAGEMENT COMMENTS *A AM CA RI CR

7. MONEYS FROM CSIRO

FINDING:

7.1 Prior to Curtin University taking over responsibility for purchasing/expenditure on behalf of the Consortium that activity was undertaken by CSIRO utilising the initial amount of $319,996 provided by Consortium members pursuant to Clause C of the Deed (page 2).

7.2 On 20 July 1988 the CSIRO provided a statement of expenditure and receipts (copy at Appendix B) indicating that $22,688.54 was available to the Consortium and would be transferred to the Curtin University Account.

7.3 On 7 December 1988 an amount of $28,789.90 was received (Receipt No. 301052) from CSIRO with a covering letter (dated 22.11.88) indicating that it represented the balance of funds from the CSIRO account "NOAA Satellite Receiving Facility". No statement as to how that figure was arrived at accompanied the letter.

7.4 The Board of Management minutes of 3 March 1989 indicated at clause 2.3 that

> "an amount of approximately $33,000 is to be transferred to the WASTAC account from CSIRO".

7.5 On 15 March 1989 an amount of $14,982.53 was received (Receipt 4181) from CSIRO. Again there was no accompanying statement to indicate how that figure had been arrived at.

EXPOSURE:

Inability to ascertain that all funds due to WASTAC from CSIRO have been transferred to the Curtin University account.

RECOMMENDATION:

CSIRO be approached to provide statements in support of their payments of $28,789.90 and $14,982.53 to WASTAC.

*A – Accepted
RI – Rejection Inappropriate
AM – Accepted with modification
CA – Consideration Accepted
CR – Consideration Rejected

W A SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

RETAINED FUNDS

		$
Retained Funds 01.01.89		94,546.35
Less: Expenditure to 28.08.89		28,811.74
		65,734.61
Plus: Revenue to 28.08.89		34,749.14
		100,483.75
Less: Major Commitments		
a) Order 21688	$22,300	
b) Possible Sun System Order	90,000	112,300.00
		$(11,816.25)
Plus: 1988/89 Fees Outstanding		38,000.00
		$26,183.75

TECHNOLOGY & INDUSTRY DEVELOPMENT AUTHORITY OF WESTERN AUSTRALIA

170 St. George's Terrace, Perth, Western Australia.

Postal Address: Box D160, G.P.O., Perth, Western Australia 6001

Telephone: (09) 327 5555
Telex: AA94681
Facsimile: 327 5542

Mr Henry Houghton
Chairman
Western Australian Satellite Technology
Applications Centre
c/- Remote Sensing Applications Centre
184 St George's Terrace
PERTH WA 6000

Dear Mr Houghton

I refer to WASTAC involvement in assisting Curtin University with a proposal to establish a NASA Earth System Science Centre (ESSC) in Perth as outlined in a letter from Mr Geoff Bebb, Chairman of the Geographic System Technology Institute, dated June 14, 1989.

TIDA has approved $10,000 funding of a consultant to develop a ESSC proposal for Curtin University. This funding is based on attaining financial contributions from other relevant agencies including CSIRO and DOLA.

I understand that you have agreed to WASTAC and TIDA joint development of:

. terms of reference;

. a process for selection of a consultant; and

. appropriate progress briefings by a consultant.

A cheque for $10,000 will be forwarded to you shortly to be used for development of a ESSC proposal.

I look forward to further development of this initiative.

Yours sincerely

MR REECE WALDOCK
DIRECTOR, TECHNOLOGY DIVISION

June 16, 1989

Enc.
ka02679:mj

WASTAC
Western Australian Satellite Technology and Applications Consortium

Postal: The Secretary, WASTAC
C/ Remote Sensing Applications Centre
8th Floor, Jardine House
184 St. George's Terrace
PERTH WA 6000
Tel: (09) 323 1520 Fax: (09) 321 8576
Telex: LANDS AA93784

Dr Ken McCracken
15/1 Elamang Ave
KIRRIBILLI NSW 2061

Dear Ken,

EARTH SYSTEM SCIENCE CENTRE PROPOSAL (PERTH)

As discussed, I have put together some thoughts for further discussion.

Background:

The State Government through the Technology and Industry Development Authority (TIDA) and the West Australian Satellite Technology and Applications Consortium ((WASTAC)) have funded a study to examine the feasibility of establishing an Earth System Science Centre (ESSC) in Perth Western Australia. The ESSC concept was developed by a USA National Aeronautics and Space Administration (NASA) Committee who:

- reviewed the science of the Earth as an integrated system of interacting components
- recommended an implementation strategy for global Earth studies
- defined NASA's role in such a programme of Earth System Science.

As part of that Committee's recommendations it was acknowledged that any programme must be part of an effective international collaboration in Earth remote sensing systems and other research activities. More specifically ESS aims to use global observations, new space technology and quantitative models to probe the complex, interactive processes of Earth evolution and global change. Further, the ESS Committee identified that research for the global future must include world wide observations, documentation of Global Change, predictive models to anticipate future globe trends and the assembly of information necessary for effective decision making to respond to the consequences of global change.

...2/

TECHNOLOGY & INDUSTRY
DEVELOPMENT AUTHORITY
OF WESTERN AUSTRALIA

170 St. George's Terrace,
Perth, Western Australia

Postal Address
Box D160, G.P.O., Perth,
Western Australia 6001

Telephone (09) 327 5555
Telex AA94681
Facsimile 327 5542

Mr Henry Houghton
Chairman
WASTAC
c/- Remote Sensing Application
Centre (RSAC)
Jardine House
184 St George's Terrace
PERTH WA 6000

Dear Henry

As previously acknowledged in correspondence from Mr Reece Waldock, Director, Technology Division on June 16, 1989, please find attached a cheque for $10,000 funding for a consultant to develop a proposal to establish a NASA Earth System Science Centre (ESSC) in Perth.

This is conditional upon TIDA and WASTAC joint development of:

- the terms of reference;
- a process for selection of a consultant;
- appropriate progress briefings by a consultant

I will contact you shortly to further develop this initiative.

Yours sincerely

Mr K Anthonisz
SENIOR PROJECT OFFICER

July 25, 1989
ka02766:mj

MINISTRY
ECONOMI
DEVELOPM
AND TRAD

FAXSHEET/WP:D

WASTAC
Western Australian Satellite Technology and Applications Consortium

Postal:
The Secretary, WASTAC
C/o CSIRO
Private Bag, P.O.
Wembley, 6014 W.A.

Telephone
(09) 387 0236
Telex: AA92178
Fax: (09) 387 6046

Dear Reece,

EARTH SYSTEM SCIENCE CENTRE (ESSC) CONSULTANCY

The development of a NASA accredited ESSC in Perth as part of the Remote Sensing Industry Development and Education Centre (WARSIDEC) has been discussed with a number of interested organisations and some progress towards implementation has occurred. To date, terms of reference have been defined, a strategy outlined, a consultant identified and detailed scoping documents prepared.

The criteria for selection of an appropriate consultant included extensive knowledge of the aerospace industry, proven record in national and international science and technology forums and a high profile in space science. Dr K McCracken, former CSIRO Chief, former director of COSSA and member of the Australian Space Board has agreed to undertake the consultancy, to address the following terms of reference:

- To define the scope of the proposed ESSC and its overall organisation

- To identify the level of USA/NASA commitment to the concept of ESSC's and their expectations of international ESSC's, particularly Wester Australia.

- To outline the social and commercial benefits that will accrue to Western Australia and Australia through the establishment of a Perth ESSC.

- To develop a strategic plan to establish a State, National and International level of commitment and support for a Perth-based ESSC.

- To define a three year implementation Budget including respective contributions (financial or otherwise) to establishing and operating an ESSC in Perth.

Initial scoping documents addressing the terms of reference are being prepared by WASTAC members and Dr McCracken as the basis for discussions proposed for September 20th - 22nd in Perth. These meetings are to be arranged as both briefing sessions for senior industry and Government personnel, and as information gathering workshops to prepare detailed documentation for national and international lobbying.

Perth groups to be contacted include TIDA, Curtin University, Geoscan, respondents to the WARSIDEC proposal, members of the Geographic Systems Technology Institute, CSIRO and the Bureau of Meteorology.

Subject to your concurrence, the Consultant can be appointed and the meetings suggested convened. Preparation of a detailed document addressing the terms of reference is anticipated to be completed by September 29th. A progress report will be supplied at that time.

I have attached copies of WASTAC correspondence with Dr McCracken and a summary of his strategy. Please contact me should you have further queries.

Yours sincerely,

H J HOUGHTON
Chairman, WASTAC

7th September, 1989.

encl.

K.G.McCRACKEN
Jellore, Spring Hill Rd,
via Mittagong, NSW, 2575

FACSIMILE MESSAGE

FROM FAX (048) 785121

TO FAX (09) 3218576 DATE 13/9/89.

FOR H. Houghton.

Number of pages including this sheet..... (1) .....

Phone (048) 785121
Alternate Ph (02) 9557010, 15/1 Elamang Ave, Kirribilli, NSW 2061

MESSAGE
The Chairman,
WASTAC, Perth.

Dear Henry,

EARTH SYSTEM SCIENCE CENTRE CONSULTANCY

Thank you for your letter of 13/9/89, outlining the task to which I will contribute, and the financial arrangements.

I understand that I will contribute , with others, to all the tasks defined in the terms of reference, under the direction of yourself, acting as project manager for the task.

I am pleased to accept the proposed consultancy.

I look forward to the discussions on 20-22 Sept.

Yours sincerely

Ken McCracken.

K.G.McCracken