WASTAC

2015 Annual Report

Western Australian Satellite Technology and Applications Consortium

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Front Cover: *The image depicts fire hotspots automatically detected from the Himawari-8 satellite, as marked in yellow. Background image is a true colour Himawari-8 image (321 RGB), captured at 13:40 WST on 17 November 2015. Satellite image originally processed by the Bureau of Meteorology from the geostationary satellite Himawari-8 operated by the Japan Meteorological Agency.*

Editor: W Thompson - Landgate

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Chairman's Report

At a strategic level, the WASTAC Board agreed to release the Request for Quotation for the Siting Study referred to last year at its 15 November 2015 meeting. Work is expected to commence sometime in the first quarter of 2016 and inform a broader discussion on the future of WASTAC in the second half of 2016.

At an operational level, both the L-band receiver at Curtin University and X-band receiver at Murdoch University operated at near capacity. Of note, we began receiving FY-3C data on 13 April only to have the satellite stop fail on 31 May 2015. No additional satellites were added to the reception list. Total number of passes received in 2015 was 14,669 compared to 14,010 passes in 2014. Software updates funded in 2014 have resulted in WASTAC being able to process FY-3B data and some of our partners are producing products from that data source.

As the Operational Applications reports show, data sourced from WASTAC is contributing worldwide numerical weather forecasting, and tracking and monitoring cyclones in Australia, as well as tracking a changing climate (Willmott et al., Bureau of Meteorology). Although it is noted that new satellites are starting to displace low earth orbit satellites in the monitoring of cyclones.

Landgate continues to exploit polar earth orbiting and geostationary satellite datasets to supply near real-time fire information datasets to land managers across Australia.

Curtin University researchers are using MODIS data to detect whether storms can resuspend sediments from spoil grounds produced from dredging in the Pilbara (Fearns et al., Curtin University)

WASTAC remains in a strong financial position with sufficient reserves to make modifications to existing systems as needed.

The WASTAC partners have contributed generously to the efficient running of WASTAC. Ron Craig, Mike Steber, Jackie Marsden, Joe Cudmore and Justin Pitsikas (Landgate), along with Russell Steicke and Denis Margetic (BOM), have kept the stations and processing systems running with a high degree of reliability. CSIRO maintains the high speed data link needed for near real-time processing at the Leeuwin Centre, as well as production of the NOAA Stitched Archive utilizing WASTAC data at the NCI in Canberra. Our Secretary, Richard Stovold (Landgate), has kept the decision making on track. Curtin University continues to manage our accounts. Murdoch University maintains an excellent site for the X-band antenna. Geoscience Australia provides valuable national coordination and access to MODIS data from Alice Springs for WASTAC members. Lastly, I would like to welcome Dr Brendon McAtee and Mr Dan Sandison, who have agreed to pick up the Annual Report editing role from Alan Pearce who was unable to edit the report this year.

As Chairman, I take pride in the major contributions WASTAC is making to advance our understanding of land, ocean and atmospheric processes within Australia.

Dr. Matthew Adams
Chairman, WASTAC 2015

WASTAC Board for 2015

Dr Matthew Adams - Chairman	Landgate
Mr Richard Stovold - Secretary	Landgate
Adjunct Prof. Merv Lynch	Curtin University (School of Science – Physics)
Prof. David Antoine	Curtin University (School of Science – Physics)
Dr Robert Corner	Curtin University (WA School of Mines – Spatial Sciences)
Dr Tom Cudahy	CSIRO
Dr Edward King	CSIRO
Ms Agnes Lane	Bureau of Meteorology
Mr Mike Bergin	Bureau of Meteorology
Dr Adam Lewis	Geoscience Australia
Dr Jatin Kala	Murdoch University
Dr Halina Kobryn	Murdoch University

WASTAC Standing Committee and proxy to the Board

Dr Matthew Adams - Chairman	Landgate
Mr Richard Stovold - Secretary	Landgate
Adjunct Prof. Merv Lynch	Curtin University (School of Science – Physics)
Dr Peter Fearns	Curtin University (School of Science – Physics)
Dr Robert Corner	Curtin University (WA School of Mines – Spatial Sciences)
Mr Russell Steicke	Bureau of Meteorology
Mr Denis Margetic	Bureau of Meteorology
Dr Jatin Kala	Murdoch University
Dr Halina Kobryn	Murdoch University
Dr Margaret Andrew	Murdoch University
Dr Nick Hardman-Mountford	CSIRO
Dr Medhavy Thankappan	Geoscience Australia

WASTAC Technical Committee:

Adjunct Prof. Merv Lynch (Chairman)
Mr Russell Steicke
Mr Ronald Craig
Dr Jatin Kala

WASTAC Strategic Plan

Vision:

Improve the economy, society and environment through the acquisition of satellite observations of Western Australia and its oceans for research and near real-time applications.

Mission:

- Provide high speed access to Aqua, Terra, National Oceanic and Atmospheric Administration (NOAA), Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) and FengYun-1D FY-1D) satellite data to members on a non-profit basis.
- Contribute these data for national and international initiatives in remote sensing.
- Adopt recognised data formats to ensure wide access to WASTAC data.
- Maintain the integrity of archived data for research and operational applications.
- Promote the development and calibration of value-added products.
- Prepare for utilisation of information from new technically and scientifically advanced sensors.
- Promote educational and research uses of WASTAC data.
- Promote use of Aqua, Terra, NOAA, SeaWiFS and FY1D data in climate studies, environmental and renewable resource management.
- Encourage WASTAC to promote awareness of products.

Current strategies:

- Upgrade existing reception and processing capabilities and upgrade Meteorological Operational (METOP) geolocation processing to utilise CSIRO's CAPS software. FY3.
- Continue to improve the products derived from Moderate Resolution Imaging Spectroradiometer (MODIS), AVHRR, and VIIRS sensors.
- Advance the processing of AIRS data from Aqua and Terra.
- Improve the management and access of the WASTAC archive through collaboration with the Pawsey Centre.
- Provide network access to other Earth Observation Satellite receiving stations in Australia.

Operations

WASTAC maintains an L-band reception facility at Curtin University and a dual X- and L-band facility at Murdoch University. The L-band facility has been operational since 1983, although satellite tracking at Curtin (then the WA Institute of Technology) began in the late 1970s. The X-band facility has been operating since 2001. WASTAC members make use of the satellite data for weather prediction, vegetation and fire monitoring, and research. WASTAC maintains an ongoing near real-time archive of L-band images beginning in 1983, and X-band images from 2001.

Curtin University – L-band

The L-band facility at Curtin University in Bentley consists of a 2.4m antenna and an antenna controller supplied by Environmental Systems and Services (ES&S) and dual ingestor computers running an AVHRR ingest and display system developed by the Bureau of Meteorology (Bureau). This data is ingested into the central processing computers at the Bureau's Head Office.

The L-band facility receives 500 to 600 passes per month from 3 satellites: NOAA-15, NOAA-18 and NOAA-19. Refer to the WASTAC DATA archive for the full list of received passes.

The Curtin University satellite reception facility is maintained by Bureau staff.

Murdoch University – X- and L-band

The X- and L-band reception facility was supplied by SeaSpace Corporation in 2001. It consists of a 3.6m antenna in a fiberglass dome, and an antenna controller computer. This facility receives data from the Aqua, Terra, MetOp, Suomi-NPP, FY3-B and FY3-C, as well as the L-band satellites such as NOAA-15, NOAA-18 and NOAA-19. Having two reception facilities for L-band allows some satellite conflicts to be resolved easily.

The Murdoch University satellite reception facility is maintained by Landgate and Murdoch University staff.

Applications

Sea Surface Temperature (SST) products are produced by Landgate. Landgate also produces vegetation indices, fire scar mapping and agricultural applications in real-time.

WASTAC Data Archive

The WASTAC archive of satellite passes continues to be managed and maintained by Landgate's Satellite Remote Sensing Services (SRSS) group at the Leeuwin Centre at Floreat in Perth. The SRSS Group actively manages the daily archive and management systems that have been installed to ensure rapid and reliable delivery of WASTAC satellite data for research and wider community use.

The archive forms the basis for the development, processing and delivery of a range of products listed in the Operational and Research Applications sections of this report.

A total of 14,669 passes were archived at Curtin and Murdoch in 2015.

The near real-time quick-look archive of VIIRS, MODIS and NOAA-AVHRR data continues to be maintained on the web. This digital archive extends back to 1983 (for NOAA-AVHRR). A similar archive of SeaWiFS quick-look data is also held on the web. The archive of MODIS, NOAA, VIIRS and SeaWiFS data can be viewed at:

www.rss.landgate.wa.gov.au/noaaql

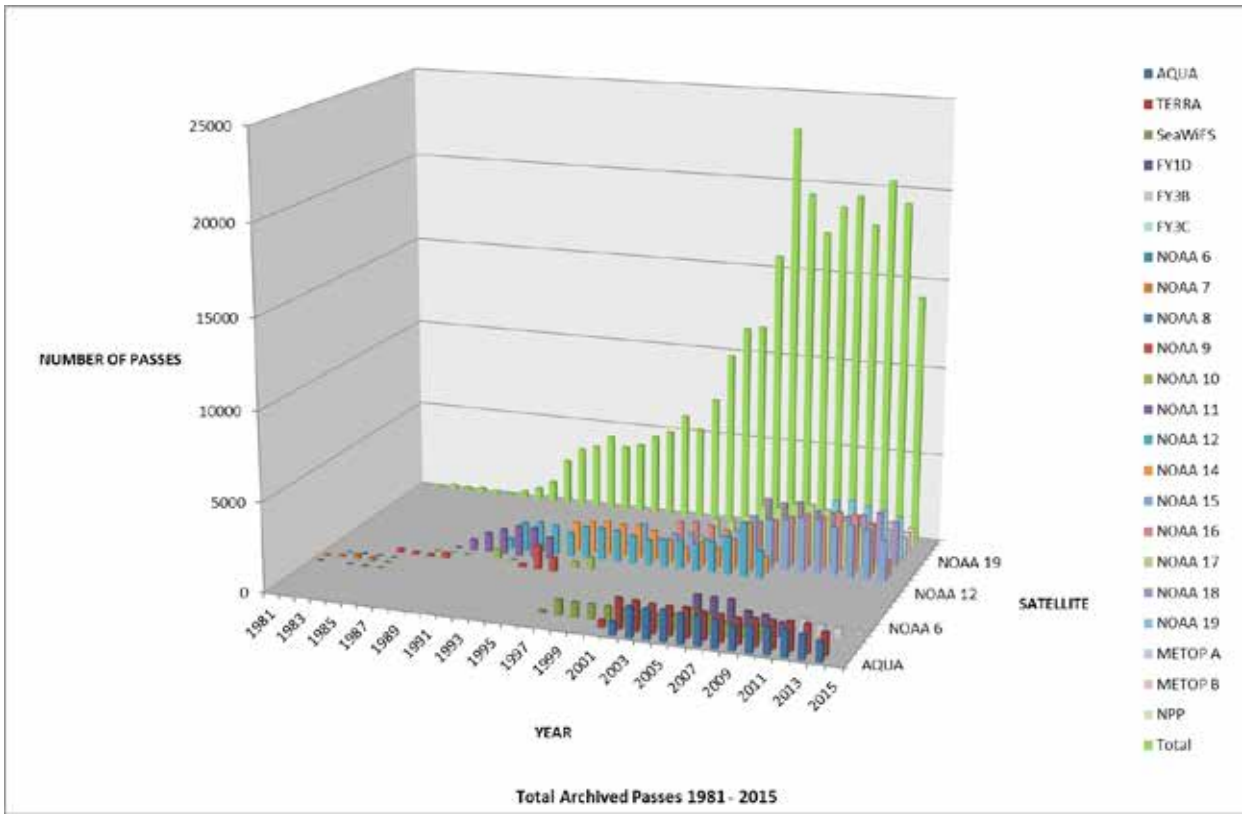
www.rss.landgate.wa.gov.au/modisql

www.rss.landgate.wa.gov.au/seawifsql

www.rss.landgate.wa.gov.au/viirsql

Landgate currently holds the archive on 8mm Exabyte and 4mm DAT tapes. 20Gb DLT tapes were introduced as the archive medium in late 2000 for the L-band data and since the commissioning of the facility in 2001, X-band data has been archived on DLT 35Gb tapes and more recently LTO5 tapes.

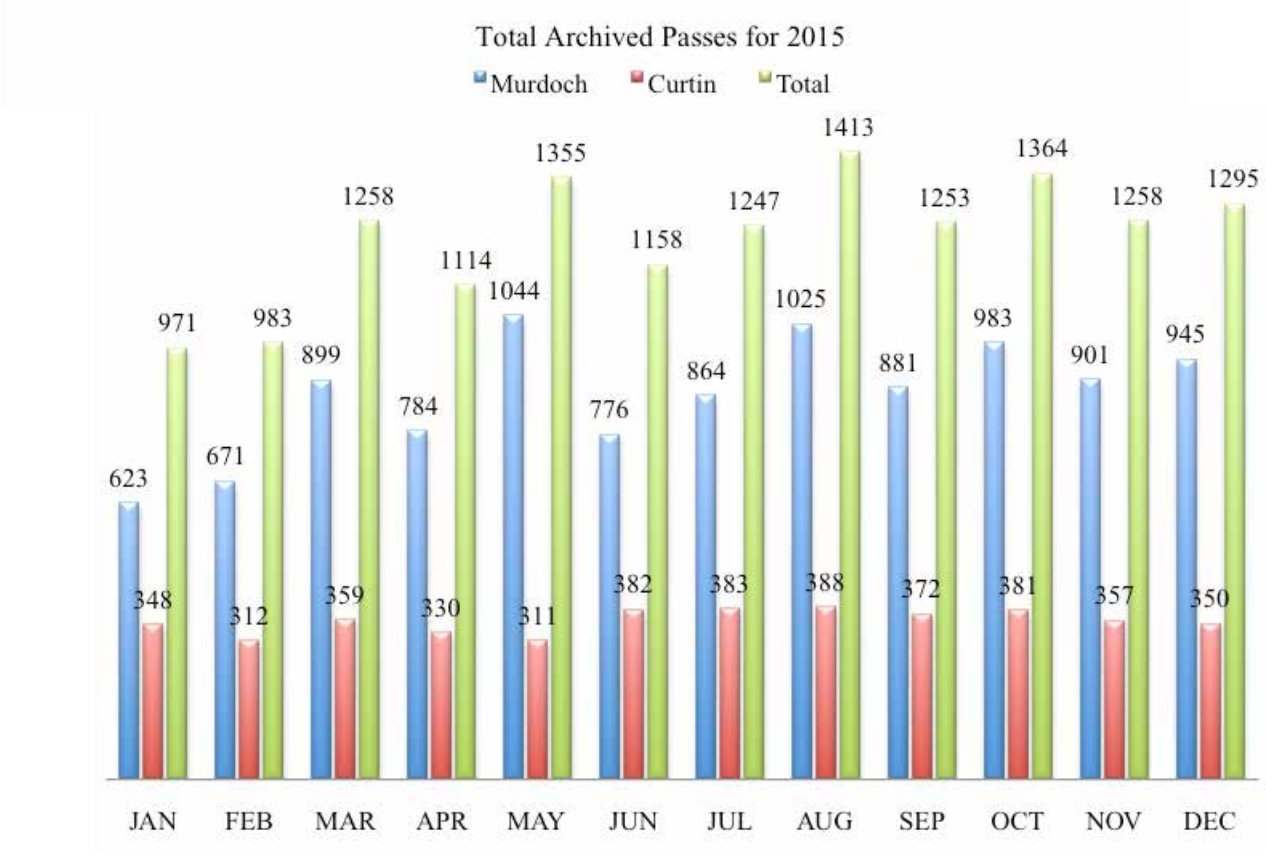
Duplicate copies of the raw data archive are produced for a national archive program hosted at the National Computing Infrastructure (NCI) in Canberra that is coordinated by CSIRO.

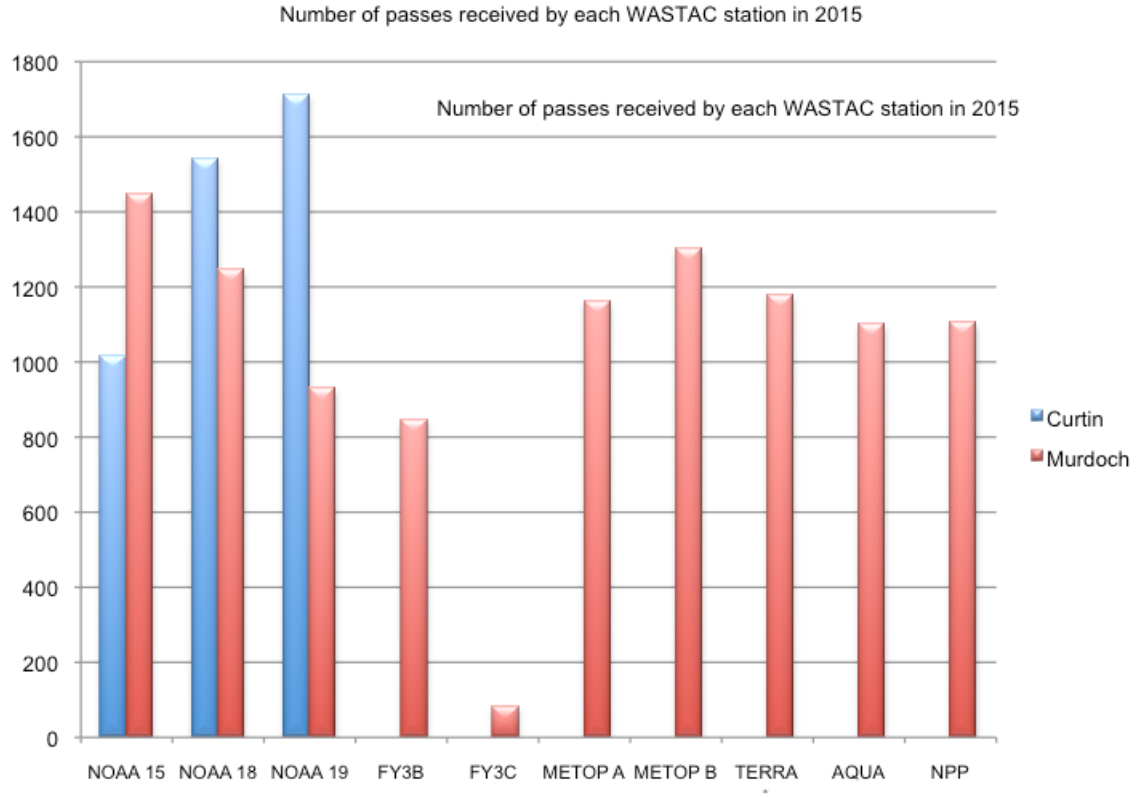


Total Archived Passes 1981 - 2015

	AQUA	TERRA	FY3B	FY3C	METOP A	METOP B	NPP	SeaWiFS	FY1D	NOAA 6	NOAA 7	NOAA 8	NOAA 9	NOAA 10	NOAA 11	NOAA 12	NOAA 14	NOAA 15	NOAA 16	NOAA 17	NOAA 18	NOAA 19	Total
1981										5	22												27
1982											115	1											116
1983										12	244	12											268
1984										7	179	4											190
1985										7	33	4	212										256
1986													151										151
1987													97	18									115
1988													280	25	53								358
1989														21	601								622
1990															1103								1103
1991														506	1399	575							2480
1992														47	1693	1571							3311
1993													183		1656	1720							3559
1994													1362		1227	1641							4230
1995													770			1326	1615						3711
1996														354		1780	1776						3910
1997								142						694		1797	1876						4509
1998								859								1763	1828	432					4882
1999								822								1589	1839	1663					5912
2000								843								1427	1681	905	341				5197
2001		390						811								1548	1271	1292	1733				7045
2002	734	1710						780								1579	976	1455	1789	709			9732
2003	1651	1645						696								1521	1351	1200	1728	1827			11388
2004	1665	1602						680								1727	1058	1481	1524	1797			11534
2005	1705	1577						863	553							2101	1706	1904	1743	2212	1339		15703
2006	1635	1639						1239	1683							3030	2761	2823	2240	2883	2989		22922
2007	1615	1512						1092	1678							1571	952	2777	2442	2869	2839		19347
2008	1553	1495						787	1673									2844	2711	3165	2985		17213
2009	1327	1411						687	1132									3055	2951	3254	2622	2306	18745
2010	1454	1516						793	1040									3061	2895	3054	2567	3058	19438
2011	1485	1537							751									2692	3282	2527	2453	3128	17855
2012	1465	1571	775		1118	316	924		255									2923	3223	2278	2677	2880	20405
2013	1349	1569	557		1383	1503	1243											2781	2845	316	2883	2752	19181
2014	1085	1232	536		1021	1044	987											2282	866		2484	2473	14010
2015	1101	1179	845	82	1161	1300	1106											2463			2790	2642	14669

		NOAA 15	NOAA 18	NOAA 19	FY3B	FY3C	METOP A	METOP B	TERRA	AQUA	NPP	TOTAL
JAN	C	100	101	147								348
	M	83	67	39	53	0	81	88	82	68	62	623
												971
FEB	C	82	99	131								312
	M	106	73	49	46	0	88	95	70	76	68	671
												983
MAR	C	83	133	143								359
	M	130	114	84	37	0	106	114	104	117	93	899
												1258
APR	C	72	126	132								330
	M	116	107	71	69	16	52	87	101	81	84	784
												1114
MAY	C	75	112	124								311
	M	135	125	89	88	66	102	97	122	108	112	1044
												1355
JUN	C	88	146	148								382
	M	123	95	82	57	0	97	103	73	69	77	776
												1158
JUL	C	89	148	146								383
	M	125	115	84	58	0	99	113	81	102	87	864
												1247
AUG	C	86	150	152								388
	M	134	125	110	92	0	108	125	112	109	110	1025
												1413
SEP	C	83	147	142								372
	M	112	90	69	90	0	107	108	108	87	110	881
												1253
OCT	C	80	148	153								381
	M	127	111	91	93	0	110	126	119	102	104	983
												1364
NOV	C	89	123	145								357
	M	121	106	93	78	0	107	121	101	84	90	901
												1258
DEC	C	90	110	150								350
	M	134	119	68	84	0	104	123	106	98	109	945
												1295
		2463	2790	2642	845	82	1161	1300	1179	1101	1106	14669
	Curtin	1017	1543	1713								4273
	Murdoch	1446	1247	929	845	82	1161	1300	1179	1101	1106	10396


Total Archived Passes for 2015
Murdoch
Curtin
Total
623
348
971
671
312
983
899
359
1258
784
330
1114
1044
311
1355
776
382
1158
864
383
1247
1025
388
1413
881
372
1253
983
381
1364
901
357
1258
945
350
1295
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


Number of passes received by each WASTAC station in 2015
Number of passes received by each WASTAC station in 2015
1800
1600
1400
1200
1000
800
600
400
200
0
NOAA 15
NOAA 18
NOAA 19
FY3B
FY3C
METOP A
METOP B
TERRA
AQUA
NPP
Curtin
Murdoch

Operational Applications 2015

Landgate, Satellite Remote Sensing Services, Floreat

New satellite data sources for the detection of fire hotspots

Satellite Remote Sensing Services (SRSS), Landgate has for many years been providing land managers, through the Firewatch web service, with real-time fire information. This real-time fire information supports government and private organisations that are involved with fire management and has been used for a variety of reasons, including to assess the effectiveness of controlled burning and to monitor currently burning fires.

The satellite technology that underpins this service is not a static environment with new satellites and sensors being launched regularly and other satellites reaching the end of their working life. As a result, SRSS is always looking for new sources of data and opportunities to utilise these new satellites and incorporate this information into the Firewatch product suite (srss.landgate.wa.gov.au/fire.php). This, in turn, improves the real-time land information that we can offer to land managers.

Two currently orbiting satellites – Suomi NPP and Himawari-8 satellite – offer this opportunity.

Suomi NPP is a satellite that is operated by NOAA and was launched in 2011. The VIIRS sensor on this satellite has both visible and thermal bands at 375 metre (m) resolution, which can be used for fire detection. VIIRS has a 3,000 kilometre (km) swath and twice daily coverage of Australia. The resolution of the channels on the VIIRS sensor are a significant advance on the one (1) km fire sensitive channels on both the NOAA satellite series and the MODIS sensor on the Terra and Aqua satellites. The data is received at the WASTAC satellite receiving stations and then processed by SRSS to detect, map and make these Fire HotSpots (FHS) available on the Firewatch web service at the 375 m resolution. This 375 m spatial resolution allows land managers improved locational accuracy for the real-time fire locations.

Himawari-8 is a geostationary satellite owned and operated by the Japan Meteorological Agency. The satellite provides Australia wide, satellite data every 10 minutes at a resolution of two (2) km in the thermal and one (1) km in the visible channels. The thermal channels have the possibility of being able to detect real-time fires (FHS) at a 10 minute interval. This is a major advance in the temporal resolution of fire information.

The Bureau of Meteorology receives and processes the raw data which is then downloaded by SRSS and undergoes more processing using a fire detection algorithm developed at SRSS (Figures 1 and 2). The algorithm is based on a global algorithm developed at the University of Wisconsin, but modified for local conditions to detect currently burning fires (FHS) at 10 minute intervals. The data is available on the Firewatch website approximately one (1) hour after the satellite has collected the data.

These two satellites have improved both the temporal and spatial resolution of the FHS available on the Firewatch website and have resulted in better and more reliable fire information for land managers.

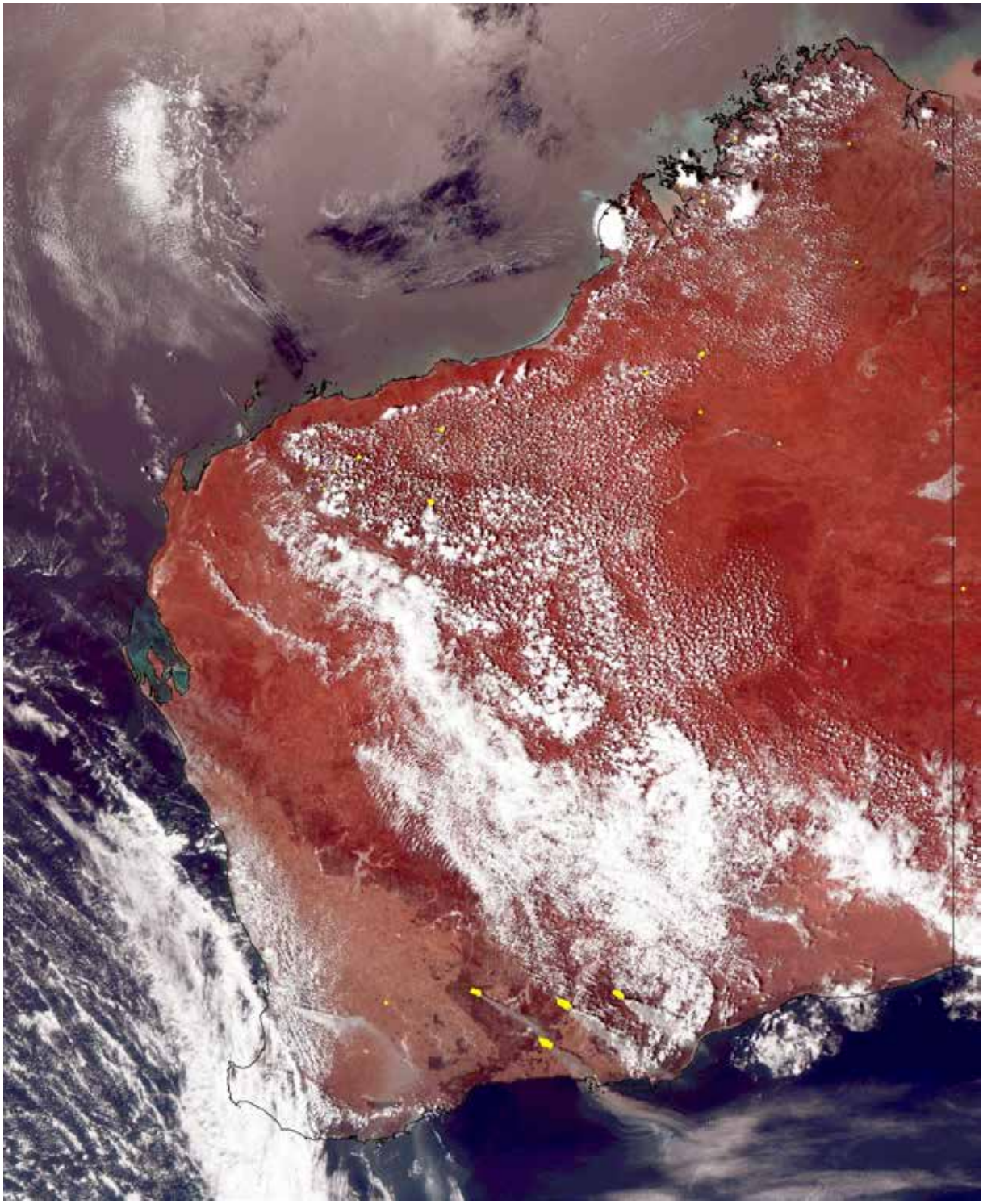


Figure 1: *Fire hotspots automatically detected from the Himawari-8 satellite are marked in yellow. Background image is a true colour Himawari-8 image (321 RGB), captured at 13:40 WST on 17 November 2015. Satellite image originally processed by the Bureau of Meteorology from the geostationary satellite Himawari-8 operated by the Japan Meteorological Agency.*

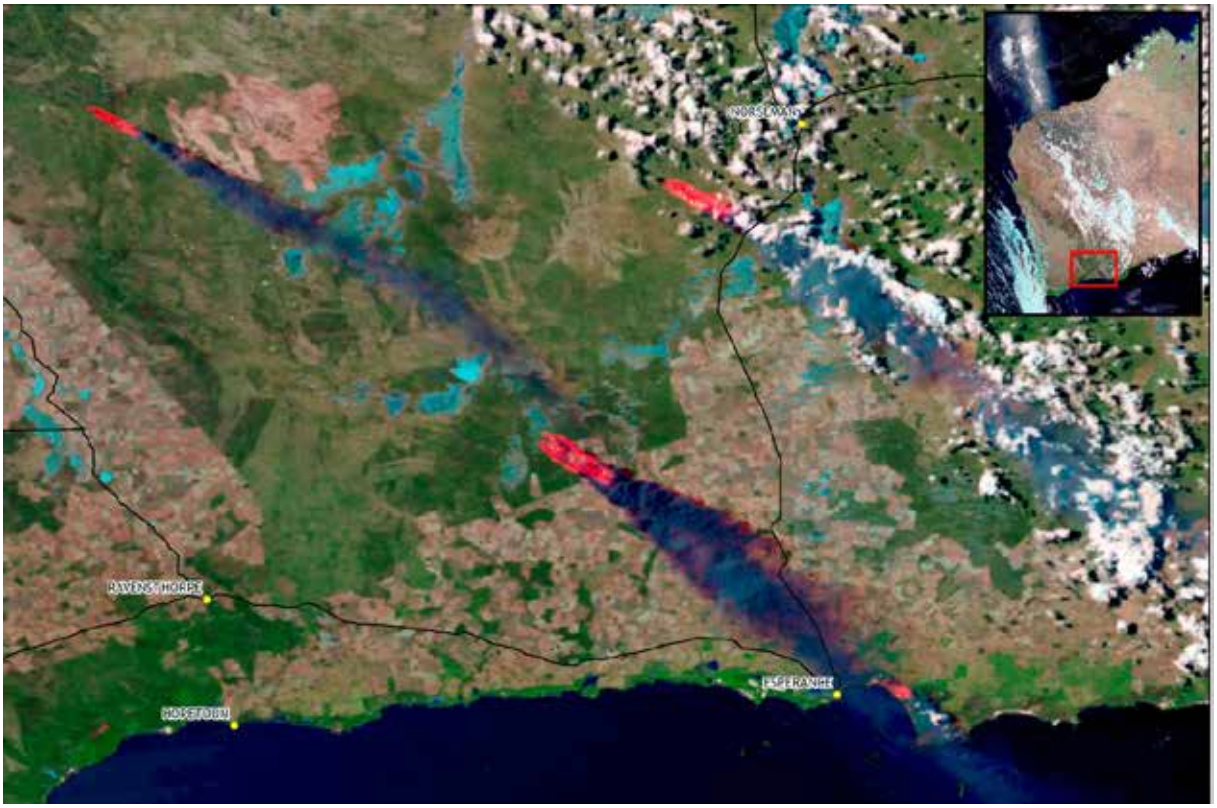


Figure 2: *Satellite image with active fires marked in bright red in the Esperance region of Western Australia, captured by the VIIRS instrument on board the Suomi NPP satellite at 13:35 WST on 17 November 2015*.

Bureau of Meteorology, Melbourne

Tropical Cyclone Monitoring

Mike Willmott and the Western Australian Regional Forecasting Centre

Overview

The Bureau of Meteorology (Bureau) is responsible for tropical cyclone warnings to the Australian public. To assist in the effective mitigation against the loss of life and damage to property, the Bureau operates Tropical Cyclone Warning Centres (TCWC) in Brisbane, Darwin and Perth. The Perth TCWC operates out of the Perth Regional Forecasting Centre. Each TCWC has an area of responsibility for tropical cyclone warnings and these areas can be found in Figure 3.

For many years the WASTAC L-band and X-band systems have been providing high resolution data to assist Bureau forecasters in the determination of intensity, movement and positioning of tropical cyclones. However, this data is now competing with the advanced capabilities of the new Himawari-8 satellite launched by the Japan Meteorological Agency in 2015, as well as the Feng Yun 2 series of satellites operated by the China Meteorological Administration. The new generation geostationary satellites deliver 10 minute data and less than one (1) km spatial resolution. As a result, there is a transition away from using low earth orbit satellites for tropical cyclone monitoring.

The Bureau continues to rely on data captured by WASTAC from the low earth orbit satellites for input to the Bureau's numerical weather prediction models.

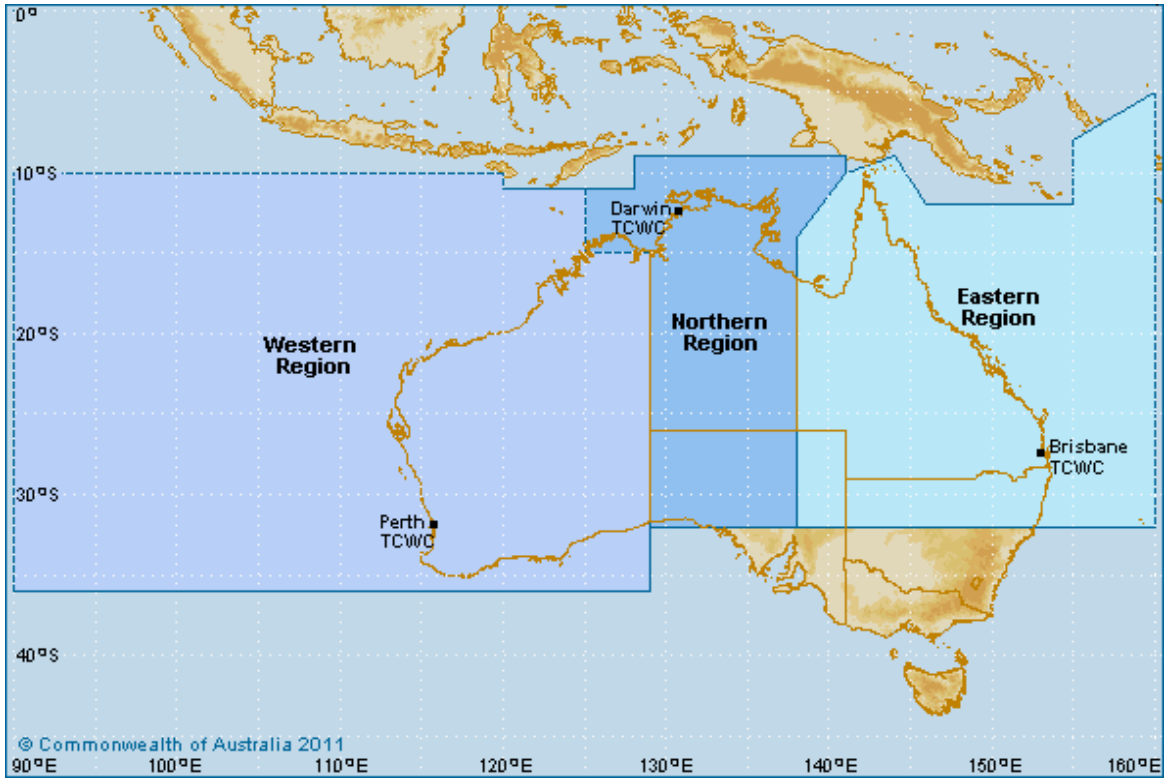


Figure 3: *The three Tropical Cyclone Warning Centres and their areas of responsibility. To the west of the Western Region, the area of responsibility falls to La Reunion.*

Tropical cyclones for the period 1 January 2015 to 31 December 2015

For the period 1 January 2015 to 31 December 2015, there were three (3) tropical cyclones (Table 1) that entered or formed within the Perth TCWC's area of responsibility (Figure 4). Of these, the most severe tropical cyclones that threatened the Australian coastline were Severe Tropical Cyclone Olwyn and Severe Tropical Cyclone Quang. Only Severe Tropical Cyclone Olwyn was captured by the WASTAC reception systems.

Tropical Cyclone	Period (2015)	Max Intensity	Impact on Coast or Other Aus. Territory	Means of Detection
Olwyn*	8 to 14 March	3	Severe	Satellite
Ikola*	4 to 8 April	4	Nil	Satellite
Quang*	15 to 22 April	4	Moderate	Satellite

Table 1: *List of tropical cyclones within the Western Region for the period: 1 January 2015 to 31 December 2015. * Classified as Severe Tropical Cyclone.*

Figure 4: *Tropical cyclone tracks within the Western Region of responsibility for the period 1 January 2015 to 31 December 2015.*

Severe Tropical Cyclone Olwyn (8 - 14 March 2015)

Summary

Severe Tropical Cyclone Olwyn (Olwyn) was the most significant cyclone to affect the Gascoyne coast in decades, tracking remarkably close to the coast – from Exmouth to Shark Bay – as a category three (3) cyclone.

Olwyn began as a tropical low in an active monsoon trough approximately 900 kms north of Exmouth during 8 March 2015. The tropical low initially moved slowly towards the east before moving towards the south on 10 March. It then maintained a southerly track while slowly strengthening. The system reached cyclone intensity at 0600 Universal Time Coordinated (UTC) on 11 March. Olwyn then moved towards the south southwest and passed just to the west of Exmouth around 1800 UTC on 12 March (Figure 5). The system reached a peak intensity of 75 knots at 1800 UTC on 12 March while it was located near the North West (NW) Cape. Learmonth Airport reported a 10 minute mean wind of 75 knots (139 km/h) and a maximum 3 second wind gust of 97 knots (180 km/h) during this period.

Olwyn continued a southerly path straddling the upper west coast (Figure 4). The centre passed just to the west of Coral Bay and then passed around 25 km to the west of Carnarvon around 0600 UTC on 13 March. Carnarvon Airport reported a 10 minute mean wind of 55 knots (102 km/h) and a maximum three (3) second wind gust of 79 knots (146 km/h) during this period. The system was then steered in a south southeast direction and crossed the coast over the Shark Bay area around 1200 UTC on 13 March. It weakened below cyclone strength by 0000 UTC on 14 March, inland of Geraldton.

Heavy rainfall was recorded over the western Pilbara and western Gascoyne districts. The heavy rainfall was mostly concentrated near the coast and caused localised flooding and road closures in the western Pilbara and western Gascoyne districts. Widespread catchment rainfall of approximately 60 – 90 mm resulted in minor to moderate flooding within the Greenough and Irwin River catchments.

Olwyn impacted the NW Cape around 1200 UTC on 12 March but the centre of the system did not cross the coast until it was located just north of Cape Cuvier at 0000 UTC on 13 March. The centre then moved south southwest out over water again until a south easterly movement steered it across Shark Bay just east of Denham. Olwyn crossed the base of Shark Bay at 1300 UTC on 13 March. The southeastern eye wall passed over the town of Exmouth located at the northeastern tip of the NW Cape where some damage to property was recorded.

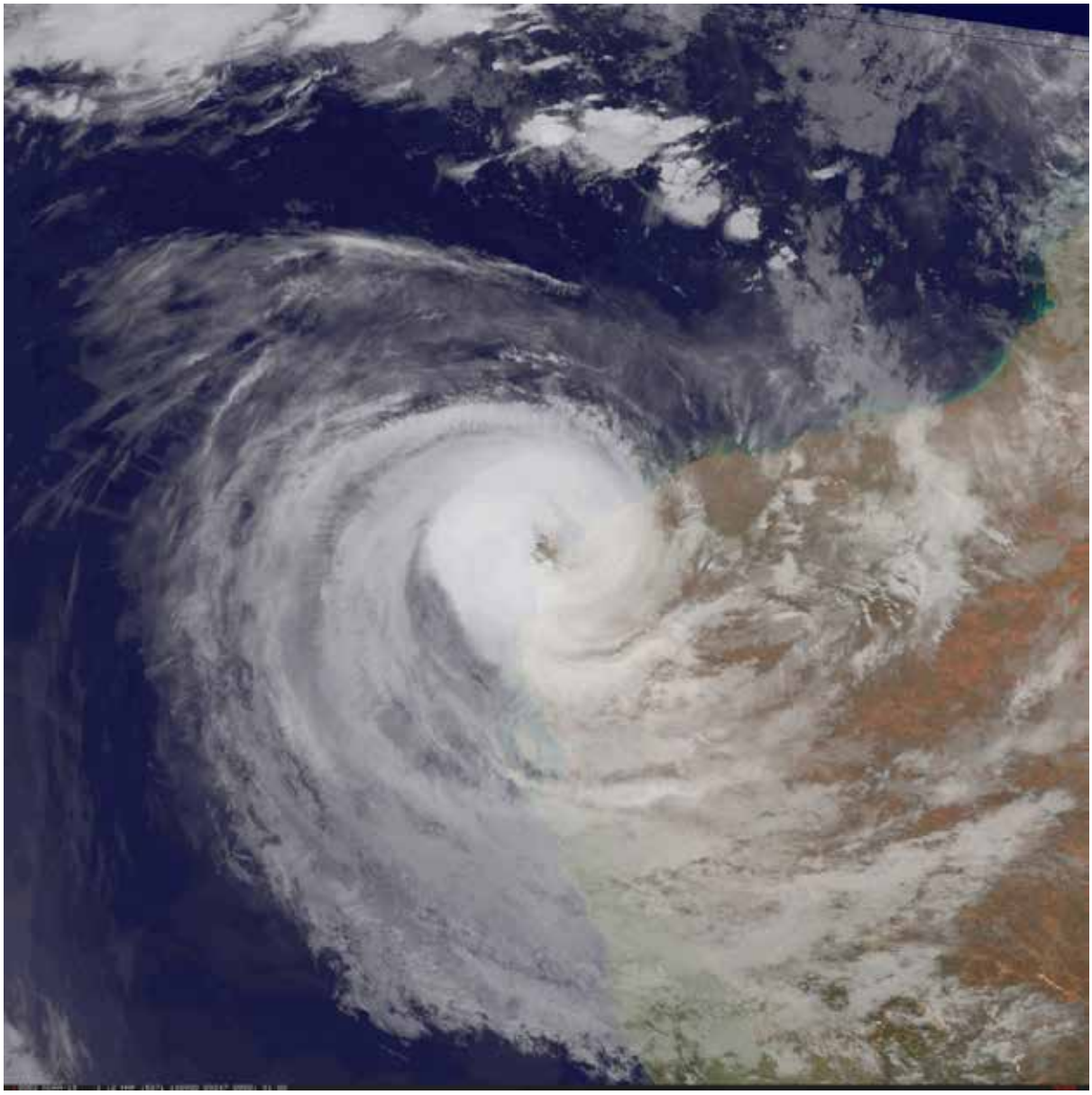


Figure 5: *Severe Tropical Cyclone Olwyn at maximum intensity lying just of the North West coast of Western Australia. Image received by the Perth receiver at 1809 UTC from NOAA-19 on 12 March 2015.*

Research and Development

Curtin University, Perth

Peter Fearns, Passang Dorji, Mark Broomhall

Monitoring turbid water using MODIS data

The Remote Sensing and Satellite Research Group (RSSRG) is collaborating with the CSIRO to develop methods to use MODIS data to monitor turbid water in the north of Western Australia. The particular regions of interest are the Pilbara, a focus of the Western Australian Marine Science Institution (WAMSI) Dredge Node, and the Kimberley, linked to the Kimberley Marine Research Program.

Curtin University collected field data, including radiometry and water samples, to derive a semi-analytical algorithm for deriving total suspended solids (TSS) concentration from MODIS reflectance data (Dorji et al. 2016). The TSS algorithm was applied to the Pilbara region to monitor the location and concentration of sediment plumes associated with dredge operations at the port of Onslow.

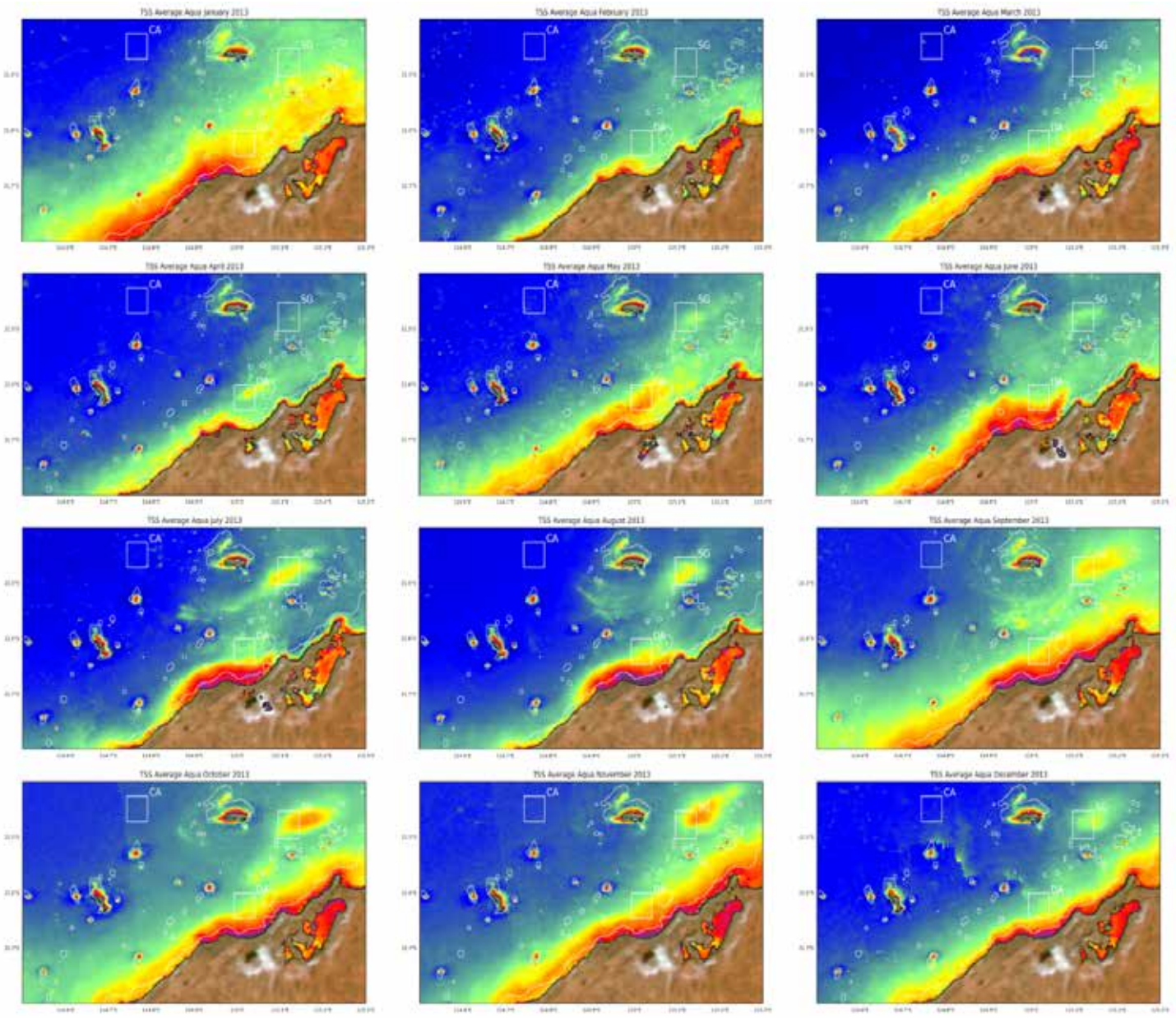


Figure 6. *Monthly average TSS images for 2013 derived from MODIS aqua data. The spatial resolution is 250m.*

An analysis of the images in Figure 6 shows the average TSS at the location of the intense dredge activity (DA), the spoil ground (SG) and a clear water area (CA) (all areas marked by a square). Some high turbidity events were associated with dredge extreme wind events, showing that storms can cause sediment to resuspend from the ocean floor. The time series of TSS and wind data for 2013 are shown in Figure 7.

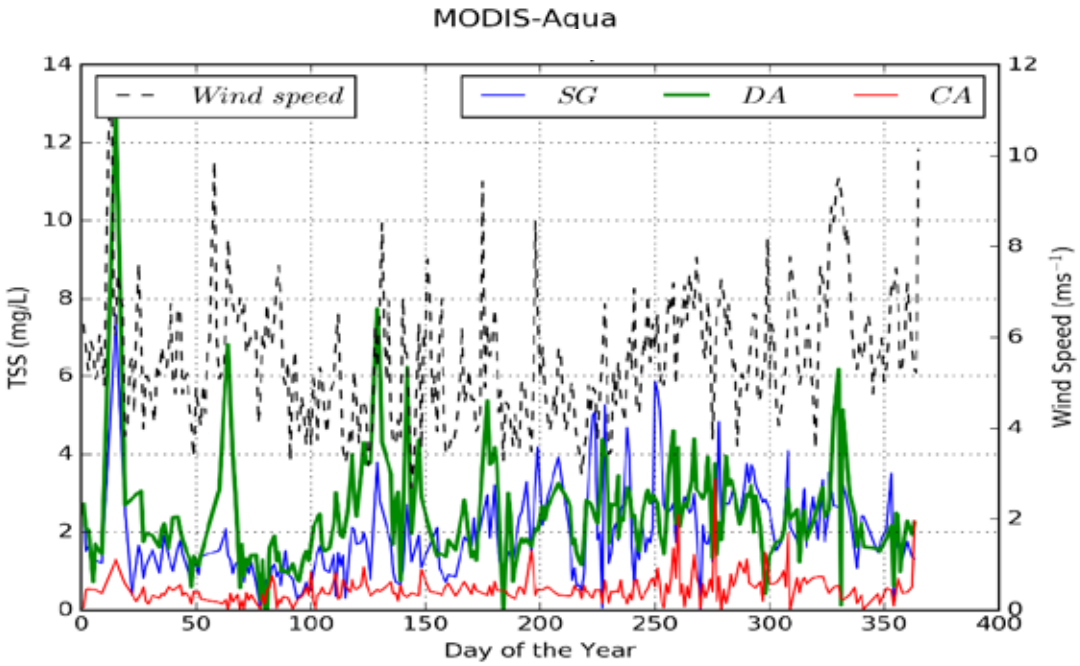


Figure 7: *Daily TSS data for the Spoil Ground (SG), Dredge Area (DA) and a Clear Area (CA). High TSS events tend to coincide with periods of increased wind speed.*

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INDEPENDENT AUDITORS' REPORT

To The Members of the Board

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM - L BAND

We have audited the accompanying special purpose financial report of the Western Australian Satellite Technology and Application Consortium – L Band which comprises the balance sheet as at 31 December 2015, income statement and cash flow statement for the period ended 31 December 2015 and notes comprising a summary of significant accounting policies and other explanatory information.

Officer's Responsibility for the Financial Report

The Board of the Western Australian Satellite Technology and Application Consortium – L Band is responsible for the preparation of the financial report information and has determined that the basis of preparation of this information described in Note 1, is appropriate to meet the reporting requirements of the Western Australian Satellite Technology and Application Consortium – L Band as per the existing joint venture agreement. The Board's responsibility also includes the establishment of internal control as the Board determines is necessary to enable the preparation of a financial report that is free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We have conducted our audit in accordance with Australian Auditing Standards. Those standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to Western Australian Satellite Technology and Application Consortium – L Band's preparation of the financial report, in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.

An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Auditor Independence

In conducting our audit, we have complied with the independence requirements of the Australian professional accounting bodies.

Electronic publication of the audited financial report

It is our understanding that the Western Australian Satellite Technology and Application Consortium intends to electronically present the audited financial report and auditor's report on its internet website. Responsibility for the electronic presentation of the financial report on the Western Australian Satellite Technology and Application Consortium website is that of those charged with governance of the Western Australian Satellite Technology and Application Consortium. The security and controls over information on the website should be addressed by the Western Australian Satellite Technology and Application Consortium to maintain the integrity of the data presented. The examination of the controls over the electronic presentation of audited financial report on the Western Australian Satellite Technology and Application Consortium website is beyond the scope of the audit of the financial report.

Opinion

In our opinion, the financial report presents fairly, in all material respects, the financial position of Western Australian Satellite Technology and Application Consortium – L Band as at 31 December 2015 and its financial performance for the period then ended.

Basis of Accounting

Without modifying our opinion, we draw attention to Note 1 to the financial report, which describes the basis of accounting. The financial report has been prepared to assist the Board and the joint venture participants of the Western Australian Satellite Technology and Application Consortium – L Band to meet the reporting requirements. As a result, the financial report may not be suitable for other purposes.

Perth

WASTAC L-Band BUDGET 2015

Estimated expenditure for the year

January 2015 – December 2015

		2015	2014
		$	$
1.	Data Tapes	-	-
2.	System maintenance/repairs	5,000	5,000
3.	Telecommunications license of facility	5,000	5,000
4.	Consultants	5,000	5,000
5.	Sundry consumables	1,500	1,500
6.	Travelling – Airfares	3,000	3,000
7.	Provision for major equipment	12,000	12,000
8.	Annual Report	6,000	6,000
	TOTAL:	**$37,500**	**$37,500**

Estimated income/revenue for the year

January 2015 – December 2015

1.	Contributions received ($10,000 each)	40,000	40,000
2.	Interest	15,000	14,000
	TOTAL INCOME:	**$55,000**	**$54,000**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
L-BAND
INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2015

	2015	2014
	$	$
REVENUE		
Contributions Received	40,000	40,000
Interest received	14,035	19,632
TOTAL REVENUE	**54,035**	**59,632**
EXPENDITURE		
Outsourced work	15,000	4,250
Depreciation expenses	6,672	7,805
Equipment maintenance	-	-
Hospitality	-	227
Microwave licence	244	2,436
Other operating expenditure	2,520	3,737
TOTAL EXPENDITURE	**24,436**	**18,456**
NET OPERATING RESULT FOR THE YEAR	**29,599**	**41,176**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
L-BAND
BALANCE SHEET AS AT 31 DECEMBER 2015

	Note	2015	2014
		$	$
CURRENT ASSETS			
Cash at Bank		485,914	449,643
Account Receivable		10,000	-
Prepayments		-	-
Accrued Revenue		-	-
TOTAL CURRENT ASSETS		**495,914**	**449,643**
NON – CURRENT ASSETS			
Property, plant and equipment	2	458	7,130
TOTAL NON – CURRENT ASSETS		458	7,130
TOTAL ASSETS		**496,372**	**456,773**
CURRENT LIABILITIES			
Income received in advance		10,000	-
Accrued Expenses		-	-
TOTAL CURRENT LIABILITIES		10,000	-
TOTAL LIABILITIES		**10,000**	**-**
NET ASSETS		**486,372**	**456,773**
EQUITY			
Retained Funds	4	**486,372**	**456,773**
TOTAL EQUITY		**486,372**	**456,773**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
L-BAND
CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2015

	Note	2015	2014
CASH FLOWS FROM OPERATING ACTIVITIES		**$**	**$**
Receipts			
Contributions Received:			
Landgate		10,000	10,000
CSIRO		20,000	-
Bureau of Meteorology		10,000	10,000
Curtin University		-	10,000
Interest received		14,035	19,632
Other Receipts			
Total Receipts		**54,035**	**49,632**
Payments			
Payments to suppliers		(17,764)	(14,651)
Total Payments		(17,764)	(14,651)
Net cash provided by operating activities	3	**36,271**	**34,981**
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment		-	-
Net cash used in investing activities		-	-
Net increase/(decrease) in cash		**36,271**	**34,981**
Cash at the beginning of the year		449,643	414,661
Cash at the end of the year		**485,914**	**449,643**

Notes:

1 Summary of Significant Accounting Policies

The principal accounting policies adopted in the preparation of the financial report are set out below. These policies have been consistently applied unless otherwise stated.

Basis of Preparation

The Western Australian Satellite Technology and Application Consortium (WASTAC) L Band financial report is a special purpose financial report has been prepared in accordance with Australian Accounting Standards including Australian Accounting Interpretations, other authoritative pronouncements of the Australian Accounting Standards Board and Urgent Issues Group Consensus Views.

Compliance with AIFRS

Compliance with Australian Accounting standards ensures that the financial statements and notes comply with International Financial Reporting Standards.

Historical cost convention

These financial statements have been prepared on the accrual basis of accounting using the historical cost convention.

(a) Valuation of Property, Plant and Equipment

All property, plant and equipment is shown at cost, less subsequent depreciation and impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the items. Subsequent costs are included in the asset carrying amount or recognised as a separate asset, as appropriate, only when it is probable that future economic benefits associated with the item will flow to the entity and the cost of the item can be measured reliably.
.

Any gains and losses on disposals are determined by comparing the disposal proceeds with the carrying amount and are included in the Income Statement.

(b) Depreciation of non-current assets

All property, plant and equipment having a limited useful life are depreciated over their estimated useful lives, in a manner which reflects the consumption of their future economic benefits.

Depreciation is calculated on a straight-line basis from the time the asset becomes available for use. Estimated useful lives are as follows:

- Computing equipment 3 years
- Other equipment 8 years

Assets' residual values and useful lives are reviewed, and adjusted if appropriate, at each balance sheet date.

A class of asset's carrying amount is written down immediately to its recoverable amount if the class of asset's carrying amount is greater than its estimated recoverable amount (see note 1(c)).

(c) Impairment of property, plant and equipment

At each reporting date, WASTAC reviews the carrying amounts of each class of asset within property, plant and equipment to determine whether there is any indication that those asset classes have suffered an impairment loss. If any such indication exists, the recoverable amount of the class of asset is estimated in order to determine the extent of the impairment loss. Where the asset does not generate cash flows that are independent from other assets, WASTAC estimates the recoverable amount of the cash-generating unit to which the asset belongs.

Recoverable amount is the higher of fair value less costs to sell and value in use. In assessing value in use, the depreciated replacement cost is used where the future economic benefits of WASTAC's assets are not primarily dependent on the assets ability to generate net cash inflows.

If the recoverable amount of a class of asset is estimated to be less than its carrying amount, the carrying amount is reduced to recoverable amount. An impairment loss is recognised as an expense to the Income Statement immediately.

(d) Income Tax

The Board considers that its operations are exempt from income tax under the provisions of section 50-25 of the Income Tax Assessment Act (1997) as amended.

(e) Goods and Services Tax (GST)

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST is not recoverable from the Australian Taxation Office. In these circumstances the GST is recognised as part of the cost of acquisition of the asset or as part of an item of the expense.

(f) Income Recognition

The Board recognises income as it is received. All income is stated net of the amount of goods and services tax (GST). Interest is recognised on the effective interest rate method.

2 Property, Plant and Equipment

	2015	2014
Computer Equipment		
At cost	35,196	35,196
Accumulated depreciation	(35,196)	(35,196)
	-	-
Other Equipment		
At cost	202,441	202,441
Accumulated depreciation	(201,983)	(195,310)
	458	7,130
Total Property, Plant and Equipment	**458**	**7,130**

Reconciliations

Reconciliations of the carrying amounts of property, plant and equipment at the beginning and end of the current financial year are set out below:

	Computer Equipment	Other Equipment	Total
Carrying amount at start of year	-	7,130	7,130
Additions/(Disposals)	-	-	-
Depreciation expense	-	(6,672)	(6,672)
Carrying amount at end of year	**-**	**458**	**458**

3 Notes to the Cash Flow Statement

Reconciliation of operating result from ordinary activities to net cash inflow from operating activities

	2015	2014
Net operating result	29,599	41,176
Depreciation expense	6,672	7,805
Movement in Current Assets & Liability	-	(14,000)
Net cash provided/(used) by operating activities	**36,271**	**34,981**

4 Retained Earnings

Balance at beginning of the year	456,773	415,596
Operating surplus/(deficit) for the year	29,599	41,176
Balance at end of the year	**486,372**	**456,773**

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INDEPENDENT AUDITORS' REPORT

To The Members of the Board

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM - X BAND

We have audited the accompanying special purpose financial report of the Western Australian Satellite Technology and Application Consortium – X Band which comprises the balance sheet as at 31 December 2015, income statement and cash flow statement for the period ended 31 December 2015 and notes comprising a summary of significant accounting policies and other explanatory information.

Officer's Responsibility for the Financial Report

The Board of the Western Australian Satellite Technology and Application Consortium – X Band is responsible for the preparation of the financial report information and has determined that the basis of preparation of this information described in Note 1, is appropriate to meet the reporting requirements of the Western Australian Satellite Technology and Application Consortium – X Band as per the existing joint venture agreement. The Board's responsibility also includes the establishment of internal control as the Board determines is necessary to enable the preparation of a financial report that is free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We have conducted our audit in accordance with Australian Auditing Standards. Those standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to Western Australian Satellite Technology and Application Consortium – X Band's preparation of the financial report, in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.

An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Auditor Independence

In conducting our audit, we have complied with the independence requirements of the Australian professional accounting bodies.

Electronic publication of the audited financial report

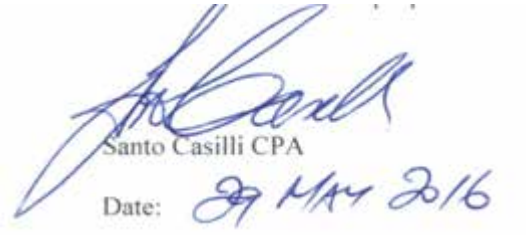
It is our understanding that the Western Australian Satellite Technology and Application Consortium intends to electronically present the audited financial report and auditor's report on its internet website. Responsibility for the electronic presentation of the financial report on the Western Australian Satellite Technology and Application Consortium website is that of those charged with governance of the Western Australian Satellite Technology and Application Consortium. The security and controls over information on the website should be addressed by the Western Australian Satellite Technology and Application Consortium to maintain the integrity of the data presented. The examination of the controls over the electronic presentation of audited financial report on the Western Australian Satellite Technology and Application Consortium website is beyond the scope of the audit of the financial report.

Opinion

In our opinion, the financial report presents fairly, in all material respects, the financial position of Western Australian Satellite Technology and Application Consortium – X Band as at 31 December 2015 and its financial performance for the period then ended.

Basis of Accounting

Without modifying our opinion, we draw attention to Note 1 to the financial report, which describes the basis of accounting. The financial report has been prepared to assist the Board and the joint venture participants of the Western Australian Satellite Technology and Application Consortium – X Band to meet the reporting requirements. As a result, the financial report may not be suitable for other purposes.



Perth

WASTAC X-Band BUDGET 2015

Estimated expenditure for the year

January 2015 – December 2015

		2015	2014
		$	$
1.	Data Tapes	-	2,000
2.	System maintenance	80,000	30,000
3.	System repairs	4,000	4,000
4.	Consultants, product development	120,000	120,000
5.	Sundry consumables	2,000	2,000
6.	Travelling – Airfares	4,000	4,000
7.	Provision for major equipment	25,000	25,000
	TOTAL:	**$235,000**	**$187,000**

Estimated income/revenue for the year

January 2015 – December 2015

1.	Annual Contributions ($20,000 each)	80,000	80,000
2.	Interest	25,000	22,000
	TOTAL INCOME:	**$105,000**	**$102,000**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
X-BAND
INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2015

	2015	2014
	$	$
REVENUE		
Contributions received	80,000	80,000
Interest received	19,181	29,676
TOTAL REVENUE	**99,181**	**109,676**
EXPENDITURE		
Freight expenses	672	-
Equipment <$5,000	-	-
Other Software & licence <$5,000	4,777	2,406
Maintenance	-	-
Outsourced work	-	8,295
Depreciation	31,915	23,709
TOTAL EXPENDITURE	**37,364**	**34,410**
NET OPERATING RESULT FOR THE YEAR	**61,817**	**75,266**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
X-BAND
BALANCE SHEET AS AT 31 DECEMBER 2015

	Note	2015	2014
		$	$
CURRENT ASSETS			
Cash at Bank		665,953	638,730
TOTAL CURRENT ASSETS		**665,953**	**638,730**
NON – CURRENT ASSETS			
Property, plant and equipment	2	174,782	120,188
TOTAL NON – CURRENT ASSETS		174,782	120,188
TOTAL ASSETS		**840,735**	**758,918**
CURRENT LIABILITIES			
Income received in advance		20,000	-
TOTAL CURRENT LIABILITIES		20,000	-
TOTAL LIABILITIES		**20,000**	**-**
NET ASSETS		**820,735**	**758,918**
EQUITY			
Retained Funds	4	820,735	758,918
TOTAL EQUITY		**820,735**	**758,918**

WESTERN AUSTRALIAN SATELLITE
TECHNOLOGY and APPLICATION CONSORTIUM
X-BAND
CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2015

	Note	2015	2014
CASH FLOWS FROM OPERATING ACTIVITIES		**$**	**$**
Receipts			
Contributions received			
Landgate		20,000	20,000
CSIRO		40,000	-
Bureau of Meteorology		20,000	20,000
Geoscience Australia		20,000	20,000
Interest received		19,181	29,676
Total Receipts		**119,181**	**89,676**
Payments			
Payments to Suppliers		(5,449)	(10,701)
Total Payments		(5,449)	(10,701)
Net cash provided/ (used) by operating activities	3	**113,732**	**78,975**
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment		(86,509)	(72,769)
Net cash used in investing activities		**(86,509)**	**(72,769)**
Net increase/(decrease) in cash		**27,223**	**6,206**
Cash at the beginning of the year		638,730	632,524
Cash at the end of the year		**665,953**	**638,730**

Notes:

1 Summary of Significant Accounting Policies

The principal accounting policies adopted in the preparation of the financial report are set out below. These policies have been consistently applied unless otherwise stated.

Basis of Preparation
The Western Australian Satellite Technology and Application Consortium (WASTAC) X Band financial report is a special purpose financial report has been prepared in accordance with Australian Accounting Standards including Australian Accounting Interpretations, other authoritative pronouncements of the Australian Accounting Standards Board and Urgent Issues Group Consensus Views.

Compliance with AIFRS
Compliance with Australian Accounting standards ensures that the financial statements and notes comply with International Financial Reporting Standards.

Historical cost convention
These financial statements have been prepared on the accrual basis of accounting using the historical cost convention.

(a) Valuation of Property, Plant and Equipment

All property, plant and equipment is shown at cost, less subsequent depreciation and impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the items. Subsequent costs are included in the asset carrying amount or recognised as a separate asset, as appropriate, only when it is probable that future economic benefits associated with the item will flow to the entity and the cost of the item can be measured reliably.
.
Any gains and losses on disposals are determined by comparing the disposal proceeds with the carrying amount and are included in the Income Statement.

(b) Depreciation of non-current assets

All property, plant and equipment having a limited useful life are depreciated over their estimated useful lives, in a manner which reflects the consumption of their future economic benefits.

Depreciation is calculated on a straight-line basis from the time the asset becomes available for use. Estimated useful lives are as follows:

- Computing equipment 3 years
- Computer software 10 years
- Other equipment 8 years

Assets' residual values and useful lives are reviewed, and adjusted if appropriate, at each balance sheet date.

A class of asset's carrying amount is written down immediately to its recoverable amount if the class of asset's carrying amount is greater than its estimated recoverable amount (see note 1(c)).

(c) Impairment of property, plant and equipment

At each reporting date, WASTAC reviews the carrying amounts of each class of asset within property, plant and equipment to determine whether there is any indication that those asset classes have suffered an impairment loss. If any such indication exists, the recoverable amount of the class of asset is estimated in order to determine the extent of the impairment loss. Where the asset does not generate cash flows that are independent from other assets, WASTAC estimates the recoverable amount of the cash-generating unit to which the asset belongs.

Recoverable amount is the higher of fair value less costs to sell and value in use. In assessing value in use, the depreciated replacement cost is used where the future economic benefits of WASTAC's assets are not primarily dependent on the assets ability to generate net cash inflows.

If the recoverable amount of a class of asset is estimated to be less than its carrying amount, the carrying amount is reduced to recoverable amount. An impairment loss is recognised as an expense to the Income Statement immediately.

(d) Income Tax

The Board considers that its operations are exempt from income tax under the provisions of section 50-25 of the Income Tax Assessment Act (1997) as amended.

(e) Goods and Services Tax (GST)

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST is not recoverable from the Australian Taxation Office. In these circumstances the GST is recognised as part of the cost of acquisition of the asset or as part of an item of the expense.

(f) Income Recognition

The Board recognises income as it is received. All income is stated net of the amount of goods and services tax (GST). Interest is recognised on the effective interest rate method.

2 Property, Plant and Equipment

	2015	2014
Computer Equipment		
At cost	119,937	26,224
Accumulated depreciation	(39,661)	(26,224)
	80,276	-
Other Equipment		
At cost	852,918	852,918
Accumulated depreciation	(758,412)	(732,730)
	94,506	120,188
Total Property, Plant and Equipment	**174,782**	**120,188**

Reconciliations

Reconciliations of the carrying amounts of property, plant and equipment at the beginning and end of the current financial year are set out below:

	Computer Equipment	Other Equipment	Total
Carrying amount at start of year	-	120,188	120,188
Additions/(Disposals)	86,509	-	86,509
Depreciation expense	(6,233)	(25,682)	(31,915)
Carrying amount at end of year	**80,276**	**94,506**	**174,782**

3 Notes to the Cash Flow Statement

Reconciliation of operating result from ordinary activities to net cash inflow from operating activities

	2015	2014
Net operating result	61,817	75,266
Depreciation expense	31,915	23,709
Movement in Current Assets & Liability	20,000	(20,000)
Net cash provided/(used) by operating activities	**113,732**	**78,975**

4 Retained Earnings

Balance at beginning of the year	758,918	683,652
Operating surplus/(deficit) for the year	61,817	75,266
Balance at end of the year	**820,735**	**758,918**