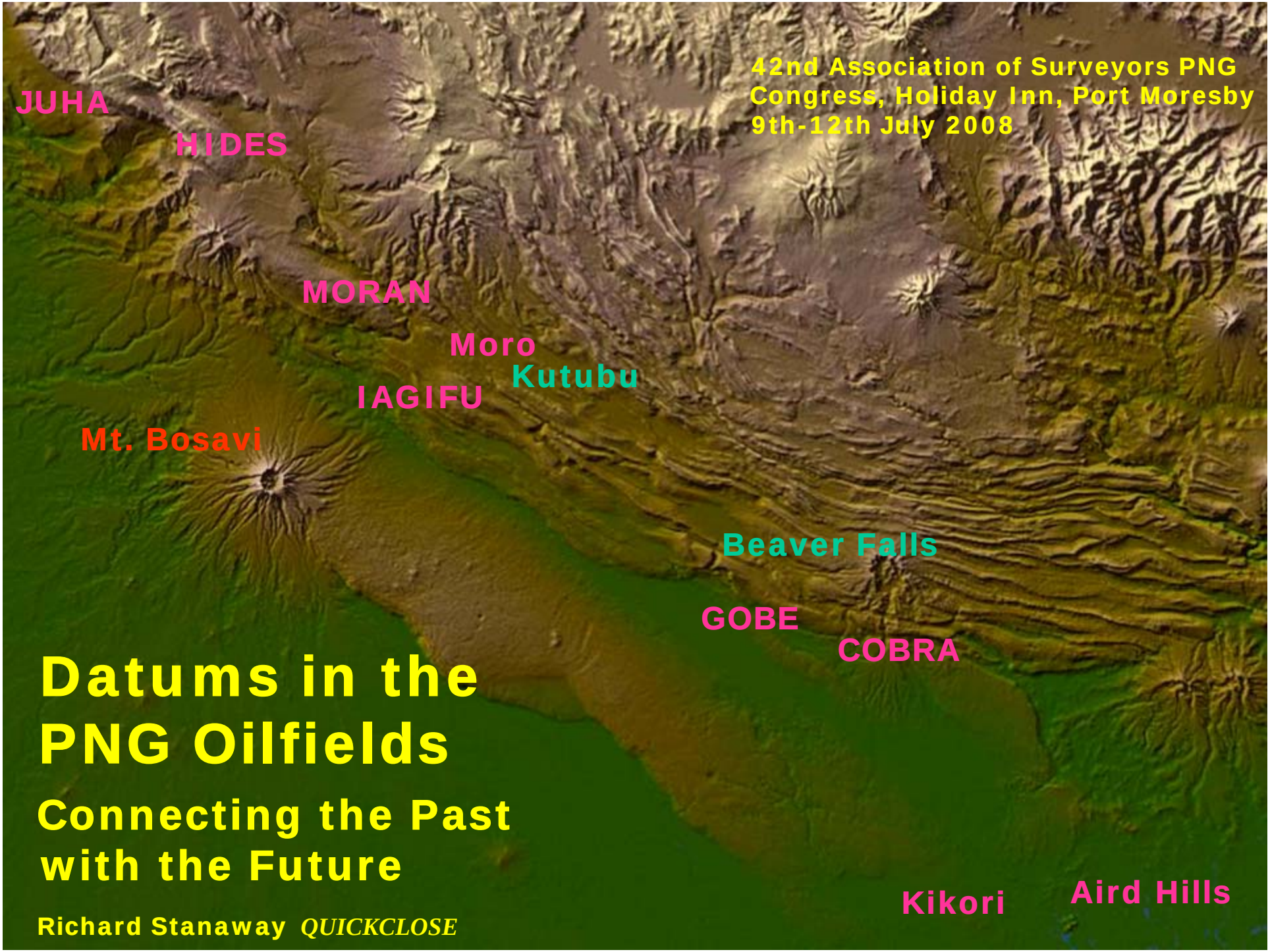

42nd Association of Surveyors PNG
Congress, Holiday Inn, Port Moresby
9th-12th July 2008
JUHA
HIDES
MORAN
Moro
Kutubu
IAGIFU
Mt. Bosavi
Beaver Falls
GOBE
COBRA
Kikori
Aird Hills
Datums in the
PNG Oilfields
Connecting the Past
with the Future
Richard Stanaway QUICKCLOSE

The setting

Establishing control has been a very challenging enterprise in the PNG Oilfields

Some of the most rugged topography on the planet

Some of the highest rainfall on the planet

Land ownership issues

Logistically and physically challenging environment for surveying

Taim bipo

Surveyors amongst the first outsiders to visit and map the PNG Oilfields

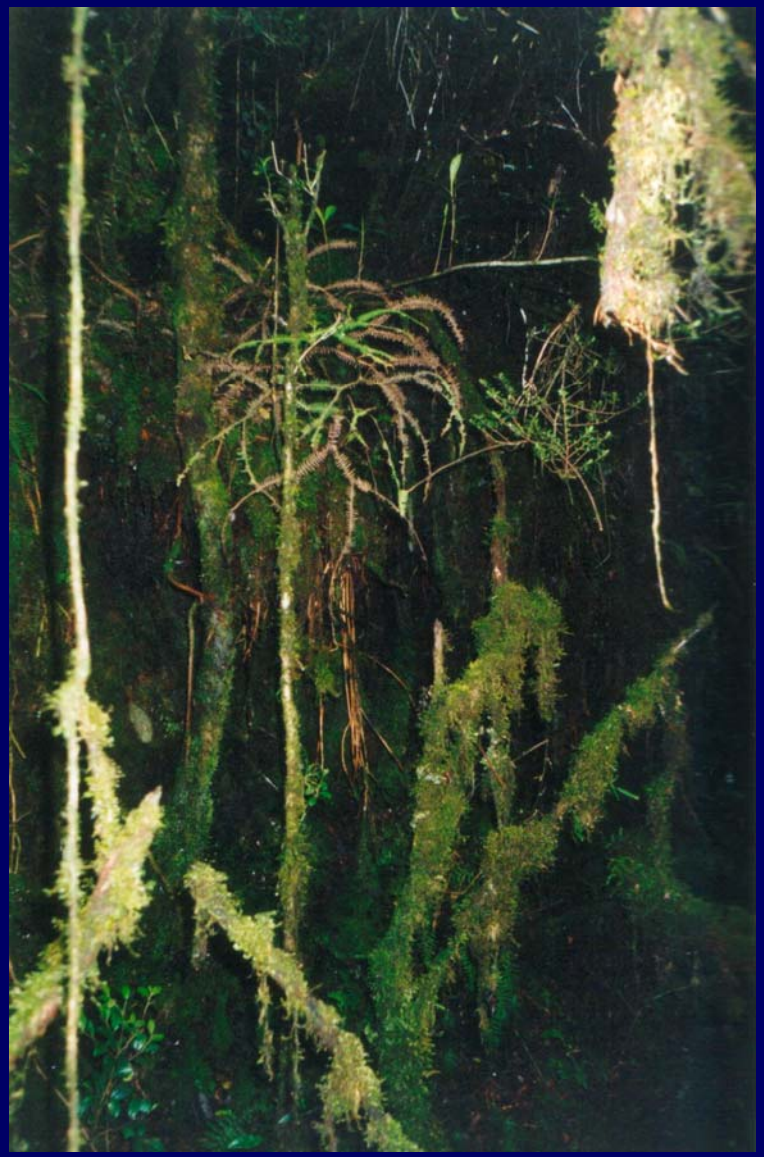
Rugged (karst) terrain, torrential rainfall

= incredibly dense & tough vegetation, debris, sinkholes, moss mattress = inclement conditions for surveyors and chainmen

need trig control on remote, cold, wet and almost inaccessible high peaks (no GPS)

Lots of waiting time for clear weather

Very, very expensive (helicopters, labour, equipment)



What PNG looks like at 3000m

And that was not all!

Laborious reduction and checking of obs in very basic fly camps

Added difficulty due to very high deflection of the vertical, atmospheric differences and scale factor variations

Very basic calculators (no PCs or laptops)

The establishment of AGD66 control in the PNG Oilfields is a testament to the determination, stamina and skill of the earlier surveyors to get accurate coordinates lists and levels for Oil & Gas

Survey underpins almost every aspect of a resource project

Aerial survey control (and now LiDAR)

Topographic surveys

Village mapping, clan boundaries

Geological mapping, gravimetric surveys, magnetic, seismic imaging control

Environmental and heritage surveys

Setout of asbuilt surveys of exploration wells and associated infrastructure

Pipelines, power reticulation, production facilities

Other problems surveyors face

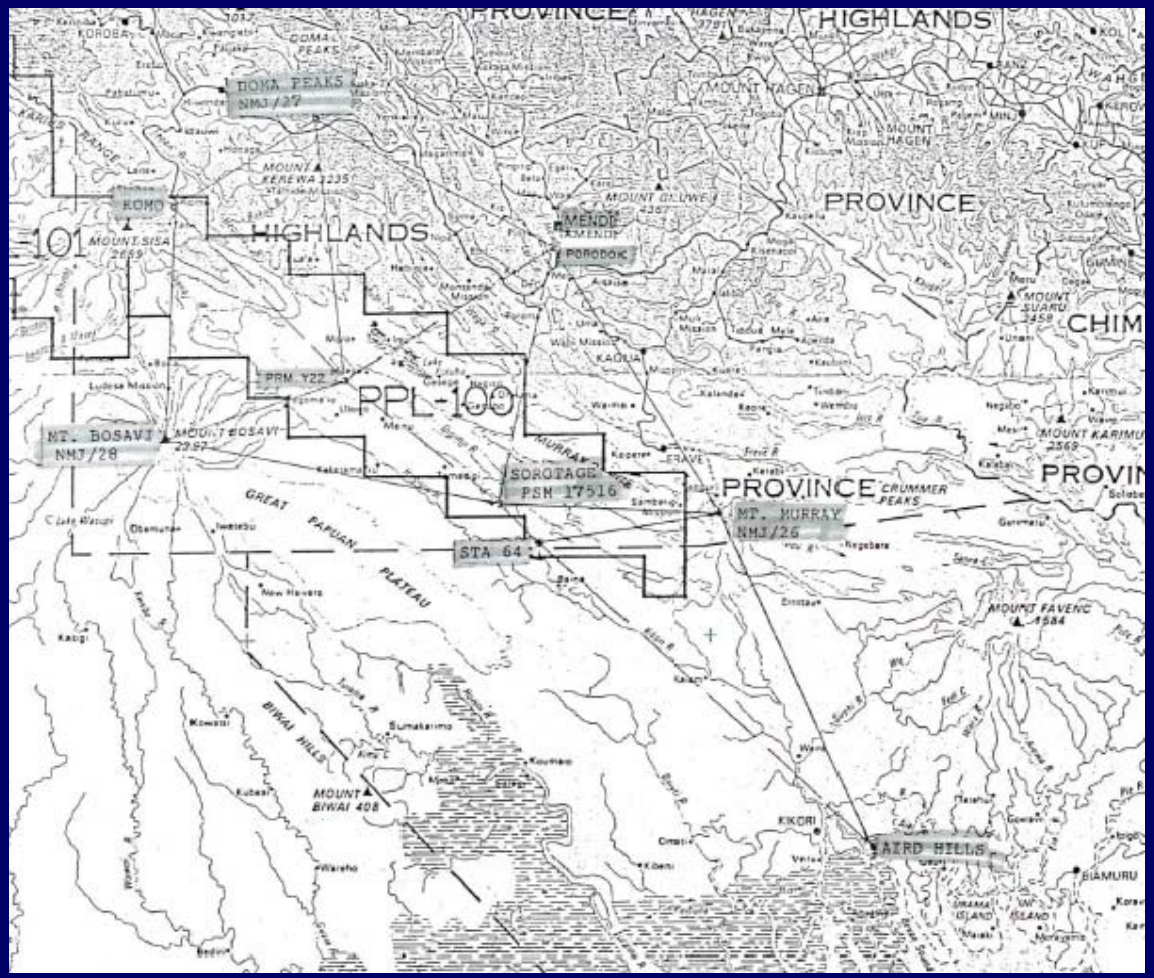
Lack of understanding of importance of surveying, field requirements and logistics at management level

Seen but not heard, so costs are pushed down. At what cost though??

Loss of information, lack of communication and reporting of datum information at each change of phase of development

Outside surveyors not connecting new surveys to old control !!!

early 1960s



National
Mapping
(NM/J/..)

National
Mapping
trig stations

MRA101
Tellurometers

including
Hiran 23
established by
US

Not closed
to a tide gauge!

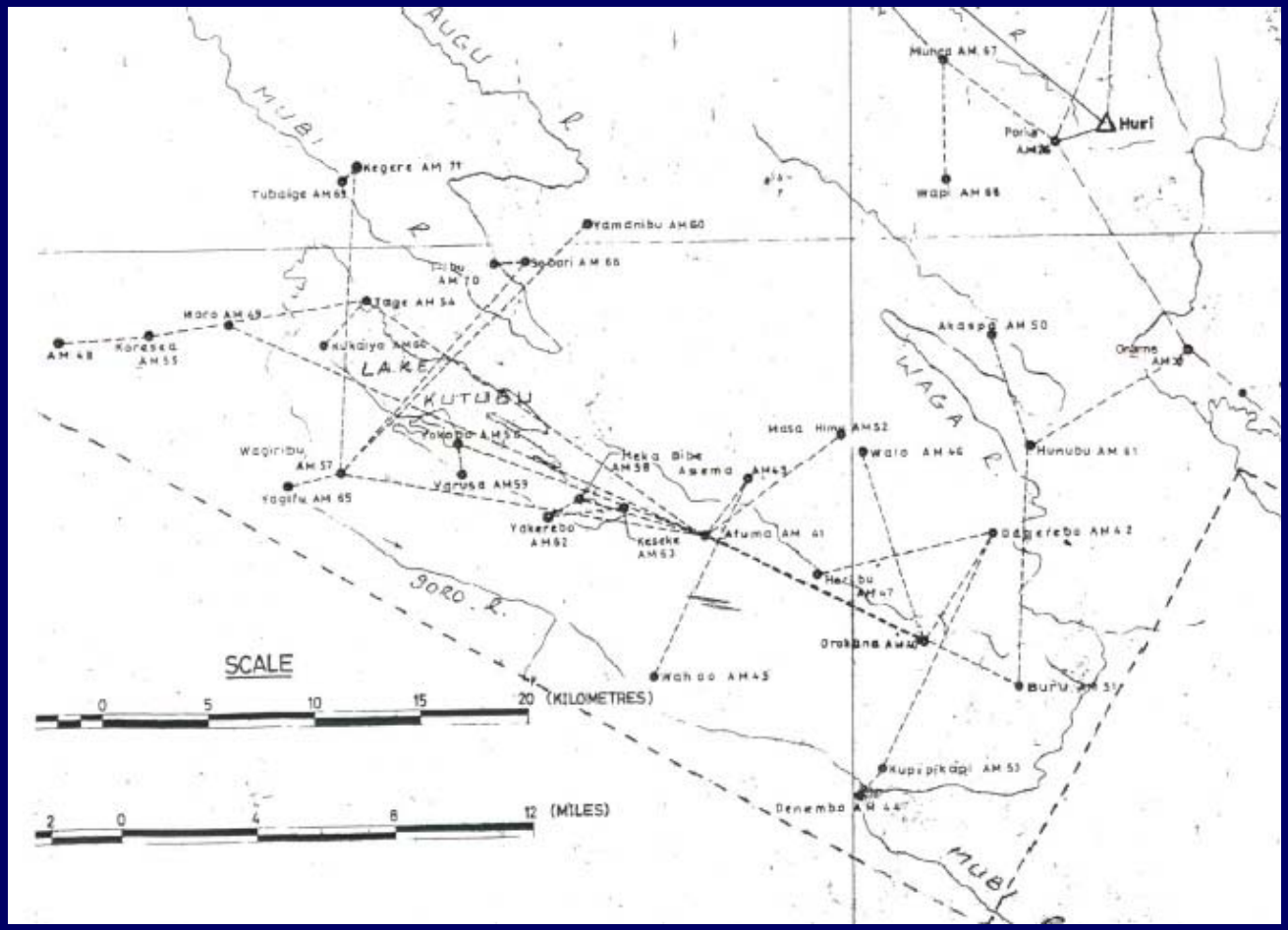
late 1960s

Alan Mail surveys for BP

Australian Army (RASvy)

AA series

AERODIST



AM series network

1970s - 1990s

AA Transit Doppler

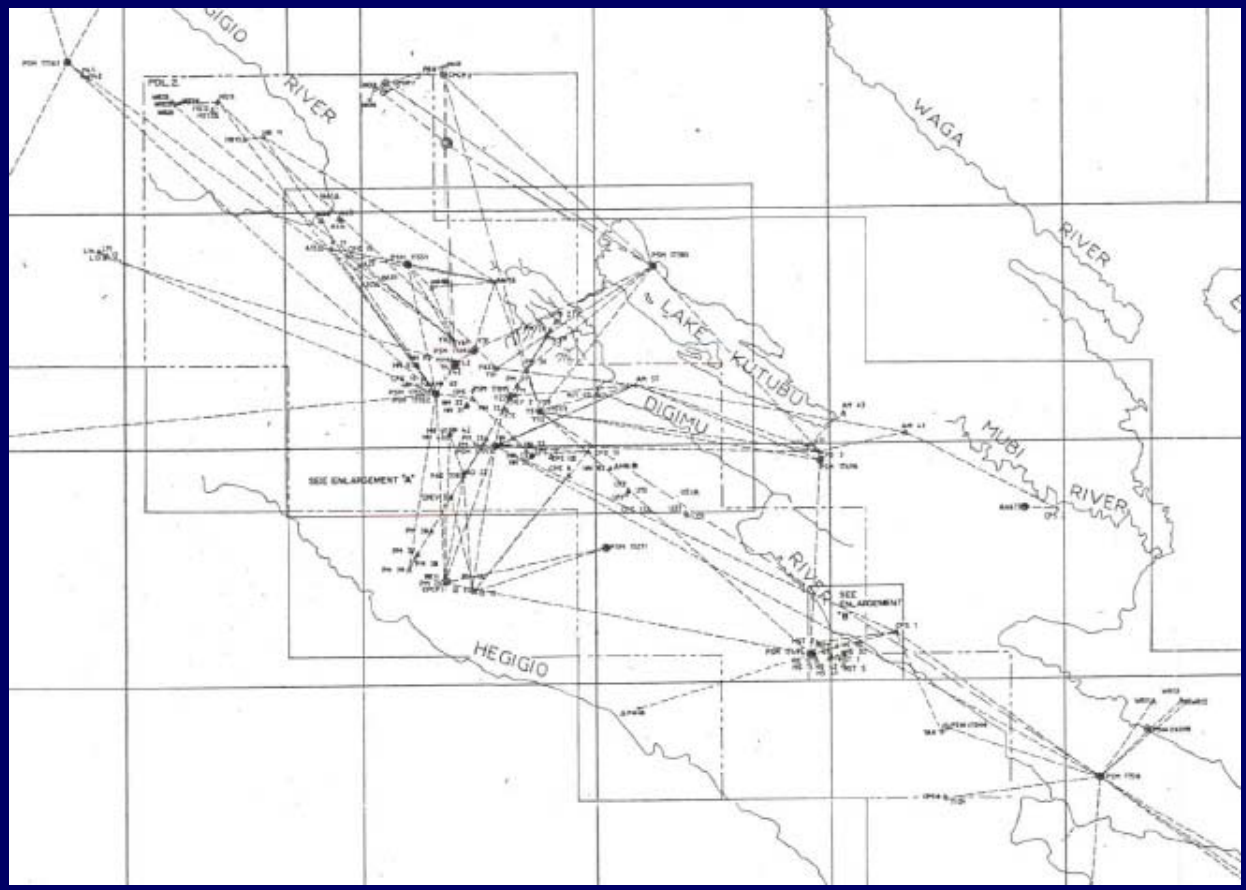
SSL Seismic Surveys

Carson Pratt Surveys (CP stations)

NORTECH (GPS)

Arman Larmer Surveys

Theodist (Patrick O'Connor)



14 m error detected in earlier heighting

2005 GAS FEED

Front-End Engineering & Design for LNG Export pipeline to Australia

Required 5 cm accurate control on same datum

PNG94 (PSM 5583 Kikori) chosen as horizontal datum and Kumul 34 chosen as vertical datum (with EGM96 geoid)

Geodetic surveys undertaken by Arman Larmer Surveys and Asia Pacific Surveys

Staff & equipment from DSLS UniTech

Quickclose for validation & finalisation

FUGRO Spatial - LiDAR survey (30 cm accurate DTM)

Some problems with the 2005 survey

Baselines not interconnected (cost)

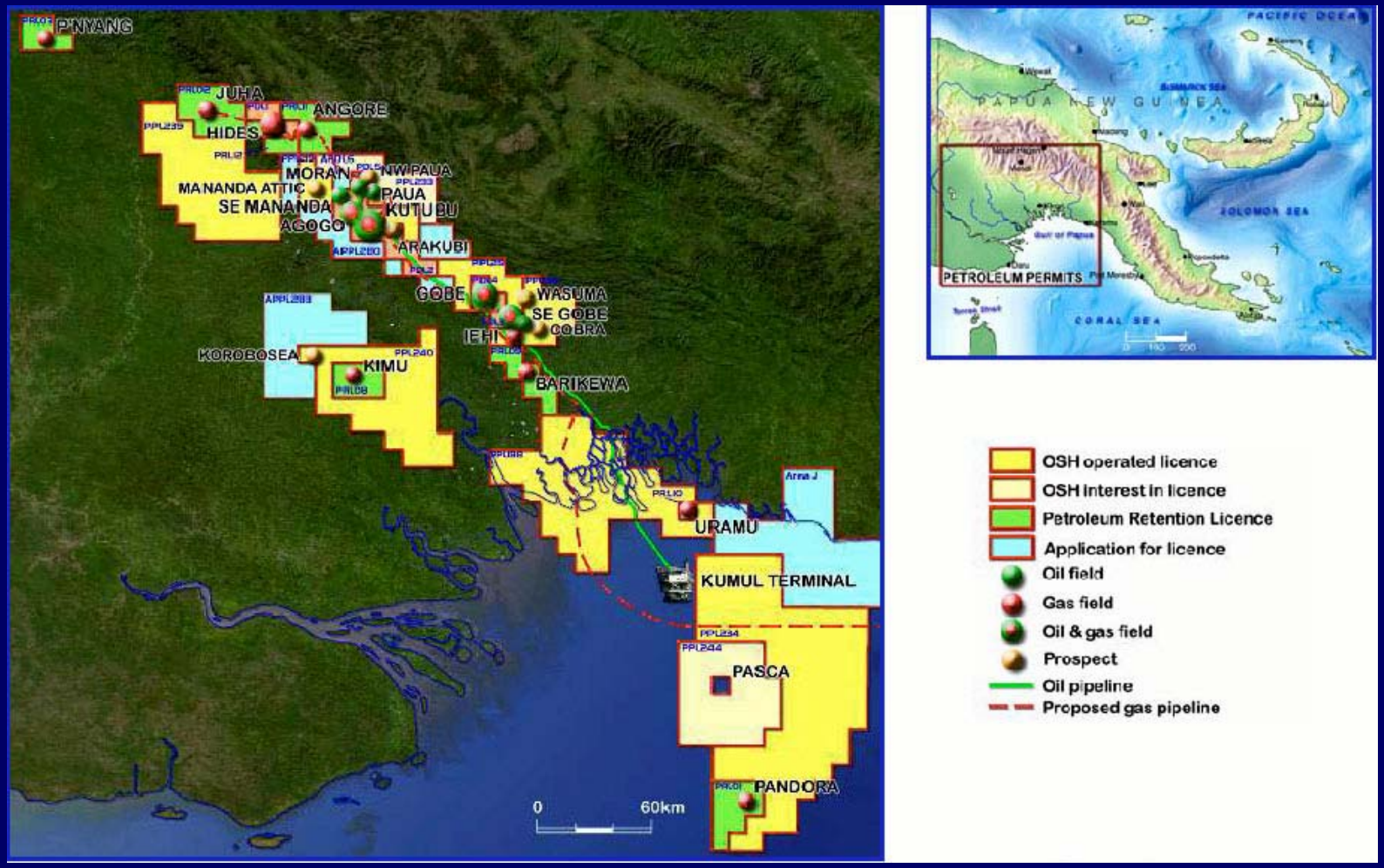
Insufficient observation times

Poor connections to earlier survey control

uncertainty in site velocities

no validation of geoid model by levelling

8 cm horizontal 30 cm MSL achieved



Map of the PNG Oilfields now

2007 Oil Search Review

Problems identified and confusion of datums used (horizontal & vertical)

Quickclose contracted to undertake review of all aspects of surveying and validate datums used

compute AGD66 to PNG94 parameters in the Oil Fields for Oil Search GIS team

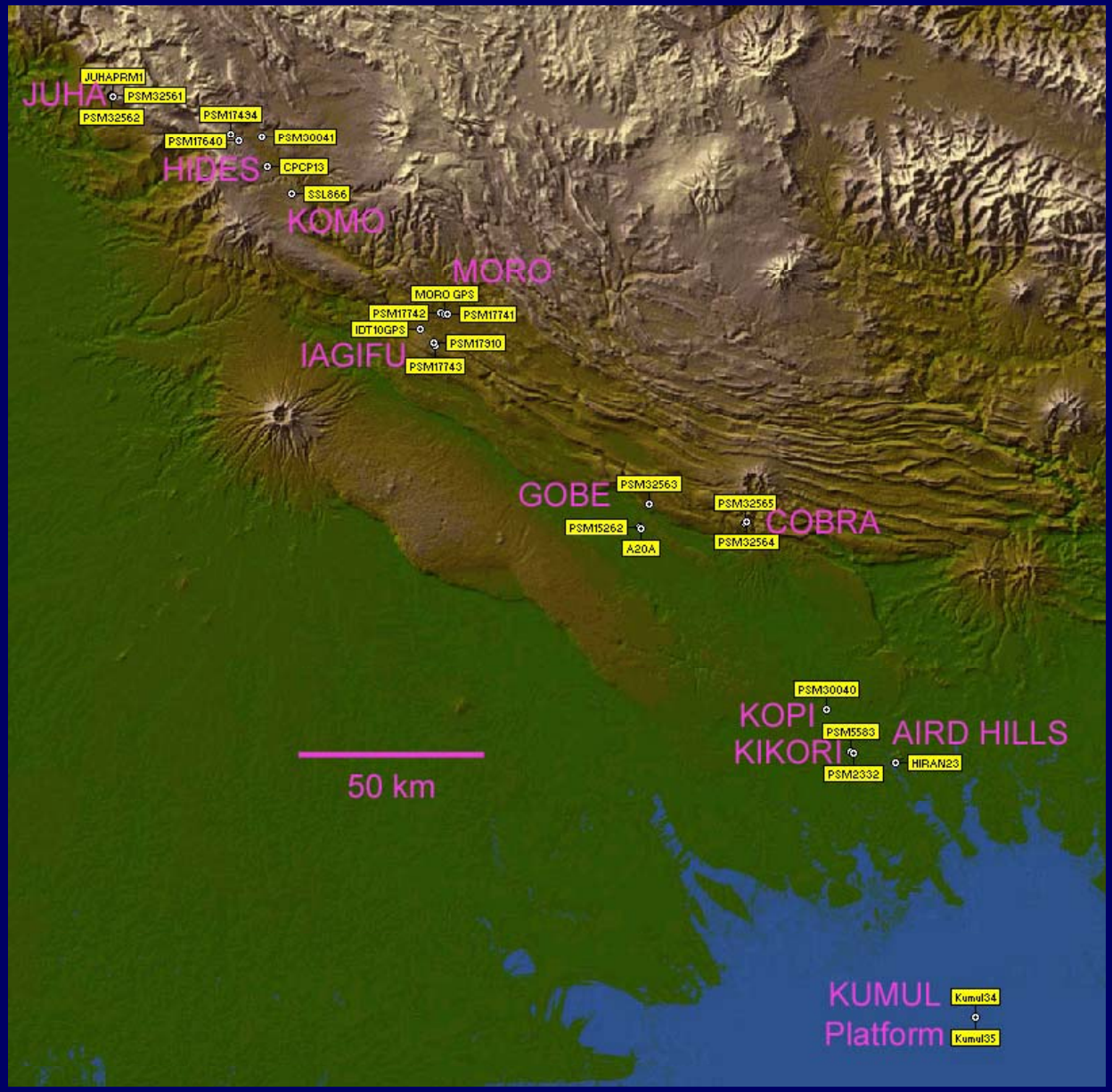
Extensive study of existing reports, collation of survey information, sketches etc..

Discussions with Fred Pratt on historical aspects

Liaison and planning

Surveys conducted in August and December 2007

2007 Network



Juha validation - Height of wet season!

Juha PRM 1 and 2

Juha 4

new PSM

MORO

HIDES

Hides Gas and setting

GOBE & COBRA


U.S. AIR FORCES GEODETIC
FOR INFORMATION WRITE TO HOUSAF
WASHINGTON DC
CONTROL STATION

AIRD HILLS

KUMUL Platform

Site velocities for AUSPOS & OmniSTAR

Kopi, Kikori, Kumul, Gobe

E 0.034 m/yr N 0.054 m/yr

Kutubu, Moro, Iagifu, Moran

E 0.033 m/yr N 0.054 m/yr

Hides, Juha

E 0.032 m/yr N 0.054 m/yr

AUSPOS & OmniSTAR solutions converted to PNG94

Mean Sea Level (MSL)

Compared EGM96 and PNG Geoid

zero order correction based on
Kumul 34 tidal observations

MSL = EGM96 - 0.87 m

EGM96 geoid equivalent to PNG Geoid
at 1 metre in the Oilfields

Offsets computed from EGM96(Kumul)
to existing height datums in the Oil fields

Geometric levelling still required for
improved heighting accurcy

MSL differences

To→ / From↓	EGM96	Kumul34	LAT Kumul	Chevron	Kutubu	Hides	Juha	Gobe
EGM96	0	-0.87	0.97	-15.9	2.6	0.55	5.3	2.3
Kumul34	0.87	0	1.84	-15.03	3.47	1.42	6.17	3.17
LAT Kumul	-0.97	-1.84	0	-16.87	1.63	-0.42	4.33	1.33
Chevron	15.9	15.03	16.87	0	18.5	16.45	21.2	18.2
Kutubu	-2.6	-3.47	-1.63	-18.5	0	-2.05	-2.7	-0.3
Hides	-0.55	-1.42	0.42	-16.45	2.05	0	4.75	1.75
Juha	-5.3	-6.17	-4.33	-21.2	-2.7	-4.75	0	-3.0
Gobe	-2.3	-3.17	-1.33	-18.2	0.3	-1.75	3.0	0

Table 1: Conversion reckoner between different height datums in PNG Oilfields

AGD66 to PNG94 transformation parameters

Transformation	Accuracy	DX(m)	DY(m)	DZ(m)	Ellipsoid
ITRF2000/WGS84 to PNG94 **2008**	0.05	0.35	0.32	-0.76	WGS84/GRS80
ITRF2000/WGS84 to PNG94 **2009**	0.05	0.38	0.34	-0.81	WGS84/GRS80
ITRF2000/WGS84 to AGD66(Oil)	2.0	124	60	-154	ANS
PNG94 to AGD66(Oil)	2.0	124	60	-153	ANS
PNG94 to ITRF2000/WGS84 **2008**	0.05	-0.35	-0.32	0.76	WGS84/GRS80
PNG94 to ITRF2000/WGS84 **2009**	0.05	-0.38	-0.34	0.81	WGS84/GRS80
AGD66(Oil) to ITRF2000/WGS84	2.0	-124	-60	154	WGS84/GRS80
AGD66(Oil) to PNG94	2.0	-124	-60	153	WGS84/GRS80

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Easting	-0.48	-0.51	-0.54	-0.58	-0.61	-0.64
Northing	-0.78	-0.84	-0.89	-0.95	-1.00	-1.05

Table 3 - Correction applied to ITRF2000/WGS84 UTM coordinates to get PNGMG94

1 metre accuracy AMG66 to PNGMG94 block shift

AMG66 Easting = PNGMG Easting - 122
AMG66 Northing = PNGMG Northing - 161

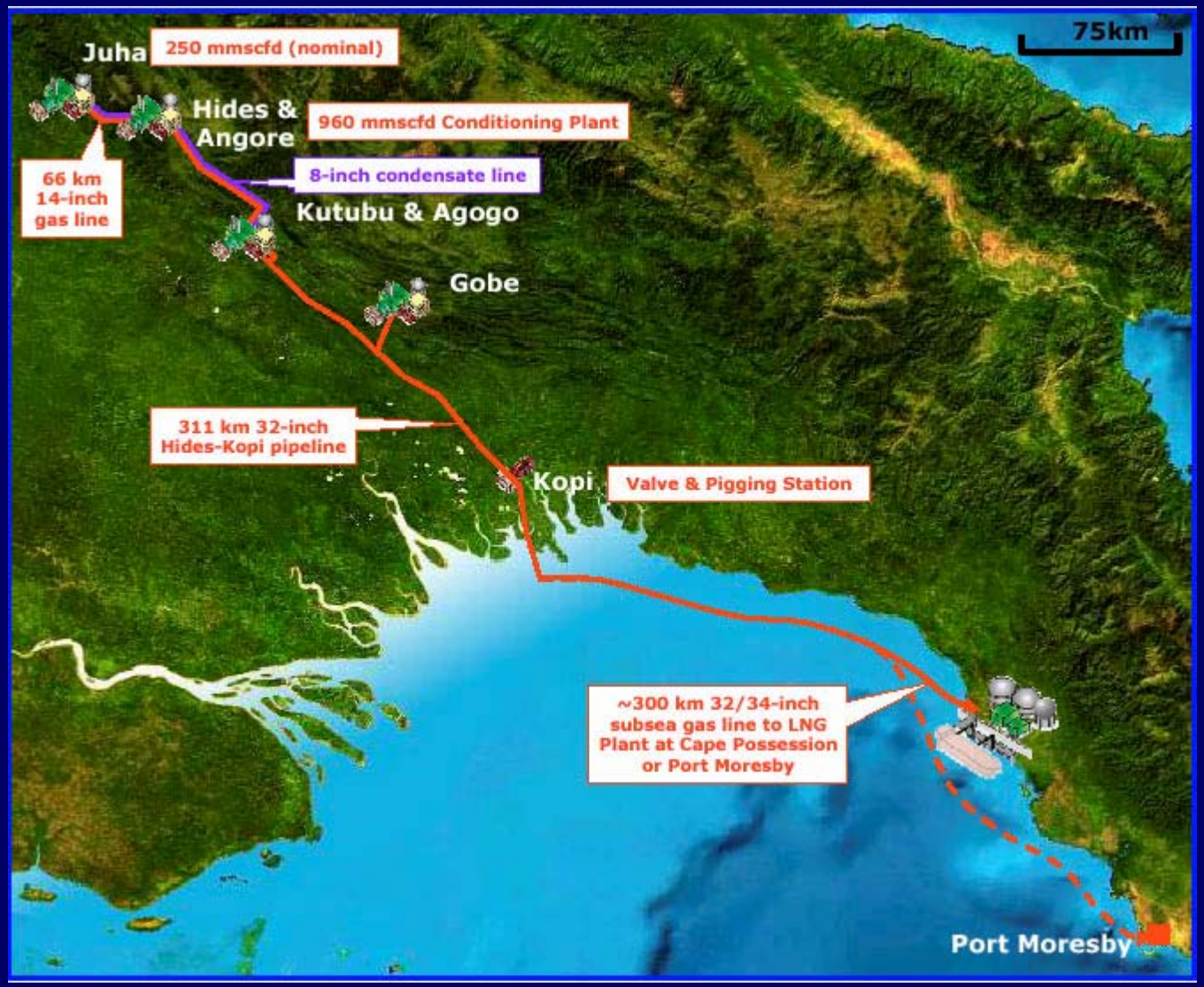
Table 4 - PNG Oilfields - Geodetic Datum PNG94 (ITRF92 Epoch 1994.0)

(To be used for primary survey control from 2008)

		PNG94 (ITRF92 Epoch 1994.0)		Ellipsoid	MSL Ht.	PNGMG94 Zone 54		Pos. Uncertainty			Vel. (m/yr)	
Station	**Location**	**Latitude**	**Longitude**	**Height**	**(Kumul)**	**Easting**	**Northing**	**σ E**	**σ N**	**σ Ht**	**East**	**North**
Fiducial Control												
LAE1	Lae IGS Base station	-6° 40' 25".3664	146° 59' 35".4670	140.33	68.28			0.01	0.01	0.010	0.026	0.052
PSM5583	Kikori Airstrip (Apron)	-7° 25' 24".6532	144° 14' 55".7667	88.93	12.00	858689.78	9178117.65	0.02	0.02	0.010	0.035	0.054
PSM17001	Kopiago Airstrip (Apron)	-5° 23' 09".0852	142° 29' 42".1907	1412.79	1327.67	665650.98	9404480.51	0.02	0.02	0.030	0.031	0.055
Primary Control												
PSM32561	Juha 4 (above)	-5° 50' 03".2869	142° 25' 10".2087	1041.18	958.31	657158.18	9354920.22	0.07	0.06	0.040	0.032	0.054
PSM30041	Nogoli Helipad	-5° 56' 02".4348	142° 47' 16".7455	1340.20	1257.54	697930.59	9343770.78	0.07	0.06	0.040	0.032	0.054
IDT10GPS	Iagifu IDT10 camp	-6° 23' 59".1002	143° 10' 43".5263	1192.81	1112.64	740997.39	9292094.93	0.07	0.06	0.040	0.033	0.054
PSM17742	Moro Airstrip (W End)	-6° 21' 44".9072	143° 13' 46".0940	917.86	837.42	746627.49	9296194.53	0.07	0.06	0.030	0.033	0.054
PSM32563	Gobe (Operations Camp)	-6° 49' 20".1261	143° 44' 42".7931	565.21	486.15	803439.28	9245035.88	0.07	0.06	0.040	0.034	0.054
PSM30040	Kopi (Valve station)	-7° 19' 19".7114	144° 11' 08".2790	84.44	7.24	851786.20	9189391.84	0.04	0.03	0.030	0.035	0.054
Secondary Control												
PSM32562	Juha 4	-5° 50' 04".8669	142° 25' 04".6812	1026.35	943.48	656988.03	9354872.12	0.07	0.06	0.040	0.032	0.054
CPCP13	Hides 4	-6° 00' 20".1417	142° 48' 05".7727	1757.65	1675.58	699412.77	9335848.86	0.09	0.06	0.040	0.032	0.054
PSM17743	Iagifu Ridge Camp (above)	-6° 26' 28".7380	143° 13' 00".6218	1470.84	1390.77	745191.88	9287478.65	0.07	0.06	0.050	0.033	0.054
MORO GPS	Fofari Camp (Senior)	-6° 21' 55".8294	143° 14' 26".7368	913.14	832.68	747875.54	9295853.49	0.07	0.06	0.060	0.033	0.054
PSM15262	Gobe Airstrip (W side)	-6° 52' 45".5701	143° 43' 21".3500	129.24	50.52	800901.00	9238734.50	0.08	0.06	0.060	0.034	0.054
A20A	Gobe Airstrip (S side)	-6° 52' 57".6856	143° 43' 36".0904	130.08	51.38	801351.74	9238359.46	0.08	0.06	0.040	0.034	0.054
PSM2332	Kikori Airstrip (S End)	-7° 25' 36".4929	144° 15' 11".8089	89.91	12.99	859179.61	9177749.89	0.03	0.03	0.040	0.035	0.054
Tertiary Control												
JUHAPRM1	Juha 4 (above)	-5° 50' 06".3449	142° 25' 11".2763	1043.23	960.36	657190.78	9354826.21	0.08	0.08	0.060	0.032	0.054
PSM17494	Hides 1 (above)	-5° 55' 42".2240	142° 42' 43".9756	2839.30	2756.68	689542.29	9344418.15	0.07	0.06	0.060	0.032	0.054
PSM17640	Hides 2 (above)	-5° 56' 44".2401	142° 43' 57".3569	2547.04	2464.54	691793.48	9342506.01	0.07	0.07	0.060	0.032	0.054
SSL866	Komo Airstrip	-6° 04' 17".1716	142° 51' 41".7762	1624.88	1543.28	706031.42	9328544.56	0.07	0.07	0.060	0.032	0.054
PSM17910	Iagifu 2 (above)	-6° 26' 02".9002	143° 12' 42".7950	1440.09	1360.00	744647.35	9288275.00	0.08	0.07	0.050	0.033	0.054
PSM17741	Moro Airstrip (E end)	-6° 21' 49".2971	143° 14' 47".5885	907.02	826.54	748517.47	9296051.44	0.07	0.06	0.040	0.033	0.054
PSM32565	Cobra 1	-6° 52' 08".3625	143° 59' 01".8200	1130.06	1051.11	829804.95	9239706.05	0.10	0.06	0.060	0.034	0.054
PSM32564	Cobra 1 (above)	-6° 52' 02".4674	143° 59' 04".6413	1136.14	1057.18	829892.78	9239886.77	0.10	0.07	0.060	0.034	0.054
Height Datum Stations												
HIRAN23	Aird Hills	-7° 26' 50".9425	144° 21' 25".6535	397.78	320.89	870639.93	9175374.19	0.04	0.03	0.030	0.035	0.054
Kumul34	Kumul platform	-8° 03' 51".3913	144° 33' 38".3558	103.30	27.96	892563.96	9106883.55	0.05	0.04	0.040	0.035	0.054
Kumul35	Kumul platform (Helipad)	-8° 03' 52".1178	144° 33' 38".8321	104.59	29.26	892578.36	9106861.08	0.05	0.04	0.040	0.035	0.054

Final PNG94 coordinates list

The Future LNG FEED 2008




Thank
you
Tomorrow: **Workshop - Using GPS to connect to PNG94**