



FINAL OPERATIONS REPORT

WEST ERREGULLA 3D SEISMIC – LINE PREPARATION

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I Introduction

Between 5th and 15th of October 2014, **wkc** provided surveying services to Warrego Energy. The West Erregulla 3D Seismic line preparation was located within EP469 near Mingenew in Western Australia. **See Appendix A – Project Map.**

wkc worked alongside line preparation contractor Central Earthmoving (CE) and KD.1 landowner liaison to provide access for upcoming 3D Seismic program.

Summary of the objects are below.

- Ensure that the interests, reputation and objectives of Warrego Energy Pty Ltd are protected.
- Act as effective Warrego HSE site manager during the line preparation phase of the West Erregulla 3D seismic survey.
- Responsible for ensuring compliance to all relevant policies and procedures.
- Participate, together with the Warrego Field Representative, in a pre-start audit of contractor's equipment, and induction of participating personnel.
- Liaise regularly with the Warrego Field Representative.
- Responsible for ensuring the access preparation adequately resourced in all respects.
- Report inadequacies to Warrego Representative.
- Load and check the previously prepared master GIS data prior to line access preparation commencement.
- Conduct training of contractor personnel in the use of the GPS machine guidance system.
- Provide on-site advice and support to the Line Preparation contractor. Such that all flora, fauna and native artefacts are appropriately avoided.
- Ensure that the needs of all stakeholders are addressed and any unforeseen issues are appropriately reported and dealt with.
- Ensure that the contractor reports the operation effectively.
- Record digital images to provide a visual overview of the operation including special terrain variation and vegetation features and a minimum of eight accessible monitoring points.

2 Terrain and Logistics

2.1 Terrain

The line preparation activities sat within vacant crown land surrounded by the traditional wheat belt rolling sandy hills of the area. The vacant crown land was covered with mixed shrubs, scattered woodland and breakaways.

2.2 Logistics

The project lasted a total of 11 days, of that 9 days spent on site preparing lines and 2 days mobilising between Perth and Mingenew.

Field crew based operations from the Mingenew Hotel, Mingenew, Western Australia. **See Appendix B – Location Map.**

3 Personnel and Equipment

3.1 Personnel

The **wkc** representative was Ben Allsopp (Line Pointer). CE provided two mulching operators and two spotters and further logistical support from Geraldton as required.

3.2 Survey Equipment

The following equipment was used during the Survey:

Equipment	Description	Quantity
Vehicle	Nissan Patrol	1
Communication	Telstra mobile phone	1
	Motorola Satellite phone	1
	Vehicle Mounted UHF	1
	Handheld 5w UHF	2
	EPIRB	1
Survey Equipment	Trimble R8 Base GPS receiver	1
	Trimble R8 Rover GPS receivers	2
	Trimble 35W Base radio modem	1
	Trimble 35W repeater radio modem	1
	Trimble Yuma Tablets	3
Office	DELL M4700 Laptop	1
	Trimble Business Centre 3.20	1
	MapInfo Professional 12.0	1
Miscellaneous	Office and field survey consumables	

4 Survey Datum

Survey datum for the project was the Geocentric Datum of Australia 1994 (GDA94). Coordinates were output in Map Grid of Australia (MGA) Zone 50. Ellipsoidal heights were reduced to the Australian Height Datum (AHD) using the AUSGeoid09¹ geoid separation model.

4.1 World Geodetic System 1984 datum

Datum	World Geodetic System 1984
Spheroid	WGS84
Semi-Major Axis	6 378 137.0
Inverse Flattening	298.2572236
Unit of Measure	International Metres

4.2 Geocentric Datum of Australia 1994 datum

Datum	Geocentric Datum of Australia 1994
Spheroid	Geodetic Reference System 1980
Reference Frame	ITRF92
Semi-Major Axis	6 378 137.0
Inverse Flattening	298.2572221
Unit of Measure	International Metres

For the purposes of this survey, GDA94 is identical to WGS84.

4.3 Map Grid of Australia 1994 datum

Projection	Universal Transverse Mercator (MGA Zone 50)
Latitude of origin	0°
Central Meridian (CM)	117° E
Scale Factor at CM	0.9996
False Easting	500 000
False Northing	10 000 000
Unit of Measure	International Metre

¹AUSGeoid09 - The current model in a series of national geoid models for Australia produced by Geoscience Australia

4.4 Australian Height Datum

Heights obtained from GPS (observed ellipsoidal heights) do not refer to the AHD (geoid heights), but to the mathematical reference surface (the ellipsoid). The geoid however is an equipotential surface closely approximated by mean sea level. The difference between the ellipsoid and Geoid is known as the geoid-ellipsoid separation (N). The N values are interpolated from the national AUSGeoid09 model and subtracted from the GPS heights to give the final AHD heights.

5 Methodology

5.1 Survey Control

Existing control was used for the duration of the project originally established for the Ground Truthing Survey previously carried out by **wkc**.

Previous methodology for control work involved the setting up of a GPS receiver to log static data on an existing point. A second GPS receiver then simultaneously logs data on new station for a minimum of 30 minutes, depending on the length of the baseline. After post processing the data to obtain accurate baseline information, a position can be determined for the unknown station.

Trimble Business Centre was used to run a network adjustment on the survey control network. This verified the integrity of the network.

Four control stations were used in the survey network, and one of these had AUSPOS checks performed. **Appendix C – Control Listing and Map.**

wkc utilised Trimble R8 GPS receivers. These units are dual frequency GNSS receivers enabling very fast and reliable initialisations. Coupled with Trimble Yuma Tablet or TSC3 survey controllers the system is very efficient and user friendly.

5.2 Line Scouting

The majority of line scouting was carried during the previous Ground Truthing Survey using Real Time kinematic (RTK) GPS method (Also referred to as DGPS). This consisted of a base receiver setup on a known control station and rover receiver connected via UHF radio link. Through the UHF radio modem the base receiver broadcasts the base position and GPS data measured at the base directly to a radio modem connected to the roving GPS receiver enabling the rover to initialise (resolve satellite cycle ambiguities). Once initialised the roving receiver can compute its own position within a few centimetres. The GPS units installed in the mulches utilised the same RTK method. **Appendix D – Line Summary.**

5.3 Mapping

On the previous survey mapping was undertaken within the vacant crown land of any features pertinent to crew operations and safety utilising the Trimble Yuma tablet and MapInfo software. Using this information combined with that supplied by client accurate prospect maps had been generated. The only additional mapping carried out was centred around the Cockatoo 10m buffers that where desktop generated after the Truthing Survey and the final mulched lines. **Appendix A – Project Map.**

5.4 Monumentation

No additional permanent monumentation was left on site during the line preparation works.

Temporary flagging in bushes and trees was used to aid the mulching operators and digital photos taken to document before and after mulching impact.

5.5 Data Processing and Quality Control

Real Time Kinematic (RTK) stakeout position data was collected in Trimble TSC3 Survey Controller. Datum transformations and geoid separations were then applied to the data. Several QC checks were done and the data was then loaded into mapping software where further checking was done. The QC checks included the following:

- Base coordinates and elevation were checked on download against the control data.
- Antenna heights were checked.
- Cross line and inline offsets from design were checked for any anomalies.
- GPS quality checks. (DOPs, Horizontal precision, Vertical precision, Number of satellites and RMS)
- Initialization checks.
- Checkshot comparisons
- Old Survey Marker comparisons
- Missing station checks.

Final coordinate data was converted to CSV, KML, TAB and shp files as requested.

6 Results

The key to successful line preparation is effective training of operators and use of machine guidance. All personal completed the Warrego online induction beforehand, site specific induction by Terry Grocke in Geraldton on Monday the 6th before mobilisation and field based training by line pointer as needed on line preparation requirements and machine guidance.

6.1 Receivers

Early in the line preparation the three access receivers lines R1000, R1054 and R1171 where completed. Primarily to allow safe and efficient access for the later stages of the operation and due to the sparse nature of environmental features allowed for good training before attempting more difficult lines. R1000 provided the perfect training ground with very few terrain issues and sparse priority flora to allow the operators to develop familiarity with the GPS machine guidance equipment and line preparation requirements.

Access through to Natta Rd via doglegs was cancelled to avoid the visual/environmental impact and limit the weed and seed hygiene points to the existing access tracks.

It's worth noting some sections of the access receivers cover rough ground limiting access speeds. This is mostly unavoidable and a side effect of using mulching appose to a blade based clearing methods.

6.2 Source

In conjunction with completing the receiver lines the perimeter source lines where done first for safe access and highlight the grid boundary's to avoid over runs. Initial works commenced in the west zig zagging east as these lines provided a steady progression in difficulty level. The sparse features allowed the line pointer to rotate between the lead and rear machines reviewing works. The crew spent two days working in this pattern until confidence in procedures and abilities developed.

The crew then jumped to the eastern lines and zig zagged westerly through the highest density priority flora areas. The aim was to tackle these hard areas while the operators were fresh earlier in the program. Through most of these areas the line pointer walked in front only leaving the operators to take before monitoring photos and move the RTK radio repeater to maintain corrections to the machine guidance.

6.3 Environmental Monitoring Points (EMP)

Thirteen perspective sites for before and after mulching monitoring photos were select by Coffey as shown on drawing 2034 REV F001 GIS. Twelve of these points where captured but site 11 was missed as the line pointer was away from the machines relocating the repeater

West Erregulla 3D Seismic – Line Preparation

at the time of the first pass. An additional four sites were selected that provide easy long term access rather than the need for extensive walking in the future for monitoring.

The EMP photographs have been presented as kmz for easy viewing in Google earth and the full resolution photos include as part of the attached digital data package. A listing of EMP locations and map can be located in **Appendix E – Environmental Monitoring Points**.

6.4 Total Mulched Area

On the completion of mulching the centre line was mapped using RTK. This data was then imported into MapInfo and 1.75m buffer generated around all segments to create the 3.5m mulched corridor. In generating the total area as one buffer around all mapped sections it avoids the double claiming of areas such as the overlap between source and receiver lines. A modest 2m buffer was generated around all the mapped tracks and then taken away from the total area, so as not to claim existing cleared ground.

The resulting total area mulched was **56.345 ha**.

7 Quality, Health, Safety and Environment

wkc has accreditation in Health & Safety (AS/NZS 4801:2001), Environment (AS/NZS ISO 14001:2004) and Quality Systems (AS/NZS ISO 9001:2008)

We are committed to the health and safety of all employees, sub-contractors and visitors. Endeavour to always conduct our business in a manner that protects the health and safety of all our people. Our vision is to maintain a goal of a zero incidents in the workplace through our commitment to health and safety.

A wide range of office and field activities are undertaken by our company. Our commitment to the environment is of the highest importance and through our environmental policy we strive to minimise our impact on the environment.

With our comprehensive in-house quality system we can consistently output the highest level of service throughout our extensive and diverse business enterprises.

During the tender and work phases **wkc** provided all information detailing our approach and commitment to satisfy the Health, Safety and Environmental requirements for work on the project.

The exploration industry is a potentially hazardous environment, because of this **wkc** goes to extensive lengths to insure the safety of employees. Taking affirmative action's such as inductions, providing relevant training like 4WD and first aid courses. Once on the job, daily prestart meetings, Job Safety & Environmental Analysis (JSEA), journey management plans and weekly Toolbox safety meetings maintain awareness and address new hazards.

All **wkc** vehicles are fitted with rollover protection, fire extinguisher, first aid kits, UHF radios and satellite phones. Mobiles, Satellite Phone, EPIRB and UHF radios were carried while operating away from the vehicles to maintain communications at all times.

All rubbish generated in the field was returned to camp for proper disposal.

wkc vehicle utilised the Trimble Yuma tablet to track all field movements.

8 Conclusion

wkc welcomed the opportunity to show Warrego Energy the level and depth of experience our personnel could bring to the survey, greatly assisting in handling the obstacles faced over the course of the program, maximising the efficiency of the line preparation crew and aid in overcoming potential obstacles to the main crew before they effect production and safety.

Equipment utilised on the project proved to be highly reliable and mobile to handle the difficult conditions and terrain and performed faultlessly for the duration of works.

Upon review of the lines nearing completion of the project it was decide to run some sections a second time to reduce the tall woody stems missed by the mulches and to ensure consistent width in tight areas. With the success of the second pass made in the opposite direction to the first and the speed in which the initial pass was completed it was decide to be worthwhile double running all the lines.

wkc at all times endeavours to carry out its duties in a professional and efficient manner. We welcome any feedback that will improve our service and aid future projects.

Yours sincerely

Ben Allsopp

Ben Allsopp
wkc | Project Surveyor

Appendix A

Project Map

Appendix B
Location Map

Appendix C

Control Listing and Map

West Erregulla 3D Seismic – Line Preparation

Below coordinate values are MGA (Zone 50) AHD (AUSGeoid09)

Control Datum

Station	Easting	Northing	RL	Comment
SSM CL	328695.744	6750996.783	255.81	P=0.036 RL=12rootK

Control Listing

Station	Easting	Northing	RL	Comment
WKC01	336982.567	6745038.133	239.879	wkc static
Dongara 23	331166.158	6739597.871	220.292	RTK
SSM LEF 8	338866.064	6742691.235	286.116	RTK

Control Checks

Station	Easting	Northing	RL	Comment
WKC01	336982.557	6745038.132	239.876	Given AUSPOS
	336982.567	6745038.133	239.879	wkc static tie
	0.010	0.001	0.003	Misclose (wkc-Given)
Dongara 23	331166.12	6739597.873	220.6	Given P=0.061 RL= 1.50
	331166.158	6739597.871	220.292	wkc RTK tie
	0.038	-0.002	-0.308	Misclose (wkc-Given)
SSM LEF 8	338866.005	6742691.307	286.161	Given P=0.54 RL=12rootK
	338866.064	6742691.235	286.116	wkc RTK tie
	0.059	-0.072	-0.045	Misclose (wkc-Given)

Appendix D
Line Summary

West Erregulla 3D Seismic – Line Preparation

Note: Below listings covers extent of line preparation via mulching, not total line lengths.

Source Lines

Line	SOL	EOL	Stn's	Length (m)
5000	1001	1153	152	6080
5009	1001	1180	179	7160
5018	1001	1207	206	8240
5027	1001	1209	1214	8520
5036	1001	1209	1214	8520
5045	1001	1209	1214	8520
5054	1001	1210	1214	8520
5063	1001	1210	1215	8560
5072	1001	1210	1215	8560
5081	1001	1210	1215	8560
5090	1001	1210	1215	8560
5099	1001	1210	1215	8560
5108	1001	1210	1215	8560
5117	1001	1211	1216	8600
5126	1001	1211	1216	8600
5135	1001	1211	1216	8600
5144	1001	1099	1101	4600
Total			17547	137320

Receiver Lines

Line	SOL	EOL	Stn's	Length (m)
1000	5001	5145	144	5760
1054	5001	5145	144	5760
1171	5010	5143	133	5320
Total			421	16840
			Project Total	154.560 km

Appendix E

Environmental Monitoring Points

Environmental Monitoring Point listing

EMP ID	MGAZ50		GDA94		Before Mulching		After Mulching	
	Easting	Northing	Latitude	Longitude	Date	Photo ID	Date	Photo ID
EMP WE001	338646	6742396	-29.43744	115.33645	8/10/2014	M019	14/10/2014	M050
EMP WE002	338333	6748773	-29.37987	115.33416	9/10/2014	M034	14/10/2014	M048
EMP WE003	335813	6745179	-29.41197	115.30768	11/10/2014	M045	14/10/2014	M056
EMP WE004	334372	6740340	-29.45544	115.29209	11/10/2014	M047	14/10/2014	M054
EMP 10a	335812	6742396	-29.43708	115.30725	8/10/2014	M021	14/10/2014	M061
EMP 12	333654	6747436	-29.39133	115.28577	8/10/2014	M026	14/10/2014	M062
EMP 13a	336894	6743480	-29.42744	115.31856	10/10/2014	M043	14/10/2014	M053
EMP 13b	336892	6745640	-29.40796	115.31887	10/10/2014	M041	14/10/2014	M059
EMP 14	334012	6740607	-29.45298	115.28843	8/10/2014	M031	14/10/2014	M055
EMP 1b	337615	6743055	-29.43137	115.32593	9/10/2014	M038	14/10/2014	M052
EMP 2	333296	6747294	-29.39256	115.28206	8/10/2014	M025	14/10/2014	M065
EMP 3	333657	6746018	-29.40412	115.28559	8/10/2014	M027	14/10/2014	M063
EMP 7a	337973	6742396	-29.43736	115.32952	8/10/2014	M020	14/10/2014	M051
EMP 7b	336532	6745636	-29.40795	115.31516	10/10/2014	M044	14/10/2014	M058
EMP 8	338331	6743845	-29.42434	115.33342	9/10/2014	M036	14/10/2014	M049
EMP 9	333299	6742043	-29.43993	115.28130	8/10/2014	M022	14/10/2014	M064