Contaminated Sites Remediation Activities
Up-scaled Active Remediation via Skimmer Pumps

Bridging document Summary

EA-00-RI-10170.01

PROJECT / FACILITY	Varanus Island
REVIEW INTERVAL (MONTHS)	N/A

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REVISION HISTORY

Revision	Author / Editor	Amendment
A	Quadrant Energy	Issued for internal review
0	Quadrant Energy	Issued to DMP for public disclosure
1	Quadrant Energy	Re-issued to DMP following DMP comments
2	Quadrant Energy	Issued to DMP following addition of GeoSorb socks

CONTENTS

Abbreviation and Acronyms	Meaning
ALARP	As Low As Reasonably Practicable
BD	Bridging Document
CPI	Corrugated Plate Interceptor
CSA	Contaminated Sites Auditor
CSRP	Contaminated Sites Remediation Project
DER	Department of Environment Regulation
DMP	Department of Mines and Petroleum
DPaW	Department of Parks and Wildlife
DPH	Dissolved Phase Hydrocarbons
DSI	Detailed Site Investigation
GDA94	Geocentric Datum of Australia
HAZID	HAZard IDentification (workshop)
HSE	Health, Safety and Environment
HSEMP	Health, Safety and Environment Management Plan
HWM	High Water Mark
IOM	Inspection Operation and Maintenance
kL	Kilolitre
LNAPL	Liquid non-Aqueous Phase Liquids
MDR	Manufacturers Data Report
MPE	Multi-Phase Extraction
MW	Monitoring Wells
OEP	Operations Environment Plan
OPG	Operational Procedural Guidelines
PSH	Phase-separated hydrocarbons
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfate
PFW	Process Formation Water
PTW	Permit to Work
PW	Pore water
QE	Quadrant Energy
RAP	Remedial Action Plan
SAQP	Sampling and Analysis Quality Plan
SB	Soil bores
SS	Surface sampling
TFP	Total Fluid Pumping
VI	Varanus Island
VO	Visual observations
VP	Vapour Probes
WN	Written Notification

1. INTRODUCTION

1.1 Purpose of this document

This Bridging Document is to the Varanus Island (VI) Hub Operations Environment Plan (OEP) (EA-60-RI-186, Rev. 6) and covers ongoing remediation activities proposed to be undertaken in relation to groundwater abstraction on VI.

Remediation works are required to remove petroleum hydrocarbons to reduce the potential for future ecological risks, and ultimately to restore sub-surface conditions on VI to those present prior to development. It is considered that application of remedial and validation methods detailed in the Contaminated Sites Auditor (CSA) endorsed VI Remedial Action Plan (RAP; Quadrant 2016a) and Varanus Island Contaminated Soil RAP (Quadrant 2016b) will result in the remediation of petroleum hydrocarbon impact on the VI site.

1.2 Contaminated Site Classification

In November 2007, the DER classified the VI lease area within which Quadrant Energy (QE) undertakes the processing of petroleum gathered from offshore facilities, as *Contaminated – remediation required under the Contaminated Sites Act 2003* (CS Act). From 2007 to the present, groundwater monitoring has established the dispersion extent and characteristics of the hydrocarbon plume. Two classifications have been applied:

1. Groundwater contamination arising from disposal of produced formation water

The classification described above was applied due to the presence of phase-separated hydrocarbons (PSH) and Dissolved-Phase Hydrocarbons (DPH) in groundwater surrounding a number of former shallow re-injection wells previously used for the disposal of Produced Formation Water (PFW).

2. Groundwater contamination arising from a condensate line leak

Subsequent to the initial classification, in late 2013 further groundwater hydrocarbon contamination in the form of Light Non-Aqueous Phase Liquids (LNAPL) was identified in a number of groundwater monitoring wells. A Detailed Site Investigation (DSI) was initiated in mid-2014 to determine the extent of LNAPL contamination and included a groundwater monitoring plan that established the dispersion extent of the LNAPL plume.

Concurrent with the DSI, QE undertook field work and identified a leak within the underground condensate delivery line (M4) extending from the liquids separation areas within the ESJV plant area to the crude/condensate storage tank. The M4 line was subsequently isolated and replaced with an above ground line. In response, DER updated the classification record and listing for VI in December 2014 and required immediate action by QE to facilitate the development of a RAP for VI.

During 2015, QE undertook a Remediation Options Assessment, and, based on the findings prepared two Remediation Action Plans: VI RAP (Quadrant Energy. 2016a) and VI Contaminated Soil RAP (Quadrant Energy. 2016b) which have been approved by the DER.

1.3 Legislative Requirement

The Petroleum Pipelines (Environment) Regulations 2012 and division 4 of the Petroleum (Submerged Lands) (Environment) Regulations 2012 prescribes the process for request and approval of revision of an approved EP. Section 18 and 21 of the Regulations are specifically relevant. Section 2.3.7 and Tables 1 and 2 of the *Guidelines for the Preparation and Submission of an Environment Plan* (provided by Department of Mines and Petroleum (DMP)) describe the required format of the revision document, based on the type of

activities, changes proposed, and the relative risks associated with the changes against the original activities detailed in the OEP.

1.4 Project Tenure

All activities described within this BD will occur within the Quadrant lease area under petroleum pipeline licence PL12.

2. BACKGROUND

QE has been investigating the contaminated site since January 2015 with a series of trials of various methods to find the best available technique for LNAPL and PSH removal from the groundwater.

2.1 Previous Activities and supporting approvals

2.1.1 PFW and LNAPL Remediation Works WN (EARS #53998)

This written notification (WN) detailed the trials for proposed remediation equipment including:

- Installation of auto-skimmer pump systems within two well bores for the purpose of trialling LNAPL recovery; and
- Installation of GeoSorb Socks in three existing groundwater monitoring wells for the purpose of trialling PFW PSH recovery

The purpose of the trials was to inform the final RAP development for submission to the CSA and DER. Revision 0 of this WN was approved on 9th March 2015 and expired following completion of the trials.

2.1.2 DMP Contaminated Groundwater and Soil Investigative Work Program BD (EARS #56054)

The bridging document (BD) for a Contaminated Groundwater and Soil Investigative Work Program (EA-00-RI-10115) includes for:

- Installation of soil vapour probes (VP) and routine sampling of vapour;
- Installation of ground water monitoring wells (MW) and routine sampling of groundwater;
- Sampling of pore water (PW) on beaches;
- Surface sampling (SS) of soil;
- Sampling of soils via Soil Bores (SB); and
- Visual observations (VO) along beaches.

Revision 3 of this document was approved by DMP on 28th August 2015 and is valid until the expiration of the VI Hub OEP. If further investigations are required, this BD may be revised in consultation with DMP.

2.1.3 DMP Phase 3 Remediation Trials WN (EARS # 56729, Extension EARS #59619)

This WN (EA-60-RI-10098) detailed a further remediation trial following the completion of the auto-skimmer pumps and GeoSorb socks (See Section 2.1.2) to enable refinement and optimisation of the skimmer pumps (referred to as “optimised skimmer trial”). It also included an additional remediation method to be trialled, Total Fluids Pumping (referred to as “TFP”) for the removal of contaminated groundwater on VI. Trials have demonstrated that skimmer pumps are successful in removing PSH and the results have been reviewed by the CSA who is aware of the proposed further active skimming.

Revision 2 of the WN was accepted by DMP in October 2015, with further extensions to the trial submitted on 5th April 2016 and 3rd June 2016. The latest extension (EARS #59619) allows for the trial to be extended to the 31st August 2016, this was accepted by DMP on 3rd June 2016.

2.1.4 Multi-Phase Extraction Trials WN (EARS #56729)

This written notification (EA-60-RI-10137) includes the proposal to undertake a multi-phase extraction (MPE) trial for a period of 45 days. Revision 1 of this document was approved by DMP on 12 August 2016 and expires at the end of the trial (30th September 2016).

3. SCOPE OF ACTIVITY

3.1 Active Skimming

Active skimming system is a process used on VI to reduce an identified condensate plume by removing the LNAPL at selected remediation wells to meet criteria set in the VI RAP (Quadrant Energy, 2015a). Active skimming has been undertaken as a trial in numerous wells since November 2015 (refer **Section 2.1**) and the data collated from these has been utilised to develop the proposed up-scaled activity.

Active skimming equipment will consist of a set of portable tanks, hoses, electric panels, test instruments, repair facilities, storage facilities and down hole pumps. The equipment will only be in service as long as it is required to remediate the condensate plume. The precise location and quantity of equipment will vary over time subject to the ongoing assessment of the performance of the equipment and progression of the remediation.

Active skimming is not critical to production and will cease and be secured during declared weather events such as cyclones or severe storm conditions. Equipment will be located, operated and maintained by a utility operator.

The active skimming process uses an air-powered down hole positive displacement pump with its intake located in the LNAPL layer by skimmer. The fluids from each of these down hole pumps is pumped into a local tank. Periodically the local tanks will either be emptied in-situ to a mobile tank facility (vacuum truck) or exchanged for an equivalent empty tank. The recovered LNAPL fluids will be disposed of into the VI CPI system via the CPI inlet point. The local tanks are atmospheric with local venting of condensate vapours.

3.2 Passive Removal of LNAPL

Current LNAPL thickness measurements indicate that a number of monitoring wells are below the 20mm Decision Rule identified within the approved RAP. The limited thickness of LNAPL means the effectiveness of active skimming (by pumps), at those locations, is reduced. Continued passive remediation at those locations could be achieved via Geosorb socks as trialled in Q2 2015. Initially the use of GeoSorb socks was not proposed for ongoing remediation due to the limited LNAPL recovery, however the trials were successful as indicated within the “Progress Report for Geosorb sock use (VI-10-RI-10011)”.

GeoSorb socks are a proprietary system designed to absorb separated phase hydrocarbon in preference to water. The use of the GeoSorb socks will allow for continued removal of LNAPL from those wells where the LNAPL thickness precludes active removal of LNAPL using skimmer pumps (i.e. <20 mm thickness).

The GeoSorb equipment consists of disposable absorbent socks that are deployed into a monitoring well bore within a perforated stainless steel carrier tube. The carrier tube is suspended within the well so that it is positioned within the LNAPL smear zone corresponding to the rise and fall of the water level due to tidal action.

Periodically, the carrier tube is recovered and the GeoSorb sock removed and replaced with a new sock.

3.3 Waste Management

LNAPL arising from abstraction will be allowed to settle out in residence tanks then transferred to the CPI inlet point. Used GeoSorb socks are disposed of in accordance with the QEAL Waste Management Procedure.

3.4 Location

QE have identified 15 wells that are suitable for skimming and for the deployment of the GeoSorb socks. Dependant on the recovery success at each of the wells, the pumps may be moved from time to time to optimise recovery. Up to 10 pumps may be in operation at any given time. **Figure 3-1** shows the groundwater monitoring wells that may be used for the active skimming and passive removal of LNAPL, and co-ordinates are provided in **Table 3-1.**

Table 3-1: Location of wells for active skimming

Well ID	Easting	Northing
MW58	352001.9	7715865.2
MW59	352016.7	7715855.9
MW60	352028.9	7715846.0
MW40	351909.1	7715858.0
MW41	352038.7	7715838.6
MW57	351800.8	7715810.7
MW69	351829.2	7715791.5
MW70	351848.5	7715774.2
MW71	351862.7	7715761.6
MW72	351878.2	7715745.4
MW73	351894.4	7715730.4
MW74	351977. 1	7715786.6
MW16	351927.0	7715743.3
MW46a	351942.2	7715761.0
MW67	351946.7	7715703.8

Figure 3-1: Varanus Island Monitoring Well Locations

3.4.1 Timing

The commencement of PSH removal via skimmer pumps will occur progressively from September (following on from the trial currently underway as per WN EARS #59619), with an aim to have all the skimmer pumps operating by December 2016.

Active skimming will occur for 24 hours a day, 7 days per week. The active skimming equipment will be operated manually, however, it will be unattended during night time. No fixed lighting is required.

The commencement of PSH removal via GeoSorb socks will occur progressively from December 2016 as the wells targeted for active remediation (via skimmer pumps) exhibit a residual thickness of LNAPL that is less than 20mm. Use of the GeoSorb socks will continue for the foreseeable future to facilitate LNAPL recovery.

4. EXISTING ENVIRONMENT

A full description of the existing physical, ecological and social environment is provided in the VI Hub OEP.

5. MANAGEMENT OF ACTIVITY RISKS

5.1 Risk Assessment of Activity

A number of HAZIDs have been conducted concerning the use of skimmers for remediation. As active remediation options were further considered following the initial trial, subsequent HAZID reviews were undertaken. The applicable HAZID dates are as follows:

- HAZID remediation using skimmers and GeoSorb socks on 11/02/15;
- HAZID review for Total Fluid Pumping (TFP) on 30/11/15; and
- HAZID review for up-scaled skimming (TFP) on 13/05/16.

The scope of the workshops included:

- Identification and assessment of the safety and environmental risks associated with the change in activity;
- Identification of the control measures in place and confirmation that they are effective and adequate; and
- Recommendations to eliminate or reduce risks to As Low As Reasonably Practicable (ALARP).

The most recent HAZID did not identify any new risks, impacts or control measures compared to those already assessed in the HAZIDs completed in 2015. This is due to the fact that the previous scopes assessed were more complex than the finalised scope described in this BD.

The hazards identified and their residual risk rankings and control measures determined through the HAZID workshops described above are presented in **Table 5-1**. The proposed control measures to manage impacts are also presented in the table. **Table 5-2** provides a breakdown of these control measures including how the control will be implemented and measured.

The proposed activities are not considered a significant modification to the operational details described within the VI Hub Operations EP (EA-60-RI-186, Revision 6).

Table 5-1: Hazards, residual risk rankings and management controls for active skimming and GeoSorb socks

Hazard/Source of Risk	Cause	Consequence (severity)	Likelihood	Residual Risk ranking	Controls
HAZID 11 February 2015: Skimmer Pump Method					
Activity: Tank installation, airline and product line set up					
Explosive atmosphere in tanks	Overpressure Static electricity Splash-filling tank Venting Fitting failure	Moderate	Rare	Tolerable	• Tank design and venting (AS1692) • New build tanks (i.e. clean) • Earthing/bunding of tank • Designated tank filling point to minimise splash-filling static charge
Activity: Pump Installation and first use					
Unplanned release of contaminated groundwater from tank/piping/fittings/ hoses	Failure of fittings/piping Overpressure (thermal expansion) Tank overfill Human error (e.g. operation of valves)	Moderate	Unlikely	ALARP	• Offsite and onsite test of equipment prior to operation • Tank vent • Tanks are self-bunded • Bunding provided for bucket test piping/valves/fittings • Quick seal/dry break fittings for tank connection • Operator daily visual check on tank level • Project Procedure • Spill kits and drip trays if required • PTW • Back pressure regulator and excess flow valve to be installed on the pump air supply • Hoses are braided where required and a trial fit up and an in-field service test completed. • Restricted operations during night shift • Tank emptying guidelines to maximise condensate accumulation • Testing of the pump and pulley system for the tracking type skimmer pumps • Lifting points on new equipment are tested and certified
Release of/exposure to hydrocarbon fluids (interface meter)	Use of interface meter	Negligible	Rare	Tolerable	• Project Procedure • Local containment / bunding

Hazard/Source of Risk	Cause	Consequence (severity)	Likelihood	Residual Risk ranking	Controls
Activity: Monitoring and ongoing management of system (visual inspection, pump recovery for maintenance, manual tank volume measurement, bucket test					
Unplanned release of contaminated groundwater from tank/piping/fittings/ hoses	Impact of equipment by vehicles Removal of pumps for maintenance Bucket testing	Moderate	Unlikely	ALARP	• Tanks are self-bunded • Bunding provided for bucket test piping/valves/fittings • Quick seal/dry break fittings for tank connection • Operator daily visual check on tank level • Project Procedure • Spill kits and drip trays if required • PTW
Generation of wastes (sampling products)	Incorrect disposal of waste	Minor	Rare	Tolerable	• Project Procedure • QEAL Waste Management Procedure
Explosion from static discharge during bucket test	Static during filling of bucket with hydrocarbon product	Moderate	Rare	Tolerable	• Project Procedure • PTW
General Hazards					
Quarantine – Introduction of non-native plants and animals	Human error Inadequate Procedure	Minor	Unlikely	Tolerable	• Quadrant Quarantine Procedure • Induction of personnel working on VI
Fauna entrapment in well	Human error – failure to replace well cap	Minor	Rare	Tolerable	• Project Procedure • Induction to all personnel working on VI
Cyclone – unexpected movement of equipment	Weather	Moderate	Rare	Tolerable	• Cyclone Preparation included in Project Procedure
HAZID 11 February 2015: GeoSorb Sock Method					
Activity: Monitoring of equipment (removal from well and weighing) and disposal					
Release of / exposure to hydrocarbons. Waste management.	Removal of geosocks for monitoring. Disposal of contaminated geosocks.	Negligible	Rare	Tolerable	• PPE • Local containment / bunding • Disposal bags • QEAL Waste Management Procedure • Project Procedure: PSH Recovery Equipment Installation and Operation (LM-10-II-10001)
HAZID 30 November-2015: Disposal of contaminated groundwater to deep disposal wells on VI					
Activity: Disposal down existing VI disposal wells					
Contaminated water contains hydrocarbons exceeding maximum permissible concentration of 1000 mg/L for	Process failure	Negligible	Very Unlikely	Tolerable	• VI Hub Operations EP (Section 6.9)

Hazard/Source of Risk	Cause	Consequence (severity)	Likelihood	Residual Risk ranking	Controls
injection into disposal well					
Unplanned release of residual hydrocarbons and chemicals (contaminants) into the subterranean environment via the existing disposal wells.	Non-competent water disposal well casing resulting in discharge at a depth shallower than the approved depth.	Major	Rare	ALARP	• VI Hub Operations EP (Section 6.9) • Laboratory analyses of contaminants in wells used for LNAPL recovery.

Table 5-2: Control measures for managing identified hazards specific to skimmer pump and Geosorb socks

Hazard/Source of Risk	Cause	Control Measures (derived from HAZIDs and HAZID reviews)	Performance Standard	Measurement criteria	VI EP Reference
Geosorb sock use					
Release of / exposure to hydrocarbons.	Removal of geosock for monitoring and disposal of socks.	PPE Local containment / bunding Disposal bags QEAL Waste Management Procedure Project Procedure: PSH Recovery Equipment Installation and Operation (LM-10-II-10001)	Spill mitigation controls as implemented to be confirmed via checklist.	Zero incidents regarding spills to ground whilst using GeoSorb socks.	Hazards presented by passive methods (i.e. GeoSorb socks) do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid hazardous substances
Tank installation airline and product line set up for active skimming activities					
Explosive atmosphere in tanks	Overpressure Static electricity Splash-filling tank Venting Fitting failure	Tank design and venting (AS1692)	Tanks will be designed with venting in accordance with AS1692	Zero incidents regarding the integrity and operation of the tanks.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid hazardous substances.
		Clean tank/gas free certificate	New tanks to be used		
		Earthing of tank	Requirement to earth tanks included in the Skimmer System OPG (VI-10-IP-10002) hereinafter referred to as “the Procedure”.		
		Bunding of tank	Requirement for periodic tank		

			integrity inspections will be described in the Procedure Note that each receiving tank has integral bunding.		
		Designated drain point/tank filling point to minimise splash-filling static charge	Tanks will have a designated drain point. Requirement evidenced in the tank data sheets (LM-10-KM-10001 and LM-10-KM-10002) and draining method included in the Procedure.		
Pump Installation and first use for active skimming activities					
Unplanned release of contaminated water from tank/piping/fittings/ hoses	Failure of fittings/piping Overpressure (thermal expansion) Tank overfill Human error (e.g. operation of valves)	Offsite and onsite test of equipment prior to operation	Testing requirements are identified in the Procedure and evidenced within the MDR's for the supplied tanks (VI-10-TG-10012 and VI-10-TG-10018).	Zero incidents involving the unplanned release of contaminated water.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid hazardous substances
		Tank vent	Tanks will be designed with venting in accordance with AS1692		
		Tanks are self-bunded	Tanks are supplied with an integral rigid bund.		
		Bunding provided for bucket test piping/valves/fittings	Requirement for local containment during the bucket test for the skimming equipment is documented in the process Checklist (VI-10-HI-10008)		
		Quick seal/dry break fittings for tank connection	Requirement for dry break fittings is evidenced in the tank data sheets (LM-10-KM-10001 and LM-10-KM-10002).		
		Operator daily visual check of tank level	Requirement for daily visual checks is described in the Procedure.		
		Project procedure	The skimmer system Procedure has been reviewed and approved by QE prior to activity commencement.		
		Spill kits and drip trays if	Requirement for spill kits and drip		

		required	trays are documented in the process Checklist (VI-10-HI-10008).		
		PTW	Standard control for all activities on VI as documented in VI Hub Operations EP.		
		Back pressure regulator and excess flow valve to be installed on the pump air supply.	Requirements are documented in the air supply control panel MDR (VI-10-TJ-10002)		
		Hoses are braided where required and a trial fit up and an in-field service test completed.	Requirement for braided hydraulic hose is evidenced within the Procedure. Service test requirements are documented within the Commissioning and Operations Checklist (VI-10-HI-10005)		
		Restricted operations during night shift.	Night shift operation is limited to visual inspections and tank dipping. Tank emptying will be done during dayshift. Requirements are documented in the Procedure.		
		Tank emptying guidelines to maximise condensate accumulation	Requirement is documented within the Procedure.		
		Testing of the pump and pulley system for the tracking type skimmer pumps	Requirement for testing of the skimmer pump pulley system is documented within the skimmer system IOM (VI-10-MG-10001).		
		Lifting points on new equipment are tested and certified	Lift point compliance and load testing is evidenced within the MDR's (VI-10-TG-10012 and VI-10-TG-10018) for the supplied tanks.		
Release of /exposure to hydrocarbon fluids (interface meter)	Use of interface meter	Project procedure	Sampling via the interface meter to determine LNAPL thickness in the supplied tanks is as identified in the Procedure.		
		Local containment / bunding	Requirement for local containment is documented in the Procedure.		

Monitoring and ongoing management of system (visual inspection, pump recovery for maintenance, manual tank volume measurement, bucket test during active skimming					
Unplanned release of contaminated water from tank/piping/fittings/ hoses	Impact of equipment by vehicles Removal of pumps for maintenance Bucket testing	Tanks are self bunded	Tanks are supplied with an integral rigid bund.	Zero incidents involving the unplanned release of contaminated water.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid hazardous substances
		Bunding provided for bucket test/piping/valves/fittings	Requirement for local containment during the bucket test for the skimming equipment is documented in the process Checklist (VI-10-HI-10008)		
		Quick seal/dry break fittings for tank connection	Requirement for dry break fittings is evidenced in the tank data sheets (LM-10-KM-10001 and LM-10-KM-10002)		
		Operator daily visual check on tank level	Requirement for daily visual checks is described in the Procedure		
		Project Procedure	The skimmer system IOM (VI-10-MG-10001) has been reviewed and approved by QE prior to trail commencement.		
		Spill kits and drip trays if required	Requirement for spill kits and drip trays are documented in the skimmer system IOM (VI-10-MG-10001).		
		PTW	Standard control for all activities on VI as documented in VI Hub Operations EP.		
Generation of wastes (sampling, and recovered fluids)	Incorrect disposal of waste	Project procedure	Management of sampling wastes and recovered fluid waste is documented within the Procedure.	Zero incidents involving the unplanned discharge of wastes associated with the active skimming.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.6 Accidental discharge of hazardous and process wastes.
		QE Waste Management Procedure	Quadrant's Waste Management Procedure (EA-60-RI-167) will be applied.		
Explosion from static discharge during bucket test	Static during filling of bucket with hydrocarbon product	Project Procedure	The requirement for an earth cable connection to the metallic sample bucket is documented in the Procedure.	Zero incidents involving the unplanned release of contaminated water associated	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid
		PTW	Standard control for all activities on		

			VI as documented in VI Hub Operations EP.	with the active skimming.	hazardous substances.
General Hazards for active skimming and GeoSorb Socks					
Quarantine – Introduction of non-native plants and animals	Human error Inadequate Procedure	Quarantine Procedure	Instructions to prevent introduction of weed or pest species on equipment and personnel on VI	Zero incidents involving introduction of non-native plants and/or animals.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.3 Introduction of Non-indigenous Flora and Fauna Species.
		Induction to all personnel working on VI	Standard control for all activities on VI as documented in VI Hub Operations EP.		
Fauna entrapment in well	Fauna entrapment in well	Project Procedure	Instructions to prevent fauna entrapment included in the Commissioning and Operations Checklist (VI-10-HI-10005).	Zero incidents involving trapped fauna.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 6.6 Disturbance to terrestrial fauna.
		Induction to all personnel working on VI	Standard control for all activities on VI as documented in VI Hub Operations EP.		
Cyclone – unexpected movement of equipment	Cyclone – unexpected movement of equipment	Cyclone Preparation in Project Procedure	Instructions for cyclone preparedness included in the Procedure.	Zero incidents involving the unplanned release of contaminated water associated with the active skimming.	Hazards presented by active skimming do not present a new or increase in risk to that documented in Section 7.4 Spillage of liquid and solid hazardous substances.
Activity: Disposal down existing VI disposal wells from active skimming					
Contaminated water contains hydrocarbons exceeding maximum permissible concentration of 1000 mg/L for injection into disposal well	Process failure	VI Hub Operations EP (Section 6.9)	Requirements for management of hydrocarbon concentration in reinjection fluids are documented in the VI Hub Operations EP (Section 6.9).	Zero incidents involving the unplanned discharge of contaminated water due to process failure of deep disposal wells on VI.	Hazard presented by active skimming does not present a new risk to that documented in Section 6.9 that covers the hazard of planned water management on Varanus Island.
Unplanned release of residual	Non-competent water disposal well	VI Hub Operations EP (Section 6.9)	Requirements for management of integrity of disposal wells are	Zero incidents involving the	Hazard presented by active skimming does not present a new

hydrocarbons and chemicals (contaminants) into the subterranean environment via the existing disposal wells	casing resulting in discharge at a depth shallower than the approved depth.		documented in the VI Hub Operations EP (Section 6.9).	unplanned discharge of contaminated water due to process failure of deep disposal wells on VI.	risk to that documented in Section 6.9 that covers the hazard of planned water management on Varanus Island. As discussed in Section 4, risk has increased, however, there are no additional controls to manage the integrity of the disposal wells.
Contaminated water contains PFOA/PFOS exceeding the Assessment Criteria concentrations advised by the CS Auditor as 2,900 µg/L (PFOA) and 6.66 µg/L (PFOS) for injection into disposal well (Appendix A).	Historical use of firefighting foam.	Laboratory analyses of PFOA/PFOS in the target wells (MW58, MW59 and MW60) that are to be used for LNAPL recovery by skimmer pump.	The SAQP (VI-10-RQ-10003) as prepared by JBS&G for the Varanus Island Remediation Options Assessment includes laboratory analysis of all contaminants of concern (Hydrocarbons, metals, PFOA/PFOS) from wells used for LNAPL recovery. Sampling and laboratory analysis for the target wells has been completed evidencing that the Assessment Criteria have not been exceeded (ALS lab reports EP1515482 and EP1515976).	Zero incidents involving the unplanned discharge of contaminated water due to process failure of deep disposal wells on VI.	Hazard presented by active skimming does not present a new risk to that documented in Section 6.9 that covers the hazard of planned water management on Varanus Island. As discussed in Section 4, risk has increased, however, there are no additional controls to manage the integrity of the disposal wells.
		Laboratory analyses of PFOA/PFOS in the target wells (MW57, MW69, MW70, MW71, MW72 and MW73) that are to be used for contaminant recovery by TFP.	The SAQP (VI-10-RQ-10003) as prepared by JBS&G for the Varanus Island Remediation Options Assessment includes laboratory analysis of all contaminants of concern (Hydrocarbons, metals, PFOA/PFOS) from wells used for the TFP trial. The requirement for sampling and laboratory testing of the TFP target wells to evidence that the Assessment Criteria have not been exceeded is documented within the relevant OPG (VI-10-IP-10001). Evidence to be obtained prior to		

			contaminated water injection into the disposal wells.		

5.2 Management of Activity

These activities will be managed under Quadrant's safety management system and the VI Hub OEP (EA-60-RI-186). The proposed activities do not constitute a significant modification to the activities described within the VI Hub OEP. There are no significant new environmental impacts or risks or significant increase to existing environmental impacts or risks in the accepted VI Hub Operations EP although additional hazards were identified as detailed in **Table 5-1**.

On site works are managed in accordance with work packs and Operational Procedural Guidelines (OPG).

5.3 Implementation

The VI Hub OEP describes the systems, practices and procedures that will be followed to avoid or reduce to ALARP the identified environmental risks and impacts of activities. These are considered to adequately describe the overall implementation strategy for the activities described in this BD. In particular, in line with the commitments made in the VI Hub OEP:

- The risks associated with each potential identified impact have been determined using a qualitative assessment process defined by the QE HAZID Procedure (AE-91-IF-038).
- Management controls will be specified in contract documentation and the contractor's HSEMP.
- The HSE department and advisors on VI will provide advisory support during the implementation of the activities described in this BD.
- Contractors and key personnel associated with the activities described in this Bridging Document will conduct or participate in daily pre-start (toolbox) meetings, daily supervisor meetings, weekly field plan meetings and Sunday Safety Meetings, as appropriate during the execution of the works.

In addition, an 'implementation pack' will be developed to ensure that the commitments made in this BD and relevant requirements from the VI Hub OEP are communicated to the contractor(s) conducting the activities described in this BD. The implementation pack will include the Varanus Island Contaminated Sites Remediation Project (VI CSRP) commitments register (VI-10-HI-001), induction material and information on incident reporting and investigation.

The commitments register is used for the purpose of tracking compliance with commitments and reporting on performance in the VI Hub OEP annual performance report.

6. STAKEHOLDER CONSULTATION

Quadrant Energy has provided DER, DPaW and DMP with updates in regards to the ongoing remediation works in meetings held on 6 March 2016, 9 June 2016 and 15th November 2016. The Contaminated Sites Auditor attended these meetings and supports the proposed active skimming activities for ongoing remediation. On a monthly basis, QE provides a progress update of the activities that form part of the Remediation Action Plan (RAP) as endorsed by the CSA in April 2016. These progress updates are provided to the relevant Regulatory authorities (DER, DPaW, DMP) and to the CSA. On the 12 March 2015, the CS Auditor provided endorsement for the use of GeoSorb socks at the VI site. No other stakeholders are considered relevant for these ongoing activities occurring on lease.

7. REPORTING AND RECORDING

If incidents do occur during the proposed activity they will be reported to DMP under established recording and reporting requirements as documented in the VI Hub OEP (EA-60-RI-186) Revision 6.

Planned and unplanned impacts of the activity are reported and recorded as per Section 9.2 in the VI Hub OEP which is commensurate with Table 8 in the DMP Guidelines.

A summary of the results of the contaminated site investigation subject to this BD will be included in the next Annual Environmental Report submitted to DMP for the VI Hub, due by the end of March 2017.

7.1 Internal Reporting

Information on all discharges and emissions to the environment to be reported as part of the activities. This data is used in quarterly and annual reports to DMP in accordance with routine reporting requirements detailed in the VI Hub OEP.

7.2 Contact

If you have any questions or concerns, please contact:

Ashlee Crabbe on (08) 6218 7154 or email Perth.HSEApprovals@quadrantenergy.com.au

8. REFERENCES

Quadrant Energy (2016a). Varanus Island Remedial Action Plan, Revision 0. Doc. Ref: VI-10-RG-10023. Report issued April 2016.

Quadrant Energy (2016b). Varanus Island Contaminated Soil – Remedial Action Plan, Revision 1. Doc. Ref: VI-10-RI-10036. Report issued July 2016.