WHITEHAVEN COAL

LEVEL 2
QUALITATIVE RISK ASSESSMENT
REPORT

Site Location	Narrabri
Activity/Situation	Subsidence LW107 to LW110
Date of Assessment	30/09/2016

1 INTRODUCTION

This Risk Assessment has been undertaken to identify the risks associated with the mining of LW107 to LW110 at the Narrabri Mine. A previous assessment was completed for subsidence hazards above LW101 to LW106 for the Narrabri Mine. The purpose of the risk assessment was to identify hazards and assess the risks associated with subsidence caused by the mining of LW107 to LW110.

2 CONTEXT

The Narrabri Mine is operated by Narrabri Coal Operations Pty Ltd (NCOPL) and is located in the Gunnedah coal basin in NSW, approximately 28km south of the town of Narrabri and approximately 400km northwest of the port of Newcastle.

One of the potential risks of longwall extraction at the mine is subsidence resulting from the mining process. The mine required a risk assessment to be carried out to assess the risks from subsidence to people, structures and services, mining operations and the environment.

This risk assessment identified and assessed the subsidence impact risks and consequences arising from longwall extraction and to identify controls to reduce the subsidence impacts and environmental consequences to an acceptable level. The risk assessment is for LW107 to LW110.

The objective of the risk assessment was to facilitate a structured process to enable critical and objective challenge of the subject, to assist NCOPL to fulfil their obligations to protect the health and safety of persons on the surface and underground and prevent damage to infrastructure and natural features in accordance with the requirements of the:

- Workplace Health and Safety Act 2011;
- Workplace Health and Safety Regulation 2011;
- Workplace Health and Safety (Mines and Petroleum Sites) Act 2013; and
- Workplace Health and Safety (Mines and Petroleum Sites) Regulation 2014.

The risk assessment process aims to involve relevant Narrabri Mine personnel and external technical specialists. The risk assessment was undertaken in accordance with the Australian & New Zealand Standard for Risk Management AS/NZS ISO 31000:2009 and MDG1010 – Risk Management Handbook for the Mining Industry.

Assumptions

The following assumptions have been made:

- Maximum predicted subsidence in report DGS NAR-002/3 are as follows:
  - S max: 2.53 – 2.75m
  - Tilts: 27 – 44mm/m
  - Strains: Max Compressive: 8 – 16mm/m
  - Max Tensile: 7 – 13mm/m
- Panel width: 408.9m (supercritical)
- Risk assessment assumes worst case subsidence with no spanning of the Garrawilla volcanics

- 230-350m depth of cover
- 4.3m mining height Hoskissons Seam
- No far field subsidence impacts assumed
- Land predicted to be impacted by LW107 to LW110 is owned by the Mine
- Pine Creek and Pine Creek Tributary 1 pass over impact area for LW107 to LW110
- Creeks are not a water supply for the local community
- Steep slopes are defined as being a slope at an angle greater than 18º (approximately 1 in 3)

Review of Subsidence Predictions v. Measured Data

The DGS (2016) report outlines the following:

- The review of measured First Maximum Subsidence above LW101 to LW102 full centrelines indicated that the 95th percentile Smax along centreline for LW101 was 0.6T or 2.52 m, and 0.63T or 2.65 m for LW102 (for a mining height of 4.2m).
- The U95%CL values of 0.64T are considered to be reasonable estimates of first goafing subsidence, which is usually higher than the rest of the panel once the goafing process has been established.
- The subsidence prediction model (DgS modified ACARP, 2003) used in the approved LW101 - LW105 EP estimated a maximum subsidence of 2.44 m or 0.58T. Although the predicted values for LW101 to LW104 have been within 15% of the measured results, the model has now been adjusted to match to reflect the actual U95%CLs for subsequent panels as follows:
    - Single Panel Smax/T increased from 0.58 to 0.60 for LW101 and 0.63 from LW102 to LW110.
    - Final maximum panel Smax/T has been increased to 0.64 for LW101 to LW110.
- The chain pillar subsidence model appears to be conservative, with measured values to-date plotting below the predicted curves.
- The empirical models used to estimate maximum tilt, curvature and strain note:
    - The maximum tilt database is satisfactorily captured by the empirical model;
    - Convex and concave curvature models capture 90% of the database with some exceedances apparent due to discontinuous behavior;
    - Supercritical width appears to occur at 1.2H instead of 1.4H, based on measured tilts, curvatures and strains at NM to-date;
    - The median Maximum Horizontal Strain = 10 x Maximum curvature. Discontinuous movements such as cracking and compression humping may increase the median values by 2 to 4 times. The U95%CL Strain values were previously assessed to be approximately 25 x median curvature; and
    - However, based on the measured strains it is apparent that the predicted compressive strains were regularly exceeded at the northern starting ends of the panel by 1.2 to 1.8 times. It has therefore been considered necessary to increase the predicted strains at the starting ends of the proposed panels (LW107 to 110) by a further 50%.

Limitations and Exclusions

The following limitations have been applied to the risk assessment:

- This risk assessment will concentrate on LW107 to LW110 only
- Water liberated by longwall mining will not be considered once it has been pumped out of the mine and discharged into surface storage ponds
- This risk assessment is undertaken based on subsidence predictions and measured values above LW101 to LW105

The following exclusion was applied to this risk assessment:

- Disposal of brine rich waters into LW107 to LW110 goaves will not be considered

3 HAZARD IDENTIFICATION

To successfully identify the hazards involved with subsidence impacts above LW107 to LW110 the following hazard identification techniques were adopted:

Hazard Identification Techniques		
Reviewing historical data including • inspections, surveys and audits • workplace observations and • incident report data	☑	
Reviewing information from equipment designers, manufacturers, suppliers and other parties	☑	
Brainstorming	☐	
Other *Use of previous risk assessment*	☑	
Scientific or historical data that identifies and/or quantifies the level of the hazard present in the work place is attached?	YES	NO

Using the above hazard identification techniques the subsidence impacts above LW107 to LW110 requirements were broken into the logical task and activity components and consideration was given to a series of hazard/ energy sources to determine if a risk existed.

Factors that were considered are outlined in Attachment 2 Hazard Prompts.

4 CONSULTATION AND COMMUNICATION

Risk Assessment (LW107 to LW110) – 30th September 2016

Person Contributing	Organisational Role	Experience relating to assessing the Activity (Yrs)	Role in Risk Assessment
1. Owen Salisbury	Technical Services Manager	35	Contributor
2. Steve Farrar	Environmental Superintendent	13	Contributor
3. Dave Ellwood	Technical Services Superintendent	10	Contributor
4. Tony Dwyer	Group Superintendent – Operations	18	Contributor
5. Steve Ditton	Subsidence Engineer	25	Contributor
6. Nick Robinson	Senior Environmental Engineer	14	Contributor

Person Contributing	Organisational Role	Experience relating to assessing the Activity (Yrs)	Role in Risk Assessment
7. Luke Kirkwood	Principal Heritage Consultant	12	Contributor
8. Nathalie van der Veer	Environmental Scientist	5	Contributor
9. Chris Jones	Associate Environmental Scientist	10	Contributor

5 LEVEL 2 QUALITATIVE RISK ASSESSMENT WORKSHEET

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
1. Subsidence Impacts to Natural Features									
Natural Water Courses / Streams	Water quality (TSS and EC increased) is impacted by subsidence in Namoi River tributaries	1. Monitoring and repairing of cracks carried out - included in Land Management Plan 2. Ongoing monitoring of water quality upstream and downstream of site, included in Water MP 3. Use agriculture methods to reduce salinity of ponded areas 4. Water quality monitoring undertaken 5. Gully Erosion Management Plan	2	D	L	1. Finalise Ponding Management Plan	2	D	L
Natural Water Courses / Streams	Channel stability is compromised leading to increased erosion and channel realignment	1. Monitoring and repairing of cracks carried out - included in Land Management Plan which includes TARP 2. Ongoing monitoring of water quality upstream and downstream of site included in Water MP 3. Riparian subsidence monitoring line installed for Tributary 1 and Pine Creek 4. LIDAR survey used across all panels 5. Subsidence monitoring lines installed along creeks 6. Gully Erosion Management Plan 7. Annual creek monitoring	2	D	L				
Natural Water Courses / Streams	In channel / over bank ponding leading to loss of farming land and / or loss of riparian vegetation	1. Monitoring and assessment of ponding carried out - included in Land Management Plan and Biodiversity MP 2. Riparian subsidence monitoring line	2	D	L	1. Finalise Ponding Management Plan	2	D	L

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
		installed for Tributary 1 and Pine Creek 3. LIDAR survey and remote sensing techniques used over extraction area							
Natural Water Courses / Streams	Reduction in stream flow during rain events	1. Modelling to confirm no interconnection between surface and seam due to depth of cover and height of fracturing according to subsidence modelling 2. Monitoring and repairing of subsidence cracking carried out - included in Land Management Plan 3. Monitoring of height of fracturing using surface extensometers and piezometers	3	D	M				
Natural Water Courses / Streams	Flooding of mine leading to stoppage of LW mining	1. Modelling to confirm no interconnection between surface and seam due to depth of cover and height of fracturing according to subsidence modelling 2. Mine dewatering system to remove water from the mine 3. Monitoring of water quantities being pumped out of mine 4. Monitoring of height of fracturing using surface extensometers and piezometers 5. Monitoring and repairing of cracking planned to be carried out - included in Land Management Plan 6. Inrush MP	3	E	M				
Creek or River Catchments	Water quality (TSS and EC increased) in the Namoi River is impacted by subsidence	1. Monitoring and repairing of cracks carried out - included in Land Management Plan 2. Ongoing monitoring of water quality	1	D	L				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
		upstream and downstream of site included in Water MP							
Swamps & Water-related Ecosystems	No swamps or water related ecosystems will be impacted by subsidence in Longwalls LW107 to LW110 area	N/A							
Foreshores / Land Prone to Flooding or Inundation	Change in flooding behaviour impacting farming land, mine infrastructure or surface improvements along Pine Creek and its tributary	1. Flood study was conducted revealing limited impacts of flooding 2. Monitoring and assessment of ponding carried out - included in Land Management Plan and Biodiversity MP 3. Riparian subsidence monitoring line installed for Tributary 1 and Pine Creek 4. LIDAR survey and remote sensing techniques used over extraction area	1	E	L				
Escarpments / Cliff Lines / Steep Slopes	No Escarpments / Cliff Lines / Steep Slopes will be impacted by LW107 to LW110 subsidence	N/A							
Threatened & Protected Species including Endangered Ecological Communities (EEC)	Potential loss of individuals of species or degradation of EEC and habitat	1. Ongoing monitoring and condition assessment under Biodiversity MP and Landscape MP 2. Well established vegetation 3. Modelling to confirm no interconnection between surface and seam due to depth of cover and height of fracturing 4. Monitoring and repairing of cracks carried out - included in Land Management Plan 5. Depth of cover is increasing reducing subsidence impacts to	2	D	L				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
		vegetation and habitat							
State Forests / Natural Vegetation	No state forests in LW107 to LW110 area	N/A							
Native fauna	Injuries to native fauna	1. Monitoring and repairing of cracks carried out - included in Biodiversity Management Plan	1	D	L				
Native fauna	Loss of habitat	1. Ongoing monitoring and condition assessment under Biodiversity MP and Landscape MP 2. No steep slopes in LW107-110 area 3. Well established vegetation 4. Modelling to confirm no interconnection between surface and seam due to depth of cover and height of fracturing 5. Monitoring and repairing of cracks carried out - included in Land Management Plan 6.Increasing depth of cover reducing subsidence impacts to vegetation and habitat	1	D	L				
2. Subsidence Impacts to Surface Improvements									
Tracks / Roads / Bridges	Damage to machinery	1. Monitoring of cracks and remediation 2. Warning signage erected in subsidence area 3. Mine owned land, authorised access only	2	D	L				
Tracks / Roads / Bridges	Injury to personnel	1. Monitoring of cracks and remediation 2. Warning signage erected in	2	D	L				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
		subsidence area 3. Mine owned land, authorised access only							
Transmission lines	No transmission lines in the LW107 to LW110 subsidence area	N/A							
Pipelines	No hazard identified to gas drainage pipelines from subsidence No other pipelines in this area	N/A							
Mine Infrastructure	Damage to goaf gas drainage boreholes	1. Steel cased boreholes 2. Flexible connection from borehole top to gas drainage surface pipeline 3. Goaf drainage plant can be located outside active subsidence area or with has the ability to be re-levelled if within active subsidence area	4	E	M				
Mine Infrastructure	Damage to PED cable buried on surface	1. PED cable has been designed/installed with sufficient slack to accommodate subsidence	2	D	L				
Mine Infrastructure	Far field impacts on mine buildings not considered a credible risk	N/A							
Survey Control Stations	Loss of function of State Survey Mark	1. Built Features Management Plan and Subsidence Assessment has SSM moving by ~820mm	1	E	L	2. Apply to undermine SSM 14 days prior to mining. 3. Update details following subsidence.	1	E	L
Public Facilities / Amenity / Users	No Public Facilities / Amenity / Users will be undermined by LW107 to LW110	N/A							

WHC_FRM_LEVEL 2 QUALITATIVE RISK ASSESSMENT

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
Environmental Monitoring Stations	Damage to piezometers	1. Life-of-mine groundwater monitoring network installed outside of LW mining area 2. Replace piezometers as required	1	E	L				
Drainage structures	Flooding and erosion of road	1. Monitoring and repairing drains as required 2. Visual inspection of roads and carrying out repairs as required 3. Signage	2	D	L				
Drainage structures	Injury to personnel due to flooding and erosion of road	1. Monitoring and repairing drains as required 2. Visual inspection of roads and carrying out repairs as required 3. Signage	3	D	M				
Farm Houses / Sheds	Damage to farm house and sheds resulting in injury to person	1. Houses/sheds are vacated 2. Mine owned 3. Built Features MP 4. Public Safety MP requires property to be secured for safety prior to subsidence 7. Mine recognises houses/sheds will be damaged and is planning for them to be demolished	1	E	L				
Farm Houses / Sheds	Damage to septic tanks from subsidence resulting in release of effluent	1. If present, septic tanks will be drained prior to undermining	2	D	L				
Industrial / Commercial / Business Establishments	No Industrial / Commercial / Business Establishments impacted by LW107 to LW110 subsidence	N/A							
Prescribed Dams and / or other Dams Safety Act 1978 structures	No prescribed dams and / or other Dams Safety Act	N/A							

WHC_FRM_LEVEL 2 QUALITATIVE RISK ASSESSMENT

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
	1978 structures								
Other Surface Improvements	Breaching of farm dam walls resulting in personal injury	1. Monitor dams and drain / remediate as required 2. Low capacity dams 3. Earthen dams 4. Each dam is to be assessed as to need to lower water level in dam based on impacts to farm dams from previous LW subsidence	2	D	L				
Other Surface Improvements	Drainage of farm dams into mine workings resulting in flooding of mine	1. Modelling to confirm no interconnection between surface and seam due to cover depth and height of fracturing 2. Monitor dams and drain / remediate as required 3. Low capacity dams 4. Large depth of cover 5. Mine inflow monitoring through water being discharged from mine	2	E	L				
Other Surface Improvements	Breaching of water storage dam resulting in personal injury	1. Dam on “Rosevale”, i.e. the only significant dam (~6ML), will be monitored and drained, if required	2	E	L				
Other Surface Improvements	Drainage water storage dam into mine workings resulting in flooding of mine	1. Modelling to confirm no interconnection between surface and seam due to cover depth and height of fracturing 2. Dam on “Rosevale”, i.e. the only significant dam, will be monitored and drained, if required	2	E	L				
Other Surface Improvements	Damage to drainage contour banks	1. Pre and post mining survey and remediate as required	2	C	M				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
Other Surface Improvements	Damage to fences releasing livestock and impacting with vehicles	1. Built Features MP requires destocking of paddocks in active subsidence zone and repair of fences post subsidence	2	E	L				
Telecommunications	No telecommunications infrastructure in the LW107 to LW110 subsidence area								
Railway	Far field impacts to railway not expected								
1. Subsidence Impacts to Subsurface									
Groundwater Resources (Quantity & Quality)	Drawdown or base flow reduction in Namoi River alluvials	1. Life-of-mine groundwater monitoring program installed 2. Western edge of the Namoi alluvium to the eastern edge of the longwall panels is approximately 4.5 – 5km 3. Conservative groundwater prediction model predicted minimal influence, confirmed in 2015 4. Periodic recalibration of groundwater model using observed data whilst longwall is being extracted 5. Significant barrier of low permeability strata between the Namoi River alluvium and the mine 6. Neither the Hoskissons Seam nor the other rocks of the Black Jack Group are directly in contact with the Namoi Valley alluvium in the project area. 7. Water quality testing	3	E	M				
Groundwater Resources (Quantity & Quality)	Decreased volume of groundwater available for	1. Groundwater monitoring program 2 Modelling to confirm no	2	C	M				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
	other users	interconnection between surface and seam due to cover depth and height of fracturing 3. Conservative groundwater prediction model predicted minimal influence 4. Periodic recalibration of groundwater model using observed data whilst longwall is being extracted 5. Groundwater take for the mine is licenced and periodically reviewed							
Increased mine water discharge	Increased water make into the mine workings due to fracturing the aquifer above the goaf resulting in flooding of mine workings	1. Groundwater monitoring program 2. Modelling to confirm no interconnection between surface and seam due to cover depth and height of fracturing 3. Conservative groundwater prediction model predicted minimal influence 4. Periodic recalibration of groundwater model using observed data whilst longwall is being extracted 5. Appropriate capacity of surface water dams 6. Contingency for construction of additional storages 7. Inrush MP	4	D	M				
2. Subsidence Impacts to Areas of Archaeological & Heritage Significance									
European heritage	No heritage sites identified	1. Unexpected finds procedure 2. Heritage Management Plan 3. Subsidence monitoring program	1	E	L				
Cultural heritage sites	Damaging, defacing or destruction of archaeological sites	1. Surveys completed and identified sites have been fenced 2. Heritage MP for site identifies	3	D	M				

Task Step/ Activity (What are we about to do?)	Hazard (What could hurt me or others?)	Existing Controls (What has been done to prevent it from happening?)	Current Risk			Additional Controls (What else can I do to prevent it from going wrong?)	Residual Risk		
			C	L	R		C	L	R
		management measures 3. Subsidence monitoring program							
3. Subsidence Impacts to Agriculture									
Agricultural Suitability / Productivity	Reduction in agricultural capability of land	1. Land Management Plan with TARP includes ongoing monitoring and remediation - Remote sensing 2. Rehabilitation MP includes weed management	2	D	L				

No.	Action Required	Person Responsible	Due Date	Completion Date	Signature
1.	Finalise Ponding Management Plan	SF	31/03/2017		
2.	Apply to undermine SSM 14 days prior to mining	Registered Surveyor	14 Days prior		
3.	Update details following subsidence	Registered Surveyor	Following subsidence		

CONSENSUS MATTERS	Are there any matters where consensus has not been reached on the method to achieve acceptable level of risk?	YES	NO

Matter	Dissenting Person	Concern

SIGN-OFF on FINAL REPORT of RISK ASSESSMENT					
AUTHORISATION of RISK ASSESSMENT			**Note: The Authoring person must be the Manager or a position higher in the organisational structure.**		
Risk Assessment Review and Authorised by	D SALISBURY	**Signature**		**Date**	30/9/16

ATTACHMENT 1: RISK MATRIX

CONSEQUENCE

LIKELIHOOD		Insignificant 1	Minor 2	Medium 3	Major 4	Catastrophic 5
Almost Certain (once per day to one week)	A	Moderate	High	High	Critical	Critical
Likely (Once per week to one month)	B	Moderate	Moderate	High	High	Critical
Occasional (Once per month to one year)	C	Low	Moderate	High	High	High
Unlikely (Once in one to five years)	D	Low	Low	Moderate	Moderate	High
Rare (Once in five to ten years)	E	Low	Low	Moderate	Moderate	High

First Aid	Medical	LTI	Disability	Fatality	Injury
<$10K	$10K -<$100K	$100K -<$1M	$1M -<$10M	>$10M	Business Impact
Minor Non-Conformance	Minor Impact	Moderate Impact	Major Impact	Catastrophic Impact	Environment

Critical	Risks that significantly exceed the risk acceptance threshold. Immediate attention needed, stop the job.
High	Risks that exceed the risk acceptance threshold. Additional risk control measures required. If further risk control measures are not practicable the responsible Manager must sign off.
Moderate	Risk acceptance threshold. Additional control measures could be implemented to control risks further. Active monitoring of risk control measures required.
Low	Risks that are below the risk acceptance threshold. No additional control measures required. Monitoring of risks may be needed.

ATTACHMENT 2: HAZARD PROMPTS & DAMAGING ENERGIES

Hazard Prompts				
People	**Equipment**	**Environment**	**Process & Procedures**	**Permits**
• Awkward working posture? • Manual handling (lifting, lowering, pushing, pulling) • Electrical circuitry energised • Can the machine be accidentally started? • Can the machine roll? • Can I hurt someone? • Is anyone in the Line of Fire?	• Tapping into cooling systems? • Breaking hydraulic lines or components? • Set off fire suppression system? • Using lifting slings or cranes? • Jacking machine up? • Stored energy sources (air, hydraulic etc)?	• Hazardous chemicals? • Rotating components nearby? • Operator assistance required? • Noise, Compressed air? • Task performed alone in a remote area (eg. in the field)? • Follow MSDS? • Chance of spills or pollution?	• Using electrical equipment? • People working below? • Falling objects? • Exposure to exhaust fumes / gases? • Working at heights? • Working near hot surfaces (eg. turbo or exhaust)? • Have I done this in the last 3mths?	• Hot work (welding, grinding, oxy cutting, brazing)? • Live work task? • Confined space entry? • Working at Height? • Digging or drilling?
Damaging Energies				
Human	**Machine**	**Gravitational**	**Object**	**Thermal**
• Heavy pushing and pulling which requires large effort or poor/difficult postures; • Repetitive tasks involving the same muscle groups; • Lifting heavy objects.	• A vehicle crashing into another vehicle (including cars, forklifts, loaders, trucks, mobile cranes etc). • A vehicle hitting a person. • Exposure to ongoing vibration – jolts. • A vehicle hitting some fixed object ie building, face wall etc. • Getting caught by or in or struck by a part of a fixed machine or moving machinery ie conveyor, hand held power tool.	• Fall from a high level ie ladder, scaffold, pipe, duct, mobile crane platform. • Slips, trips, overbalancing on slippery and uneven surfaces ie walkways, platforms, outside yards, underground tunnels. • Climbing “up” or “down” steps, stairs, ladders ie accessing vehicles, large gearboxes, conveyors. • Hit by falling rocks, tools, objects etc.	• Inadvertent release of stored energy from such things as accumulators in pneumatic or hydraulic systems. • Some object on the road being flipped into a pedestrian as a vehicle passes. • A shackle breaking under load and flying through the air and striking a person. • A fan disintegrating on a motor and pieces of fan flying through the air and striking a person.	• Coming into contact with hot material (solid, liquid or gas) • Fires or explosions.
Electrical	**Chemical**	**Noise**	**Biological**	**Radiation**
• Electric shock or burns.	• Breathing in or coming into contact with dangerous chemicals (acids, corrosives etc)	• Exposure to noise levels in excess of 85 dBA.	• Risk of infections, animal bites • Entering enclosed spaces that are oxygen deficient or contaminated	• Exposure to dangerous radiation.